BOOK OF ABSTRACTS

10TH WORLD CONGRESS OF HERPETOLOGY

5–9 August 2024

Compiled by

Indraneil Das

World Congress of Herpetology (WCH)

Institute of Biodiversity and Environmental Conservation
Universiti Malaysia Sarawak

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Indraneil Das
Institute of Biodiversity and Environmental Conservation
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia

2024

COMPILER'S NOTES

The 10th World Congress of Herpetology is being held at the Borneo Convention Centre Kuching, in the State of Sarawak, Malaysia, 5–9 August 2024. The Congress is organised by the World Congress of Herpetology (https://www.worldcongressofherpetology.org) and the Institute of Biodiversity and Environmental Conservation (https://www.ibec.unimas.my), Universiti Malaysia Sarawak. The event is supported by Business Events Sarawak, Ministry of Tourism, Creative Industry and Performing Arts Sarawak, Sarawak Forestry Corporation, Sarawak Biodiversity Centre, AGARK DGHT, the Institute of Agriculture, University of Tennessee (UT AgResearch) and the Society for the Study of Amphibians and Reptiles.

A total of 1,481 abstracts of oral and poster papers were received at the website of the Congress (https://2024wch10.com), through an online conference management system (KonferenceX Content Management System), or came in via email. Only those submitted by registered delegates were included in this book of abstracts. Poster presentations include the full spectrum of herpetological topics, including subject material corresponding to Symposia. Also included are abstracts of Plenary Lectures, Special Presentations and Official Side Events.

Abstracts were formatted and lightly edited for content and style but did not undergo a full peer review. Any new taxon descriptions or other nomenclatural acts contained in this book of abstracts and programme should not be considered published in the sense of Article 8 of the International Code of Zoological Nomenclature (1999).

We welcome all delegates to the beautiful city of Kuching, Sarawak and to the 10th World Congress of Herpetology.

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Kuching, Sarawak
30 July 2024

INAUGURATION

Presentation:
Society for the Study of Amphibians and Reptiles (SSAR)
Multimedia Show

Kraig Adler
Cornell University, Ithaca, NY, USA

Presented by Aaron M. Bauer
Villanova University, PA, USA

The SSAR Multimedia Programs are used for evening entertainment at the Society's annual meetings in the USA. They have also been seen at several World Congresses of Herpetology, including the first (Canterbury, UK, in 1989), and at other herpetological events around the world. These audiovisual shows were created by David M. Dennis and J. Eric Juterbock; the first was shown at an SSAR meeting in Knoxville, Tennessee (USA, 1979). Each program consists of a series of color images accompanied by appropriate classical or popular music. Most of the animals, habitats, and panoramas were photographed digitally in the field by Dennis and Juterbock; a few photos were of captive animals. The shows made in the field required about ten years to photograph. New and better images are regularly swapped out so that the programs change from year to year. All field work was sponsored by the SSAR.

At the inauguration, we are pleased to screen an audio-visual, introduced by Prof Aaron M. Bauer on behalf of the SSAR, entitled: Herpetological Namesakes. This show features amphibians and reptiles named for people. The format is like a university lab quiz: first the image of an animal is presented without a caption, giving the viewer a few seconds to identify it; then the portrait of the person memorialized in the animal's name appears as a hint; and finally the species and person are identified. This show was written by Kraig Adler and is international in scope.

PLENARIES

P-01
The Challenges and Successes in the Conservation of Coastal Nesting Turtles in Peninsular Malaysia

Dionysius S.K. Sharma
Universiti Malaysia Terengganu, Malaysia

The plenary will cover conservation initiatives undertaken by government and NGOs in the conservation of marine turtles (*Chelonia mydas* and *Eretmochelys imbricata*) and the coastal nesting Batagur borneoensis, and lessons learned over several decades of such initiatives. The plenary n will also showcase several successes in terms of community engagement, local protection of nesting beaches and the ongoing battles with coastal development.

P-02
Evolvability of the Explosive Sea Snake Radiation

Emma Sherratt
Division of Ecology and Evolutionary Biology, University of Adelaide, Australia

Sea snakes are a relatively young yet speciose clade with remarkable morphological diversity. This plenary will showcase this successful lineage from the oceans around Australia and South East Asia, showing how integrating different analytical approaches has allowed us to uncover the developmental and evolutionary mechanisms underlying this diversity.

P-03
Decoding Frog Diversification: Cues from Old-World Tree Frogs

Madhava Meegaskumbura
Key Lab in Forest Ecology and Conservation, College of Forestry, Guangxi University, China

I will examine patterns and processes of diversification in frogs, highlighting the Rhacophoridae family. I will particularly emphasize key innovations such as reproductive mode evolution and explore the influence of ecological opportunity, climatic factors, mountainous regions, islands, and refugia in the diversification of rhacophorids. My examination will be grounded in analyses like phylogenetic diversity, phylomorphospace, ancestral state reconstructions, lineage-through-time plots, biogeographic analyses and climatic niche analyses. Furthermore, I will spotlight adaptive radiations in frogs, with an emphasis on *Pseudophilautus.* In conclusion, I will emphasize the critical importance of conserving the processes of diversification.

P-04
The Challenges of Conserving Reptiles and Amphibians in Madagascar

Julie Hanta Razafimanahaka
Madagasikara Voakajy, Madagascar

Despite Madagascar's high species richness and endemism of reptiles and amphibians, advocating their conservation remains a challenge. In this plenary, I will reflect on how herpetologists have to persevere in order to draw people's attention and interest to conservation issues, and what they can achieve if they successfully do so.

P-05

Greatest Loss to North American Biodiversity is Imminent: Consequence of *Batrachochytrium salamandrivorans* Invasion

Matthew J. Gray
Center for Wildlife Health, School of Natural Resources, University of Tennessee, Tennessee, USA

Batrachochytrium salamandrivorans (Bsal) is a novel fungal pathogen of amphibians that is believed to originate from Asia, is emerging in Europe, and could be introduced to North America through international trade or other pathways. Previous Bsal risk analyses ignored host susceptibility to Bsal infection and chytridiomycosis. Thus, we performed dose-response experiments on 36 North American species from 10 families, and estimated indices of Bsal infection and disease susceptibility. Using these data, estimates of environmental suitability of Bsal zoospores, and amphibian species distributions, we modeled invasion potential and predicted biodiversity losses of salamanders in the United States (US) and North America, if Bsal was introduced. Overall, we discovered that Bsal caused infection in 72% and mortality in 36% of species tested. Geographically, there were no regions in the US where Bsal could not invade into resident amphibian communities. Predicted biodiversity loss is expected to be greatest in the Appalachian Mountains and along the West Coast, where salamander species richness is greatest and amphibian communities are composed of moderately to highly susceptible species. These risk analyses coupled with a series of controlled experiments and simulations with compartmentwise models indicate Bsal transmission will occur rapidly followed by rapid population declines in < 3 months. Bsal persistence will be prolonged by carcasses that continue to produce and transmit zoospores. Although outbreaks are initiated by direct contact events, the environmental pathway will contribute more to transmission as the outbreak progresses. We estimated that > 80 salamander species in the US and > 140 species in North America could experience population declines and possible extinction if Bsal is introduced, which would result in the greatest loss to continental vertebrate biodiversity in recorded history. Intervention strategies we tested that may reduce invasion potential and population impacts include: decreasing host contacts by either lowering host density or increasing habitat complexity, removing carcasses, increasing water temperature by decreasing vegetative shade, and use of curcumin to prevent infection. Our results also suggest that emphasis should be placed on preventing Bsal introduction into North America. Given that international trade of pet amphibians is one of the most likely pathways of introduction, we created the Healthy Trade Institute Inc., which is a non-profit organization that is empowering businesses to incorporate biosecurity practices into operations that enhance the wellbeing of captive amphibians and reduce the likelihood of pathogen spillover to wild populations. Our socioeconomic surveys indicate that US businesses are supportive of healthy trade practices and that US consumers are willing to pay up to 75% more for pathogen-free amphibians. Thus, private industry can play an integral role in reducing the movement of Bsal and other pathogens in trade and potential negative impacts on native biodiversity.

P-06

Desert Dynasties: Unraveling the Tales of Arabian Reptiles through Systematics, Biogeography and Evolution

Salvador Carranza
Institute of Evolutionary Biology (CSIC-UPF), Barcelona, Spain

In this talk, I will share the outcome of nearly two decades of research aimed at understanding how biodiversity is generated and maintained in arid environments, using Arabian reptiles as a model. Phylogenetic and genomic data, along with morphological and geospatial information, have been employed to uncover the role of major tectonic events, mountains, and deserts in the origin, dispersal, and maintenance of Arabian reptile diversity. While the main goal is to comprehend the evolutionary history as well as the biogeographic and diversity patterns and drivers of Arabian squamates, I will also focus on the dynamics of phenotypic variation and species diversification of some selected groups showing species radiations in Arabia and in the Socotra Archipelago.

P-07

***Telmatobius* Water Frogs: An Approach to the Knowledge and Conservation of the Most Threatened Amphibians in Bolivia**

Teresa Camacho Badani
Museo de Zoología - Escuela de Biología, Universidad Católica del Ecuador, Ecuador

Water Frogs belonging to the genus *Telmatobius* stand out as one of the most threatened amphibians in the Neotropics. This plenary will delineate the holistic conservation endeavors undertaken in Bolivia, encompassing *in-situ* conservation initiatives involving collaboration with local stakeholders and authorities, cross-border initiatives, an innovative communication effort, and an *ex-situ* program. Through these efforts, we have not only contributed significantly to the understanding of these species but have also successfully addressed resolution of taxonomic uncertainties within this group.

P-08

Biodiversity and Conservation of Chinese Amphibians

Jian-Ping Jiang
Institute of Biology, Chinese Academy of Sciences, Chengdu, China

The current status and distribution patterns of amphibians in China, trends and causes for change in species richness, and the conceptual contributions of systematics to species diversity will be discussed. Assessment of the threat status of Chinese amphibian species and an analysis of their conservation needs will also be presented, along with an overview of species conservation actions and their effectiveness. The contributions of government bodies and individual herpetologists will be highlighted, including an update of the list of key protected species, establishment and implementation of biodiversity observation and research networks, and the implementation of conservation technologies for key endangered species.

ORAL AND POSTER ABSTRACTS

A-0010 (Oral)
Reptiles of Ecuador | Book Presentation

Alejandro Arteaga[1,2], Lucas Bustamante[2], Jose Vieira[3] and Juan M Guayasamin[4]
[1]Khamai Foundation, Quito, Ecuador
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[3]ExSitu, Quito, Ecuador
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We present the book "Reptiles of Ecuador," a comprehensive monographic catalogue about every single one of Ecuador's 494 non-avian reptiles. This updated field guide is designed to be used primarily as a tool to identify species in the field and is written so that it can be easily understood by any reader. It includes photographs, illustrations, and distribution maps covering all reptiles in the country. It also summarizes novel as well as historical information about each species and presents it in the form of individual accounts. Each account includes the following sections: names, recognition, natural history, distribution, conservation, etymology, see it in the wild, and references.

A-0012 (Oral)
Methods in Marking Toads: PIT Tagging vs Photography

Erin Muths[1], Lindsey S. Roberts[2], Bennett M. Hardy[3],
Abigail B. Feuka[4] and Larissa L. Bailey[5]
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Investigations that examine population-level changes (i.e., demography, disease) and the mechanisms associated with those changes in wild animal populations require individual identification. This typically requires the application of a mark, or the documentation of characteristics unique to the individual animal. To minimize effects on captured individuals and populations, marking strategies that minimize handling time (i.e., stress) are needed. Decisions on what method to use to identify individuals are based on multiple factors, but differences in method relative to the length of the study or life expectancy of the individual animal are seldom considered. We compared passive integrated transponder (PIT) tagging and photo-identification techniques used to individually identify Boreal toads (*Anaxyrus boreas boreas*) in field and environmentally controlled settings. We evaluated whether initial handling time was affected by method (PIT tag or photo-identification) and environment (field or controlled). We found that initial handling time was higher for PIT tagging than photo identification and was higher in the field than in a controlled environment. Long-term studies often span multiple generations such that an individual might be exposed to handling throughout its life. Thus, we also examined handling time over the life-time of a toad. Handling

time was initially shorter for photo-identification compared to PIT-tagging, but cumulative handling time over the expected lifetime of an individual was >5 times longer for photo-identification, suggesting that the species' life expectancy and the planned duration of the study should be considered when selecting marking methods.

A-0016 (Oral)
High Freshwater Turtle Occupancy in a Sustainably Managed Tropical Forest, Borneo

Wei Cheng Tan[1], Victor Vitalis[2], Julsun Sikuim[3], Dennis Rödder[1],
Mark-Oliver Rödel[4] and Sami Asad[5]
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Despite suffering dramatic declines due to habitat loss and overexploitation, tortoises and freshwater turtles, particularly those in Southeast Asia remain largely understudied. This region is not only a diversity hotspot, but also the centre of an international turtle trade and increasing anthropogenic pressures. In the face of these threats, the utility of sustainable forest management for the conservation of threatened freshwater turtle populations is unknown. This study examines the impact of Reduced Impact Logging, a sustainable forestry method, on two freshwater turtle species. We examined the detectability and habitat relationships of a threatened hard-shelled turtle, *Notochelys platynota* and a non-threatened soft-shelled turtle, *Dogania subplana* within a commercial forest reserve in Sabah, Malaysian Borneo. Using single-species occupancy models, we identified covariates associated with the detection and occupancy probabilities of the species across a post-harvest recovery gradient (1–21 years since logging). Results for *D. subplana* were inconclusive. In contrast, we found a significant negative association between monthly rainfall and *N. platynota* detectability. The occupancy probability of *N. platynota* was positively associated with greater distance from logging roads and higher stream flow accumulation. Occupancy probability for *N. platynota* and *D. subplana* was relatively high throughout the reserve. These results, suggest that forests managed sustainably, i.e. using RIL methods, could serve as invaluable conservation areas for imperilled freshwater turtle species in the region.

A-0017 (Poster)
Contribution of Skeletal Muscle for Thermogenesis during Reproduction in the Tegu Lizard *Salvator merianae*

Livia Saccani Hervas[1], Marina Rincon Sartori[2],
Johannes Lerchner[3] and Kênia Cardoso Bícego[1]
[1]Department of Animal Morphology and Physiology
São Paulo State University, Jaboticabal, SP, Brazil
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The Tegu *Salvator merianae* is one of the largest lizards in South America. It exhibits a robust annual cycle of high activity during spring (reproductive phase) and summer (activity phase), and low metabolism during winter hibernation. This species particularly outstands on presenting facultative endothermy during spring, although molecular mechanisms involved in this phenomenon are not known. The aim of the present study was to evaluate the contribution of the sarcoplasmic reticulum Ca+2-ATPase (SERCA) in skeletal muscle for heat production in Tegu lizards during spring. To this end, muscle biopsies of the forelimb were collected from anesthetized animals (5 females) in both seasons. Fibers were mechanically separated, and saponin-permeabilized, for direct measurements of heat rate in a chipcalorimeter at 25°C. Heat rate was measured in muscle samples in a basic buffer (containing Antimycin A, AA, a respiratory chain inhibitor) and in samples incubated in a buffer with the specific SERCA inhibitor, thapsigargin (+ AA). During spring, SERCA contributed with 15% ($p < 0,001$) of the total heat produced by the muscle. In the summer, the remaining heat after the inhibition of SERCA was not different from that of the inhibition with AA alone. This indicates that SERCA is a major contribution in the muscle heat production when compared to summer, coinciding with the reproduction season in these animals, and with a higher mitochondrial density and uncoupling by the ATP/ADP transporter, as we previously observed. Our results contribute, at least partially, to the understanding of cellular mechanisms involved in the reproductive endothermy in Tegu lizards.

A-0021 (Oral)
Anthropogenic Disturbance, a High Constraint on the Evolution of Paedomorphosis in Newts

Mathieu Denoël
Laboratory of Ecology and Conservation of Amphibians
FOCUS, University of Liège, Belgium
Research Director, Fonds de la Recherche Scientifique - FNRS, Belgium

Paedomorphosis is a developmental pathway in which larval traits are retained in adults, which bypass then the abrupt morphological and habitat changes caused by metamorphosis. In newts and salamanders, the evolution of these developmental pathways results from varied advantages and pressures occurring in the aquatic and terrestrial environments. The study of contemporary facultative paedomorphic species, which exhibit both paedomorphosis and metamorphosis, can therefore learn us on the benefits but also the constraints that may canalize species into single developmental pathways. To this end, we examined more than one hundred facultative paedomorphic populations of newts in Europe and carried out targeted lab experiments in light of recent habitat disturbance: fish introduction and drying. Although paedomorphosis is expressed in a plethora of taxa, it was rare at the species level in facultative paedomorphic newts, with hundreds less populations of paedomorphs than metamorphs. Lab experiments showed that, in presence of fish and drying, newts can opt for metamorphosis instead of remaining paedomorphs. Longitudinal surveys showed that fish was the main global determinant of the shift from paedomorphosis to metamorphosis in wild populations. Although drying could be favorable in some ecosystems, such as Mediterranean ponds, it can also constraint paedomorphosis in some populations in preventing larvae to reach an adult gilled stage. In contrast, despite being impacted at local scales, metamorphosed phenotypes can subsist in alternative habitats. The level of rarity of paedomorphosis over metamorphosis is thus increasing across years at a such high rate that it is now getting almost extirpated from entire biogeographic regions and environments. Altogether, these results show us that focusing on current anthropogenic environmental constraints can help us to disentangle across the

selective factors that may have driven the evolution of alternative developmental pathways.

A-0023 (Oral)
'Cool' Tadpoles Impacted by Check Dams? The First Step in Conserving Overwintering Tadpoles of Western Himalaya

Jithin Vijayan[1], Jeyaraj A. Johnson[2] and Abhijit Das[1]
[1]Department of Endangered Species Management, Wildlife Institute of India, Dehradun, India
[2]Department of Habitat Ecology, Wildlife Institute of India, Dehradun, India

Himalayan riverscape is being modified heavily for hydroelectric, recreation, and water extraction purposes. Check dams built in montane streams are essential for providing water for people, but also impact some of the vulnerable organisms in cold waters like overwintering tadpoles. How can better conservation strategies be developed in this scenario? To understand the influence of check dams on overwintering tadpoles. We studied the morphometric traits using photogrammetry; behavioural changes using systematic scan sampling and visual density estimation; and habitat availability-use dynamics by stream inventory and habitat suitability analysis. We analysed the datasets using statistical methods such as GLMMs and CLMMs. Overwintering tadpoles are showing morphometric, behavioural and habitat use pattern changes in response to habitat alteration by check dams built in the montane stream. It is important to consider the impact of habitat modification and seasonality when developing aquatic conservation plans including minimum ecological flow requirements for instream flow management. To conserve these poorly known and vulnerable tadpoles living in the anthropogenically modified and highly seasonal environment, the habitat suitability curves designed can be effectively used; especially for flow recommendations during environmental assessments for developmental activities. The study calls waterway managers' attention to meet the needs of amphibians and people.

A-0025 (Oral)
Predators with a Complex Toxic Diet Show a parallel Voltage-Gated Sodium Channel Evolution (*Erythrolamprus* spp.)

Valeria Ramírez-Castañeda[1,2], Rebecca D. Tarvin[1] and Roberto Marquéz[3,4]
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Chemical defences play a key role in shaping ecosystems by orchestrating interactions between species and offering unique opportunities for animals to specialize in either avoiding or consuming toxic prey. In ecosystems with complex chemical scenarios like highly biodiverse tropical ecosystems, several toxic molecules coexist, often secreted by the same prey or by several prey. These multiple selective forces impose new challenges for the study of toxin resistance evolution and urge us to introduce new models to the field. For instance, field observations suggest that *Erythrolamprus* tropical snakes play a significant but understudied role as predators of multiple taxa of poisonous frogs (Bufonidae, Dendrobatidae). Several of these toxins affect the Voltage-Gated Sodium Channels (VGSCs) and often mutations in target

proteins evolve as a toxin resistance mechanism against neurotoxin exposure, also known as target-site resistance (TSR). Using target sequencing, we aimed to reveal potential TSR sites in VGSC orthologs and trace their phylogenetic origin and geographic presence in six *Erythrolamprus* species and 15 snake outgroups from various Colombian locations. We found nine neurotoxin resistance-related amino acid changes at homologous positions in the pore and p-loop of eight VGSC genes, suggesting tissue-specific toxin sensitivity. Notably, four of these positions were previously reported as conferring some degree of TTX resistance. All the potential TSR sites found in this study are present among other toxin-resistant organisms and display diverse allele variability across populations, suggestive of a geographic mosaic of coevolutionary dynamics. These findings provide insight into resistance mechanisms within a predator with a complex toxic diet, paving the way for new research models to address complex coevolutionary questions in tropical ecosystems.

A-0027 (Oral)
Once Infected, Always "Infected"? Long-term Consequences of Batrachochytrid Infections at the Molecular Level

María Torres-Sánchez
Department of Biodiversity, Ecology, and Evolution, Complutense University of Madrid, Madrid, Spain

Human-mediated habitat perturbations can have an immediate impact on species but also a silent repercussion that could lead to a later unexpected collapse of ecosystems. Examples of this are emerging infection diseases, whose initial catastrophic effects are blatant, while consequences of transitions from epizootic to enzootic scenarios are often neglected. Numerous anthropogenic stressors threaten amphibians, including emerging pathogens such as batrachochytrid fungi. Two species of this group have been spread by intercontinental wildlife trade, impacting amphibians worldwide and establishing as enzootic diseases in many locations at present. Despite this, little is known about the long-term consequences of batrachochytrid infections. Here, I proposed a theoretical framework studying molecular biomarkers (telomeres and DNA methylation) to unravel the long-term cost of infections, predict individual infection histories, and estimate population evolutionary pressures related to infection. Ultimately, these biomarkers could enable better outbreak predictions helping to prevent higher biodiversity losses.

A-0028 (Poster)
Blind Dates: Caecilian Amphibians and the Evolution of Courtship Pheromones

María Torres-Sánchez
Department of Biodiversity, Ecology, and Evolution, Complutense University of Madrid, Madrid, Spain

Chemical communication is an important mechanism of species interaction, modulating social and reproductive behaviours, particularly when other communication systems, such as visual or acoustical systems, are reduced. This could be the case for caecilian amphibians (order Gymnophiona). Caecilians are limbless fossorial amphibians with vestigial eyes and a lack of tympanic cavities. Conversely, caecilians possess unique sensory tentacles between their eyes and nostrils, which are believed to sense chemical cues, including pheromones for mate attraction and courtship. While there is extensive literature about sex pheromones in other amphibians, especially in salamanders, little is known about the production of such chemical

signals in caecilians. Recently, sequences coding for well-known vertebrate courtship pheromones, the sodefrin precursor-like factor (SPF) proteins, were molecularly identified from the skin transcriptomes of several caecilians. Here, I revisited the molecular evolution of SPF proteins in amphibians by including sequences from caecilian species. I inferred the evolutionary relationships of candidate caecilian SPF sequences with SPF sequences from salamanders and frogs. To associate molecular evolution with ecological changes, I performed phylogenetic comparative analyses to describe the evolution of pheromone transmission among the studied amphibian species (eight caecilians, 35 salamanders, and five frogs). I reconstructed the character state of ancestral nodes and inferred the transition probability of the potential pheromone transmission mechanism (airborne and waterborne) to guide branch-site positive selection analyses for the SPF molecular phylogeny. SPF proteins are the result of multiple gene duplication events, mutating and potentially co-opting for pheromone roles not only in salamanders and frogs but also in caecilians. Uncovering the molecular mechanisms of pheromone signalling in caecilians opens new research avenues to further explore reproduction biology and sexual selection in this enigmatic amphibian group.

A-0030 (Oral)

Malagasy Amphibians and Reptiles: Patterns of Colonisation, Diversification, Species Richness and Endemism

Angelica Crottini[1,2,3]

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Madagascar is a large continental island which is known to host exceptional levels of diversity and endemicity. It was once part of the Gondwana supercontinent, and has remained isolated from all other landmasses from mid-Late Cretaceous (ca. 85 million years ago). I provide an overview of the current state of knowledge on Madagascar's herpetofauna, presenting data on species colonization and diversification, species richness and endemism and rates of species description. Available time-calibrated phylogenies suggest that Madagascar has been colonized by the majority of amphibian and reptile lineages by overseas dispersal and that the species that succeeded to colonize the island have evolved in isolation since then. The accumulation of data over the past decades has increased the resolution of the pattern of species richness, endemism and phylogenetic diversity. The majority of the amphibians are found along the north and eastern rainforests of the island, while richness among reptiles is high also in the south. However, these patterns correspond closely to collection effort, suggesting that field-based research remain crucial for advancing biodiversity knowledge for these groups. Phylogenetic diversity tends to mirror that of species richness, while levels of endemism are extremely high and unevenly distributed across the island, with all native amphibians and the 98% of reptile species being endemic. The description of the herpetological diversity of Madagascar organically began in the 19th Century, but we had to wait until the last few decades to observe a substantial increase of species descriptions. This has been possible thanks to the availability of field guides, to the use of standard markers for the molecular taxonomic identification of collected material and to the intensification of field investigations, which resulted in the availability of comprehensive museum collections. Despite all this, undescribed

diversity remains widespread, and is occurring at both poorly explored and in better-studied areas.

A-0031 (Oral)
The Mixed Flavour of the Herpetofauna of Madagascar

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The island country of Madagascar contains a large and old (ca. 85 My) continental island and numerous smaller peripheral islands. Despite the limited fossil record, it is thought that most of its Cretaceous herpetofauna went extinct during the last mass extinction (66 Mya), at the boundary between the Cretaceous and Paleogene (K-Pg). Time-calibrated phylogenies suggest that some old lineages of probable vicariance origin are present (e.g., *Erymnochelys madagascariensis*), but are few, and most of its extant herpetofauna is the result of species diversification processes that took place within the island. These, started from a limited number of unrelated colonizers that reach Madagascar by rafting along favorable oceanic currents, mostly from Africa, after the K-Pg mass extinction. During this event, Madagascar was already an isolated landmass and its biota had likely remained heavily depauperated. The colonizers that arrived subsequently thus had access to a vast ecospace that enable them to diversify widely. We observe a correlation between the age of a clade and its species-richness, with the oldest, yet post K-Pg boundary radiations, being the most species-rich. Similarly, those radiations that have a large proportion of species diversity in rainforests are significantly more species-rich and have higher micro endemicity patterns. Due to their high species richness and ecomorphological diversity, several old clades of Malagasy amphibians and reptiles have been proposed as adaptive radiations. In contrast with this hypothesis, accelerated phenotypic evolution is often associated with constant diversification rates (i.e. Mantellid frogs, ca 61 My; Pseudoxyrhophiinae snakes, ca. 37 My; Scincinae skinks, ca. 58 My), which can possibly be explained by their ancient origin. On the contrary, younger clades show a more conserved morphology (e.g. Hyperoliid frogs, *Astrochelys-Pyxis* tortoises), lower species-richness and, in some cases, wider distribution.

A-0032 (Oral)
The Evolution of Colour Polymorphism in the Sea Snake, *Emydocephalus annulatus*

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The existence of distinct colour morphs within a single population is puzzling from an evolutionary perspective, because we would expect a morph that confers higher fitness to replace any others. Inshore populations of Turtle-headed sea snakes (*Emydocephalus annulatus*) contain many melanic individuals, whereas banded patterns dominate most of the species' range. We show that melanism may enhance fitness in polluted sites because darker skin both concentrates pollutants, and induces more frequent sloughing. The long-term stability

in frequencies of melanic versus banded morphs in our study populations may reflect frequency-dependent fitness advantages driven by mimicry of sympatric and more toxic sea snakes. Consistent with that hypothesis, predatory fish were more likely to attack snake-shaped lures that were black rather than lures that were black-and-white banded. Overall, our data highlight the advantages of novel systems, such as sea snakes, for research on classic questions in evolutionary ecology.

A-0033 (Oral)
The Evolutionary Genetics of Color Pattern in a Mimetic Radiation of Poison Frogs

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The evolutionary genetics of color pattern in a mimetic radiation of poison frogs, *Ranitomeya imitator*, the mimic poison frog, has undergone a mimetic radiation, in which different populations have evolved to resemble different model species in different geographic regions of Peru. Here I will review results from different approaches we have been using to elucidate the genes and biochemical pathways underlying the divergence in color and pattern associated with this mimetic radiation. We have used exome capture techniques to obtain markers across the genome. These were used to investigate allelic divergence across multiple populations of *R. imitator* spanning a transition zone between two mimetic morphs (banded and striped) along the Huallaga River in Peru. Divergence and admixture analyses of genotype-phenotype associations were used to identify candidate genes affecting color and pattern development. Between-morph crosses were used to produce a multi-generational pedigree, which was used to confirm the effects of specific candidate genes. We have used genome sequencing with the PacBio platform to obtain a high-quality genome for *R. imitator*. We have used transcriptome sequencing combined with differential expression and gene network analyses to elucidate patterns of gene expression associated with distinct color phenotypes. We have used molecular evolutionary methods to infer historical patterns of selection on genes associated with color and pattern. These various approaches allow us to identify some interesting connections between the candidate color and pattern genes identified using the different methods.

A-0034 (Oral)
Comparative Genomics of Poison Frog Tadpole Gut Microbiomes

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Here I review previous and recent work on the gut microbiomes of poison frog tadpoles from the genus *Ranitomeya*. Males and females of the Peruvian mimic poison frog, *Ranitomeya imitator*, form a pair bond, place their tadpoles in phytotelmata and feed them trophic eggs. In contrast, *R. variabilis* consumes the ancestral detritus diet in their nursery pools. Each species' diet was experimentally switched. Analyses of the prokaryotic gut microbial communities of each species revealed no diet-related differences in diversity or richness. These analyses did uncover bacteria commonly found in the gut microbiome of many animals that may aid digestion (Rikenellaceae in *R. variabilis*, Bacteroidaceae in *R. imitator*). The family found in *R. variabilis* was identified to genus level (*Mucinivorans*), which could be associated with digestion. Desulfovibrionaceae, found in egg-fed *R. imitator*, are composed of sulfate-reducing bacteria commonly found in aquatic environments. When investigating the eukaryotic gut microbiome, we found preliminary evidence of a symbiotic protist in *R. imitator* tadpoles.

Gene expression analyses revealed elevated expression of proteases in the R. imitator egg-fed treatment. These digestive proteins came from parabasalians, a group of protists that form symbiotic relationships with hosts that enhance digestion. Genes that code for these digestive proteins are not present in the *R. imitator* genome, and phylogenetic analyses confirm that these mRNA sequences are from parabasalians. Bar-coding analyses of the tadpole microbiomes further confirmed this discovery. These symbiotes may aid *R. imitator* tadpoles in protein/lipid digestion in the context of an egg diet. This may have enabled the exploitation of a key ecological niche, allowing *R. imitator* to expand into an area with ecologically similar species (e.g., *R. variabilis* and *R. summersi*). In turn, this may have enabled a Müllerian mimetic radiation, one of only a few examples of this phenomenon in vertebrates.

A-0035 (Poster)

Saving Frogs through Proteomics: *in-silico* Identification of Anti-chytrid Peptides from Malaysian Frog Skin Secretion

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Amphibians globally face a formidable threat from the chytrid fungus *Batrachochytrium dendrobatidis* (Bd), contributing to declines in numerous species. While the situation in Malaysia appears less severe compared to Neotropical regions, the need for proactive measures prompted an exploration of the skin secretion of Malaysian frog species for potential anti-chytrid peptides. This study employs proteomics to identify antimicrobial peptides (AMPs) within the skin secretions of three Ranidae species in Peninsular Malaysia: *Hylarana glandulosa, H. labialis* and *H. erythraea*. The identified AMPs from *H. erythraea* include Temporin-Tob, Temporin-1Ob, Esculentin-2L, and Esculentin-2PRa. *H. labialis* produces Ranalexin and Esculentin-1Arb, while *H. glandulosa* secretes Esculentin-2L and Esculentin-2PRa. This research sheds light on the potential defensive mechanisms of Malaysian frogs against the chytrid fungus, providing valuable insights into natural defences that could be harnessed for conservation efforts. Understanding the chytrid situation in Malaysia and identifying these AMPs marks a crucial step in developing effective strategies for protecting and conserving amphibian populations. The study paves the way for further research into these peptides' fragmentation, isolation, and synthesis, opening new avenues for potential cures and mitigation strategies against chytridiomycosis. This research not only enhances our understanding of the intricate relationship between amphibians and Bd but also holds promise for developing innovative conservation tools to safeguard these vulnerable species on a global scale.

A-0036 (Oral)

Salamander Genomes Bloat up with Transposable Elements, Affecting Gene Expression, Development, Organ Morphology, and Life History

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Amphibians encompass a huge range of genome sizes, and the largest genomes are found in salamanders. Diploid salamander genomes range from 15 Gb to 120 Gb, and much of this sequence consists of active or inactive transposable elements (TEs). All eukaryotic genomes are populated by TEs, and the TEs in salamanders are not unusual – they are just far more abundant. Why do salamanders have so much DNA? How does this copious DNA shape development, phenotype, and life history? To answer these questions, my lab characterized the TE landscapes of salamanders, revealing a dynamic community of sequences that changes in ways not predicted by prevailing TE dynamics models. Next, we tested whether the molecular mechanisms that repress TE insertions have fallen down on the job in salamanders, enabling massive TE amplification. Surprisingly, we find that TEs are repressed in enormous genomes by the same silencing pathways deployed across metazoans. In contrast, we found that TEs are not deleted from salamanders as readily as they are from smaller genomes, suggesting that TE persistence underlies their staggering accumulation. We then examined the effects of these huge genomes on cell biology, revealing that the long introns and huge nuclei and cells that accompany huge genomes cause significant delays in gene expression kinetics because of the time it takes to transcribe, splice, and export mRNA molecules from the nucleus. This slowing of gene expression explains the slow development long noted in species with huge genomes, and we demonstrate associated impacts on life history evolution. Finally, we reveal that organ morphology is profoundly influenced by genome size in ways that impact performance. In sum, our work reveals that not deleting TE sequences over millions of years is associated with changes in cell physiology, developmental tempo, organ structure and function, and life history evolution in salamanders.

A-0037 (Oral)
Validating Indicators of Poor Welfare for Amphibians Used in *Ranavirus* Challenge Experiments

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Experimental research to understand the effects of the highly infectious disease ranavirosis, requires live amphibians to be used in experiments. *Ranavirus* is a deadly pathogen to susceptible species with ongoing studies providing valuable information to conservation management. Yet there is a significant lack in our understanding as to what constitutes best practice to safeguard the welfare of the animals used. Coupled with the heightened application of the 3Rs (replacement, reduction and refinement) to research governance, validated welfare indicators are needed to reduce the suffering experienced by the experimental animals. *Ranavirus* is a quick-acting pathogen, with clinical signs of disease indicating that significant suffering has already been experienced. Therefore changes in amphibian behaviour, before the onset of these signs of ill-health, need to be observed and validated against the biological costs of disease, to refine experimental practice. To do this non-intrusively and demonstrate that welfare-informing research can be undertaken alongside *Ranavirus* challenge investigations, we used overhead cameras to record frog behaviour, before, during and after pathogen exposure. Leading to the validation of new indicators of poor welfare that can be used to help specify humane endpoints.

A-0040 (Oral)
Ecology and Evolution of Ultraviolet Color in Snakes

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Ultraviolet (UV) reflective coloration is present across many taxa and is a critical mechanism for communication both within and among species. However, the relative contribution of sexual selection, predator defence, and evolutionary history to the distribution of UV reflectance across species is unknown for most clades. Here we combined multispectral image analysis of 110 wild-caught snake species with cone-catch models of avian, mammalian, and snake visual systems to test among hypothesized drivers of UV color evolution across the Western Hemisphere. We found that although UV reflectance was widespread among species and showed no phylogenetic signal, there was a clear signature of predator-mediated effects, with age, diel activity cycles, and habitat as strong predictors of UV reflectance despite no differences among sexes. We also found that coloration in the visible spectrum was not a reliable predictor of reflectance in UV wavelengths, such that the full reflectance profile of a snake is simply not quantifiable from the color pattern visible to the human eye alone. Surprisingly, although we show that these snakes were an order of magnitude more conspicuous to bird receivers than to mammalian receivers, we were unable to fully exclude snakes as potential secondary receivers of UV information based on their visual systems. Together, these novel tests of UV reflectance in snakes suggest the critical importance of quantifying both visual systems and hyperspectral reflectance and that future potential for major research discoveries regarding the adaptive function of these "invisible" elements is high.

A-0042 (Oral)
Spatially Explicit Capture-recapture based Assessment for Estimation of Population and Density of an Endemic Himalayan Stream Frog (*Amolops formosus*): Field Study from Churdhar Wildlife Sanctuary, India

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Amolops formosus or the Assam cascade frog can act as a key indicator for stream health as they are a rare endemic species of the Himalayas associated with riparian habitats. We employed the first ever Spatially-explicit capture-recapture technique for a more robust estimate of the density of an anuran species based on individual identification without physically capturing and handling the species in the western Himalayas. We identified 51 individuals from the two sampled streams. The minimum average movement for the species was 57.14 ± 7.14 m and 75 ± 11.18 m in the two survey streams. The average abundance was 12.73 ± 2.83 individuals based on the top N-mixture model. Water flow showed a statistically significant negative correlation with species abundance. Density was evaluated using Spatially explicit capture-recapture methods. The mean density of species was 5.58 ± 1.95 and 5.11 ± 1.61 individuals per hectare in the two surveyed streams, respectively. The mean density based on linear habitat was 90.51 ± 21.68 and 87.53 ± 18.81 individuals per kilometre in the two surveyed streams, respectively. Our study demonstrates the use of spatially explicit techniques for quantifying, conserving and monitoring important sentinel species such as *Amolops formosus* using different stream parameters.

A-0044 (Oral)
Seen through the Heart: What is Going on During Cardiac Regeneration in Squamate Reptiles

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Reptilian myocardial regeneration and its mechanisms are still elusive. Squamates could fill knowledge gap between traditional poikilothermic anamnian (zebrafish) and homeothermic placental (neonatal mammals) models and thus could reveal myocardial regenerative mechanisms not only in reptiles but also in amniotes. Factors, potentially influencing myocardial regenerative potential, are: i) ventricular septation, and ii) taxon-specific regenerative abilities (reflected in metabolism, ecological niche, and phylogeny). Therefore, the crux of the problem is what is the relationship among regenerative potential and those factors. Detecting time course and mechanisms of cardiac tissue regeneration with respect to ecological niche and metabolism. Cryoinjury was performed on heart apex in three squamate species (*Eublepharis macularius, Python regius* and *Varanus acanthurus*) chosen for different life-histories and phylogenetic positions. After various healing intervals, physiological (heart rate, blood pressure, optical mapping) and morphological measurements (microCT, histology and immunohistochemistry) were used for evaluating myocardial regeneration. Physiologically, heart rate differed significantly between *Eublepharis* and *Varanus.* In *Python*, there were differences among pseudo QRS complexes as in *Varanus*. Morphologically, recovery period was divided into i) initiating period with macrophages infiltration (first week), ii) fibrotic scar formation (second week), and iii) fibrotic scar resolution and its myocardial replacement (third week). There was no fibrotic scar after three weeks healing period in all tested species but species differed in regenerative velocity. *Varanus* and *Python* were ahead of *Eublepharis. Varanus* and *Python* replaced scar during second week, *Eublepharis* in third one. *Eublepharis* does not have good ventricular septation and together with nocturnal life-style, this could lead to slower cardiac regeneration compared to *Python and Varanus*. Observations are connected to different metabolic rates and thus to different life-histories and ecological niche. The role of the position in the phylogenetic tree is not excluded but not confirmed yet.

A-0046 (Oral)
Color Genomics of *Oophaga pumilio* in Bocas del Toro

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The strawberry poison dart frog, *Oophaga pumilio*, exhibits a distinctive red hue with blue limbs across its continental range. However, Bocas del Toro, a province in Panama distinguishes by its archipelago remarkable color diversity. Each island and the adjacent peninsula present a unique phenotypic morph. This study investigates the factors influencing this phenotypic variation. We aimed to understand when the populations diverged and how is the polymorphism maintained. Using genotype likelihoods and selection scans, we found ttc39b, a gene involved in yellow-to-red carotenoid conversion, with extremely reduced variation in yellow and green frogs. A haplotype with a defect in ttc39b, which can no longer convert the dietary yellow carotenoid into red, was introduced from Colon Island green population into Bastimentos, a predominantly red frog island. By studying the population of Dolphin Bay, which contains blue and red frogs, we found kit as our top candidate for the color shift. This gene is involved in melanin production. We identified two non-synonymous mutations and a higher content of melanosomes in blue frogs. The phenotypic diversity of these populations is not only restricted to hue but also to pattern. We extracted the patterns using pixel thresholding and a pre-trained neural network. We found that color and pattern are not randomly associated with each other. Finally, using demographic inference, we found that all the populations in Bocas del Toro diverged before the formation of the islands. Previous hypotheses attribute the striking diversity to genetic drift. In contrast, we found causal genes for color variation with a significant reduction of diversity, indicating selective sweeps. The islands have been connected and disconnected through time with glaciation cycles. Our results indicate that the populations' divergence times are older (on average 27,000 years old) than the last island formation 1,000–9,000 years ago.

A-0047 (Oral)
Recent Advances of Taxonomy on Cobras and Kraits of China

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Cobras (*Naja* Laurenti, 1768) and kraits (*Bungarus* Daudin, 1803) are deadly snakes causing numerous snakebites every year. Taxonomic framework for these snakes is essential for snakebite treatment and antivenoms development. Monocled Cobra (*N. kaouthia* Lesson, 1831) and Many-banded Krait (*B. multicinctus* Blyth, 1860) are species widely recorded. However, integrative taxonomy research based on morphological evidences and mitochondrial gene sequences revealed that the taxonomy of these wide-spread species remains unsolved. Taxonomic revision for these species were conducted based on data of multiple geographical populations covering most of their distribution area. The revision on *N. kaouthia* lead to description of a new cobra species *N. fuxi* Shi, Vogel, Chen and Ding, 2022, designation of neotype and supplementary description of *N. atra* Cantor, 1842. The revision on *B. candidus/multicinctus/wanghaotingi* complex described a new species *B. suzhenae* Chen, Shi,

Vogel, Ding and Shi, 2021, and suggested to treat these taxa as separate species. Although these medically important species have recently been revised, there are still mysteries and controversies on cobras and kraits in Asia. We hope that more cross-border collaborations in future will help to build a better taxonomy frame work for these snakes and eventually benefit a large number of people.

A-0048 (Oral)
Moving to the Unknown: Assessing the Effectiveness of Mitigation Translocation in British Columbia, Canada

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Mitigation translocation is a commonly used strategy in British Columbia (BC), aimed at safeguarding herpetofauna from the adverse effects of human-induced habitat alteration and destruction. Despite its widespread application since 2010, the efficacy of this mitigation strategy remains uncertain. This project is the first to complete a full review of the scale of mitigation translocation in BC from 2019 to 2022 and the associated financial investment, alongside a case study of survival, movement, and habitat choices post-translocation in Columbia Spotted Frogs (*Rana luteiventris*), a common, native amphibian. The scale and associated costs were collected through a comprehensive analysis of mandatory permit applications and expert elicitation from applicants. The case study uses passive integrated transponder (PIT) tags and capture-mark recapture methods from 2023 to 2024 to assess post-translocation survival in Columbia Spotted Frogs, which are notably impacted by mitigation translocation projects in BC. Frogs were moved to one of three treatments: 1) control, 2) over 1 km away, and 3) a wetland over 5 km away from the control. Radio transmitters were assigned to a subset of frogs in 2023 and tracked over 3–6 weeks to understand if movement patterns and habitat choices changed post-translocation. Results are being analyzed; however, the scale of mitigation translocation reveals over 2.7 million herpetofauna have been translocated, with amphibians being the most impacted. The case study indicates that all frogs survived the translocation in 2023, and those with radio transmitters reveal that frogs relocated a short distance away exhibited more movement, on average, than those in the control or long-distance treatment, as most tried to move back to their original point of capture. This study will fill knowledge gaps and provide valuable insights into improving the effectiveness of mitigation translocation for amphibians.

A-0049 (Oral)
Effects of Global Climate Change on Embryonic Development of Egg-laying Reptiles

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The warming brought on by climate change threatens the planet's biodiversity. Embryos of egg-laying may be particularly vulnerable to climate change due to narrow heat tolerance ranges, limited behavioral heat regulation, direct exposure to fluctuations in ambient temperature. Climate change is already a threat to reptiles, and the embryos of egg-laying reptiles may be particularly vulnerable to climate change due to the reptiles' lack of parental care behavior. Therefore, it is important to study the effects of climate change on the embryonic

development of egg-laying reptiles. Based on the data on embryo development, body length, and nest site selection collected from literature searches, databases, and other publicly available information resources, we are expected to build embryonic development models for dozens of egg-laying reptiles distributed around the world, and conduct research on the effects of climate change on the embryonic development of egg-laying reptiles. Our research will answer the following scientific questions: a. What is the pattern of geographic and interspecific variation in the thermal sensitivity (development rate and hatching success) of embryonic development in egg-laying reptiles?; b. How will climate change affect the embryonic development temperature of egg-laying reptiles worldwide?; and c. How will climate change affect the embryonic development of egg-laying reptiles around the world? Data collection, modeling, data analysis were used.

A-0050 (Oral)
Diversity and Evolution of the Size and Shape of the Ocular Lens of Snakes

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In vertebrates, ocular lens morphology determines the camera-type eye's image-focusing abilities. Among squamates, one of the many notable differences between the eyes of 'lizards' and snakes is reported to be in the shape and rigidity of the lens, and mechanism of accommodation. Snake lenses are reported to be spherical and rigid, with accommodation achieved by moving the lens towards or away from the retina, in contrast to more ovoid and elastic lenses of 'lizards' that are deformed to achieve accommodation. However, there have been few investigations into variation in the morphology of the snake lens. More detailed information might contribute to discussions about the ecological nature of the 'lizard'-snake transition, and the origin and function of some of the many unusual aspects of snake visual systems. We measured lenticular morphological metrics in > 130 micro X-ray computed tomography (microCT) scans of > 110 phylogenetically diverse snake species, testing for correlations with ecological habits and diel activity patterns. We identified previously unrecognised morphological diversity in snake ocular lenses, in both shape and relative size. Some of this diversity is explained by ecology and/or phylogeny. For example, aquatic species have relatively smaller lenses, scansorial species have less-spherical lenses, and semiaquatic species have more asymmetrical lenses. Some aspects of the morphology and of the morphological diversity of snake lenses are difficult to reconcile with current understanding of vertebrate vision, including the widespread presence of spherical lenses in non-aquatic species.

A-0052 (Oral)
Visual System Evolution of Snakes Across the Terrestrial-marine Transition

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Fully marine sea snakes share a recent ancestor with terrestrial Australian snakes, yet the sensory adaptations that accompanied this land-sea transition are largely unknown. Our team has previously shown that some sea snakes have expanded "UV-blue" spectral sensitivity via adaptive changes to their Short-Wavelength-Sensitive-Opsin-1 gene. We have since confirmed that some sea snake species of the *Hydrophis* genus possess multiple SWS1 visual opsin genes. Gene duplications of this nature are of high evolutionary significance, as the advanced visual ability observed throughout much of the animal kingdom evolved via duplications of photopigment-encoding opsin genes and subsequent shifts in wavelength sensitivity of the copies. Though significant, these duplication events are also incredibly rare; with only three occurrences within the last ~400 million years of tetrapod evolution having been confirmed outside of the current study. It has also been discovered that in the case of *Hydrophis*, these SWS1 copies have diverged at key spectral tuning nucleotide sites. This likely means that some SWS1 copies allow for the retinal perception of blue-light spectra, while other copies allow for UV-light perception. Furthermore, co-expression of SWS1/RH1 visual opsins within single cone photoreceptor cells provides further evidence for expanded spectral sensitivity ranges. Comparative assessment of retinal architecture in *Aipysurus* and *Hydrophis* lineages also presents compelling evidence for photoreceptor transmutation, and suggests divergent visual evolution in these marine sister clades. It is likely that these unique features have resulted in novel visual adaptations to the marine photic environment following ancestral regression.

A-0053 (Oral)
From Effluent to Oestrogen, Exploring the Role of Sewage in Turtle Reproductive Physiology

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Endocrine-disrupting chemicals (EDCs) have been of concern for wildlife since the 1950s. For wildlife exposed, endocrine-disrupting chemicals are known to have reproductive and physiological effects that can impact embryonic development and survival, and affect thyroid function, the immune system, and the nervous systems. Turtles are considered one of the most

threatened vertebrate groups in the world. In south-eastern Australia, freshwater turtles are common within settling ponds of wastewater treatment facilities. However, our understanding of effluent exposure to reptiles overall is extremely limited. Due to freshwater turtles long life spans and potential site fidelity to these settling ponds, this may increase their vulnerability to impacts from EDCs. The aim of our study is to see whether environmental oestrogens within wastewater settling ponds disrupt the natural oestrogen and testosterone cycle within Murray River turtles (*Emydura macquarii*) and Eastern long-necked turtles (*Chelodina longicollis*). To address our aim, we assess oestrogen and testosterone cycles in turtles in sewage settling ponds compared with nearby reference sites (natural wetlands), where we sampled blood from turtles at three time points (autumn, spring and summer). We also did ultrasounds on female turtles to confirm the reproductive stages of individuals across the three seasons. The results from our study will provide insight as to whether turtle reproductive hormones may be impacted by EDCs found in sewage-settling ponds.

A-0055 (Oral)
An Extravagance of Breathing Modes in Anuran Tadpoles

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It is easy to assume that an aquatic tadpole transitions from gill-breathing to lung-breathing at metamorphosis, and this is reinforced by poetry, science education, and potentially the historical bias towards the study of common European species. The reality is that tadpoles are extremely diverse in breathing modes, and most species breathe air throughout the larval period. We present a series of examples of this respiratory diversity, highlighting the independent evolution of different air-breathing modes in varying evolutionary and ecological contexts, the many independent losses of air-breathing across tadpoles, and present the first known re-evolution of air-breathing following loss in tetrapods. Using highspeed video, we show that lung-breathing varies across tadpoles, with some hypoxia-prone species evolving unique biomechanical patterns that appear to increase respiratory efficiency, while other species retain similar breathing patterns despite major changes in mouth morphology. We show that lung loss is common in certain stream-adapted ecomorphs, but that one large family, Bufonidae, is universally lungless with no obvious adaptive explanation. Finally, we present novel behavioral, natural history, and physiological data on tadpoles of the African Red Toad (*Schismaderma carens*), a lungless bufonid, which has evolved a unique, respiratory head-crest. We find that *S. carens* breathes air into its gut, apparently to increase buoyancy and thus facilitate respiration with its sky-facing vascular crest. We conclude by placing this evolutionary novelty in an eco-evo context, showing that an ancestral loss of larval lungs likely was required for its origin, and speculate on the role of trait loss in generating phenotypic novelty. We intend to show that tadpole respiratory biology is far more than has been previously acknowledged, and could represent a powerful system for understanding the evolution of different respiratory strategies.

A-0056 (Oral)
Movement and Resource Selection by Texas Tortoises (*Gopherus berlandieri*) in Relation to Prescribed Fire

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Fire is a critical ecological process that structures many ecosystems globally. Prescribed fire can be used to mimic historical fire regimes in areas where fire has been suppressed by humans, which in tu alters vegetation species composition and structure. As such, it is important to examine the effects of fire on wildlife species within these systems to understand the implications for species management and conservation. In southern Texas, prescribed fire is used to manage woody plant encroachment and improve quality of forage for cattle and wildlife in grassland savannas, a vegetation community in which Texas tortoises (*Gopherus berlandieri*) are found. The Texas tortoise is a species of conservation concern, facing loss and fragmentation of habitat. We aim to assess the movement and resource selection of Texas tortoises in response to prescribed fire on a coastal rangeland in southern Texas where patch burning has been used since 2016. Patches of ≥ 200 ha were randomly assigned either winter (dormant season) or summer (growing season) burning at either 3-year or 5-year fire return intervals with generally 2 patches burned in each season each year. We affixed 30 Texas tortoises with GPS tags on a private ranch in both burn and non-burn (control) patches. The GPS tags collected locations every 5 hours, resulting in locations taken at all hours of the day during the 9-month study period, which includes periods before and after prescribed fires were applied. Using GPS locations of the tortoises and satellite imagery, we will conduct resource selection analyses using step-selection functions and calculate home range (size and fidelity) and movement (distance or rate of travel) metrics. These data and findings will describe how Texas tortoises respond to fire and altered vegetation communities and structure, which will provide the basis of developing strategies for integrating fire into holistic management plans.

A-0058 (Oral)
Color Dynamism in Changing Urban Environments: Lessons from Chameleons in Madagascar

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Urbanization is inevitable, and several studies now show that species undergo changes in their morphological, behavioral, or life-history traits when they inhabit urban environments. For example, multiple species exhibit increased melanism, and dullness in sexual signals in urban environments. Some species may cope with such rapid changes using flexibility in traits such as behavior. However, we don't know if that might be the case for highly flexible morphological traits such as color dynamism. Chameleons are known for their camouflage and color dynamism/flexibility, but the extent to which these may allow them to accommodate changes due to urbanization is unknown, especially with respect to increased urban artificial light at night (ALAN). Given that effective color signaling relies on the light conditions, predator and conspecific vision, and background color, one may expect urban, specifically

ALAN, environments to exert novel pressures in each regard. The objectives are to compare daytime sexual signals and nighttime color during rest, using conspecific and predator visual models, under natural and urban artificially lit conditions for dynamically colored organisms exhibiting circadian changes in color. I am studying two species, *Furcifer oustaleti* and *Furcifer lateralis*, found in Antananarivo, Madagascar. I will be recording color for individuals from three urban and three non-urban sites at night in the field and then under experimental light conditions using a spectrophotometer. Subsequently, I will conduct conspecific trials to record sexual signals. The results from this research will provide evidence of how flexibly colored urban organisms may cope with rapid changes in their environment. It will also be the first in studying the role of color change at night and impacts of ALAN on chameleons. With chameleons of Madagascar being endemic to the island, the results from my study will be imperative to inform future development and policies in urban environments.

A-0059 (Oral)

Vegan or Not: Diet Influences Latitudinal Gradients in Life-history Traits, but not Reproductive Output, in Ectotherms

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Latitudinal gradients in life-history traits are apparent in many taxa and are expected to be strong for ectotherms that have temperature-driven constraints on performance and fitness. The strength of these gradients, however, should also be affected by diet because diet type (carnivory, omnivory, herbivory) influences accessibility to nutrition and assimilation efficiency. Objectives were to investigate how diet affects latitudinal gradients in lifetime reproductive output and the underlying life-history traits in ectotherms. We used empirical (352 species) and phylogenetically imputed data (563 species) to analyse the interactive effects of latitude and diet on life-history traits (longevity, age at maturity, reproductive life span, hatchling mass, clutch/brood size, clutch/brood frequency, female mass) and lifetime reproductive output of lizards. Lifetime reproductive output does not significantly differ in lizards across diet types, and only carnivores exhibit a small increase at higher latitudes. Diet type, however, influences latitudinal patterns of individual life-history traits. Carnivores exhibit a shift towards 'slower-paced' life histories at higher latitudes for most traits (increased longevity, age at maturity, reproductive life span, and decreased clutch frequency). By contrast, herbivores either display 'faster-paced' life histories (reduction in reproductive life span, hatchling mass, female mass) or no change (clutch frequency, clutch size, age at maturity) at higher latitudes. Omnivores exhibit intermediate and muted latitudinal patterns. We suggest that the nutritional challenges of herbivory, compounded by thermal constraints at higher latitudes, may explain differences in life-history characteristics of herbivorous ectotherms. Intermediate patterns exhibited by omnivores highlight how flexibility in diet can buffer environmental challenges at higher latitudes. Our results indicate that lizards with different diet types display various trends in their life histories across latitudes, which eventually balance out to result in similar reproductive outputs throughout their lifetime, with little benefits to carnivory.

A-0060 (Oral)

A Biased Introduction to Improving Animal Welfare in Herpetological Research

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Reptiles and amphibians are disproportionately affected by the global biodiversity crisis, meaning we are constantly increasing the number of non-model species that are the focus of research. While the academic and conservation justification for why we work on these species is clear, our understanding of the welfare impacts of how we work with a new species is frequently uncertain. This despite the legal and ethical requirements for working with wild animals. This symposium is designed to raise awareness of the need to improve welfare research in herpetology, and here we set the stage by providing some historical examples of why welfare needs attending to and how some researchers have been thinking about this topic for quite some time.

A-0061 (Oral)

Evidence for a Metal Disease Refuge: The Amphibian-killing Fungus (*Batrachochytrium dendrobatidis*) is Inhibited by Concentrations of Metals Tolerated by Amphibians

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The amphibian-killing fungus *Batrachochytrium dendrobatidis* (Bd) has caused declines in amphibians worldwide. Small populations of Bd-susceptible frogs have managed to survive in metal-polluted sites, giving rise to a hypothesis that in some instances frogs can persist in the presence of Bd because Bd is inhibited by metals at concentrations that frogs can tolerate. We tested this hypothesis by measuring the sensitivity of Bd to metals in the zoospore life stage and over the whole life cycle using single and multigeneration tests and compared Bd sensitivity to that of frogs. In the zoospore life stage, we conducted 96-hour exposure tests to measure the survival of zoospores to environmentally relevant elevated concentrations of copper (Cu), zinc (Zn), and their combination (Cu+Zn) and compared the sensitivity of zoospores relative to amphibians using species sensitivity distributions (SSDs). We investigated the transgenerational (TGEs) and multigenerational (MGEs) effects of metals on Bd over its entire life cycle for three consecutive generations. For TGEs, we exposed the first generation of Bd to metals and allowed the following two generations to recover in the absence of metals. For MGEs, we exposed three successive generations to metals. SSDs of Bd and frogs showed that Bd is 10 to 8 times more sensitive to Cu and Zn concentrations respectively than the most sensitive amphibian species reported in the literature. In TGEs experiments, there was no indication of recovery in subsequent generations reared in metal-free environments. In MGEs, we found no indication of pre-adaptation in second-generation offspring after the first generation was exposed to metals, and in continuous exposures up to the third generation Bd became more sensitive to metals with each passing generation. These findings might explain the persistence of some Bd-sensitive frog species in the presence of Bd in metal-polluted sites where metals may provide a refuge from Bd.

A-0062 (Oral)

Phylogenetically Unconstrained Trait Variation Dictates Divergent, Continental Competitive Interactions amongst Genotypes of *Batrachochytrium dendrobatidis*

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Animal fungal pathogens with genetically diverse lineages, extensive variation in epidemiological traits and broad host niches are emerging worldwide. Yet, there is little understanding of epidemiological outcomes following the introduction of multiple lineages into naïve host populations. Here, we combine theory, field surveillance, mathematical modelling and experimentation in order to determine the outcome of lineage interactions for the globally emerged amphibian pathogen *Batrachochytrium dendrobatidis* on two continents, Europe and Africa. We show that trait variation in one of the two predominating lineages, BdGPL, drives divergent distributions. In Europe the increased infectivity, virulence and competitive ability of BdGPL has historically restricted the distribution of the other, BdCAPE, to two locations on Europe and eliminated another lineage, BdCH, from Switzerland. In Africa, the two lineages do not diverge in trait values and have the capacity to invade host populations when the other lineage is already resident. As a result, both lineages have extensive distributions and, in South Africa, overlapping distributions that enables coinfections and interlineage recombination.

A-0064 (Oral)
Conservation Status and Natural History of a Mountaintop Endemic: Updates on the Golden Treefrog from Trinidad

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The golden tree frog (*Phytotriades auratus*, Hylidae) is a stunning bromeliad specialist found globally on only four tropical mountaintops (three in Trinidad, one in Venezuela). It is currently classified as endangered by the IUCN. While described over one hundred years ago, very little of its life history is known and no surveys have been conducted in Trinidad since 1993. To help remedy this, we conducted fieldwork on one population on El Tucuche in Trinidad in 2022. This work revealed several aspects of the natural history of this species including the first documentation of its breeding vocalization, reproductive behavior and tadpole diet. We

also tested this species for *Batrachochytrium dendrobatidis* (the amphibian chytrid fungus) for the first time and found that a high proportion of individuals tested positive. Lastly, we repeated plot searches for the giant arboreal bromeliad *Glomeropitcairnia erectiflora* within which the golden tree frog is an obligate inhabitant. These were last conducted in 1993 on an elevational transect on the south face of El Tucuche. The 2022 re-survey indicates a dramatic decline in the density of *G. erectiflora* which is now found only within ~ 40 m of the peak. Thus, the conservation status of this mountaintop endemic may be worsening and be more precarious than previously believed.

A-0065 (Oral)
Is Bromeliad-breeding in Poison Frogs a Mutualism?

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It is clear that phytotelma-breeding frogs receive many benefits from utilizing these plant-held water bodies. However, it is not at all clear if the plant also receives some benefit. The interaction between frog and plant could be mutualistic (both parties benefit), commensalistic (only frogs benefit) or parasitic (frogs benefit, plants are harmed). Establishing the nature of this interaction is crucial to know whether coevolutionary responses are to be expected. To experimentally examine this question, we grew bromeliads in the presence and absence of bromeliad-breeding strawberry poison frogs (*Oophaga pumilio*, Dendrobatidae) in a greenhouse setting. Over this five-year experiment, we measured bromeliad survival, growth rate, flower production, and nitrogen content in treatment and control plants. While the experiment is still ongoing, initial results indicate that bromeliad nitrogen content and growth rate are significantly higher in the presence of frogs compared to controls. These results suggest that the bromeliad-frog relationship is a mutualism and that coevolutionary influences between the partners are likely.

A-0066 (Oral)
Males Care Early- More than Late-developing Embryos Supports the Harm to Offspring Hypothesis in an Arboreal Breeding Treefrog

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Parental care benefits offspring but comes with costs. To optimize the trade-off between costs and benefits, parents should adjust care based on intrinsic and/or extrinsic conditions. The harm to offspring hypothesis suggests that parents should invest more in young offspring compared to older offspring due to the vulnerability of the young. However, this hypothesis has rarely been fully tested, as many studies only reveal an inverse correlation between parental care and offspring age, without directly testing the effects of offspring age on vulnerability. To fully test this hypothesis, we studied *Kurixalus eiffingeri*, an arboreal treefrog with paternal care. We first conducted field experiments to assess the prevalence of egg predators and the plasticity of male care. Subsequently, we performed a field survey by monitoring paternal care during embryonic development and conducted a laboratory experiment to assess the predation rate of embryos by the semi-slug, *Parmarion martensi*. Our results showed that (1) the semi-slug was the main predator to embryos, and male frogs elevated attendance frequency when the predators were present; (2) we found that males attended and brood eggs more frequently in the early than late developing embryos; (3) the predation rate of the early- was significantly

higher than late-developing embryos. Overall, our study provides experimental evidence consistent with the predictions of the harm to offspring hypothesis.

A-0067 (Poster)
Dumb and Hot? Relationship between Cognitive and Thermoregulatory Performance in the Common Wall Lizard (*Podarcis muralis*)

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Behavioural thermoregulation is critical for reptiles in order to maintain their body temperatures within a physiologically acceptable range. This requires sensing, processing and retaining information on the thermal environment, possibly mobilizing several cognitive processes. Surprisingly however, the relationship between cognitive performance and efficiency of thermoregulation has hitherto remained virtually unstudied. Here, we examined whether enhanced cognition translates into more efficient thermoregulation in the common wall lizard (*Podarcis muralis*). To do that, we first assessed the cognitive performance of lizards in two different spatial learning tasks. We then recorded the lizards' preferred body temperature range in a thermal gradient, to obtain an estimate of the thermoregulatory setpoints. We marked lizards with individual PIT tags and released them in a large enclosure with different types of heating sources (lamps, stones, mats), mimicking a spatiotemporally heterogeneous thermal environment. The lizards' body temperatures and movements were tracked in order to assess the efficiency of their thermoregulatory performance.

A-0069 (Oral)
Phylogeny of the Genus *Elachistocleis* (Microhylidae: Gastrophryninae)

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The Neotropical Gastrophryninae Fitzinger, 1843 currently contains 80 recognized species. The genus *Elachistocleis* Parker, 1927 is the second larger genus of Gastroprhyninae with currently 18 described species, after *Chiasmocleis* Méhely with 37 species. The remaining 9 genera are poorly speciose each containing between 1–6 species. *Elachistoclies* has a wide distribution across South America and two species reach (*E. pearsei* and *E. panamensis*) into Central America. A phylogeny of *Elachistocleis* with primarily focus on Brazil is available (Fagundes et al. 2022). The species "*E. ovalis*" was considered a species inquirenda Caramaschi 2010, i.e., doubtful identity, which left populations across the Neotropical region as *Elachistocleis* sp. Herein, we present a phylogeny for of the genus with all available data in Genbank and additional sampling in northern South America, particularly Colombia.

A-0070 (Oral)
The Evolution Thermal and Hydric Physiology of Hispaniolan Anoles

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Behavior is a factor that can directly shape evolution: regulatory behaviors like thermo- and hydroregulation, for example, shield organisms from environmental selection, resulting in slower rates of evolution and limited physiological divergence across environmental gradients (a phenomenon known the Bogert Effect). The Bogert Effect has most frequently been investigated by examining the effect of thermoregulatory behavior on the rate and pattern of thermal physiological evolution. Nevertheless, thermal and hydric physiology are tightly intertwined: a more holistic understanding on the Bogert Effect – and its limitations – urges a shared investigation of thermal and hydric physiology. Here we examine the patterns and rates of evolution of hydric and thermal physiologies in a model system of ectotherms, Anolis lizards. We focused on a group of closely related anole species from the Caribbean island of Hispaniola that are found in a variety of habitat types and across an elevational gradient to investigate if the Bogert effect impacts various physiological traits in similar or contrasting ways.

A-0071 (Poster)
Is the Climbing Ability Related to the Different Dietary Pattern Between Two Bird-Eating Snakes?

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Two species of bird-eating snakes, the Japanese rat snake (*Elaphe climacophora*) and the Japanese striped snake (*E. quadrivirgata*), are distributed on main islands of Japan. A review of previous bird predation cases of these two species revealed that *E. climacophora* preys on a wide variety of birds, including those nesting on trees, whereas *E. quadrivirgata* mainly preys on ground-nesting birds. Based on this finding, we hypothesized that the difference of food utilization pattern might be related to the difference of the climbing ability between them. To test this hypothesis, we conducted the following three experiments. In experiment 1, we compared the speed of climbing on a vertical wall in adults between *E. climacophora* and *E. quadrivirgata*. The result showed that *E. climacophora* is able to climb significantly faster than *E. quadrivirgata*. In experiment 2, we compared the speed of climbing on the tree trunk (*Cedrus libani*) in adults between these snakes. The result showed that *E. climacophora* is able to climb faster on average than *E. quadrivirgata*, although no statistically significant difference was detected. In experiment 3, we compared the maximum height of climbing on a vertical wall in hatchlings. The result showed that hatchlings of *E. climacophora* are able to climb significantly higher than those of *E. quadrivirgata*. These results suggest that *E. climacophora* is innately superior to *E. quadrivirgata* in their climbing ability. This difference of climbing ability would be contributed to the differences of the type of birds that the two snake species utilize as food.

A-0072 (Oral)
Caught on Camera: Camera Traps as Sources of Opportunistic Herpetological Natural History Observations

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Camera trap studies have the potential to yield unexpected natural history observations of non-target organisms. A preliminary survey of mammals in the southern Rio Balsa region, Darien, Panama provided incidental information on the herpetofauna of the region. Turtles, snakes and frogs made appearances in camera trap recordings. Video recordings were found to be more informative as they contribute audio information on frog species presence and activity. In conjunction with traditional surveying methods, this information can help target surveying as well as identify species that are active when surveying is not possible. The predation of the foam nests of the frog *Leptodactylus savagei* by a feline (an ocelot, *Leopardus pardalis*) is the type of interaction that is unlikely to be witnessed by an observer in the field but was caught on camera. Camera trap data can provide an additional source of information for species diversity studies as well as to observe rare behaviours and events.

A-0073 (Oral)
Thermal Ecology, Activity Patterns, and Ecological Niche Modeling of *Gopherus* Tortoises

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Almost 50% of modern tortoise species are endangered or already extinct. Niche modeling predicts extensive range contractions for many chelonian species due to climate change induced habitat loss. For example, tortoise habitat in arid environments is expected to increase in temperatures and prolonged drought reducing habitat availability. Desert-dwelling tortoises dig burrows or seek refuge in rock crevices to avoid the heat and potential risk of overheating. There are six tortoise species in North America and Mexico (genus *Gopherus*) and they differ in genetics, distribution, morphology, body size, diet, habitat, and shelter site selection. Most *Gopherus* species have been assumed to have a similar physiology as *G. agassizii* despite differences in genetics and ecology and more recent evidence suggesting varying thermoregulatory strategies for different species. Therefore, understanding each species' specific habitat requirements and physiological properties are important to allow inferences about tortoises' potential to cope with temperature shifts and habitat alterations. Further, there is a lack of sufficient physiological data at an appropriate resolution of microhabitats to refine existing ecological niche models and improve predictions to guide conservation action for specific populations and species. Our study measures core physiological data, operative environmental temperatures, and movement and activity patterns of several species of *Gopherus* tortoises occupying differing habitats, ranging from desert habitat and arid grasslands to tropical deciduous forest habitat.

A-0075 (Poster)
Exploring Colour Polymorphism in the Mole Snake (*Pseudaspis cana*)

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Colour polymorphism is widespread in reptiles. However, colour variation might also indicate important underlying genetic variation that indicates genetic isolation or even speciation. In southern Africa, Mole Snakes (*Pseudaspis cana*) are known to range in colour from pale

yellow-brown to black. Moreover, differences in colour pattern are known to correlate with hemipenal morphology in at least some populations, resulting in speculation of potential taxonomic differences among colour patterns. In this context, we aimed to explore geographical variation in *P. cana* colour. We specifically asked whether the variation in colour represents a simple geographical gradient, whether extremes of colour variation occur sympatrically, and if so, can we identify such geographic regions to target for genetic sampling? We downloaded 809 Research Grade *P. cana* records from iNaturalist and scored each for the presence of patterning (marked vs plain) and colour (using a five-category colour scale ranging from very pale to black). In total, we were able to score 548 records of plain snakes. We mapped colours to their geographic locations and assessed the resulting patterns visually. We showed that although there is an overall colour gradient running along a SW to NE axis, most regions host both light and dark coloured individuals. We showed that extremes of colour variation can be found in close proximity to one another, particularly in the Kalahari, ranging from Kgalagadi Transfrontier Park eastwards to Mahikeng, and northward through central Botswana. We recommend that a thorough genetic analysis of *P. cana* take place, including sampling from geographic regions with extreme variation in colour. Such a study would inform the taxonomic status of these animals, but also provide a basis for understanding colour polymorphism in general.

A-0076 (Oral)

Molecular Mechanisms of Environmental Adaptation in an Island Endemic Lizard

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The ectothermic nature of reptiles makes them particularly vulnerable to environmental changes, of which we can observe behavioural and phenological shifts; however, the molecular processes that govern environmental adaptation are less understood. The Western-Canaries Lizard (*Gallotia galloti*) occupies a vast diversity of environments on the island of Tenerife, ranging from cool exposed high-altitude peaks to hot, low-lying coastal regions. This makes them an interesting system to explore the molecular processes underlying adaptation to different environments. We explored how different environmental conditions affect the expression of cellular protective proteins (heat-shock proteins) and related markers of oxidative cellular stress (protein carbonylation). We found that solar radiation-related stressors, in combination with microclimate, drive levels of these markers. We uncover a further

relationship with operative lizard temperature, demonstrating that thermoregulatory capacity is closely linked to these underlying biochemical processes. These protein-level responses may help buffer more rapid environmental changes, but ultimately for populations to persist, change must occur at the genomic level, for example, in sequences regulating the activity of these proteins (promoters). We used multiplex Oxford Nanopore sequencing to test for selection and evolutionary capacity at spatial and temporal scales in a subset of genes known for their involvement in vertebrate climate adaptation (https://www.odysyslab.org/cassandra.html). We found that selection acts differently on promoters than on downstream coding sequences. These results indicate conservation of protein-coding sequences, and the change in upstream sequence may impact gene regulation of these environment-responsive loci. This demonstrates the importance of non-coding regions in the genome when studying environmental adaptation.
In summary, we show that changes in gene regulation and protein expression govern responses to different climates within a widespread lizard species, providing insight into cellular stress mechanisms and evolutionary processes that govern resilience, or vulnerability, of reptile populations during the changing climate of the Anthropocene.

A-0077 (Oral)
Visual Communication in Reptiles and Amphibians – Integrative Approaches to Studying Function and Evolution

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The bizarre and elaborate visual displays that animals use to communicate have fascinated biologists for decades. Why do such signals evolve, and what pushes their evolution to such bewildering extremes? Many researchers have sought to address these questions by studying reptiles and amphibians, given that the species within these groups are known to perform some of the most spectacular visual displays on our planet. In recent years, we've seen a major rejuvenation in this work, as physiological and genetic approaches to understanding signal evolution and function have become a mainstay. The purpose of this talk is two-fold. First, it will survey the incredible diversity in visual displays among reptiles and amphibians, highlighting systems that are well studied and systems that are not (but equally fascinating from a signaling perspective). Second, this talk and the symposium that follows will start a conversation about the way integrative approaches to studying display behavior can further enrich our appreciation of visual signal evolution in reptiles and amphibians. Our goal is to emphasize the powerful role that herpetological research can have on future studies that attempt to delineate evolutionary principles of signal design in the animal kingdom.

A-0078 (Oral)
What Makes a Snake Bite? A South African Perspective

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Snakebite is a public health challenge that has a substantial impact on humans and snakes. While considerable investments have been made in the treatment of snakebite, our knowledge on the ecology of snakes in relation to snakebite is low. Millions of people are affected by snakebite globally, particularly in rural areas and in South Africa this number is in the thousands. Historically, case studies on snake bites have only been published by medical professionals and few scientists, however most snakebite cases are not published. We reviewed past and present literature on snakebite in the South African context and compared this to known bite incidences from personal accounts, hospital records and a national snakebite database. We also discuss the behavioural ecology of several medically important venomous snakes in South Africa and the likelihood of these snakes to bite people from experimental procedures conducted using a fake arm model. The results from the literature indicate that while many venomous snakes are featured in the snakebite literature, there are also numerous bites from non-venomous snakes. We discuss various bites and the circumstances under which people have been bitten and the corresponding snake behaviour that may have led to the bite. Our behavioural experiments further show that snakes are less likely to bite if they have the option to flee but if aggravated consistently, they will bite to defend themselves. To prevent snakebite, it is pertinent that we learn about the situations that lead to snakebites by gaining more insight on the activity and behaviour of not only medically important snakes but also other snakes that feature in snakebites.

A-0079 (Poster)

Parturition of a Rear-fanged Rainbow Water Snake (*Enhydris enhydris*) Involved in Snakebite and Effects of its Envenoming in Nepal

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Based on a specimen preserved in the snakebite treatment center in eastern Nepal, I analysed brief life history (i.e., litter size, and parturition date) of *Enhydris enhydris*, effects of its envenoming, and human impact on its populations. My record of its parturition suggested high reproductive potential. Its bite to a man walking on the road caused no ill-effects. These findings can be a basis for assessing conservation status and options for its conservation as well as prehospital care and prevention of its bites.

A-0080 (Oral)

The Clot Thickens: Insights on Ontogenetic and Geographic Venom Variation in a Mexican Rattlesnake

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Rattlesnakes are a diverse clade of pit vipers that consists of numerous medically significant species. We used validated *in vitro* assays measuring venom-induced clotting time and strength of any clots formed in human plasma and fibrinogen to assess the coagulotoxic activity of the

medically relevant Northwestern Neotropical rattlesnake (*Crotalus culminatus*) from Mexico. This species was previously shown to possess a strong ontogenetic coagulotoxicity dichotomy (neonates are strongly procoagulant via metalloprotease-induced Factor X activation whereas adults tend to lose this trait). We also assessed the neutralization of these venoms by three antivenom products and three metalloprotease inhibitors to provide knowledge for the design of evidence-based treatment strategies for envenomated patients. We found a previously unknown geographic component in venom variation, with the ontogenetic trend being stronger in the state of Morelos compared to Guerrero and Michoacan. Neither geographic provenance ontogeny proved significant in explaining venom variation, as did not the combination of the two. Overall, none of the antivenoms succeeded in neutralizing the potent procoagulant toxic action of neonate *C. culminatus* venom, highlighting limitations in snakebite treatment for this species. However, the metalloprotease inhibitors Prinomastat and Marimastat substantially thwarted the procoagulant venom activity, while 2,3-dimercapto-1-propanesulfonic acid (DMPS) was much less effective. Our results highlight an exceptionally complex pattern of venom variability in a scarcely investigated rattlesnake species and its apparent lack of definitive correlation to common drivers of variation (age and geography) in these vipers.

A-0082 (Oral)

Linking Physiology and Climate to Infer Species Distributions in Australian Skinks

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Climate has a key impact on animal physiology, which in turn can have a profound influence on geographic distributions. Yet the mechanisms linking climate, physiology, and distribution are not fully resolved. Using an integrative framework, we tested the predictions of the Climatic Variability Hypothesis (CVH), which states that species with broader distributions have broader physiological tolerance than range-restricted species, in a group of Lampropholis skinks (8 species, 196 individuals) along a latitudinal gradient in eastern Australia. We investigated several physiological aspects including metabolism, water balance, thermal physiology, thermoregulatory behaviour and ecological performance. Additionally, to test if organismal information (e.g., behaviour and physiology) can enhance distribution models, hence providing evidence that physiology and climate interact to shape range sizes, we tested if species distribution models incorporating physiology better predict the range sizes than models using solely climatic layers. In agreement with the CVH, our results confirm that widespread species can tolerate and perform better at broader temperature ranges than range-restricted species. We also found differences in field body temperatures, but not thermal preference, between widespread and range-restricted species. However, metabolism and water balance did not correlate with range size. Biophysical modelling revealed that the incorporation of physiological and behavioural data improves predictions of *Lampropholis* distributions compared to models based solely on macroclimatic inputs, but mainly for range-restricted species. By integrating several aspects of the physiology and niche modelling of a group of ectothermic animals, our study provides evidence that physiology correlates with species distributions. Physiological responses to climate are central in establishing geographic ranges

of skinks, and incorporation of processes occurring at local scales (e.g., behaviour) can improve species distribution models.

A-0083 (Oral)
Genes under Selection due to Bd

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With an ever-growing number of amphibian species being affected by *Batrachochytrium dendrobatidis* (Bd), research into this parasitic fungus and how it impacts wild amphibian populations is crucial for the preservation of the taxa as a whole. Our understanding of Bd and its interaction with amphibians has increased with much of the focus on the distribution and limitations of the fungus itself. With regards to amphibian response to Bd, the majority of studies attend to immune responses of species. However, the Alpine tree frog (*Litoria verreauxii alpina*) has shown no resistance to Bd, yet populations are able to persist despite an almost 100% infection rate in adults and a low infection rate in juveniles. Thus, recruitment of new individuals plays an important role in maintaining population levels. Molecular analyses in many taxa have shown that genes and proteins involved in reproduction are rapidly evolving and subject to positive selection. In several cases, nucleotide variation within and between species suggest that selective pressures have promoted the divergence of reproductive proteins. With the decrease in generational length and increase in selection for reproduction caused by Bd within the *L. v. alpina* system, this makes them a suitable candidate to observe reproductive selection at an accelerated rate. Historic samples were collected from the Melbourne Museum as well as from the field in 2013 and 2018 from populations that were both pre and post Bd introduction, some of which were Bd endemic for >25 years. These samples were then sequenced using high-coverage DArTseq™ in order to locate loci under selection. With this data, we expect to find reproductive genes under positive selection due to endemic Bd within populations.

A-0084 (Oral)
Burrowing in Snakes: a Comparative Study on the Performance and Mechanics of Snake Burrowing

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Snakes are an incredibly diverse lineage of squamates that have radiated into a great diversity of habitats from a possibly fossorial ancestor. Fossoriality imposes strong constraints on obligatory head-first burrowers and this has been suggested to have impacted the

morphological evolution of both head and cranial shape. The strength of constraints on head shape likely depend on the taxon and burrowing style but quantitative data on the forces exerted during burrowing or the kinematics of burrowing remain scarce. Preliminary data suggested that typhlopid snakes were capable of generating higher forces than other snakes for a given size and body diameter but taxon sampling was limited. Here, we present data on the three-dimensional burrowing forces for 26 species of snakes distributed across most major lineages. We further present the first X-ray data on the kinematics of locomotion through tunnels and soil for a subset of species including sand swimmers (*Eryx*) and true burrowers (*Anilius, Xenopeltis, Cylindrophis, Homalopsis* and *Aspidelaps*). Our data show significant differences in maximal resultant forces and force orientation in different species. Moreover, our kinematic data show that sand swimmers are unique in showing kinematics of subsurface locomotion similar to those observed in snakes swimming in water. Finally, we show that some snakes such as *Anilius* are capable of performing internal concertina locomotion documented previously only for caecilians. Overall our data shed new light on the diversity of burrowing performance and kinematics in snakes and help understand the evolution of this lifestyle and its constraints on form and function.

A-0085 (Oral)

Exploration of Adaptive Radiation Factor in Mimetic *Ranitomeya* of Amazonian Peru

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We investigate why some species, diversify into multiple forms while others do not. We focus on the exploitation of new ecological niches, mimetic circles, sexual selection, and genetic architecture among mimetic Peruvian poison dart frogs of the genus *Ranitomeya*. Despite strong selection on their warning signals, significant variation exists within *Ranitomeya* populations. Our findings illustrate complex speciation mechanisms in these frogs and contribute to broader evolutionary theories. We demonstrate rapid speciation through postzygotic barriers, aligning with Haldane's rule. We highlight the dynamic interplay of genetic variation, founder effects, behavioral factors, and genetic barriers in the diversification of warning signals and speciation. These insights underscore the dynamic nature of evolutionary biology, highlighting how standing genetic variation, founding effects, immediate behavioral factors, and genetic barriers contribute to the diversification of warning signals and rapid speciation in *Ranitomeya* frogs and provide new perspectives on evolutionary processes.

A-0086 (Oral)

How does Global Change Impact the Neotropical Poison Frog *Dendrobates tinctorius*?

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Global change is deteriorating the status of amphibians worldwide, driving population declines both in developed and pristine areas. Factors such as habitat disturbance, infectious disease and pollutants are identified as some of the main drivers. However, the impacts of these stressors are often analysed independently, missing potential interactions and synergic effects in the wild. The Neotropical poison frog *Dendrobates tinctorius* is a protected species facing multiple challenges simultaneously. For instance, artisanal and small-scale gold mining (ASGM) has become a major threat for Neotropical forests by driving small-scale deforestation and increasing dramatically mercury (Hg) emissions to both the atmosphere and freshwater systems. We found high Hg concentrations in phytotelmata, the aquatic microenvironments D. tinctorius use as tadpole-rearing sites (mean ± SD: 1.43 ± 2.19 ppm) in six locations across its natural range. In 17% of the cases, Hg concentrations were above the severe effect level (SEL = 2 ppm) for freshwater sediments, and tadpoles were found in pools with concentrations up to 8.68 ppm. This suggests that *D. tinctorius* fathers do not avoid pools with high Hg levels for tadpole deposition. Hg levels tended to increase in proximity to ASGM sites and to reduce the body condition of tadpoles from later developmental stages. At the same time, we found adult individuals infected with *Bactrachocytrium dendrobatidis* (Bd) in all populations, although with different prevalence of infection. Probability of infection was higher in females than males and decreased with increasing body size. Interestingly, Bd prevalence was also negatively correlated with Hg pollution levels measured in the phytotelmata of each population. Although we cannot draw any conclusions from this correlation, we highlight the need for further studies investigating the implications of Hg concentration for tadpole development, as well as the potential role of Hg in host-Bd infection dynamics through its possible fungicidal effect.

A-0087 (Oral)
Gene Flow Confounds Species Estimation and Phylogenetic Inference

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In cryptic amphibian complexes, there is a growing trend to equate high levels of genetic structure and mitochondrial divergence with hidden cryptic species diversity. Typically, phylogenetic structure and distance-based approaches are used to demonstrate the distinctness of clades and justify the recognition of new cryptic species. However, this approach does not account for gene flow, spatial, and environmental processes that can obfuscate phylogenetic inference and bias species delimitation. As a case study, we used genome-wide target-capture sequencing to evince the processes that underlie the diversification of Fanged frogs from the *Limnonectes kuhlii* complex in Borneo.

A-0089 (Oral)
Iguana Detection Canine: Meeting the Challenges of Training Canines to Detect Rare Species

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The Anegada Rock Iguana, *Cyclura pinguis*, is a critically endangered lizard species on the island of Anegada, British Virgin Islands. Through a collaborative partnership between the Fort Worth Zoo and the National Parks Trust of the Virgin Islands a headstart program was established on the island to mitigate the negative effects of feral cats on juvenile iguanas. It is supported by researchers conducting surveys to locate iguana nest sites, protect them with metal barriers, and collect the hatchlings. Hatchlings are taken to a captive facility and raised for approximately three years before being released to the wild. A significant issue in the process is locating iguana nests, which are underground and provide minimal signs of their existence. To aid in the nest entrance location, a canine, Pena was trained to search likely nest areas to assist in the location of the nest entrances. Additionally, she was trained to detect and locate hatchlings. Due to the unique way iguanas constructed their nests and the lack of training samples (nest material) to train the canine on, protocols had to be developed to meet the challenge of training Pena. Also, as no *Cyclura pinguis* hatchlings were available within the USA to train Pena, unique training devices were developed to enable her to be trained on Anegada in the first couple of days after arriving on the island. In this presentation, Paul Bunker, the trainer, and Kelly Bradley, the handler, will discuss the specific challenges in training and deploying an iguana nest and hatchling detection canine.

A-0092 (Oral)
Ontogenetic Color Shifts in Antipredator Camouflage in Wallace's Flying Frogs

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Several anurans change their body coloration slowly and permanently between life stages. In the Wallace's flying frog, (*Rhacophorus nigropalmatus*) juveniles are striking bright red, and they develop conspicuous white spots after metamorphosis. However, in adulthood, individuals are cryptic emerald green. We hypothesize that this change in body coloration represents an ontogenetic shift in antipredator camouflage strategy. Accordingly, we expect that the combination of bright red and white spots in juvenile frogs helps individuals masquerade as bird or bat droppings, so that predators misidentify them as inedible objects. We tested this idea with differently colored wax models—red with white spots, red without white spots, green, and unpainted—and placed them in equal numbers within a > 800 m^2 rainforest house at the Vienna Zoo. This environment closely resembles the Bornean rainforest, and it includes several free-living species of avian predators. The attack rate was greatest for red model frogs but was reduced by half when red models had white spots. Thus, juvenile coloration, particularly the white spots, acts as visual feature that turns an otherwise highly conspicuous individual into a surprisingly camouflaged one. This strategy provides similar protection to the cryptic green color of adults, which can also be dynamically adapted. We therefore find that body colorations provides two distinct—but equally successful—antipredator defence strategies potentially driven by environmental and natural selection factors the frogs experience in different habitats at different life stages.

A-0094 (Oral)
Dynamic Color Change Promotes Mate Recognition by Co-opting "Flight or Fight" Responses

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Many frogs and toads are explosive breeders, meaning that large groups of males suddenly come together to compete for limited breeding opportunities. In some species, males that engage in such behavior rapidly and dynamically change their color. Male Asian Common toads (*Duttaphrynus melanostictus*), for example, change body coloration from brown to bright yellow during their short breeding period. We hypothesize that male yellow color is either a male quality signal influencing mating success and/or a male-male signal promoting mate recognition. To test this idea, we measured male body color of mated and non-mated males in their natural habitat and correlated the coloration with body condition. In behavioral experiments, we tested the interactions of male toads with a yellow (resembling a breeding male) and a brown (resembling a female) 3D model toad. Mating success was not influenced by color and/or body condition. Males, however, avoided yellow rivals and had twice as much physical contact with brown models, clasping them ≈ 40x more often. From a mechanistic perspective, we found that the catecholaminergic hormones epinephrine and/or norepinephrine cause the toads' skin to become yellow in minutes, even in the absence of sociosexual and environmental cues associated with explosive breeding. Together, our results suggest that dynamic yellow coloration evolved as a visual signal to mediate fast mate recognition in dense breeding aggregations by co-opting the functional effects of flight or fight responses.

A-0097 (Oral)
Assessment of the Occurrence and Impacts of *Batrachochytrium dendrobatidis* Infection in the Highly Threatened Andean Water Frogs (*Telmatobius* spp.)

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Amphibian chytridiomycosis, caused by the fungal *Batrachochytrium dendrobatidis* (Bd), has been associated with the most significant biodiversity loss due to a single pathogen. Among Bd-affected amphibian populations is the genus *Telmatobius*, which includes 61 aquatic and threatened species distributed across the tropical Andes of South America. To assess the impacts of Bd in *Telmatobius* species, an epidemiological study was conducted using Bd prevalence and infection intensity data. The study analyzed quantitative real-time PCR data of 2,618 *Telmatobius* individuals sampled from 2000 to 2021, comprising 18 species distributed in six ecoregions. The information came from scientific literature (n = 2,202) and a set of unpublished data (n = 416) generated by the authors. Overall, the prevalence of Bd was found to be 49% (CI:47–51%), and it was greater in tadpoles than adults (52%, CI:49–54% vs. 42%, CI:39–45%; $x^2 = 23.1$, $p<0.01$). The Central Andean Puna showed a higher Bd prevalence (61%, CI:57–65%) compared to other ecoregions ($x2 = 291.08$, $df = 5$, $p < 0.01$). Infection intensities ranged from 0 to 11,600 genomic equivalents (GE) in tadpoles and from 0 to 101,861 GE in adults. Among infected frogs, 95% had low (0.01–999 GE), 4% had moderate (1000–9,999), and less than 1% had high Bd loads (≥ 10,000 GE). The Central Andean Wet Puna (583 [GE], CI:81.4–1,085) had the highest mean Bd infection intensity between ecoregions (Kruskal-Wallis $x^2 = 208.62$, $df = 5$, $p < 0.01$). At the species level, *T. chusmisensis* (1,895 [GE], CI:902–2,888) exhibited higher Bd loads, followed by *T. culeus* (632 [GE], CI:0–1,390) and *T. marmoratus* (587 [GE], CI:0–1,180). This study is the first to assess the impacts of Bd in the family Telmatobiidae, providing essential information to identify affected species and ecoregions to guide mitigation strategies of Bd in this highly threatened amphibians. The study was funded by Fondecyt Regular 1211587.

A-0098 (Oral)
Heterogeneity of Chytrid Infection in the Wake of Extreme Climatic Events

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The disease chytridiomycosis, caused by *Batrachochytrium dendrobatidis* (Bd) has swept through amphibian communities worldwide. As a fungal pathogen of ectothermic hosts, Bd occurrence is particularly influenced by environmental factors. We examined the influence of environmental conditions on Bd infection patterns across populations of Fleay's barred frog (*Mixophyes fleayi*), a recovering species in the rainforests of eastern Australia. We sampled the species' complete geographical distribution and conducted surveys four times within a 10-month period. Three consecutive survey periods coincided with unprecedented droughts, heatwaves, and heavy rainfall in Australia. This allowed us to assess the impact of compound extreme climatic events on host-pathogen dynamics. A total of 509 post-metamorphic *M. fleayi* were sampled, and Bd prevalence ranged from 0 to 85% per stream. Infection prevalence varied seasonally, with minimum values at early Austral summer during prolonged drought, and intensifying two months later, after flooding rainfall. Conditional inference trees showed Bd prevalence spiking when long-term cumulative rainfall increased, weekly humidity was below

83% , and weekly radiation was low. Low cumulative rainfall and warmer water temperatures during droughts resulted in reduced prevalence detected despite lower capture rates during this time. On average, chytrid load fluctuated across streams, and animals at higher elevation had higher loads. Loads of high impact on survival occurred mainly in streams at high elevations under increased rainfall and once frogs had lower Body Index. We showed that across the distribution of a recovering but still endangered host species, patchy environmental conditions mediated heterogeneity in infection levels. More broadly, our results are consistent with the mounting evidence wildlife infection combined with extreme and back-to-back climatic events can seasonally disrupt the link between host and pathogen.

A-0099 (Poster)
New Methods to Monitor Tropical Riparian Ecosystems

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Riparia, complex ecotones between freshwater and land, exhibit unique biotic and hydraulic interactions. Disproportionately contributing to landscape function and biodiversity, these ecosystems support wide ecological processes, assemblages, and human health. Unfortunately, human activities have led to a severe global loss of riparian areas. Historically, conservation studies of these areas have been largely conducted in temperate climates, on hydrology and vegetation, with limited tracking of species occurrences, especially in tropical zones. Current conventional methods of sampling biodiversity have high labour, expertise and monetary cost associated with them, limiting their availability to projects with less funding or across large scales of time or space. Our project leverages new technological developments to build an assessment tool for riparian biodiversity; environmental DNA (eDNA) and Passive Acoustic Monitoring (PAM), two cutting-edge methods that are increasingly used to track biodiversity assemblages. We conducted paired eDNA and PAM over 7 months in 10 sites along tributaries and rivers linking the Cardamom Mountains to the Tonle Sap Lake in Cambodia. The Cardamom Mountains represents one of the largest, most diverse, and least developed remaining evergreen rainforests in mainland Southeast Asia. Alongside passive data collection, genetic and voucher specimen reference libraries will be built during joint surveys with the Cambodian Royal University of Agriculture Faculty of Fisheries, to sample riparian biodiversity and contribute towards the building of Khmer natural history collections. To determine the efficacy of these methods in tropical riparian ecosystems, we are conducting comparisons of eDNA and PAM, investigating their correlations to hydrological-based riparian health assessments, and evaluating if the combination of these methods track and classified riparian ecosystem health and services. Our results are aimed at both developing eDNA and PAM methodologies in tropical ecosystems, as well the creation of a biodiversity-based monitoring tool for riparian conservation tracking and prioritisation.

A-0100 (Oral)
Deciphering the Behavior and Personality of the Fringed leaf frog (*Cruziohyla craspedopus*)

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Animal personality is the set of behavioral differences presented by individuals of the same species that are stable in time and across different contexts. These behavioral syndromes are fundamental for understanding different aspects of the reproductive and survival capabilities. Even if personality and behavior remain underexplored in many families of amphibians, there is evidence that they show personality and behavioral syndromes along three behavioral axes: boldness, exploration, and activity. We studied these behavioral axes in fringed tree frog *Cruziohyla craspedopus* raised in laboratory conditions and in the wild. We predicted that most animals would be relatively shy. We recorded five situations: individual activity in their home tanks and in the field, exploration in an open field arena, risk-taking by exiting a shelter, stress response behavior and reaction to a new object. We observed *C. craspedopus* sleep during the day and are night active where they explore different features of their environment including plants, branches, and water pools. When exposed to a new environment, most individuals explored by climbing the walls of the arena more than other elements. In general, when frogs were placed in a shelter at the entrance of an arena, they left their shelter. When facing fear or stress, we observed an undescribed behavior where individuals inflate, place their front legs to the sides and raise their hinds and back legs. This behavior is complemented by a color change of the individuals and the emanation of an odor. Finally, most individuals used a new object (ramps) placed in the arenas, sometimes to help them to jump between places and others to just rest and even sleep. Contrary to our expectations, *C. craspedopus* is a bold species, but this depends on the social environment, as individuals tend to be either socially shy, but bold in isolation and vice versa.

A-0101 (Oral)
Following the Footsteps of Burmeister's Leaf Frog (*Phyllomedusa burmeisteri*) in the Atlantic Forest of Brazil

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Amphibians are organisms which mainly have a biphasic life cycle. When at the larval stage, their habitat is generally aquatic, and when adults, they become terrestrial. Pond-breeding amphibians are sensitive to some disturbances in their environment which lead to the decline of a population. The interactions between the species and their environment are performed through movement. Movement ecology combines and explains the movement data of organisms with biotic and abiotic factors and because of this, knowing the movement of these creatures is of great ecological importance. We used the spool-and-line methodology in individuals of the treefrog *Phyllomedusa burmeisteri*, at the Reserva Ecologica Michelin, located in the southern region of Bahia in Brazil to study their movement patterns in different environments inside and outside of the forest. We monitored 19 *P. burmeisteri* individuals that presented a mean total movement distance of 2160.76 cm (S.D. 1152.42). We found no significant difference in the trajectories of individuals in forested and open areas, as well as a positive relationship between the distances individuals moved and their weight only in forested areas. no relationship between distance and weight of these individuals. We observed that

individuals followed non-linear paths and the number of steps from one place to another varied among individuals. Our movement ecology data allows us to answer questions about short-term movement patterns of *Phyllomedusa burmeisteri*. This is the first step to start understanding the spatial cognition of treefrogs from the Atlantic Forest and to fill gaps about life habits of these frogs. Information on the movement patterns of a species, as well as its home range can help to create conservation strategies, regarding the creation or delimitation of protected areas, for example.

A-0102 (Oral)
Contrasting Nidification Behaviors Facilitate Diversification and Colonization of an Amphibian Group under a Changing Paleoclimate

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In order to cope with the complexity and variability of the terrestrial environment, amphibians have developed a wide range of reproductive and parental behaviors. Nest building, especially for mud nest construction, occurs in some anuran species as parental care. Species of the Music frog genus *Nidirana* are known for their unique courtship behavior and mud nesting in several congeners. However, the evolution of these frogs and their nidification behavior has yet to be studied. With phylogenomic and phylogeographic analyses based on a complete sampling of the genus, we find that *Nidirana* originated from central-southwestern China and the nidification behavior initially evolved at ca 19.3 Ma but subsequently lost in several descendants. Combined with population genomic analyses, our results further suggest that the nidification species have an older diversification and colonization history while those congeners within *N. adenopluera* complex that without nidification behavior have experienced a recent rapid radiation. The presence and loss of the nidification behavior in Music frogs may be associated with paleoclimatic factors such as temperature and precipitation. This study highlights the nidification behavior as a key evolutionary innovation that has contributed to the diversification of an amphibian group under past climate changes.

A-0103 (Poster)
Island Time: A Comparison of Reproductive Traits and Hatchling Growth Rates of *Podarcis siculus* Populations

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The Italian wall lizard, *Podarcis siculus* (Rafinesque-Schmaltz, 1810), occurs abundantly in peninsular Italy and across many Mediterranean islands, where it displays a remarkable variation in ecology, morphology, and behavior. Many of the observed phenotypic shifts fit the "island syndrome" hypothesis, with island lizards predictably differing from their mainland counterparts (e.g., in body size, skin coloration, wariness, etc.). Despite the putative importance of life-history trade-offs within this framework, differences between mainland and island populations in reproductive traits have not yet been described for this species. In this study, we compared clutch size, egg size, neonate dimensions, and hatchling growth rates of mainland and island populations of *P. siculus*. Our results are consistent with the island syndrome, as island lizards laid smaller clutches of bigger hatchlings compared to mainland lizards. The number of clutches did not differ between island and mainland populations within this timeframe, however, the island eggs had a much lower hatching success compared to the mainland eggs. In addition, island hatchlings had a slower growth rate compared to mainland hatchlings, resulting in equal body sizes after merely 1.5 months despite the initial difference in hatchling size. The key determinant possibly underpinning this phenomenon would be the increased intensity of intra-specific competition on islands, selecting for larger offspring sizes because of competitive advantage and slower juvenile growth because of limited resources.

A-0104 (Oral)

Phylogeographic Barcoding as a Powerful Tool for Biodiversity Inventory: an Application to the Snakes from Morocco

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The use of DNA barcoding for species identification has increased over the years. However, its potential for investigating and distinguishing intraspecific genetic diversity remains largely unexplored. The Maghreb region (North Africa) is a hotspot of reptile diversity, yet the number of evolutionary lineages is highly underestimated as a result of limited surveys as well as due to the occurrence of several cryptic lineages that can only be identified by molecular tools. Furthermore, often molecular studies used different markers making comparisons and compilation of results across studies very difficult. In this study, we applied the DNA barcoding approach to compile a cox1 reference database for the identification of snake specimens from Morocco at the species level but also at the evolutionary-lineage level. We obtained sequences of up to four mitochondrial markers (12S, 16S, nd4, and cytb) plus the barcode marker cox1 from multiple (1–14) individuals representing 20 snake species and 27 evolutionary lineages. Sequences were compared with earlier phylogeographic studies to assign individuals to evolutionary lineages and compile a cox1 reference library for evolutionary lineages identification including 106 newly generated sequences and 666 cox1 sequences from GenBank and BOLD. The reference library was assessed against threshold optimization and barcoding gap analysis methods and experimentally validated for the identification of 27 roadkill snakes at species and at evolutionary-lineage level. The phylogeographic DNA barcoding tool developed in this study allowed an accurate description of snake diversity in Morocco at a high-resolution phylogeographic scale and provides a robust and universal (i.e. cox1-based) reference library to map the distribution of evolutionary lineages, the location of contact zones, and the occurrence of new cryptic lineages. Such an approach facilitates

knowledge building and cross-studies comparisons, generating a promising tool for biodiversity studies on elusive and rare species as well as in remote and under-sampled regions.

A-0106 (Oral)
Snake Farming: Towards Sustainability, Quality and Community

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Snake venoms are starting materials for antivenom production, research and biologically active substances. A large number of snakes are needed for venom extraction to supply the high demand for antivenom production for Thailand and other countries. The complete reproduction cycle of snakes can reduce the introduction of snakes from nature which benefits conservation and provides sustainable use of this natural resource. Quality systems snake farm has become an important entity in raising snakes in captivity to assure sufficient and high-quality venom supply with traceability, reproducibility, taxonomic accuracy and cover the venom variability. A well-designed husbandry area with a complete veterinary health record for snakes is needed. The quarantine period is performed before introduction into the farm. Parent stocks of each species are selected and paired in the correct breeding season leading to high production of eggs or offspring. The high percentage of hatchlings is related to conventional artificial incubation. The juveniles are raised with the proper food and care. The health of all snakes is monitored by trained snake handler and veterinarians. With optimal care, snakes can yield good venom quality and quantity. Appropriate diagnosis and treatment of illness can prolong the snake's lifespan in captivity. Currently, the Institute raises approximately a thousand snakes of fifty species for venom production, research and community education. The educational museum and workshop on basic snake handling and proper snakebite first aid are recognized community engagement programs. Better understanding of snakes and how to respond when confrontation will help to prevent snakebites. The correct snakebite first aid can reduce loss from envenoming. In conclusion, the institute gathers a hundred years of experience to develop sustainable and quality use of snakes and their venom then transfers the practical knowledge about snakes to the community that will help to prevent snakebite and reduce loss from envenomation.

A-0107 (Oral)
The Behavioral Component and Neuroendocrine Responses of Hooding Defensive Repertoire in Monocled Cobra (*Naja kaouthia*)

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The hooding defensive repertoire of cobra is one of the most distinct antipredator behavior which can be provoked by natural predators as well as human. Cobras have been raised in captivity for various purposes, of which the antivenom production and venom research are scientific endeavors that cannot avoid provocation of hooding defensive behavior. Numerous studies have focused on behavioral patterns and the functional morphology of their hoods but the detailed interaction between the hooding repertoire and the neuroendocrine system is

limited. The objective of the present experiment is to study the behavioral pattern of hooding displays and the possible physiological responses of neuroendocrine of HPA axis activation after provocation in captive cobras. The experiment was carried out in three parts; the first part investigated the effect of human provocation on plasma corticosterone (CORT) and arginine vasotocin (AVT) after provocation, the second part compared the chronological pattern of CORT and AVT, and the last part investigated the effect of provocation on body temperature. The restrain-induced stress model was used for comparing with provocation. The defensive behavior from the first and second experiments was recorded and used to analyze the relationship between behavior and stress hormones. Plasma CORT and AVT were measured by commercial ELISA kit test. Body temperature was obtained by implanting a thermosensitive microchip intracoelomically. The results found that during provocation cobras displayed hooding defensive repertoire consist of two components, the primary component as increased apparent size includes vertical posturing, hooding and primary hissing. The second component as bluff charge includes secondary hissing and striking. Meanwhile, the human provocation could activate HPA axis by increased plasma CORT but not AVT and the pattern of activation is different from the standard model of restraint-induced stress. There was no correlation of any pattern of hooding defensive repertoire with stress hormones.

A-0109 (Poster)

Same Same, but Different – A Holistic Examination of Convergent Evolution in Frogs

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In this project, we aim to study convergent evolution in frogs on a large scale. Not only are there plenty of striking examples of species resembling each other or showing highly specific similarities in lifestyle, but even whole groups of frogs developed intriguing morphological and life history traits parallel to others, not related ones, in apparently similar niches. Some species on opposite sides of the globe display exceedingly similar color patterns and call phenotypes. To study the processes and drivers of evolving these traits, we will build a large multi-variate global database of as many species as possible. This will include morphometrics and coloration, call-data, life-history, and habitat data and will allow to define potential morpho-types of frogs. By identifying and comparing morpho- with eco-types and contrasting these with phylogeny it should be possible to disentangle eco-evolutionary drivers from a phylogenetic frame. As especially ecological data is lacking or unpublished for many frog species around the world, we seek and call for the contribution of interested people and groups and thus openly invite for collaboration.

A-0111 (Oral)

A Comparative Study of the Herpetofauna between Pristine and Anthropogenically-modified Habitats at Cameron Highlands, Pahang, Peninsular Malaysia

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Habitat destruction and modification have been some of the greatest threats affecting biodiversity worldwide. In Peninsular Malaysia, Cameron Highlands (CH) is one of the most heavily impacted upland areas due to agriculture activities. A comparative study of the herpetofauna in opposing habitats was conducted at CH from December 2021 to November 2022, where two pristine (PS) and two anthropogenically-modified sites (MS) were selected for study. A total of 802 individuals from 29 species (17 frogs, five lizards and seven snakes) were recorded. Out of the 29 species, 12 species were found only from PS, seven species only from MS, and ten species from both PS and MS. The amphibian diversity is highest at Strawberry Park Trail with a Shannon-Wiener Diversity Index (H') of 1.868, while the reptile diversity is highest at Robinson's Fall (H'=1.846), of which both are PS. Vegetable farm surprisingly has a high amphibian diversity (H'=1.515), but the majority of the individuals were observed along the forest edge instead of within the farming plot. These observations indicate that modified habitat for farming becomes less suitable for amphibians. Both amphibian and reptile diversity are lowest at MARDI (H'=1.075 and 0.353 respectively), due to the domination of three commensal species, *Duttaphrynus melanostictus, Polypedates leucomystax* and *Gekko monarchus*. The results generally show that PS has a higher species richness and diversity compared to MS. Besides that, more common and disturbance-tolerant species were observed from MS, while more endemic species such as *Limnonectes nitidus, Leptobrachella kecil, Asthenodipsas lasgalenensis* and *Trimeresurus nebularis* were observed from PS. Logging and habitat destruction of upland areas in Peninsular Malaysia are ongoing and becoming more extensive. More studies on the impacts of habitat destruction and modification on the herpetofauna community must be conducted in order to develop effective conservation strategies before it is too late.

A-0113 (Oral)

The Efficacy of Acoustic and Visual Cues as the Lure for Invasive Herpetofauna Control in South Korea

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Invasive species pose a significant threat to native ecosystems worldwide, impacting the environment, economy, and human health. Commonly employed methods to mitigate their impact include traps with baits or lures. Effective trapping lures play a crucial role in controlling invasive species populations and minimizing their ecological impact. The American bullfrog (*Lithobates catesbeianus*) and the Red-eared slider (*Trachemys scripta elegans*) are notorious invasive species around the world. However, mass trapping for these two species is still lacking in the long-term invasive species management. Our study assessed the attractiveness of conspecific calls to American bullfrogs and the efficacy of four different trap materials (tarpaulin, styrofoam, wood and plants) for capturing Red-eared sliders in the field. We found that male bullfrogs exhibit a higher susceptibility to traps compared to females. In comparison, traps equipped with conspecific calls did not show increased effectiveness in capturing bullfrogs. In the experiment of Red-eared sliders, we found that traps equipped with wooden materials significantly caught more turtles than those with other materials. Our study indicates that acoustic signals may not be highly effective in attracting bullfrogs in the wild. Instead, the success of trapping bullfrogs may be influenced more by selecting locations with a high density of bullfrogs. On the other hand, using the wooden material to construct the trap can improve the capture rate of Red-eared sliders, and potentially other invasive turtles. The results highlight the importance of tailoring lures to the animal's behaviour and the success of traps with lures in the management of invasive herpetofauna.

A-0114 (Oral)
Potential Evolutionary Convergence in Trophic Adaptations of Two Booidean Snake Lineages as Evidenced by Skull Morphology

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Booidean snakes are a diverse and widespread lineage with an intriguing evolutionary and biogeographic history. By means of cranial morphology and osteology, this study investigated the evolutionary convergence in the Neotropical genera *Boa* and *Corallus* on the one hand and the Malagasy clade comprising *Acrantophis* and *Sanzinia* on the other. We hypothesise that the mostly arboreal *Corallus* and *Sanzinia* present larger jaws and longer teeth to keep hold of the prey and resist gravity and torsional forces acting on their skull while hanging from branches, while terrestrial genera such as *Acrantophis* show thinner, more elongated jaws with shorter teeth because they can rely on the full length of their coils to immobilise and constrict the prey together with a substrate that supports the whole of their body. Overall, we highlight how booidean snakes can serve as intriguing subjects for the study of contingency, determinism, and opportunity in the evolution of distant lineages both phylogenetically and geographically. We also provide the first complete description of the skull of *Boa constrictor*.

A-0115 (Oral)
The Evolutionary Origins and Ecology of Parthenogenesis

in Enigmatic Neotropical Night Lizards (*Lepidophyma* spp.)

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Parthenogenesis, a kind of asexual reproduction which requires only females, is considered to be rare in amniotes, however, several lineages of squamate reptiles (snakes and lizards) have convergently evolved this mode of reproduction. Some species employ facultative parthenogenesis, primarily characterized by a fusion of the egg cell with a polar body at the end of meiotic cell division. In contrast, some species are obligately parthenogenetic and recent studies have shown that the most prevalent mechanism for this strategy is premeiotic endoreplication in the germ cells, resulting in clonal offspring. Obligate parthenogenetic reptiles are generally believed to be of a hybrid origin. Here, we study a genus of neotropical night lizards (Xantusiidae: *Lepidophyma*) from Central America, which might include the only obligatory asexual vertebrates of non-hybrid origin. Within this genus, there are species with frequent facultative parthenogenesis (*Lepidophyma smithii*), obligate parthenogenesis (*L. reticulatum*) and sexual reproduction with geographically restricted exclusively parthenogenetic populations (*L. flavimaculatum*). Using a combination of tropical fieldwork, genomic and cytological approaches, we aim to unravel the evolutionary mechanisms underpinning parthenogenesis in these enigmatic lizards.

A-0117 (Oral)
Evaluating Wetland Conservation Policies for the Conservation of Mugger Crocodile in Terai-Arc Landscape, Nepal, Using Spatially Explicit Population Simulation Model

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Multiple ecosystem services provided by the freshwater ecosystems make them one of the most productive for humans. However, these ecosystems are threatened due to numerous human-induced factors, which have led to the complete or local extinction of many wetland-dependent species and threatening others equivalently. Nepal is no exception to this trend and has lost a significant proportion of healthy wetland ecosystems, but only a few policy practices exist for their conservation. In this study, we evaluate the usefulness of these policies to support the conservation of a threatened crocodile, the Mugger crocodile, in the Terai Arc Landscape of Nepal using a spatially explicit individual-based population simulation model. We define multiple scenarios based on the management recommended by these policies, viz. wetland protection in protected areas only, forested areas, government-owned wetlands, and complete protection of currently identified wetlands. We estimated multiple demographic and dispersal parameters using available literature on related species and ran a population simulation model on a freely available program, RangeShifter 2.0, for 100 years over 20 replicates. We found that the crocodile population persisted for 100 years in all the scenarios, and the population at the end of the simulation was significantly higher in the scenario assuming total protection. The total protection scenario also showed significantly more dispersers. However, the total distance traveled by the dispersers was not different between scenarios. We conclude that better

protection of available wetland habitats will increase population sizes. Maximizing the conservation of wetlands increases the survival of dispersing individuals by creating multiple stepping stones for dispersal and greater availability of habitat patches to hold higher populations. But it might also lead to increased human-crocodile conflict. Integrating possible conflict management in wetland-related policies will promote co-existence in these wetlands.

A-0118 (Oral)
Conserving the Comoros Iguana (*Oplurus cuvieri comorensis*) in the Face of an Invasive Competitor

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The artificial introduction of non-native species can significantly impact native communities and ecosystem functioning. Island systems are particularly vulnerable to the negative effects of biological invasions. Peters's Rock Agama (*Agama picticauda*), a medium-sized lizard native to sub-Saharan Africa, is one such biological invader that has been artificially introduced to various regions globally. Since its introduction to Grand Comoro in the Comoros Archipelago in 1998, A. picticauda quickly established breeding populations and proliferated throughout the island. As a lizard of a similar ecotype, *A. picticauda* poses a potential threat as a non-native competitor to the Comoros Iguana (*Oplurus cuvieri comorensis*). Endemic to Grand Comoro and known from a single locality, *O. c. comorensis* is likely the most threatened vertebrate taxon in the Comoros Archipelago. As such, this timely study investigates the status of A. picticauda's spread (i.e., occupancy) on Grand Comoro, its potential impact on the vulnerable *O. c. comorensis* (i.e., competitive potential between the two lizards), and the population status of *O. c. comorensis* (i.e., occupancy and abundance). Here, we present results from the first-ever targeted surveys for *A. picticauda* and *O. c. comorensis* on Grand Comoro conducted in 2022 and 2024. During our surveying, we collected novel occurrence records and tissues of both species in addition to establishing a mark-recapture program for *O. c. comorensis*. These tissues and data are being used to evaluate and monitor the population status of both lizards as well as predict the nature, intensity, and outcome of their potential trophic interaction using stable isotope analysis. This study provides novel information on *O. c. comorensis* population dynamics, trophic ecology, and major threats, which will be used to evaluate its extinction risk and develop a specific conservation management plan to safeguard the future of this unique lizard on Grand Comoro.

A-0119 (Oral)
The Forgotten Hotspot: 15 Years of Research into the Herpetofauna of the Comoros Archipelago

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The Comoros is an archipelago of four major oceanic islands in the Western Indian Ocean. Unlike Hawai'i, the Canaries, the Galápagos, and most other oceanic archipelagoes, the fauna of the Comoros remains poorly studied despite its high diversity and endemism. Today, reptiles may be the best-studied animal group of the Comoros. Reviewing my work of the last 15 years, I highlight the various biogeographic connections of the archipelago and the different colonization mechanisms of the past. Most reptile clades colonized the Comoros from the Northern tip of Madagascar, where the fast-flowing North-east Madagascar Current acts as an overseas dispersal 'conveyor'. Other ancestral species of reptiles colonized the Comoros from central western Madagascar, continental Africa, or the Eastern Indian Ocean. In addition to common intra-archipelago dispersal and speciation, I present possible evidence of several extinction events followed by, or following, (re-)colonization by closely related lineages from Madagascar. In the *Ebenavia inunguis* species complex of geckos, the clade inhabiting the Comoros is sister to all other extant lineages. Its estimated age is substantially older than the extant islands of the archipelago (13–20 vs. ca. 11 million years). Finally, the three species of frogs from the Comoros are among the comparatively few unambiguous examples of amphibian species endemic to oceanic islands.

A-0120 (Oral)
Evaluating Chytridiomycosis Susceptibility in Northern and Southern Corroboree Frogs

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Amphibian populations have been declining faster than any other group of vertebrates with more than 40% of species now threatened with extinction. One major cause of declines is the disease chytridiomycosis caused by the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (Bd). Southern Corroboree Frogs (SCF, *Pseudophryne corroboree*) are functionally extinct in the wild due to this disease, whereas populations of Northern Corroboree frogs (NCF, *P. pengilleyi*), still occur but are declining rapidly. These species are being bred in captivity to prevent extinction and for re-introduction programs. We aim to unravel the factors that contribute to disease resistance in NCF and SCF. We conducted an experimental study to assess the susceptibility of both species, and within NCF, we investigated the impact of age and population on susceptibility. Our approach involved exposing frogs to Bd, daily monitoring of clinical signs, and individual weekly assessment of Bd loads during the infection period. We hypothesize that there will be variations in susceptibility to chytrid within different age groups of NCF. Furthermore, variations in susceptibility will likely explain the differences observed among groups and populations within NCF, as well as between NCF and SCF. Notably, the genetic diversity within NCF could be linked to a reduced susceptibility compared to SCF. This insight is crucial for informing global efforts to combat chytridiomycosis and aid in the conservation of these rapidly declining amphibian populations.

A-0121 (Oral)

Experimental Drought Drives Shifts in the Composition of the Amphibian Skin Microbiome in a Tropical Frog under Fungal Disease Pressure

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Climate change-induced variability in rainfall patterns is anticipated to reshape ecological interactions between hosts and symbionts, potentially compromising organismal resilience to disease. Brazil's Atlantic Forest, an amphibian biodiversity hotspot, is likely to experience more droughts and higher rainfall variability with progressing climate and land-use change. Building on our prior research in this region, which identified skin microbiome disruption by drought as a key factor in chytridiomycosis-related die-offs of Brazilian pumpkin toadlets (Buttimer et al., in press), this study delves into the experimental assessment of the impact of rainfall exclusion on *Batrachochytrium dendrobatidis* (Bd) disease dynamics and cutaneous microbiome composition and putative function. To simulate climate-change-induced drought conditions, we subjected half of our forest-floor mesocosms to dry conditions by hanging translucent tarps over them. Each of the twenty mesocosms contained ecologically realistic densities of micro-endemic pumpkin toadlets *Brachycephalus pitanga* (eight individuals per enclosure). We identified individuals using their unique markings and collected skin swabs from the toadlets every two weeks for a total of twelve weeks, and implemented molecular techniques to measure Bd loads and characterize skin bacterial diversity and composition over time. The removal of tarps eight weeks into the experiment simulated a return to normal rainfall, with results indicating a potential resilience of the skin microbiome to drought. Our study provides valuable insights into the ecological implications of climate change on host-microbiome interactions in amphibians, emphasizing the importance of understanding how environmental disruption may impact disease susceptibility and overall survival in vulnerable species. Further analyses are underway to unravel the intricate dynamics between rainfall patterns, the amphibian skin microbiome, and disease susceptibility, contributing to a more nuanced understanding of the far-reaching consequences of anthropogenic climate change.

A-0122 (Oral)
Combination of Phylogenomic and Phylogenetic Approaches Helps to Resolve the Evolutionary History of Vipers

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With a worldwide distribution and diversification into almost 390 species, Viperidae is considered one of the evolutionarily most successful families of snakes. The group is of a broad scientific and public interest for its medical importance and is popular amongst reptile enthusiasts. The evolutionary success of the family is attributed to various key innovations; traits that have emerged throughout its evolutionary history that significantly contributed to increased rates of diversification. These include the distinctive solenoglyphous dentition, viviparity and heat-sensing pits found in the Crotalinae subfamily. In order to accurately assess the impact of these evolutionary novelties, it is essential to have a well-sampled and robust phylogeny. In this study, we have combined genomic data obtained from UCE (ultra-conserved elements) sequences with Sanger-sequenced loci to construct a robust topology that incorporates as many species as possible. The resulting tree encompasses 95% of the currently recognized species, with genetic data having been generated for several species for the first time. Subsequently, we then use the phylogeny to estimate diversification rates within the family and to examine its correlation with the emergence of key innovations and macroecological variables such as distribution area sizes, inhabited altitudes, and body size. As a result, this study provides insights into the evolutionary history and diversification patterns of viperids, shedding light on the factors that have contributed to its remarkable success as one of the most diverse snake families on the planet.

A-0124 (Oral)
Lizard Responses to Experimental Fire Regimes in an Australian Savanna

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Fire is a primary disturbance agent that plays a key role in shaping biodiversity in savanna ecosystems. However, the effects of different fire regimes on a major faunal group in tropical savannas, lizards, are still poorly understood. This hinders the development of appropriate fire management for biodiversity conservation. A controlled fire experiment at the Territory Wildlife Park in northern Australia has been running for 20 years, which provides an opportunity to study the long-term impacts of different fire regimes on lizards. We are using pitfall and funnel traps with drift fences to examine the effects of four fire regimes (burnt early in the dry season every one, three and five years, and unburnt) on lizard assemblages. In addition, we are conducting lab-based physiological experiments to examine if the physiological characteristics of species influence their responses to fire. Preliminary results indicate that the unburnt plots have the highest and the annually burn plots have the lowest number of lizard catches in wet-dry season trapping, but these results were reversed in the dry season. Annually burnt plots have the highest, and the 5-yearly burnt plots have the lowest total species richness. Different fire regimes seem to have little impact on overall species composition, but some species can be identified that favour frequently burnt or unburnt habitats. Preliminary results from the physiological experiments indicate that the thermal preferences of such species are consistent with their habitat selection. Species with higher

thermal preferences are recorded more frequently in burnt plots, while species with lower thermal preferences are recorded more frequently in unburnt plots.

A-0125 (Oral)
Deforestation Limits Evolutionary Rescue under Climate Change in Amazonian Lizards

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The impact of climate change on biodiversity is often analyzed under a stable evolutionary perspective focused on whether species can currently tolerate warmer climates. However, species may adapt to changes, and particularly under conditions of limited fragmentation, adaptive genetic variation can spread across populations tracking changing climates, a process termed evolutionary rescue. Here, we integrate genomic data, niche modeling and landscape ecology to predict range shifts and the potential for evolutionary rescue in a whiptail lizard (Teiidae: *Kentropyx calcarata*) broadly distributed across the megadiverse Amazonian rainforest. We use genome-environment association analyses to search for candidate loci under environmental selection, while accounting for neutral genetic variation. We then model the distribution of individuals with genotypes adapted to different climate conditions. Finally, we predict range shifts in distinct future climate change scenarios by integrating this information with dispersal constraints based on predicted scenarios of forest cover across Amazonia. We find that the potential for evolutionary rescue and, therefore, a smaller degree of range loss buffering extinction risk in the future is considerably high, provided that current forest cover is retained and climate change is not extreme. However, under extreme environmental change scenarios, range loss will be high in central and southern Amazonia, irrespective of the degree of deforestation. Our results suggest that protecting the Amazonian rainforest against further deforestation and mitigating climate change to moderate scenarios until 2070 could foster evolutionary rescue and prevent substantial biodiversity loss.

A-0127 (Oral)
Resistance Is Not Futile: Widespread Convergent Evolution of Resistance to Alpha-Neurotoxic Snake Venoms in Caecilians (Amphibia: Gymnophiona)

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Predatory innovations impose reciprocal selection pressures upon prey. The evolution of snake venom alpha-neurotoxins has triggered the corresponding evolution of resistance in the post-synaptic nicotinic acetylcholine receptors of prey in a complex chemical arms race. All other things being equal, animals like caecilians (an Order of legless amphibians) are quite vulnerable to predation by fossorial elapid snakes and their powerful alpha-neurotoxic venoms; thus, they are under strong selective pressure. Here, we sequenced the nicotinic acetylcholine receptor alpha-1 subunit of 37 caecilian species, representing all currently known families of caecilians from across the Americas, Africa, and Asia, including species endemic to the Seychelles. Three types of resistance were identified: (1) steric hindrance from N-glycosylated asparagines; (2) secondary structural changes due to the replacement of proline by another amino acid; and (3) electrostatic charge repulsion of the positively charged neurotoxins, through the introduction of a positively charged amino acid into the toxin-binding site. We demonstrated that resistance to alpha-neurotoxins convergently evolved at least fifteen times across the caecilian tree (three times in Africa, seven times in the Americas, and five times in Asia). Additionally, as several species were shown to possess multiple resistance modifications acting synergistically, caecilians must have undergone at least 20 separate events involving the origin of toxin resistance. On the other hand, resistance in non-caecilian amphibians was found to be limited to five origins. Together, the mutations underlying resistance in caecilians constitute a robust signature of positive selection which strongly correlates with elapid presence through both space (sympatry with caecilian-eating elapids) and time (Cenozoic radiation of elapids). Our study demonstrates the extent of convergent evolution that can be expected when a single widespread predatory adaptation triggers parallel evolutionary arms races at a global scale.

A-0128 (Oral)
Head Shape Evolution in Fossorial Lizards: Correlations with Substrate, From Development to Burrowing Performance

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The occupation of subterranean habitats is frequently associated with the evolution of elongated and limb-reduced phenotypes within Squamata. Snakelike bodies facilitate locomotion through the soil and represent a striking modification from lacertiform phenotypes

mediated by changes in developmental pathways. Fossorial lizards frequently use their heads to perforate the substrate and specific head shapes evolved in association with specific soil types. Sand-swimming lizards exhibit wedge-shaped snouts while leaf-litter dwellers evolved more conical heads. We investigate patterns of head shape evolution in association with burrowing substrate integrating two distinct but complementary perspectives. We focus on a neotropical family of lizards (Gymnophthalmidae) that comprises at least two independent origins of snakelike phenotypes in association with fossoriality. First, we evaluated the resistance of distinct substrates to different head shapes. We simulated head-first burrowing in three distinct soils using 3D-printed skull models obtained from ct-scan images of six gymnophthalmid species. Additionally, we investigated if molecular signatures in the coding region of Runt-related transcription factor 2 (Runx2) are associated with burrowing substrate. RUNX2 has a poly-glutamine and poly-alanine tandem repeat domain involved with rostral elongation. We sequenced this domain in multiple gymnophthalmid species and implemented phylogenetic comparative methods to test if the proportion of glutamine over alanine differs between species burrowing through distinct substrates. We thus integrate functional ecology and eco-evo-devo to better understand the evolution of seemingly convergent phenotypes associated with the occupation of subterranean habitats and its associations with subtle differences in their burrowing substrates.

A-0129 (Oral)
A Global Map of Morphological Diversity in Lizards

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Global gradients of biodiversity have been described for multiple taxa, including Squamata (lizards, snakes and tuatara). Previous studies demonstrated that these animals exhibit a latitudinal gradient of species richness, higher in tropical rather than temperate regions. Incongruencies with phylogenetic and functional diversity have also been evaluated at global scale, indicating that the diversity of Squamata needs to be further investigated. Overall, the distribution of morphological diversity remains largely uncharacterized because most research has so far relied upon a few restricted morphological traits, such as body size. In this study, we mapped the distribution of morphological diversity in lizards based on 18 morphological measurements representing head, trunk, limbs, and tail traits. Over 1,450 species were measured by a single person using a digital caliper during visits to herpetological collections, representing circa 65% of all extant genera of lizards. All living families of lizards (including amphisbaenians) were included in our study. Using this multi-trait morphological database, we generated a global map of morphological diversity for this group for the first time. We also mapped taxonomic and phylogenetic diversity and tested for correlations between these three biodiversity dimensions using spatial autocorrelation models. To explore potential determinants of morphological diversity distribution, we investigated how it correlates with local environmental conditions (temperature, precipitation, topography and habitat

heterogeneity), using phylogenetic comparative methods. This study contributes to our understanding of macroevolutionary and macroecological processes shaping the current distribution of lizard diversity. Moreover, by considering a multi-trait approach to characterize functional phenotypes that interact with their surroundings, it can also provide insights into projected impacts of climate change on biodiversity.

A-0130 (Oral)
Diversity, Conservation, and Persistence of Mexican Amphibians in an Age of Declines

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Mexico straddles the boundary between the Nearctic and Neotropical biogeographic regions and its diverse amphibian fauna contains significant elements of both regions. Mexico is notable for its high number of species of salamanders (159), second only to the United States in terms of overall salamander diversity. The majority of these species belong to the Plethodontidae, with an important radiation of Ambystomatidae in Central Mexico. Direct-developing terrestrial frogs and hylid frogs have diversified significantly, as have bufonids and ranids. Mexico's complex topography has resulted in high levels of species endemism (approximately 60%) and three genera of hylid frogs as well as six genera of plethodontid salamanders are endemic to the country. Over half of amphibian species in Mexico are threatened with extinction, including 18% classified as Critically Endangered. Threat levels are especially high in salamanders, with 82% of Neotropical plethodontid salamanders in Mexico classified as endangered. Destruction of habitats, especially of cloud forest, is a major cause of these declines; disturbance of aquatic habitat in the heavily populated highlands of Central Mexico has negatively impacted many ambystomatid salamanders and ranid frogs. Chytridiomycosis is suspected to have caused many population declines as well and has been documented in historic samples from many regions of Mexico. Despite these threats, no species of Mexican amphibian has yet been declared extinct and there have been several important rediscoveries in recent years of species feared extinct. The continuing description of amphibian species from Mexico, together with the high level of threat to most species, illustrate the urgency of continued research and need for increased conservation efforts in the country. No

A-0131 (Oral)
Waorani Anacondas: Ecotoxicology at the Crossroads of Conservation and Public Health

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The N. Green Anaconda (*Eunectes akayima*) has been recently discovered by us in the Orinoco basin of Amazon, revealing its genetic distinction from the S. Green Anaconda (*E. murinus*).

This underscores the Amazon's rich, but threatened biodiversity. The discovery highlights a need for conservation efforts due to its confined habitat and threats from environmental changes and pollution. The objectives of this study are- ascertain the conservation status and ecological significance of *E. akayima*; assess the bioaccumulation of petrochemical metals within the species; and understand the potential health implications for the anaconda and the Waorani people, who inhabit the same environment, and obtain all their food/medicine from the natural world. A detailed study was conducted in the Ecuadorian Amazon, home to the Waorani. Genetic analysis was undertaken to ascertain species-level divergence. Mass spectrometry of scales, undertaken to measure the bioaccumulation of the potent endocrine disrupting metals cadmium and lead, was measured in both sexes of the anaconda, to determine differential metal accumulation relative to predatory ecology. Dramatic disparities were found in metal accumulation between sexes. The massive females had lower levels, attributed to their diet of prey lower in the food chain. The much smaller, eel-like males showed over 1,000% higher concentrations of toxic metals due to a diet of higher trophic prey, suggesting ecosystem-level biomagnification. The N. Green Anaconda serves as an indicator of the Amazon's ecological health and the Waorani's well-being. The high levels of cadmium and lead are major hazards, particularly for foetal development in both animals and people. The marked biomagnification of metals in males signifies a severe ecotoxicological risk, necessitating integrated policies for environmental and community health protection. Preserving *E. akayima* intertwines with safeguarding the Waorani's health and heritage amidst ecological adversities.

A-0132 (Oral)

Defying Decline: Unique Infection Patterns in a Naturally Recovering Frog Species

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The Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*) has been a key driver of amphibian declines globally for the past forty years. While many impacted species continue to face ongoing declines and extinctions, there are instances of natural recovery, such as the whistling tree frog, *Litoria verreauxii*, in south-eastern Australia. In this study, we investigated potential factors facilitating the natural recovery of *L. verreauxii* by examining Bd prevalence and intensity in both adult and tadpoles. We examined three hypotheses: firstly, that tadpoles would have lower chytrid infection compared to adults; secondly, that warmer microhabitats during the spring season would lead to lower rates of chytrid infection in tadpoles; and thirdly, that the presence of abundant and diverse microfauna may indirectly mitigate chytrid infections by consuming chytrid zoospores. Our findings indicate that tadpole infection prevalence remained consistently low throughout our sampling period, across different developmental stages, with no clear effects of temperature or microfauna diversity or abundance. Our research underscores the intricacies of chytrid infection patterns and emphasizes the need for comprehensive investigations into amphibian chytrid infection dynamics across all life history stages within recovering and declining amphibian populations.

A-0133 (Oral)
Impact of Age and Chytridiomycosis on Longitudinal Gene Expression in Southern Corroboree Frog (*Pseudophryne corroboree*)

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The iconic Southern Corroboree frog (*Pseudophryne corroboree*), once abundant in alpine forests of Kosciuszko National Park, now hangs on the brink of extinction resulting from the spread of the foreign chytrid fungus, *Batrachochytrium dendrobatidis*. *P. corroboree* is currently reliant on captive breeding and reintroduction programmes, though persistence in the wild is grim since chytrid fungus is maintained on the landscape by the resistant Common Eastern froglet (*Crinia signifera*). To understand the immune response to the fungal pathogen we need to determine how infection effects gene expression. We collected toe clips from infected and uninfected *P. corroboree* of three different age classes at set time points. Toe clips will be used to sequence the transcriptome across disease progression to identify longitudinal changes in expression across early disease progression. We hypothesize that genes that experience differential expression post infection will play an important role in immune response to chytrid.

A-0134 (Oral)
Application of a Video Surveillance Framework for the Evaluating Disease Progression in Amphibians

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A key factor of addressing wildlife disease is understanding disease progression and susceptibility. Lab-based infection challenge studies are invaluable to determine disease mortality and treatment options. In challenge studies researchers are reliant on observing changes in behavior to assess individual health. However subtle changes in behavior can be difficult to consistently detect and measure in reptiles and amphibians, especially when there are multiple study animals and observers. Computational ethnology utilizing cameras and machine learning can be used to provide 24 hour observation of lab animals and provide constant quantification of behavioral changes. This can reduce observer bias and lead to earlier, more consistent detection of disease. This would allow for a better understanding of disease progression and help to reduce individual suffering by allowing earlier intervention. Southern Corroboree frogs (*Pseudophryne corroboree*) and *Batrachochytrium dendrobatidis* (Bd) (the

causative agent of chytridiomycosis) will be used to develop and assess the methodology and application, but this technique will be broadly applicable to other species and taxonomic groups and diseases such as snake fungal disease, *Ranavirus*, and other emerging diseases.

A-0135 (Oral)
Distribution of the Medically Important Snakes and the Availability of Antivenom in Vietnam: A Hospital-based Study

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Vietnam has over 240 species of snakes, of which approximately 60 are venomous. The World Health Organisation (WHO) has considered 22 species as medically important and categorised them into Category 1: Highest medical importance and Category 2: Secondary medical importance. However, this classification was only based on herpetological and epidemiological literature but did not include medical data, such as hospital admission of snakebite patients. The present study uses hospital data to inform the medically important snakes in all geographical regions of Vietnam. This study analyses data from a hospital-based study conducted at major provincial hospitals across Vietnam. The data was retrospectively collected from randomly selected medical records of snakebite-envenoming patients, including treatment practice and outcomes. The culprit snakes are identified based on the patients' narratives, clinical symptoms and lab results. Besides, the study also collected data on the availability and use of antivenom at the hospitals. The most medically important snakes of Vietnam are the Malayan pit viper (*Calloselasma rhodostoma*), green pit vipers (*Trimeresurus* species), cobras (*Naja* species) and kraits (*Bungarus* species). However, different regions yield different rankings of the medical importance of these snake species. Only two types of monovalent antivenom against *Trimeresurus albolabris* and *Naja kaouthia* are locally produced, and a significant number of hospitals do not have these antivenoms available. Antivenom against Malayan pit viper and *Bungarus* species are available in limited supply in one major hospital in Ho Chi Minh City in South Vietnam. This study provides a better understanding of the distribution of medically important snakes in eight different geographical regions of Vietnam. This might help allocate antivenom effectively for snakebite treatment. The lack of antivenom in many provincial hospitals leads to expensive and high-risk long-distance patient transfers.

A-0136 (Oral)
The Heat is on! Mild Winter Temperatures can Benefit Overwintering Wall Lizards (*Podarcis muralis*)

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Global climate change is altering winter conditions, resulting in warmer winters compared to summers. The impacts of warmer winters have, however, been consistently overlooked in climate change biology, particularly concerning ectothermic animals such as reptiles, which

face increased vulnerability due to their physiological reliance on ambient temperatures. Despite the importance of winter for reptiles, wherein they can allocate over half of their time budget in a dormant or half-dormant state to save energy in a period of low resources, the impacts of warming winters on their physiology and behaviour remain poorly documented. We conducted a brumation experiment using the Common Wall Lizard (*Podarcis muralis*) to monitor changes in body condition and behaviour under different winter temperatures. We collected lizards from Bournemouth (southern England) and overwintered them under three different temperature regimes: a cold winter (4 ± 1°C), a mild winter (8 ± 1°C), and a winter with fluctuating temperatures (5 days at 4°C, 2 days at 8°C). We found that lizards overwintering under mild winter temperatures experience reduced mass loss and increased response to light and tactile stimuli compared to other treatments. Moreover, we observed a high movement frequency, regardless of treatment. Our results indicate that a moderate rise in overwintering temperatures may benefit certain temperate reptiles, creating conditions that allow wall lizards to be more active and readily emerge from their light-sleeping state to forage and drink. Considering the Common Wall Lizard's introduced status in the UK, our findings may also hold implications for the potential expansion of non-native species in cooler climates as winter temperatures rise. However, the elevated activity levels found could lead to faster energy depletion that affects overall fitness. Further examination of the effects of warming winters on stress response and reproductive output is necessary to draw conclusive findings, which represent the next step of our study.

A-0138 (Oral)

Independent Origin or Single Dispersal? Phylogenetic Study Supports Early Cenozoic Origin of Three Endemic Indo-Sri Lankan Lygosomine (Reptilia, Scincidae) Skink Genera

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The Western Ghats-Sri Lanka biodiversity hotspot is home to three endemic Lygosomine (Reptilia, Scincidae) skink genera- *Kaestlea, Ristella* and *Lankascincus*. Phylogenetic reconstructions in the past have suggested a sister relationship between the Western Ghats endemic *Ristella* and the Sri Lankan endemic *Lankascincus*, while the placement of *Kaestlea* has been uncertain. We reconstruct a global, genus-level, multi-locus phylogeny of the sub-family Lygosominae to ask if these endemic genera share an immediate common ancestor, that is, did they arise from a single dispersal event? Furthermore, to understand the possible centres of origin and dispersal routes of these three genera of Indo-Sri Lankan skinks, we construct a time-calibrated phylogeny and perform ancestral range evolution. We find that *Kaestlea* does not share an immediate ancestor with *Ristella* + *Lankascincus*. Therefore, their presence in the Indian subcontinent results from two independent colonization events. Both these dispersal events likely occurred during the late Palaeocene-early Eocene from the Asian landmass. Our molecular dating and ancestral range evolution analyses add further evidence of probable transoceanic dispersal in skinks and early land connections between the Indian subcontinent and Asia. It also reveals that these skinks were some of the earliest lizards to disperse into the Indian subcontinent.

A-0140 (Oral)
Dynamics of Cryptic Diversificatioin Semaphore Geckos – Morphometric and Phylogenomic Analyses of the *Pristurus rupestris* Species Complex

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Among geckos, an ideal group to investigate the roles of population dynamics and ecological adaptation in species diversification are semaphore geckos of the genus *Pristurus*. Numerous ecologically diverse species can be found across Afro-Arabia. On the one hand, strong environmental gradients promoting ecological speciation are present; on the other hand, allopatric or peripatric speciation caused by isolation, gene flow discordance and fragmentation of populations and species ranges can be found. Previous studies indicate that particularly the *Pristurus rupestris* species complex includes high levels of cryptic diversity. Here, we performed state-of-the-art population genomic and phylogenomic analyses based on genome-wide datasets (including a new reference genome for *P. rupestris*) to investigate if and how diversification dynamics are associated with the presence of cryptic phylogeographic lineages in this species complex across the Hajar Mountains of south-eastern Arabia. Zones of gene flow within the *P. rupestris* species complex have been identified, and species delimitation analyses revealed the presence of five distinct taxa. Molecular species delimitation results have been corroborated with morphological data to clearly define the tempo and mode of cryptic diversification. To understand phenotypic adaptations and their underlying constraints, 86 individuals representing 16 genetically identified lineages have been studied with µ-computed tomography. Based on these scans, 3-dimensional models of skulls and limbs were created and subsequently used for geometric morphometrics. Newly identified species were described based on the analysis of phenotypic and molecular data. In addition, the morphological results of the landmark-based 3D shape analyses were linked with a broad set of ecological parameters and aligned to the phylogenomic tree inferred through the molecular analyses. This sophisticated methodological approach of studying associations of morphological traits with diversification dynamics allows to trace the different adaptation patterns and evolutionary trends within a single species-rich and phenotypically diverse clade.

A-0141 (Oral)
Herpetological Explorations of the Norwegian Explorer and Ethnographer Carl Sofus Lumholtz in Borneo (1913–1917)

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Mainly well-known as a widely-travelled Norwegian explorer and adventurer, Carl Sofus Lumholtz originally was a naturalist, and his collecting activities resulted in valuable additions to several natural history collections, including the Naturhistorisk museum in Oslo (NHMO),

Norway. After having been sent to Australia to obtain specimens for the collections in Oslo, and after returning from primarily ethnographical explorations in Mexico, Lumholtz traveled across Borneo between the years 1913 and 1917. In his book 'Through Central Borneo' (1920), he provides a detailed description of his travels and observations during several expeditions across former Dutch Central Borneo. Apart from about 150 mammals and 800 birds currently in the NHMO collections, he brought back to Oslo over 100 specimens of amphibians and reptiles. Here, we shed light on Lumholtz' detailed travel routes and report on the specimens housed in the herpetological collections of the NHMO. Three main areas of intense herpetological collecting activities – all located in Kalimantan (Indonesia) – were identified, namely: (1) Bulungan, in what is today North Kalimantan; (2) Tumbang Marowei, and (3) Poerok Tjahoe (today: Puruk Cahu) both in Central Kalimantan. Among the amphibians and reptiles Lumholtz collected, there are three name-bearing types, all described by the Swedish herpetologist Lars Gabriel Andersson, to whom Lumholtz' material was sent for identification: *Rana macrodon* var. *leporina* Andersson, 1923 (= *Limnonectes leporinus* [Andersson, 1923]) (Dicroglossidae); *Calamaria lumholtzi* Andersson, 1923 (Colubridae); *Aeluroscalabotes longicaudatus* Andersson, 1923 [now synonymized with *Aeluroscalabotes felinus* (Günther, 1864)] (Eublepharidae). Some detailed observations given by Lumholtz in his travel reports also allowed the identification of the corresponding specimens housed in the NHMO collections today. In addition to cross-referencing these specimens with Lumholtz' known travel routes to provide more precise localities and species identification, we have updated the condition of the physical specimens and taken photographs.

A-0142 (Poster)

Conservation Strategies: Management of the Critically Endangered Patagonia Frog (*Atelognathus patagonicus*) in Argentina

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The Patagonia Frog (*Atelognathus patagonicus*) is an endemic species confined to a few lagoons in north-western Argentinian Patagonia, some of them located within the Laguna Blanca National Park (LBNP). The species suffered a substantial population decline triggered by the introduction of invasive predator fishes, leading to the extinction of the largest local population in Laguna Blanca Lagoon. Smaller subpopulations still survive in temporary and isolated lagoons, facing human-induced pressures like livestock activity. Furthermore, a severe drought from 2010 to 2016 intensified the decline to more than 90%, pushing the species to the brink of extinction. This situation led specialists to list Patagonia Frog as Critically Endangered in the IUCN Red List. Efforts to eradicate invasive fishes initiated in 2007 by the LBNP

administration, achieving a decrease in their abundance. Ecological restoration of Laguna Blanca is one of the goals outlined in the park's Management Plan. Additionally, protective fencing was implemented around three lagoons within LBNP to prevent livestock entry. In 2023, an *ex-situ* breeding program was established at Fundación Temaikèn with the goal of supporting a future reintroduction program. To further safeguard the species, a sanctuary composed by an artificial pond, near a spring-fed lagoon and fenced to avoid the access of livestock, was established. This sanctuary, free of threats, will provide a secure haven to receive the first group of individuals from the *ex-situ* breeding center before their eventual return to the natural lagoons. Despite all these actions, the challenge persists and requires continuous collaboration between local stakeholders, environmental authorities and the academia to preserve this species. The establishment of sanctuaries, combined with captive breeding and reintroduction programs, restoration actions and research into its population ecology, offer a comprehensive approach to protecting the Patagonia frog from extinction and guaranteeing its long-term survival.

A-0143 (Poster)

Nonlethal Injuries and Home-Range Movement Patterns in the Endangered Spotted Turtle (*Clemmys guttata*) in North America

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Predation can lead to nonlethal injury as well as mortality in turtles, but the extent of injuries in endangered turtles is unknown as are the potential effects of nonlethal injuries. We investigated nonlethal predator effects on turtles on the Atlantic Plain of the Eastern United States. We found significantly more injuries in the Endangered Spotted Turtles (*Clemmys guttata*) than other, more common, sympatric species. The impact of such injuries on freshwater turtle movement remains poorly understood. We tracked *C. guttata* with predator-induced amputation of limbs using radio telemetry transmitters for approximately one year. Seven turtles had at least one limb partially or completely amputated by a predator, and the remaining 13 were uninjured. When comparing movements among turtles, we found significantly smaller home ranges in injured turtles than uninjured turtles during the nonbreeding season. However, we found no difference in home range sizes between injured and uninjured *C. guttata* during their breeding season. This suggests a potential ecological concern, as predator effects might extend beyond removal from the population and could affect fitness of survivors of attempted depredation.

A-0145 (Oral)

Lizards at Work: Investigating their Ecological Role in Agricultural Ecosystems

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Agro-environments play a crucial role in providing essential ecosystem services, such as food production and raw materials. However, the reliance on constant human interventions, as the use of agrochemicals to combat pest outbreaks, raises concerns about potential ecotoxicological risks and loss of biodiversity. Maintaining high biodiversity in agricultural landscapes could be an alternative method to achieve sustainable production thanks to the role different taxa play in maintaining agroecosystems functional. This study aims to unravel the intricate relationship between agricultural management practices and lizard fitness, as well as their trophic networks. In temperate regions of Europe, lizards are common in agricultural habitats like walls, and they may play multifaceted roles. They seek microhabitats for thermoregulation, find shelters from predators, and contribute to the ecosystem dynamics by preying on ground and flying invertebrates. Considering that some invertebrates may represent pests for agricultural products, lizards may even act as pest-controllers. We evaluated lizards' ecosystem role and services in vineyards from N Portugal from April to June 2023. Since management practices may decrease lizard fitness, compromising their ecological role, seven vineyard sites with widespread management regimes (from low to intensive pesticides applications) were selected, and habitat quality for lizards assessed. Biomarkers of fitness quality (body condition, parasitisation, asymmetry) were recorded and lizards' abundances were estimated. Potential prey (including pests) in the diet of lizards was identified by metabarcoding and isotopes analysis. By combining these diverse datasets, this study not only contributes to our understanding of functional ecology but also provides quantitative evidence for informed decision-making in agricultural management. The ongoing research in Portugal will be replicate in other European countries and ultimately enhancing our estimations of lizards' contribution to ecosystem services in agroecosystems. The incorporation of functional ecology and the ecosystem services framework opens new avenues for sustainable agricultural practices.

A-0146 (Oral)

A Newfound Snake in Newfoundland: Investigating the Origins of an Invasive Population of *Thamnophis* and the Traits that Facilitated their Success

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There are no extant herpetofauna that are native to the large Canadian island of Newfoundland. In recent years, however, Common Gartersnakes (*Thamnophis sirtalis*) have been observed on the island, with official reports dating back as far as 2010. The extent of the snakes' presence on the island, the source of their introduction(s), and their capacity to detrimentally impact the native fauna and ecosystem have not yet been investigated. Our objectives are to (1) identify the source of gartersnakes on the island using molecular analyses, (2) determine the diet of gartersnakes on the island by studying their gut contents, and (3) compare the behaviour of the Newfoundland gartersnakes to that of conspecifics in their native range to determine if individuals in the invasive population possess traits that may have promoted their success. In 2023 and 2024, we collected snakes from across the island, and tissue samples from snakes in native mainland populations nearby, to determine the origin of the invasive gartersnake populations. By identifying the source population, we will be able to test for phenotypic changes in morphological and behavioural traits resulting from colonization of the novel landscape, traits that may have provided an advantage as snakes overcame the challenges of integrating into an ecosystem naturally devoid of reptiles. Our goal is to carry out the first

comprehensive study of the invasion history and potential ecological impacts of a gartersnake population well outside of its native range, which will guide management practices in Newfoundland and potentially predict future impacts of gartersnakes if they are introduced elsewhere globally.

A-0147 (Oral)
Seasonal Activity of the Monte Albo Cave Salamander *Speleomantes flavus*

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The Monte Albo cave salamander (*Speleomantes flavus*) is one of the eight European plethodontid species, and it is endemic to the namesake massif located in north-east of Sardinia Island (Italy). Although being epigeous species, *Speleomantes* often have stable populations inside different typologies of subterranean environments, where they can find suitable microclimatic conditions all year round. In this study we aim to assess the seasonal activity of subterranean populations of *S. flavus*, also evaluating whether differences between sex and life stage exist. We analysed a dataset that contains abiotic (microclimate and cave features) and biotic data (presence of other species) related to seven subterranean populations of *S. flavus*. We performed five Generalized Linear Mixed Models to assess whether abiotic and biotic factors can affect the activity of the species. Results demonstrate that the species is generally more abundant close to the entrance, while in winter and summer its abundance tends to increase in deeper cave sectors. Among the considered invertebrate species, the presence of *Oxychilus oppressus* and *Metellina merianae* significantly affected the abundance of *S. flavus*, the former positively while the latter negatively. This research underlines biotic and abiotic factors that influence the *Speleomantes flavus* yearly activity and the importance of improving the knowledge of this species for conservation activities. These results can also support further studies on different life traits of cave salamanders, and it can implement monitoring actions to evaluate when it is more appropriate to be conducted.

A-0148 (Oral)
Integrating Phenotypic Plasticity into Species Distribution Models to Forecast Resilience to Climate Change in the Frog *Dryophytes arenicolor*

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Climate change is leading to modifications in temperature regimes and rainfall patterns. Amphibian species are particularly vulnerable to these changes, given that their survival and breeding are highly influenced by precipitation and temperature. Phenotypic plasticity in amphibians has been linked to their ability to adapt to environmental shifts. Recent species distribution models now integrate phenotypic plasticity to generate more accurate forecasts of

future species distribution under various climate change scenarios. In this study, we incorporated phenotypic plasticity values from a common garden experiment. Tadpoles of the canyon treefrog (*Dryophytes arenicolor*) were raised under different temperature and desiccation conditions, simulating various severities of climate change, subsequently, we assessed the reaction norms' amplitude and utilized these norms to project the future distribution of the species, thereby creating maps illustrating prospective species range, which we compared with forecasts that did not consider phenotypic plasticity. Models incorporating reaction norms differ in both areas and shapes when compared to classic species distribution models. They reveal fewer alarming changes in future species distribution under climate change conditions, suggesting the potential role of phenotypic plasticity in adapting to rapid environmental changes. The development and application of these models are crucial for obtaining more accurate predictions of species' geographic distribution, emphasizing the importance of considering intraspecific variation in multiple traits, especially for widespread species.

A-0149 (Oral)
Improving Species' Detectability 'on the Fly'

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Frog-biting flies are important wildlife parasites. They transmit pathogens among frogs but can also be used as a tool for improving the detectability of rare frogs through iDNA (DNA screening of their blood meals for host species detection). Thus, they are crucial for understanding frog evolution and informing conservation efforts. However, traditional parasitological investigation methods are not effective for large-scale studies on the host-parasite dynamics of small, inconspicuous species like frog-biting flies. We trawled citizen science photograph repositories for secondary data (accidental inclusions of species or phenomena in observations of another, primary subject) to conduct a continental analysis of frog and frog-biting fly species associations in Australia. We preliminarily identified frog species' traits likely driving the risk of parasitism by flies, and thus which frog species may be ideal candidates for detection via iDNA. Frog call frequency is a trait that likely strongly drives parasitism frequency, so we also tested this experimentally. We determined the spectral preferences of Australian frog-biting flies and designed a hyper-attractive acoustic stimulus to improve fly collection efficacy for future iDNA studies.

A-0151 (Oral)
Evolution and Diversification of the Neotropical Herpetofauna – Unveiling the History

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The Neotropical region stands as unparalleled region of biodiversity, hosting six of the 25 recognized global biodiversity hotspots and encapsulating 70% of the world's total biodiversity. Among its remarkable inhabitants, the Neotropics proudly showcase one of the most diverse herpetofauna communities on our planet. Every passing year reveals new species, underscoring the ongoing underestimation of the true extent of species richness in this region.

This diversity is the result of a dynamic interplay between biogeographic and evolutionary forces, shaping the distribution patterns of species. This talk serves as the symposium's introduction, offering a profound exploration of the region's background before unveiling the outcomes of recent research endeavours. These studies delve into biogeographic patterns that contribute to the genetic diversity of Neotropical herpetofauna. Our discussions will encompass the evolution and testing of hypotheses, the current paradigms shaping diversity patterns, and our insights into the future, particularly concerning the challenges posed by climate change.

A-0152

Cryptic Dragons Down Under: Unraveling Evolutionary Histories and Conservation Challenges of Australian Earless Dragons (*Tympanocryptis*)

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The Australian earless dragon lizards (*Tympanocryptis*) are renowned for their secretive habits and the unique challenges posed by their highly localised and fragmented habitats. Many species are restricted to natural temperate grasslands, regions prone to habitat destruction and conversion, leaving them at risk of extinction. Here, we integrate SNPs, mitochondrial sequences, and ecological insights to unravel the captivating evolutionary history and demographic dynamics of this group. We also discuss the rediscovery of the Victorian Grassland Earless Dragon (*Tympanocryptis pinguicolla*) 50 years after the last confirmed sighting and all the work that is currently being done for its conservation, together with Zoos Victoria.

A-0153 (Oral)

Understanding Effect of Season on Sperm Quality can Help Inform Sample Collection for Genetic Management in an Endangered Frog

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Amphibians are the most threatened vertebrate taxa globally and face an elevated risk of extinction. A combination of factors has contributed to severe population declines, including the spread of the pathogenic fungus *Batrachochytrium dendrobatidis*, habitat loss, pollution, and climate change. One frog species in urgent need of conservation is the Littlejohn's tree frog, *Litoria littlejohni*, an endangered species that exclusively inhabits the east coast of New South Wales, Australia. This species has experienced a 29% reduction of occurrence over the past decade with only four small populations persisting. Recent genetic screening indicates two of these populations are exhibiting low genetic diversity and high inbreeding. Initial findings from a biobanking project in *L. littlejohni* revealed low sperm numbers, suggesting a potential correlation with diminished fertility associated with inbreeding, however it is also unknown how season affects sperm quality in this species. To bolster these small populations and restore genetic diversity we have established a breeding program at the University of Newcastle consisting of founder frogs which have successfully produced F1 progeny from parents of spatially distanced ponds. We have evaluated seasonal variations in sperm quality among individuals from the founder population. To test the effects of seasonality on frog sperm

quality, hormonally induced spermic urine was collected monthly from eight male founder frogs across a year. Sperm concentration, motility, and membrane viability was measured and related to season. Sperm concentration varied across the twelve months with lower counts observed in autumn and winter months. Sperm motility and membrane viability counts remained comparable across the entire year. Understanding seasonal variations in sperm quality is essential for optimizing the timing of breeding within our captive colony and enhancing the quality of sperm collection for biobanking purposes. Future work will compare sperm quality from F1 offspring to founder males.

A-0155 (Poster)
Too Plain: Shared Patterns in Amphibian Distributions in Northeast Asia are Informed by Similar Habitat Niches

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Amphibians are excellent models for studying large scale biogeographic questions due to their limited dispersal abilities. Northeast China is home to 20 species of amphibians, representing five families, yet the species are unevenly distributed along similar landscapes. Only four species are found in the Songliao Plain, a wide area of low-elevation habitat (< 200 m), with the other species found only in the mountains on either side of the Plain, yet only a few species have been traditionally regarded as upland specialists. We generated habitat suitability models to calculate the environmental preferences of each amphibian species of Northeast China and analyzed the extent to which their fundamental niches are larger than their realized niches. Overall, the models showed very limited suitable habitat for almost all amphibian species within the Songliao Plain, despite the species' presence at low elevations in other parts of their ranges. Our results indicates that the Songliao Plain is distinctly different from the surrounding area, less suitable for the nearby amphibian species, and potentially functions as a biogeographic barrier in northeast Asia. For the few widespread species that occur in the Plain, future research to test for a gap in genetic diversity would be valuable. For some species found only in the eastern mountains, such as *Bufo stejnegeri*, the models predicted no suitable habitat in the mountains west of the Plain. However, for about half of the species found on only one side, such as *Rana dybowskii*, the opposite mountains were predicted to be equally suitable habitat. These results show that species distributions within the same class are often shaped by similar habitat preferences, yet in many instances species are limited from filling their full potential climatic niche due to factors such as competition, dispersal abilities, and phylogeographic histories.

A-0156 (Oral)
Can Critically Endangered Tree Frogs Learn to Avoid Chytrid Zoospores?

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Batrachochytrium dendrobatidis (Bd) is a fungal pathogen known to cause chytridiomycosis in amphibians. The disease has been associated with the extinction of at least 90 species

worldwide, including four Australian frog species. Although anti-parasitic behaviours are the first line of defence against infection, behavioural responses to Bd have been largely overlooked. We conducted a pilot study to test if green and golden bell frogs (*Litoria aurea*) are capable of learning to avoid Bd after exposure to and subsequent recovery from infection. Juvenile frogs that had never been exposed to Bd were individually placed in simple choice chambers, one side of which was inoculated with Bd, while the other was not. The location of the frog (Bd-inoculated side or Bd-free side) was recorded for 4 hours. Frogs were then inoculated with Bd and subsequently cleared of infection before being trialled in the chamber a second time. In the first trial frogs spent significantly more time on the Bd inoculated side of the chamber, possibly revealing an innate attraction to Bd. This may suggest that Bd employs mechanisms that attract frogs in order to maximise opportunities for host colonisation. Conversely, in the post-recovery trial the frogs spent less time on the Bd inoculated side of the chamber than previously, and less time overall on that side, indicating that they had learned to avoid the pathogen.

A-0157 (Oral)
Identification of Genomic Diversity and Genes Under the Selection in "Hot-Spring Frog", *Buergeria japonica*

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The Japanese Stream Tree Frog (*Buergeria japonica*), also known as the hot spring frog, is widely distributed in the southwestern islands of Japan. It has been reported that frogs experience a drifting migration from Amami Island to Tokara Islands. During the migration process, severe natural selection is predicted to affect heat tolerance adaptation in the Seranma hot spring (Kuchi Island). However, the pattern of selection on their genome and the genes involved in the adaptive traits during migration remains unknown. To understand the evolution of their thermal adaptation, we investigated the genomic diversity and selection among the *B. japonica* populations using Genotyping by Random Amplicon Sequencing-Direct (GRAS-Di). Based on 93 individuals from ten representative localities, we identified 102,581 biallelic SNP loci and successfully demonstrated a clear population structure of three distinct groups. Interestingly, populations from Okinawa and Tokashiki Islands showed significant genetic differentiation. A genomic scan analysis based on Fst identified 564 potential loci under positive selection, and several candidate genes were enlisted. Furthermore, Gene Ontology (GO) enrichment analysis confirmed several potential genes are related to the heat response.

A-0158 (Oral)
Hotspot Shelters Enable Frogs to Survive Chytridiomycosis and Stimulate Resistance

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Many threats to biodiversity cannot be eliminated; for example, invasive pathogens may be ubiquitous. To help endangered frogs coexist with the emerging fungal disease chytridiomycosis that has been devastating populations worldwide, we devised an intervention that both exploited pathogen vulnerabilities and boosted host defenses. We constructed artificial refugia that attracted threatened frogs and enabled them to maintain body temperatures high enough to clear infections. Recovered frogs were resistant to subsequent exposures, even under cool conditions that are optimal for pathogen growth. With numerous threatened amphibian species now viable only in captivity, our artificial "hotspot" shelters present a simple way to enable the return of some amphibians to their local habitats to resume their ecosystem functions.

A-0159 (Oral)
I have a Genome, Now What? Using a Reference Genome for Conservation with Synthetic Biology

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Biodiversity conservation faces many contemporary challenges but new technologies in molecular biology may offer creative solutions. Affordable genome sequencing and a new generation of molecular tools (e.g., CRISPR) have the potential to change the way we study and combat intractable threats such as climate change and infectious diseases. The pandemic fungal disease chytridiomycosis has caused devastating declines of amphibians, but using modern tools we may unravel the host mechanisms that determine disease outcomes and greatly diversity our options for conservation. For example, if disease resistance is governed by one or a few genes, this information would be useful for efforts to increase host resistance via selective breeding or synthetic biology. We propose a conceptual framework using modern methods to study and promote amphibian resilience to chytridiomycosis. This includes generating a high-quality reference genome, optimising methods to produce amphibian embryos, and developing and using molecular tools to produce genome-edited animals. We show this conceptual model in practice, illuminating the critical capacity needed to go from reference genome to synthetic biology.

A-0160 (Oral)
Unlike Habitat Alteration, Spot Size does not Affect Predator Deterrence in Juvenile Fire Salamanders

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The ongoing struggle between predators and prey often leads to an evolutionary arms race, a dynamic influenced by environmental factors. The European fire salamander (*Salamandra salamandra*) has a distinctive black and yellow warning coloration, coupled with toxic skin secretions, acting as an aposematic signal to deter predators. Previous studies using clay models have shown that individuals with a higher proportion of yellow coloration on their dorsal area, hence the more conspicuous ones, face fewer predator attacks. Expanding on this knowledge, we conducted an experiment using clay models representing juvenile fire salamanders, a more vulnerable life stage. Each model displayed an identical amount of yellow coloration but differed in the distribution of the yellow color, with some having three large spots and others having 12 small spots. The aim of this study was to examine the impact of yellow dorsal coloration distribution on predator attack rates. Two distinct forest zones within the Biosphere Reserve Wienerwald were selected for the deployment of these models. These zones varied in terms of protection status and human impact, with one being a protected zone and the other being a managed zone. The models were positioned along a transect for a four-day duration. All predation attempts were meticulously documented based on the marks left on the models, and the predator type (bird/mammal/rodent) was noted whenever possible. The data revealed that neither color distribution nor forest type significantly influenced overall predation rates. However, we observed a higher frequency of bird attacks in the managed forest zones compared to the protected zones. Consequently, our findings indicate that the distribution of yellow coloration does not affect predator attack rates in juvenile Fire salamanders. However, habitats with varying levels of disturbance can support different predator communities, which may impact the effectiveness of warning signals.

A-0161 (Oral)
Image-Based Snake Auto-Identification: Museum Collections as a Rich Source for Species Image Database

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Generating a robust and accurate model for automated snake image identification is one step forward for reducing human-snake conflict and also human health. AI-based models require huge image databases of the desired snake species. Finding proper images of rare species is always a challenge for making image-based auto-identification models. In this research, we present a novel approach using museum reptile collections in the process of database generation of snake photos. This study is performed on 14 genera of snakes from west Asia and north Africa. The sources of images were from web-based photo repositories and herp photographers. Images of the rare genus, *Eristicophis* were taken based on preserved specimens

from the MNHN reptile collection. In total, 1017 images were sorted. DenseNet121 models were first trained based on a dataset of ImageNet, and then trained on our snake database. The test accuracy of the final model is 100% for training and 88.62% for testing. This study revealed that museum specimens are a hidden but useful source to contribute to the generation of balanced image databases of species, including rare species. Resulting AI-based models can enhance the capacity of recognizing unknown snake biodiversity, even undetermined preserved specimens at museum collections.

A-0163 (Oral)
Exploring Lineage and Trait Diversification in an Asiatic Cobra Clade

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The Asiatic cobras are a group of twelve morphologically conserved snakes distributed across central, south, and southeast Asia. Despite a long history of scientific interest, the group has been shrouded in taxonomic confusion due to high morphological similarity and over description of regional forms. The monocled cobra (*Naja kaouthia*) is an abundant medically-important snake distributed across lowland habitats in south and southeast Asia. Ongoing research efforts on this taxon have uncovered polyphyly, and the presence of additional undescribed cryptic species of Asiatic cobras has been suggested. Recent investigation has resulted in the description of a new Asiatic cobra, *Naja fuxi*, distributed across high-elevation regions of Indochina that is morphologically very difficult to distinguish from *N. kaouthia*. The description of this new taxon has brought into question the current systematic and distributional framework for Asiatic cobras more broadly, creating uncertainty pertaining to these topics in *N. kaouthia* especially. We use an integrated suite of tools including field work, genomics, venom proteomics, and museomics to understand lineage and trait diversification in *N. kaouthia*. Here, we describe spatial variation in morphology of *N. kaouthia* sensu stricto via analyses of morphometric and meristic measures from natural history specimens. We explore specialization in fang morphometrics between spitting and non-spitting populations using a historic dataset augmented with data from new specimens. Additionally, we present species distribution models to disentangle the geographic distributions of *N. kaouthia* and *N. fuxi* from one another. Further work is needed to clarify the affinities and distributions of Asiatic cobras, especially throughout Indochina. Cobras are major contributors to global snakebite statistics, and so a rigorous taxonomic framework and understanding of geographic distributions is vital to mitigating snakebite mortality.

A-0166 (Poster)
Unveiling *Batrachochytrium dendrobatidis* Distribution in Europe: Identifying Threats and Potential Refuges for Amphibians

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Amphibians face significant threats due to climate change but also the widespread of the agent of the chytridiomycosis fungal disease *Batrachochytrium dendrobatidis* (Bd), posing severe risks to amphibians' survival. This study was aimed to uncover the influencing factors driving the geographic spread of Bd (Tytar et al., 2023) using species distribution models (SDM, BART algorithm). Our vital goals were to identify potential areas vulnerable to Bd outbreaks and to discover environmental refuges ("coldspots") from infection. Analyzing 42 diverse environmental layers comprising climate, soil, and human impact data, revealed that 'Continentality' and 'Cultivated and Managed Vegetation' were the prominent predictors of Bd distribution, especially impacting Western European amphibians' populations. Importantly, our models identified Eastern Europe (including Central and Eastern Ukraine, Belarus, and Latvia) as potential environmental refuges. Furthermore, our analysis indicated that suitable areas in Ukraine for Bd are predominantly situated in the western parts of the country, particularly within and around the Carpathian region and the marshy forest area of the Polissia zone lining the Pripyat River and its tributaries in Northern Ukraine. Given that the Carpathians and forest regions harbor the highest amphibian species diversity in Ukraine, these findings underscore the significance of protecting these regions for amphibian conservation efforts. This research serves as a foundation for future chytridiomycosis investigations and, also, underscores the urgent need for collaborative efforts among scientists, policymakers, conservationists, and the public to protect amphibian populations, especially from fungal diseases through preventive measures. This research is supported by the projects EMYS-R https://emysr.cnrs.fr and Nr.lzp-2021/1-0247.

A-0168 (Oral)
A Woman Leading an Alliance for the Conservation of the Iconic Jambato Harlequin Toad, *Atelopus ignescens*

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The Jambato harlequin toad, *Atelopus ignescens*, is a microendemic harlequin toad species native to the Ecuadorian Andes, considered extinct for nearly thirty years until its rediscovery in 2016 in Angamarca, Cotopaxi. Since its rediscovery, an *ex-situ* conservation program has been initiated, but no actions have been taken to assess the status of the local population or to conserve it *in situ*. In 2021, a socio-environmental study was conducted to understand the limiting factors and evaluate the possibility of initiating a project to conserve the remaining population. As a result, it was revealed that the Jambato survives closely associated with human activities, facing threats that endanger it. However, opportunities were also identified to initiate a conservation project through four components: research, education and engagement, communication, and conservation. Additionally, a strategy was designed to ensure sustainability, considering the complex issues surrounding a critically threatened species. Thus, the Jambato Alliance was born, an initiative currently bringing together an interdisciplinary team of about 50 professionals from 26 national and international institutions. The approach of collaborative and interdisciplinary science, active community involvement, and joint efforts has proven effective. This initiative has had a high impact nationally and internationally and currently works towards the conservation of threatened species in general, providing advice,

support, and the exchange of experiences. Furthermore, being created and led by a woman has helped overcome gender gaps within herpetology in the country and the region. Additionally, due to the milestones achieved, she now leads the *in situ* conservation of harlequin toads at the regional level within the Atelopus Survival Initiative. Thanks to this, the Jambato harlequin toad has a second chance, and women again demonstrate our leadership in science and conservation.

A-0169 (Oral)
Resistance is Not Futile: Evolutionary Adaptations in Reptiles Against Snake Venoms

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The evolutionary arms race between venomous snakes and their reptilian prey/predators has led to a fascinating array of adaptations. This talk will explore the intricate biological mechanisms that some reptiles have evolved to counteract the lethal effects of snake venoms. Central is the role of steric hindrance in toxin resistance, particularly the molecular mechanisms of N-glycosylation and proline substitution. N-glycosylation adds bulky carbohydrate groups to the nerve receptor site, which can physically block venom components from binding to the receptor. Similarly, mutations removing prolines changes the receptor secondary structure, impeding the interaction between venom toxins and the receptors. These modifications create spatial constraints that reduce the binding affinity of venom toxins, thereby mitigating their lethal effects. More recently discovered by us is the electrostatic charge repulsion mechanism, whereby the introduction of positively charged amino acids into nerve receptor sites repels similarly positively-charged venom toxins, preventing them from docking and exerting their harmful effects. This phenomenon of charge repulsion is particularly effective against the common three-finger toxins (3FTxs) found in many snake venoms, which often carry a strong positive charges on their surface. The evolution of positively charged amino acids in the binding sites therefore act as a shield through same-charge repulsive effects, neutralizing the threat posed by these potent neurotoxins. This presentation combines recent findings from genetic studies, protein chemistry, and ecological observations to construct a comprehensive overview of these resistance mechanisms. Also discussed are the implications of such adaptations for the co-evolution of snakes and their prey, and how these insights enhance our understanding of evolutionary biology. By examining the molecular underpinnings of these evolutionary strategies, we gain a deeper appreciation of the complex interplay between predator and prey, highlighting the extraordinary lengths to which life will go to survive in a world rife with natural toxins.

A-0171 (Oral)
A Systematic Review of Snake Translocations to Identify Potential Tactics for Reducing Postrelease Effects

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Advancements in the field of reintroduction biology are needed, but understanding of how to effectively conduct translocations, particularly with snakes, is lacking. We conducted a systematic review of snake translocation studies to identify potential tactics for reducing post-release effects. We included studies on intentional, human-mediated, wild-wild or captive-wild translocations to any location, regardless of motive or number of snakes translocated. Only studies that presented results for at least one of four outcomes (movement behavior, site fidelity, survival, or population establishment) were included. We systematically searched 4 databases for published studies and used five methods to search the gray literature. Our search and screening criteria yielded 121 data sources, representing 130 translocation cases. We quantified the association between 15 translocation tactics and short-term translocation outcomes by calculating odds ratios and used forest plots to display results. Snake translocations involved 47 species (from mainly two families), and most were motivated by research, were monitored for at least six months, occurred in North America, and took place from the 1990s onward. The odds of a positive snake translocation outcome were highest with release of captive reared or juvenile snakes, release of social groups together, delayed release, provision of environmental enrichment or social housing before release, or minimization of distance translocated. The odds of a positive outcome were lowest when snakes were released early in their active season. Our results do not demonstrate causation, but outcomes of snake translocation were associated with eight tactics (four of which were strongly correlated). In addition to targeted comparative studies, we recommend practitioners consider the possible influence of these tactics when planning snake translocations.

A-0172 (Oral)
Communities as Primary Allies for the Conservation of Endangered Species

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Angamarca is the last refuge of the Jambato harlequin toad, *Atelopus ignescens*. In this valley, the species is closely associated with human activities such as agriculture and livestock farming. Despite the significantly altered environment, the ambient conditions still appear favorable, possibly due to traditional organic farming practices. However, the community faces social issues such as a high poverty rate, malnutrition, and limited job opportunities. Consequently, a high migration rate leads individuals to return with knowledge of agrochemicals. Additionally, productive projects have been promoted for trout farming, used as a source of food and income. These actions put the last population of the Jambato at risk, presenting the challenge of actively involving communities and designing effective conservation strategies. Thanks to the engagement interventions we have carried out, using a participatory action research methodology and working closely with local authorities, we've achieved significant milestones, including the approval of a parish resolution and the declaration of the Jambato Harlequin Toad Day, turning it into an emblematic species. We promote cultural events as they enhance awareness of the importance of conserving the species. A tool that proved to be very useful was the development of an agrobiocultural calendar constructed collaboratively with local communities that aimed to revive traditional agricultural practices and integrate them with local cultural celebrations and the life cycles of biodiversity, including the Jambato. Moreover, this species becomes a flagship to raise awareness about the importance of conserving local herpetofauna, as there is a negative preconception towards these species. Additionally, the site has recently been approved as an Alliance for Zero Extinction (AZE), allowing the expansion of conservation measures. Based on the work done,

it's considered that the revival of agroecological practices and the establishment of sustainable economic activities such as scientific and community tourism will address local needs and conserve endangered species.

A-0173 (Oral)
Scent-Sational Saviours: Can Sniffer Dogs Help Preserve Endangered Lizards?

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Pygmy bluetongues lizards are an endangered species and the extent of the current geographic range is unknown. This species only occurs in intact grasslands in the mid-north of South Australia and all known locations occur on private land. Searching for these lizards is difficult and using sniffer dogs would be more efficient. This project will train and test sniffer dogs to determine the efficiency with which they can find these endangered lizards to increase conservation efforts by assisting in the finding of new populations and finding the extent of known ones easier. Thesis will be complete in May and the abstract will be updated,

A-0174 (Oral)
What is the Point? The Functional Role of Claws in Pad-bearing Geckos (Gekkota: Diplodactylidae)

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Claws are one of the most common morphological adaptations in vertebrates and enable defence, predation, gripping and climbing, and other tasks. Some taxa that use claws for climbing also have adhesive hairs or 'setae' that aid climbing. In taxa that exhibit both these mechanisms to perform similar functions, what are the relative contributions of claws and setae? We addressed this question using diplodactylid gecko species with well-developed toepads and reduced claws. We measured two functional aspects, attachment (mechanical interlocking) and friction (shear force) on a range of substrates comparable in roughness to those geckos used in nature. We found that the probability of mechanical interlocking was highest on coarse surfaces in geckos both with and without claws (claws partially clipped), and claws were more important for attachment on intermediate- and fine-grained substrates than were setae, i.e., shear force generated by claws and setae on coarse substrates was similar, but shear force generated by claws was significantly greater on intermediate- and fine-grained surfaces. Both attachment via mechanical interlocking and friction via shear force generation was greater on coarse surfaces than intermediate and fine-grained surfaces in diplodactylid geckos, highlighting that on coarse surfaces, setae fulfil similar functional roles to claws,

whereas claws are more important for attachment on intermediate- and fine-grained surfaces. Furthermore, our findings show that contrary to other gecko radiations, diplodactylid geckos are capable of functioning effectively on coarse surfaces comparable to those found in nature.

A-0177 (Poster)
Population Structure Analysis of Geckos of the Genus *Bavayia* (Diplodactylidae) by Utilization of Rapidly Evolving Long Exon Capture (RELEC) Datasets

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New Caledonian diplodactylid geckos of the genus *Bavayia* comprise 41 described species, most of which appear to have arisen via allopatric speciation following habitat fragmentation. Most of these species are microendemics, but two species, *B. septuiclavis* and *B. geitaina*, have broad distributions across the ultramafic substrates in the south of New Caledonia. Sampling in these species is adequate to investigate patterns of population structure. In addition to existing mitochondrial ND2 data and data from several widely used nuclear markers, we used RELEC (Rapidly Evolving Long Exon Capture) loci, particularly PKDREJA and PKDREJC, to conduct expanded phylogeographic studies and evaluate population structure within these two taxa. Both species exhibit substructuring, but *B. geitaina* shows more well-supported geographical patterning than does its congener. This may relate to the greater reliance of *B. geitaina* on forest habitats than the more thoroughly terrestrial *B. septuiclavis*. This work represents the first use of the rapidly evolving PKDREJA and PKDREJC genes in a phylogeographic study of squamates.

A-0178 (Oral)
Venom Versatility: Coagulotoxic Venom Variation Between and Within *Bothrocophias* (Toadheads) and *Bothrops* (Lanceheads) Pit Vipers

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Pinpointing the emergence of evolutionary novelties can be challenging. In American pit vipers, anticoagulant venoms are common, except in *Bothrops* (lanceheads), which are potently procoagulant. A recent study found that the basal *Bothrops* (*B. pictus*) is anticoagulant, raising two competing hypotheses: ancestral *Bothrops* were anticoagulant with procoagulant venom evolving later, or ancestral *Bothrops* were procoagulant with anticoagulant venom in *B. pictus* being a derived trait. To resolve this, we tested venoms of the sister genus *Bothrocophias*. The Ecuadorian *Bothrocophias* venoms (*B. campbelli, B. lojanus*, and *B. microphthalmus*) were compared to *B. pictus*. The basal *Bothrocophias* species (*B. lojanus*) was, like *B. pictus*, anticoagulant. This suggests anticoagulation as the ancestral trait of both genera, and procoagulation is therefore a derived trait. Both species inhibited various blood clotting enzymes, but *B. pictus* was more potent. Unlike *B. lojanus, B. pictus* was additionally

anticoagulant through destroying phospholipids. Intriguingly, procoagulant venom in *Bothrocophias* evolved independently from *Bothrops*, with *B. campbelli* and *B. microphthalmus* clotting plasma through different mechanisms. Both species activated prothrombin, indicating this trait in their last common ancestor. *Bothrocophias microphthalmus* activated prothrombin in both populations studied, but the Zamora Chinchipe locality also activated Factors X and VII. *Bothrocophias campbelli* showed a novel activity, using Factor Va to activate prothrombin. Antivenom efficacy tests showed PoliVal-ICP (Costa Rica) and SAB (Brazil) were effective on *B. microphthalmus*, but PoliVal-ICP significantly more effective. In contrast, SAB was effective on *B. campbelli*, while PoliVal-ICP had marginal activity. These findings aid in designing clinical management strategies and understanding venom evolution.

OLD

A-0178 (Oral)

Clinical and Evolutionary Implications of Dynamic Coagulotoxicity Divergences in *Bothrops* (Lancehead Pit Viper) Venoms

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Despite coagulotoxicity being a primary weapon for prey capture by *Bothrops* species (lancehead pit vipers) and coagulopathy being a major lethal clinical effect, a genus-wide comparison has not been undertaken. To fill this knowledge gap, we used thromboelastography to compare 37 venoms, from across the full range of geography, taxonomy, and ecology, for their action upon whole plasma and isolated fibrinogen. Potent procoagulant toxicity was shown to be the main venom effect of most of the species tested. However, the most basal species (*B. pictus*) was strongly anticoagulant; this is consistent with procoagulant toxicity being a novel trait that evolved within *Bothrops* subsequent to their split from anticoagulant American pit vipers. Intriguingly, two of the arboreal species studied (*B. bilineatus* and *B. taeniatus*) lacked procoagulant venom, suggesting differential evolutionary selection pressures. Notably, some terrestrial species have secondarily lost the procoagulant venom trait: the Mogi Mirim, Brazil locality of *B. alternatus*; San Andres, Mexico locality of *B. asper*; *B. diporus*; and the São Roque, Brazil locality of *B. jararaca*. Direct action on fibrinogen was extremely variable; this is consistent with previous hypotheses regarding it being evolutionary decoupled due to procoagulant toxicity being the primary prey-capture weapon. However, human patients live long enough for fibrinogen depletion to be clinically significant. The extreme variability may be reflective of antivenom variability, with these results thereby providing a foundation for such future work of clinical relevance. Similarly, the venom diversification trends relative to ecological niche will also be useful for integration with natural history data, to reconstruct the evolutionary pressures shaping the venoms of these fascinating snakes.

A-0179 (Oral)

City Slicker or City Sicker? How Australian Frogs are Responding to Urbanisation

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A major driver of amphibian declines is the disease chytridiomycosis, caused by the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (Bd). As a result, there has been extensive research on amphibian immunity over the past 30 years. This research has identified that for frogs, a crucial component of their immune system is contained within their skin glands. These glands produce a range of bioactive peptides, including anti-microbial peptides (AMPs), which are documented to be an effective mechanism against a range of pathogens, including Bd. However, research has also suggested AMP production can be hindered with rising stress levels. This is concerning when considering that more and more frog populations need to contend with urbanisation pressures globally, such as habitat loss and modification, altered food resources, and the effects of various pollutants (sound, light, toxins) – all of which have been shown to influence stress levels. Despite the link between urbanisation and stress, and the link between stress and AMP production, little work has focused on examining the effects human activity has on AMP production in frogs. Furthermore, no research currently exists for Australian frog species or in a field-based setting. Thus, we aimed to determine the effect stressful anthropogenic activity had on the production of AMPs and disease susceptibility in Australian frogs *in-situ*. We focused on a widespread tree-frog species (Litoria peronii) in urban and non-urban areas in Greater Sydney – Australia's largest urban centre. We took blood samples to quantify stress hormone levels, swabbed for Bd, and sampled skin AMPs. In my talk, I compare the stress levels, infection status, and AMP differences between frogs found in urban and non-urban areas. Additionally, I present a new profile of skin AMPs for *Litoria peronii*. Lastly, I discuss what implications this may have for disease susceptibility of frogs in an urbanising world.

A-0180 (Oral)
Does Size Really Matter? Effects of Climate Change on Australian Frog Body Size

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Understanding the current and future impacts of climate change on species and their ecosystems is integral to the conservation of global biodiversity. Research has predominantly focused on phenological shifts and changes to species distributions and abundances. However, recent work has begun to highlight that species are changing their morphology in response to climate change. For example, increases in temperature can lead to increased metabolism in ectotherms, such as amphibians, which can lead to smaller body size if they fail to fuel their metabolic demands. Similarly, rainfall can also influence body size. More rainfall usually leads to more resources in an area and thus larger body sizes. However, reduced rainfall can also lead to larger body size as larger frogs are less prone to desiccation. Australia is a continent predicted to be greatly impacted by climate change in the coming decades and is home to hundreds of frog species not found anywhere else. Thus, we aimed to investigate how temperature and rainfall has influenced Australian frog morphology. However, tracking

morphological changes over time through field studies can prove difficult. Fortunately, museum collections span the onset of human-induced climate change. We measured over 600 museum specimens for four Australian frog species (*Litoria peronii, Litoria ewingii, Limnodynastes peronii*, and *Limnodynastes dumerilii*). Using extensive climate data from the past 150 years, each specimen was linked to temperature and rainfall data for its year of collection and locality. In my talk, despite no relationship between collection year and body size, I show how temperature and rainfall have impacted Australian frog morphology since the onset of human-induced climate change. I also discuss the implications this may have under future climate scenarios as temperature continues to increase and rainfall events become more stochastic.

A-0182 (Oral)

Diversity and Origins of a Frog Genus (Microhylidae: *Hylophorbus*) Endemic in New Guinea, the Largest Tropical Island on Earth

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New Guinea is the largest tropical island in the world and hosts immense endemic biodiversity. However, our understanding of how the gradual emergence of the terrestrial ecosystems of the island over the last 40 Myr has generated this biological richness is hampered by poorly documented species diversity and distributions. We addressed both these issues through an integrative taxonomy and biogeographical approach using *Hylophorbus*, a New Guinea-endemic genus of frogs with 12 recognized species. We delimited candidate species by integrating mitochondrial DNA, nuclear DNA, and bioacoustics, then investigated their evolutionary history. Our results suggest that the current taxonomy of the genus misses true species diversity by ≥ 3.5-fold. Nevertheless, most candidate species (27) remained unconfirmed because of missing data, whereas five were identified unambiguously as undescribed (we described three of these formally). Time-calibrated phylogenetic analyses suggest that *Hylophorbus* diversification began ~9 Mya in the northern or eastern portion of New Guinea. It would appear that lineages dispersed to new terrestrial habitats in the west,

notably uplifted by the central range orogeny, until eventually reaching the Bird's Head during the Mio-Pliocene (7–5 Mya). Conversely, a past barrier appears to have prevented north–south dispersal. These data suggest that new habitat availability has primarily driven the diversification of *Hylophorbus*.

A-0183 (Oral)
Environmental Conditions and Handling Impact Behaviour in Tadpoles of a Laboratory-housed Amphibian

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The Mallorcan midwife toad (*Alytes muletensis*) is a species of conservation concern whose population is threatened by climate change and the anthropogenic introduction of novel invasive non-native predator species, the viperine snake (*Natrix maura*). Understanding how these threats affect the behaviour of individuals is extremely important for the purpose of predicting the future impacts on the remaining wild population and the conservation measures that can be implemented *in-situ* to aid in this species' survival. Due to these threats in its native range, current conservation efforts for the Mallorcan midwife toad are largely being carried out *ex-situ*. It is therefore of the utmost importance to gain a holistic understanding of how best to care for these individuals in a captive setting. This introduces an urgent need to characterise this species' welfare needs throughout their ontogeny. Presently, little is known about the indicators of and environmental and handling impacts on tadpole welfare and, thus, we discuss the experimental approach to identifying behavioural welfare indicators in a laboratory population of Mallorcan midwife toads and the development of automated tools through which to monitor them. This constitutes a crucial first step in improving not only the captive welfare of this species, but potentially of many amphibian species whose welfare requirements during their larval stage are currently poorly understood.

A-0184 (Oral)
New Perspectives on the Evolution of "Dance" Displays in Frogs – Insight from Perceptual Bias Theory

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Animals communicate using a wide breadth of seemingly bizarre displays, and we still know little about how and why these behaviors evolve. We study this topic in frogs that produce an elaborate dance display known as the foot flag which is performed when a frog fully extends its hindlimb out away from its body and moves it downwards in an arc like motion. In particular we explore the role that perceptual biases might play in the evolution of this visual signal. Past work finds that the foot-flagging display likely evolved to leverage the conserved receiver perceptual bias in frogs known as the worm/antiworm motion detector. The worm/antiworm motion detector works simply. If an object moves parallel to its length, it's perceived as prey (worm) and if an object moves perpendicular to its length, it's perceived as a threat (antiworm). We performed visual playback experiments of worm and antiworm stimuli and injected frogs with testosterone to test the role of this perceptual bias in the design of the foot-flagging signal. We find that the foot-flagging frog *Staurois parvus* competes using the antiworm motion to deter rival males and this antiworm motion is increased with an increase in circulating

testosterone. These findings reveal how perceptual biases may have shaped the evolution of the foot-flagging signal in frogs.

A-0185 (Oral)
Disentangling the Complex Evolutionary History of Sex Chromosomes in Snakes

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Snakes have played an important role in the development of the classical paradigm about the sex chromosome evolution since its onset by Ohno in 1967. For decades, the prevailing view was that all snakes possess homologous ZZ/ZW sex chromosomes ranging from undifferentiated, homomorphic in boas and pythons to increasingly heteromorphic in caenophidian snakes. However, recent studies revealed that homologous ZZ/ZW sex chromosomes characterize only caenophidian snakes and that two different XX/XY sex chromosome systems independently evolved in the genera *Python* and *Boa*. Here, we identified sex chromosomes in 14 species of non-caenophidian snakes. We found XX/XY sex chromosomes in the blind snake from the family Typhlopidae, which are homologous to XX/XY we documented in sand boas (Erycidae), and other booid species such as anacondas, but surprisingly not to the previously discovered XX/XY in the genus Boa. On the other hand, members of the booid families Sanziniidae and Calabariidae have ZZ/ZW sex chromosomes containing genes linked to the caenophidian ZZ/ZW sex chromosomes and the XX/XY sex chromosomes of pythons, the sister group to Booidea. We revealed another non-homologous XX/XY system in *Tropidophis melanurus* (Tropidophiidae). Although current data cannot unambiguously differentiate between sex chromosome homology and independent co-option of the same genomic regions for the role of sex chromosomes, our findings point to two intriguing patterns: (1) snake lineages highly differ in the rate of differentiation of sex chromosomes; (2) snakes likely possessed ancestrally undifferentiated sex chromosomes prone to turnovers, which attained evolutionary stability in the highly diverse caenophidian snakes once their differentiation proceeded. In addition to their historical importance to the field, snakes emerge as an ideal system for studying the evolutionary factors driving unequal rates of differentiation, turnovers and stability of sex chromosomes. Moreover, our genetic markers provide a means of reliable molecular sexing for specimens of the studied lineages.

A-0186 (Oral)
Trophic Ecology and Body Condition of three Syntopic Newts in Response to Fish Introduction in a Southern Mediterranean Glacial Refugium

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We studied the trophic ecology of three syntopic newt species, *Ichthyosaura alpestris inexpectata, Lissotriton italicus*, and *Triturus carnifex*, in four water bodies that are the core area of the glacial relict *I. a. inexpectata*. Newts' survival is currently threatened by the recent introduction of allochthonous fish into lakes originally fishless. We investigated the prey preferences, assessed potential competition and trophic niche overlap, and examined the health status among newts inhabiting lakes with or without fish. Throughout the entire aquatic phase of the target species (May–October), we stomach-flushed 219 individuals while concurrently assessing the prey availability at each site. In addition, we collected body mass and snout-to-vent length for each captured individual to compute the body condition index (Scaled Mass Index: SMI) for the three newt species. Overall, the data unveiled a generalist feeding strategy in the three species, indicating a food selection for specific prey categories and a mostly shared feeding strategy across different water bodies. Notably, *T. carnifex* exhibited exclusive dietary choices, engaging both cannibalistic behavior and predation towards eggs and tadpoles of other amphibians. Results from SMI highlight a contrasting trend in body condition in the presence of invasive fish. Despite the presence of allochthonous fish, the adults of *I. a. inexpectata* and *T. carnifex* showed good health conditions, as evidenced by their high SMI. In contrast, *L. italicus* showed a higher SMI in the fishless pond. Our results suggest that introduced fish can have a potentially low impact on adult newts. Instead, they may represent demographic sinks for newts due to their predatory effect on larvae and eggs.

A-0187 (Oral)

Timing of Limb and Jaw Embryonic Characters Uncovers the Origin of Squamate Diversification

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Comparative embryology is the subject to study the 4-dimensional morphological changes occurring during early development. For this study, we compiled various embryonic staging tables from the literature using the Standard Event System coding. We focused on the external morphological changes during the development of various squamate species, incl. snakes. To control for the noise of temperature and the observers' biases and to normalize in a phylogenetic framework, we carried out a relative time transformation of all available data, making the interspecific variation of the developmental timing more comparable. The proportion of embryonic development before egg-laying was estimated based on empirical data from breeding records and field notes. We reconstructed the patterns of developmental change among squamate clades using squared-change parsimony. The ancestral state reconstruction also considers the wide variation of egg retention in squamate reptiles. The analysis reveals that the long embryonic diapause of *Chamaeleo calyptratus* is very unique among squamates. However, this species undergoes a faster pace of embryonic development after the end of the diapause. The analysis shows that varanids (Anguimorpha) generally feature an earlier beginning of embryonic development, likely associated with an earlier onset of fetal growth to reach large body sizes. We further created a more compact data set of two organic systems, jaws and limbs, and correlated their timing to metrical measures of the respective adult organs and reconstructed evolutionary correlations through squamate evolution.

A-0190 (Oral)

Dehydration Effects in Thermoregulation and Behavioral Performance in Leptodactylidae Frogs

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Given their ectothermy and highly permeable skin, behavioral thermoregulation in amphibians often involves trade-offs with water balance. Maintaining a body temperature (Tb) compatible with biological activities will be determined by the species' intrinsic sensitivity to dehydration and thermal and hydric ranges available in their habitat. Higher temperatures favor most aspects of performance but increase risk of excessive water loss; on the other hand, lower temperatures reduce water loss rates, but are detrimental for performance. Thus, animals need to balance these parameters to optimize physiological function. Can this fine balance be affected by the stress of dehydration? To investigate this, we measured the preferred temperature (Tpref), thermal tolerance limits (CTmin and CTmax) and locomotor performance of *Leptodactylus fuscus* under different levels of dehydration. Fully hydrated animals showed a preference for higher temperatures (Tpref) than dehydrated animals. We observed higher CTmin and lower CTmax when animals were dehydrated, indicating that dehydration reduces their thermal tolerance breadth. In general, we observed that higher temperatures are more favorable for the species locomotor performance. However, increased dehydration has a negative effect on the locomotor performance of *L. fuscus*, regardless of the temperature. Our data indicates that animals will behaviorally adjust their Tpref to avoid the potential of increased desiccation, even at the cost of suboptimal temperatures for performance. Dehydration also narrows their thermal tolerance breadth, which, ultimately can interfere with thermoregulation. In addition, our data also shows that dehydration impacts locomotor performance, even in optimal temperatures. Our study gives an insight on the determining role of dehydration in amphibian thermoregulation - not only an animal's thermal tolerance can be limited by desiccating conditions, but also that thermal preference and performance might be sacrificed to compensate for inadequate hydric conditions.

A-0191 (Poster)
Sexual Dimorphisms in Eastern Hellbender Odontology

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Some groups of amphibians are known to exhibit sexually dimorphic traits indicative of their reproductive roles, mating behaviors, and related morphological traits. Within the family Cryptobranchidae, or giant salamanders, morphological differences between males and females are subtle and understudied. Researchers have suggested that there may be apparent sexual dimorphisms concerning body size, head shape, and cloacal anatomy. Cryptobranchids are among the fully aquatic salamanders that are suction feeders. However, unlike suction-feeding frogs lacking teeth these salamanders have numerous sharp bicuspid teeth arranged in single rows as well as vomerine teeth arranged parallel to the tooth row. Their teeth may be used, instead of feeding, for defense or male-male competition, which differentiate between the sexes. Our lab at Bucknell University has been examining the possible sexual differences of the Eastern Hellbender (*Cryptobranchus allegheniensis allegheniensis*) specimens

preserved at the Carnegie Museum of Natural History in Pennsylvania. Through dentition examination and morphometric measurements of the specimens, we are testing previously unexplored hypotheses that (1) Male specimens would contain, on average, a larger number of teeth than female specimens, and (2) Males, on average, exhibit larger teeth and jaw size than females. Our hypotheses are driven by the life histories and known behaviors exhibited by male cryptobranchids, who utilize their teeth to a greater extent than females to occupy and protect limited nesting sites from other males via biting. In this amphibian group, it is the males who exhibit parental care, serving as 'den masters' that will use their teeth to defend their eggs from nest intruders including conspecifics. Sexual dimorphism in teeth has not been reported in amphibians previously. Through the investigation of possible sexual teeth dimorphisms in giant salamanders, our study would add a valuable piece of knowledge to the field.

A-0192 (Poster)
Snake-Human Coexistence and Snakebite Management in Bangladesh

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Snake is a neglected animal in this world. The treatment of snake bites was one of the most neglected medical procedures in this world. Many people have lost their lives in the past and are losing their lives due to this snake bite. This issue comes under the scrutiny of WHO. In 2017, WHO seriously brought the treatment of snake bites under noncommunicable diseases. In countries with high rate of snake bites, WHO has focused on developing their own antivenom. Each year about 150,000 to 185,000 people worldwide die from snake bites. In this case, Bangladesh was not spared. 4 lakh to 4.5 lakh people are victims of snake bites in Bangladesh alone. According to government estimates, every year around 7000 people are dying because of snakebite. Outside of government calculations, its numbers will increase. This death doesn't occur only by the bite of a poisonous snake. Non-venomous snake bites also cause death. There are many reasons behind this snake bite as an influencer. Normally snake bites don't occur when snakes and humans live in parallel. The medical curriculum for snake bites in private medical colleges is insufficient. It is important to include snake bite management in private medical colleges as they are later employed as physicians in government hospitals. As a result, they're unaware of this. It's impossible for them to treat snake bites in Upzila Sadar hospitals. Reasons for this is inadequacy of antivenom, lack of adequate knowledge, lack of ventilation system, fear of doctors to provide medical services, etc. To reduce the mortality rate in snake bites, I have divided the research into two parts, namely, Reducing Snake-Human conflict and After-snake bite. Through this research, I prove that snake bites mortality can be reduced by more than half if clear steps can be taken.

A-0193 (Oral)
Unique Extraembryonic Blood Structure in Diapausing Turtle Embryos

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Early embryos of many turtles may or even must enter diapause, a state of arrested development that occurs in response to or in anticipation of adverse environmental conditions. However, the

harsh physical environment and the risk of predation are not the only dangers to dormant eggs, which also have to survive surrounded by numerous bacteria and fungi. Little is known about the active protection of diapausing eggs against such threats. In the diapausing eggs of the Leopard tortoise (*Stigmochelys pardalis*) of the family Testudinidae, we discovered previously undocumented extraembryonic blood structure. The structure develops at the beginning of the dormant period while the embryo stays in the gastrula stage, persists for several weeks or even months during the whole diapause, and regresses as the embryo continues to develop after the diapause termination. Surprisingly, the blood structure develops at a very early embryonic stage, long before other known hemopoietic tissues such as blood islands differentiate. The adaptive function of the structure in embryonic immunity is not only supported by the timing of its development, but primarily by the presence of numerous granulocytes and other cells with significant immune function, including red blood cells. We revealed the same blood structure in diapausing eggs in several other testudinids; the phylogenetic distribution suggests that it evolved no later than the Eocene. This newly uncovered structure highlights the significant role and evolutionary potential of extraembryonic tissues in vertebrates and reinforms concepts on early blood development.

A-0195 (Oral)

Adulthood is Just an Illusion? Testing the Impact of Ontogeny on Suction Feeding Kinematics in the Axolotl (*Ambystoma mexicanum*)

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Although most salamander species undergo metamorphosis, i.e., individuals transition from a larval to an adult stage, often associated with a change from aquatic to terrestrial habitat, some species have developed other type of life cycle strategies. This is the case of paedomorphic species, in which individuals retain larval traits throughout their life, even if they are sexually mature. Among these paedomorphic species, the most emblematic is the axolotl, Ambystoma mexicanum, which has an obligatory paedomorphic life cycle, spending its entire life in the aquatic habitat and using suction to suck its prey into its mouth while feeding. Here we test the influence of size and ontogeny on suction feeding kinematics using high-speed videos of A. mexicanum adults and larvae at different developmental stages and size classes. We showed that size had an influence on nearly all kinematic variables. However, the effect of size on the velocity of both mouth and hyoid movements differed according to the developmental stage. The rate by which gape and hyoid velocity increased with size was greater in adults. This could be explained by the fact that hydrodynamic constraints are different depending on the size of the individual and/or also by the fact that adults eat larger and faster, more elusive prey.

A-0197 (Oral)

Impact of Life Cycle Variation on Sexual Dimorphism in European Fire Salamanders

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Many Caudata display notable male-female morphological differences. However, some salamanders lack clear external sexual traits, with distinctions mainly in size. While previous studies on life cycle explored its effects on overall morphological diversity, here, we focus on how life cycle variations impact sexual dimorphism. To do so, we use fire salamanders (*Salamandra salamandra*) as model, as they are capable of exhibiting different life cycle strategies within the same species (simple as pueriparous or complex as larviparous). Fire salamanders can be larviparous, giving birth to a larval stage encountering a metamorphosis with associated ecological changes after birth, whereas pueriparous one's gave birth to fully developed juveniles. Our study aims to i) identify sex-dependent morphological differences in external features and feeding apparatus and ii) determine whether life cycle influences these variations through measurements and geometric morphometrics analysis across over 250 belonging to 20 European populations. We expect finding sexual dimorphism variations and hypothesize that individuals with a complex life cycle, capable of morphological changes, will display more pronounced sexual differences compared to those with simple life cycle. Preliminary findings indicate morphological differences between sex and life cycle type mostly related to size and head traits. In contrast to our prediction, our results also showed a greater sexual dimorphism and disparity between male and female in pueriparous fire salamanders. Finally, this study may be valuable for sex identification in specimens of collections or in the field, using non-invasive measurements of the trait of interest.

A-0198 (Poster)

A Decade of Conservation Efforts: The Journey Towards an Integrated Strategy for *Ceratophrys ornata* in South American Temperate Grasslands

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The Argentine Horned Frog (*Ceratophrys ornata*) is an iconic amphibian species inhabiting the temperate grasslands of Argentina, Brazil, and Uruguay. Inferred population declines and local extinctions led the IUCN (2021) to assign the species the Near Threatened conservation status, while national assessments have categorized it as Vulnerable in Argentina and Uruguay, and Critically Endangered in Brazil. Both, national and international assessments identified potential threats (habitat loss, pollution, pet trade, and aversion) and recognized the limited knowledge about the occurrence and natural history of *C. ornata* as an obstacle to implementing conservation measures. In 2014, we initiated the "Giant of the Pampas" project, whose first objective was to identify the current range of the species. To achieve this, we implemented a citizen science program that is still ongoing in Argentina, Brazil, and Uruguay, gathering more than 1000 confirmed records. In collaboration with academic/scientific institutions in Uruguay and Brazil, we conducted passive acoustic monitoring in 25 locations

in both countries to rediscover the species which has been missing since 1982 in both countries. Various data sources confirm that *C. ornata* is likely extinct in Uruguay and Brazil, while also enabling us to identify two priority areas for its conservation in Argentina (northern Buenos Aires Atlantic Coast and eastern Inland Pampa). In these areas, our team has been conducting population dynamics studies, reproductive phenology research, and habitat requirements assessments since 2019, alongside a communication and education strategy to engage communities and key stakeholders. Subsequently, we identified local threats related to elimination due to aversion and the increasing urbanization impacting on wetlands where the species reproduces. The next steps will focus on a rescue and relocation program for individuals at risk, population genetics studies, and the evaluation of suitable release areas within a network of private and public protected areas.

A-0200 (Oral)
Engaging Youth in Amphibian Biodiversity Education Through Visual Narrative

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Engaging youth in early and sustained amphibian conservation education has important implications for promoting positive attitudes and behaviors in those who will become the future of conservation and management. Towards this goal, visual narratives (comics, graphic novels) are increasingly popular methods used by conservation scientists to educate young people due to their approachable use of art and narrative storytelling. However, no studies have directly assessed how visual narratives compare to more traditional forms of amphibian conservation education for youth. In this study, we asked, how does education about amphibian biodiversity through visual narrative affect student perceptions and knowledge of science content relative to a traditional resource, and is there a novelty effect when using visual narrative vs. traditional resources? To assess our questions, we developed an amphibian biodiversity education program using a semi-structured approach. Specifically, we developed an original graphic novel (visual narrative treatment), and a slideshow presentation (traditional treatment) with the same content to educate children about amphibian and wetland biodiversity. We recruited, trained, and randomized 26 third grade teachers to deliver either the visual narrative or traditional resource in their classrooms. Students completed pretest, posttest, and follow-up surveys assessing their perceptions of science and knowledge of the lesson content. We found that students in the visual narrative treatment held more positive perceptions of science, while students in the traditional treatment performed better on content quizzes. Additionally, we find evidence for a novelty bias when using the visual narrative but not the traditional resource. These findings point toward the importance of understanding the target audience and clearly defining educational goals. Overall, this study contributes to our understanding of the relative benefits and limitations of amphibian conservation education through non-traditional means as well as practices for successfully delivering effective, accessible, and rewarding amphibian conservation education to educators and youth.

A-0201 (Oral)
Inhibition of Prodigiosin Production by *Batrachochytrium dendrobatidis* Metabolites

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Globally, amphibians have faced declines on an unprecedented scale due to novel stressors such as anthropogenic shift, climate change, and the introduction of disease. One disease in particular, *Batrachochytrium dendrobatidis* (Bd), has been responsible for mortality events in all corners of the world. One of the key defense elements of the amphibian against Bd has been demonstrated to be the microbiota living in symbiosis with the amphibian. Bacterial symbionts are capable of the production of antifungal metabolites which can act in concordance with components of the innate immune response to fight off Bd. Bd, however, also produces a full metabolite profile with which it can influence changes in the host immune response. The direct effects of these Bd metabolites on the bacterial symbionts with which it competes is presently understudied. We tested two different isolated strains of *Serratia marcescens*, a noted anti-Bd symbiont producing an antimicrobial pigment called prodigiosin, by growing the strains in serial dilutions of Bd metabolites grown across the temperature gradient that Bd is capable of surviving. Using UV-vis spectrophotometry, we were able to observe the relative production of prodigiosin as the bacteria proliferated over the course of 7 days. We discovered that the reduction of prodigiosin occurred in both strains at a higher rate as the concentration of Bd metabolites increased, and that these reactions occurred regardless of the temperature in which the S. marcescens and Bd were grown at. *S. marcescens* was then tested in the same fashion against the metabolites within the Bd profile that had noted immunomodulatory results, and inhibition again occurred regardless of temperature. These results demonstrate that Bd is capable of producing metabolites that are sufficient in suppressing the production of antimicrobial agents in an amphibian anti-Bd symbiont.

A-0202 (Oral)

Evolutionary Processes and Environmental Pressures Underlying Skull Diversity of New World Toads (*Anaxyrus, Incilius* and *Rhinella*)

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The vertebrate skull serves critical functions and is likely under multiple evolutionary pressures (phylogenetic history producing conserved phenotypes; allometry constraining phenotypes due to body size; bioclimatic variables driving traits to converge). The diverse New World toads (NWT) of the genera *Anaxyrus* (North America), *Incilius* (Middle America) and *Rhinella* (South America) form an ideal clade for investigating the evolutionary processes promoting skull diversity given they occupy varied microhabitats and elevational ranges. Forty-three species are on the IUCN Red List and two are Extinct. Although their overall external morphology is relatively conserved, they exhibit remarkable cranial diversity. Using CT scan, 3D geometric morphometrics and phylogenetic comparative methods, we quantified the diversity of skull shape and addressed four questions: Is phylogenetic history posing an intrinsic constraint on skull diversification? Is allometry influencing skull diversification? Are bioclimatic variables posing a selective pressure on skull evolution? We demonstrate substantial variation in skull diversity, with significant phylogenetic history on skull shape and size. We found bioclimatic variables related to thermal profile and rainfall regimen associated with NWT skull shape. There is no support for significant correlation between skull shape and skull size, elevation, nor microhabitat. Our findings suggest that NWT might be under different selective pressures compared with anurans in general. Although NWT skull shape presents

significant influence of phylogenetic history and bioclimatic variables, most taxa possess intermediate shapes, which indicates that they might have been influenced by the interaction of these factors, or others not explored in this study. Furthermore, we highlight that it is necessary to consider that bioclimatic variables might be exerting an indirect effect on NWT skull shape, whether by influencing the abiotic or biotic aspects of their habitat. We highlight the importance of taking into consideration multiple evolutionary processes that may influence the diversification of phenotypes.

A-0205 (Oral)

Heat Water and Reptiles—Do the Hydro-Thermal Properties of Animals at the Source Location Persist at the Translocation Site?

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Assisted colonisation to locations predicted to remain climatically suitable in the future is increasingly necessary to mitigate climate change effects in ectotherms such as reptiles. However, these future-suitable locations are often currently cooler than those from which individuals are sourced. While species-wide paradigms prevail, responses to thermal regimes may vary across a species range, affecting daily activity, colonisation, and survival in a new environment. Additionally, hydro-regulatory behaviours are severely understudied, despite the need for understanding trade-offs between thermoregulation and hydroregulation for successful assisted colonisation strategies. We investigated behavioural responses to temperature and relative humidity in two latitudinally distinct lineages of pygmy bluetongue (*Tiliqua adelaidensis*), a cryptic, burrow-dwelling endangered lizard, in the Mid-North of South Australia. From spring 2020 to autumn 2021 we took monthly field-based approach distance and behavioural footage at the source locations and at a southerly translocation site. Behaviours were matched to site-specific microclimate data prior to principal component and generalised linear mixed model analysis. We found lineage differences in behaviour that persisted after translocation; southern lineage lizards showed significantly less daily activity and were active at lower temperatures and higher humidity than northern lineage lizards. Southern lineage lizards allowed a human observer to approach closer as base-of-burrow humidity increased, while northern lineage lizards were quicker to retreat into burrows, at both source and translocation sites. Novel, non-invasive field-based activity curves successfully identified lineage differences in humidity and temperature ranges for surface activity, implying environmental preferences of target populations that were reinforced by the models. Specifically, we found evidence for thermoregulation and adaptation/acclimation to higher temperatures in northern lizards and hydroregulation and adaptation/acclimation to cooler, more humid conditions in southern lizards. The limited behavioural plasticity shown by translocated individuals over the season demonstrates the importance of understanding lineage-level behaviours, hydro-regulation, and micro-climate when selecting individuals for assisted colonisation.

A-0206 (Oral)

Differential Antivenom and Small-Molecule Inhibition of Novel Coagulotoxic Variations in *Atropoides, Cerrophidion, Metlapilcoatlus*, and *Porthidium* American Viperid Snake Venoms

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Within Neotropical pit-vipers, the Mexican/Central-American clade consisting of *Atropoides, Cerrophidion, Metlapilcoatlus*, and *Porthidium* is a wide-ranging, morphologically and ecologically diverse group of snakes. Despite their prevalence, little is known of the functional aspects of their venoms. This study aimed to fill the knowledge gap regarding coagulotoxic effects and to examine the potential of different therapeutic approaches. As a general trait, the venoms were shown to be anticoagulant but were underpinned by diverse biochemical actions. Pseudo-procoagulant activity (i.e., thrombin-like) was evident for *Atropoides picadoi, Cerrophidion tzotzilorum, Metlapilcoatlus mexicanus, M. nummifer, M. occiduus, M. olmec*, and *Porthidium porrasi*. In contrast, other venoms cleaved fibrinogen in a destructive (non-clotting) manner, with *C. godmani* and *C. wilsoni* being the most potent. In addition to actions on fibrinogen, clotting enzymes were also investigated for inhibitory action. While inhibition was observed across each species, some of these traits had been relatively amplified between species, causing strong variation in potency. In contrast to the anticoagulant activities of the other species, *Porthidium volcanicum* was uniquely procoagulant through the activation of Factor VII and Factor XII. This viperid species is the first snake outside of the *Oxyuranus*/*Pseudonaja* elapid snake clade to be shown to activate FVII and the first snake venom of any kind to activate FXII. The regional polyvalent antivenom produced by Instituto Picado Clodomiro was tested and was shown to be effective against the diverse anticoagulant pathophysiological effects. The small-molecule metalloprotease inhibitors prinomastat and marimastat prevented the procoagulant toxicity of *P. volcanicum*, neither ICP antivenom nor inhibitor DMPS showed this effect. The extreme variation among the snakes here studied underscores how venom is a dynamic trait and how this can shape clinical outcomes and influence evolving treatment strategies.

A-0207 (Oral)
Is Bergmann's Rule Valid for Nonavian Reptiles?

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The impact of environmental gradients on the evolution of life history traits is a central issue in macroecology and evolutionary biology, particularly among ectotherms with temperature-sensitive performance and fitness constraints. A few hypotheses have been formulated to explain factors shaping patterns of variation in animal traits. One such example is Bergmann's

rule, which predicts that body size will increase with latitude, and hence, with decreasing environmental temperatures. However, there are different opinions about how this rule applies to ectotherms. In our study, we explored latitudinal patterns of body size in nonavian reptiles using body size data from the ReptTraits dataset (2024) and latitudinal centroids from the Global Assessment of Reptile Distributions (GARD 1.7, 2022). The complete dataset, including body size values, covered 8369 species (Amphisbaenia = 191, Sauria = 6584, Serpentes = 1409, Testudines = 185). We employed ordinary least squares regressions as a linear mixed model (LMM) to investigate the relationships between latitude and body size, with the taxonomic rank of family included as a random effect. The analysis revealed varying relationships between body size and absolute latitude across different groups of reptiles. Amphisbaenia, Sauria, and Serpentes did not exhibit a significant relationship ($t = 1.895$, $p = 0.0613$; $t = 1.602$, $p = 0.109$, and $t = 0.991$, $p = 0.322$). However, Testudines demonstrated a significant negative relationship ($t = -4.027$, $p < 0.0001$), indicating a decrease in body size with increasing latitude. In summary, while turtles do not conform to Bergmann's rule by decreasing in size at higher latitudes, other groups of reptiles did not show any relationship between latitude and body size in the global pattern. Therefore, our results suggest that Bergmann's rule does not apply to nonavian reptiles in general.

A-0208 (Oral)

Two Distinct Ranid Frog Lineages (Anura: *Hylarana*) from Halmahera, Northern Moluccas, with the Description of a New Species

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We revise the systematics of the ranid frogs of the genus *Hylarana* occurring on Halmahera Island, northern Moluccas of eastern Indonesia based on molecular and morphological data. Our results show that two distinct species each being nested within two distinct clades (here after Papua clade and celebensis clade) exist on the island, one corresponds to *H. moluccana* (*celebensis* clade) and the other one to an unnamed species (Papua clade) that we describe herein. The new species is genetically distinct from all congeners of the Papua clade by p-distance ranging from 6.9 to 11.5 % on the 16S rRNA gene. Morphologically, the new species can be distinguished from all congeners by having the following combination of characters: A large species with adult males reaching a maximum SVL 67.3 mm; vomer teeth in two oblique rows with narrow inter-vomer distance; snout rounded dorsally; dorsum with few scattered cone-shaped tubercles that are black with white tips; distinct skin folds (ridges) on the dorsal side of the thigh coinciding with dark brown cross bars; a marbled pattern on the ventral side of thigh and yellowish groin. Here we provide a redescription for *H. moluccana* based on its

lectotype from Ternate. We also provide new occurrence records for *H. daemeli, H. volkerjane,* and *H. arfaki* from the western part of mainland Papua. Furthermore, we demonstrated that *H. celebensis* harbours multiple mtDNA lineages suggestive of cryptic diversity within the *celebensis* clade. The occurrence of two distinct species from Halmahera calls for further research on the biogeographic history of *Hylarana* in northern Moluccas.

A-0209 (Oral)
Adaptive Trait of a Forager's Success: Differential Numeric Abilities in Two Salamander Species Pre- and Post-metamorphosis

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Quantity discrimination plays a crucial role in adaptive decision-making and this ability originated early in evolution. Until recently, little was known about this ability in amphibians, and especially salamanders, a key basal group for developing our understanding of the evolution of cognitive abilities amongst vertebrates. Quantity discrimination is a highly adaptive trait as it allows animals to choose a larger food quantity, which is consistent with predictions based on optimal foraging theory. Investigating how this cognitive trait varies between species and across life-history stages can inform the differential adaptive abilities of species and help understand why some species are more vulnerable than others. In this study, we examined relative numeric abilities using a spontaneous forced-choice food quantity discrimination task between larvae (n = 32) and metamorphs (n = 16) of two salamander species: *Hynobius leechii* and *Salamandrella tridactyla*. The food items were 0.025 vs 0.1 g of blood worms for larvae and 1 vs 8 cockroaches for metamorphs. Salamanders had to choose between two different quantities of food items within 15 minutes and perform 10 successful trials. Overall, *S. tridactyla* took significantly less time to approach food compared to *H. leechii*. Both species showed evidence of learning across trials. Larvae of *S. tridactyla* approached food faster and showed a significant preference for larger quantities while metamorphs did not show any significant discrimination. Larvae and metamorphs of *H. leechii*, showed similar latencies to approach food. However, metamorphs of *H. leechii* significantly chose the larger of the two quantities, but larvae showed no preference. Our study for the first time shows that numeric competence varies between the two species and genera, and across life history stages. Such information can significantly contribute to our understanding of numeric abilities in amphibians, as well as the ecological needs of species and hence appropriate conservation strategies.

A-0210 (Oral)
Comparing Stress-induced and Predator-induced Morphological and Behavioural Responses across Anuran Species

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All living organisms experience significant spatial and temporal environmental heterogeneity. Adaptive plasticity evolves if reliable cues to assess such environmental variation are available. This evolutionary process facilitates adaptation to novel environments, increases the viability and persistence of populations, and contributes to the maintenance of genetic variability within populations. Defences displayed by preys when they detect risk of predation are an excellent

example of adaptive plasticity. Amphibian larvae are able to change their morphology, behaviour, physiology and life history traits if they detect water-borne predator cues. These inducible responses allow tadpoles to reduce the risk of predation, and are thought to be regulated by the hypotalamus – pituitary – interrenal (HPI) axis. Nevertheless, several studies in amphibians have found discrepant results regarding the role of glucocorticoids (corticosterone) as regulators of anti-predator plastic defences. Here we present an experimental comparative study, including twelve phylogenetically distant anuran species, aimed at evaluating the role of corticosterone in the inducible responses of tadpoles to perceived risk of predation. By exposing larvae from each species to either the presence/absence of predator cues, or different levels of exogenous corticosterone, we compared the effect of these two strong inducers on morphology, activity rate and life history traits. In addition, we measured the endogenous levels of corticosterone and assessed the oxidative stress experienced. We observed extensive interspecific variation in their degree of plasticity, both morphological and behavioural. Predator-induced phenotypic responses across species were generally divergent to those triggered by increased corticosterone. Furthermore, individuals exposed to predator cues did not increase their corticosterone levels. Despite the limited number of species compared in this study, we present solid evidence suggesting that tadpoles' defences against predators are not entirely regulated by the HPI axis and that therefore other mechanisms are necessarily at play.

A-0211 (Oral)

Diversity and Evolution of Hemipenes in Serpentes (Reptilia: Squamata)

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The hemipenis is a copulatory organ found only in male squamates, its morphological characteristics are crucial in the study of taxonomy, evolutionary biology, and developmental biology in the order Squamata. This study presents an updated method for preparing hemipenial specimens, both fresh and preserved, and for hemipenis eversion in various states. To improve the hemipenis filler, we use industrial yellow petrolatum stained with printing oil. We fix the hemipenis using thin glass fiber rods to enable its re-eversion for the study of comparative morphology. The hemipenis is photographed using a digital camera mounted on a tripod head, and multifocal photographs are combined and montaged. In addition, it is recommended to evert only the left hemipenis for comparative and geometric morphometric studies, while keeping the right hemipenis *in situ* to study morphology in the retracted state. To promote more scientific and standardized morphological research in hemipenis morphology, we standardize the morphological specimen preparation method of the hemipenis. Based on our newly improved method, we prepared 384 hemipenes from 176 species of snakes belonging to 54 genera and 16 families. Our findings indicate that while hemipenis is conservative within a given species, most families, genera, and even species have unique combinations of hemipenial characters, making it an ideal diagnostic character in taxonomic studies. In addition, for groups with relatively conservative hemipenial morphology, we performed elliptic Fourier geometric morphometric analysis based on the sulcate surface contour of fresh everted hemipenial specimens. Our findings indicate that geometric morphometry can discriminate slight shape differences of some hemipenes, which could be the focus of further studies. Finally, in combination with the hemipenial morphology of the suborder Lacertilia, the evolutionary trend of the shape and ornamentation is also discussed.

A-0212 (Oral)
Trophic Ecology of Sea Snakes in Japan: Insights from Stomach Content and Stable Isotope Analysis

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Sea snakes are marine reptiles that play diverse and crucial roles in coastal ecosystems. Information on the trophic ecology of sea snakes can help us assess how sea snake and prey populations interact, and how habitat change may affect sea snake populations. The Ryukyu Islands in Japan represent the northern range limit for sea snakes, but ecological data on Ryukyuan sea snakes is limited. Here, we used two complementary approaches, namely stomach content analysis and stable carbon and nitrogen isotope ratios (δ13C and δ15N), to investigate specialization and ontogenetic/sexual variation in trophic ecology in two viviparous sea snakes (*Hydrophis melanocephalus* and *H. ornatus*) and one oviparous sea krait (*Laticauda semifasciata*) from the Ryukyus. Stomach contents of *H. melanocephalus* and *H. ornatus* comprised predominantly of snake eels and gobies, respectively, whereas those of *L. semifasciata* included diverse reef-associated fish taxa. Isotopic niche areas calculated by δ13C and δ15N values were large in *H. melanocephalus* and *L. semifasciata* but relatively small in *H. ornatus*, suggesting population-level trophic specialization in *H. ornatus*. The large isotopic niche in *H. melanocephalus* may indicate that this eel-specialist exploits prey of various sizes, species, and habitats. In *L. semifasciata*, males had higher δ13C than females, and multi-tissue stable isotope analysis using red blood cells and plasma revealed extreme individual trophic specialization. These results may reflect a tendency for females to forage further offshore, as well as individual preference for a specific habitat type. Our study demonstrates the utility of the isotopic approach for assessing trophic interactions in elusive sea snakes. Future research should incorporate prey taxa and primary producers to provide a full view of the food web, as well as describe the geographical distribution of isotopes (i.e., isoscape) to link intra-specific variation in isotope values with habitat use.

A-0213 (Poster)
Seasonal Change of Thermal Preference and Habitat Use of the Japanese Five-Lined Skink, *Plestiodon japonicus*

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In lizards as ectotherms, maintaining a body temperature that optimizes physiological and behavioral performance is critical for individual fitness. Therefore, habitat use by lizards is strongly influenced by temperature. Seasonal changes in environmental temperature would induce physiological responses that alter preferred body temperatures optimizing to thermoregulation and/or behavioral responses that alter microhabitat use. However, habitat selection based solely on thermoregulation may impede other fitness related behaviors such as foraging, and thus temperature-related trade-offs are expected. In this study, we aimed to examine physiological and behavioral responses of the Japanese five-lined skinks, *Plestiodon japonicus*, to seasonal changes in environmental temperature in order to elucidate whether P. japonicus exhibits seasonal change in thermal preference and habitat use and what trade-offs drive seasonal changes in its habitat use. We conducted laboratory experiments and field

studies to answer these questions. We found no seasonal changes in both field active body temperature and preferred body temperature, suggesting that lizards behaviorally maintain their body temperature throughout the seasons. The lizards used full shaded microhabitat only in summer, suggesting that high temperature is a factor that enables them to use full shaded microhabitat. A higher percentage of lizards engaged in foraging in filtered sun and shaded microhabitats than in full sun, suggesting that the former environments are suitable foraging habitats for lizards. It is considered that although shade is suitable for foraging, it has a lower thermal quality and thus, lizards require frequent movements to the sun from the shade to regulate body temperature. This trade-off between the cost of thermoregulation and foraging efficiency in the shade is presumed to induce seasonal changes of habitat use. The results suggest that *P. japonicus* behaviorally regulates its body temperature in response to seasonal changes in environmental temperature and that high environmental temperature facilitates its foraging behavior in the shade.

A-0214 (Poster)
Ontogenetic Change of a Tail Display of a Japanese Five-Lined Skink, *Plestiodon japonicus*

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Many lizards perform tail displays to convey signals in various contexts. A Japanese five-lined skink (*Plestiodon japonicus*) also performs tail displays. My observations in 2022 suggested that the lizard has a repertoire of different tail displays and that among the repertoire, raised-tail wag may disappear ontogenetically. While there have been several descriptions on the disappearance of raised-tail wag in congeneric species, virtually no quantitative study has been conducted in the field, and the detailed timing of its disappearance is unknown. We conducted a quantitative field study on raised-tail wag of *P. japonicus* in the eastern part of Hyogo Prefecture in the summer of 2023. We observed behavior of the lizards by video camera and recorded the surrounding environment to determine the relationship between raised-tail wag and openness. The results showed that raised-tail wag is dependent on body size, and that the timing of its disappearance is between 45 and 60 mm of snout-vent length of individuals. We compared the environment at the site where the raised-tail wag was observed with that at the site where the individual was initially found, using plant cover and sky view factor as indices. The results showed that raised-tail wag was observed even at sites with high plant cover and low openness. These results suggest that this tail display may function to increase individual survival in interactions with ambush predators and that its disappearance may be caused by factors that change in relation to the increased body size.

A-0215 (Poster)
Contributions to the Knowledge of Pit Vipers (Genus *Gloydius*) in the Democratic People's Republic of Korea

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Basic knowledge of species distribution and diversity is crucial for broader studies of ecology, evolutionary biology, and conservation. However, for some countries, even a basic inventory of species diversity is difficult to compile due to the inaccessibility for fieldwork. The Democratic People's Republic of Korea (D.P.R. Korea) is one of these countries. The diversity and distribution of snake fauna of D.P.R. Korea are described in only a few publications, and no physical specimen has been examined in recent studies. Here, we provide the first description of pit vipers of the genus *Gloydius* from D.P.R. Korea, based on four legally purchased specimens. We use morphological and genetic analyses to identify these specimens at the species level. In addition, we implement ecological niche modeling to estimate the suitable habitats of all known *Gloydius* within D.P.R. Korea. The results of morphological analyses recovered three distinct clusters and diagnostic scalation and body patterns correspondingly identified three different species. Similarly, phylogenetic analyses of the mitochondrial 12S rRNA gene unambiguously identified the samples belonging to *G. ussuriensis*, *G. brevicauda*, and *G. intermedius*. The niche models had high predictive performance and predicted suitable habitats that were consistent with the ecology of the three species. For example, the models for *G. ussuriensis* predicted suitable habitats spanning low- to high-elevation regions. However, the models for *G. brevicauda* predicted suitable habitats mostly in low-elevation regions, whereas the models for *G. intermedius* predicted high-elevation regions in northern D.P.R. Korea as suitable habitats. With this study, we provide the first morphological and genetic data for *Gloydius* from D.P.R. Korea that can be incorporated into future studies. In addition, the predicted distribution of *Gloydius* within D.P.R. Korea can be used to map the snakebite risk in the country. Therefore, our study adds to the recent efforts towards better understanding the herpetofauna of D.P.R. Korea.

A-0216 (Oral)
Foraging Mode Moulds the Evolution of Cephalic Horns in Squamates

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Several species of snakes and lizards carry rostral and ocular horn-like appendages. The presence of these enigmatic structures in several squamate lineages allows testing different hypotheses on their possible costs and benefits. In some squamate groups, species with horns share aspects of their ecologies, suggesting that horns may be advantageous in particular environments. However, the possible costs of bearing horns have hardly been explored. In this comparative study, we test for correlated evolution between cephalic horns and foraging mode in squamates. We hypothesise that, although horns may be beneficial (e.g., in camouflage and defence) for species that ambush their prey and move less frequently, they may be detrimental for active foragers, by making them more conspicuous to prey and predators while moving. As

a result, we predicted that cephalic horns would occur more frequently in sit-and-wait species while being less common among active foragers. To test our hypothesis, we performed a phylogenetic comparative analysis of published data on 1939 squamate species. Our results show that cephalic horns are present almost exclusively in sit-and-wait species, corroborating our initial hypothesis and adding further evidence that foraging mode shapes the morphology of squamates.

A-0217 (Oral)

Taxonomic Study of the Enggano Rat Snake *Coelognathus enganensis* (Vinciguerra, 1892) Based on Morphological Characters

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Coelognathus enganensis is an endemic rat snake from Enggano Island, an oceanic island (raised from the seabed) and has never been connected to mainland Sumatra and this isolation caused uniqueness on its fauna and flora. Since original description in 1892, noone of information is available about this rat snake. This research was carried out in February–July 2023 to redescribe the species *Coelognathus enganensis* and determine the relationships between species of the genus *Coelognathus* in Indonesia based on morphological characters. In this study, six morphometric characters, 26 meristic characters, and three morphological characters (color pattern and sex) were used. The data was analyzed statistically using PCA (Principal Component Analysis) in R Studio and UPGMA Cluster analysis with the Simple Matching Coefficient (SSM) similarity index using NTSYS 2.11a. The results are displayed in scatter plots, biplot graphs (PCA analysis), and dendrograms (UPGMA cluster analysis). The main characteristics of *C. enganensis* are that it has nine supralabial scales where the IV─VI or V─VII supralabial scales contact with orbit, 10─11 infralabial scales, 2+2 or 2+3 temporal scales, a faint short line pattern located behind the eyes, 21 or 23 dorsal scales, and 227─249 ventral scales. The relationship between five species in the genus *Coelognathus* spread across Indonesia here are: *C. enganens* is closely related to *C. erythrurus* with an SSM value of 29%, and the distinguishing characters are EYEN, DOR2, and DOR3; *C. radiatus* and *C. flavolineatus* have an SSM value of 33% with differentiating characters are WSNT, HL, and VENT. Meanwhile, *C. subradiatus* is separated from others with an SSM value for all species of 51.6%, with the distinguishing characters being DOR1, DOR2, DOR3, VENT, and GUL. Further study in analysis molecular is needed to solve the relationship of *C. enganensis* with other *Coelognathus* species.

A-0218 (Oral)

An Integrative Analysis for the Reconsideration of Species Boundaries in East Asian *Pelophylax* Species

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The phylogeography of the *Pelophylax* genus in East Asia is poorly resolved and dated, partially because of the ability of the species to hybridise, the intense trade by humans, and the lack of fossils to calibrate molecular dating estimates. For the first time, we reconstructed the biogeography of *P. plancyi* (1520 bp concatenated CYTb-POMC-TYR; and 714 bp 12S-ND3 gene fragments) using fossil-based molecular dating, morphometry and ecological models. Our results highlight four cryptic lineages within *P. plancyi*, but also recovered two well-supported clades for *P. chosenicus*, on either side of the Yellow Sea, and recovered *P. hubeiensis* as a well-supported monophyletic clade. Additionally, our fossil-based molecular dating analyses supported the emergence of *P. hubeiensis* circa 10.89 (6.31–16.71) Ma and *P. chosenicus* circa 1.36 (0.96–1.69) Ma. To determine the morphological differences among the four focal clades (*P. plancyi, P. chosenicus* "east", *P. chosenicus* "west", and *P. hubeiensis*), we analysed morphological data known to be variable in this clade. Our morphometric analyses showed that morphological characters differed significantly among clades. In general, the distributions of four characters related to head width, head length, eye lateral diameter, and tympanum diameter did not overlap among clades and may be used for species identification. Finally, we modelled the suitable habitat for each of the four clades to clarify their putative distributions. The highest suitability area for *P. hubeiensis* matched the currently known distribution of the species in the Yangtze River Basin. The highest suitable habitat for *P. chosenicus* "east" was located on the plains east of the Yellow Sea, and the suitable habitat for *P. chosenicus* "west" was located on the plains west of the Yellow Sea. Our phylogenetic analysis, divergence dating estimates, morphological analyses and landscape models strongly support the monophyly and species-level taxonomy of *P. chosenicus, P. hubeiensis* and *P. plancyi*.

A-0219 (Poster)

Conquering the World: Biogeographic Reconstruction Demonstrates an Indian Origin for the Cosmopolitan *Hemidactylus* Geckos

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Hemidactylus is a speciose gecko genus with a global distribution. Despite being well-studied, the origins and inter-clade relationships of this group remain unclear. To fill these knowledge gaps, we first used six nuclear genes to reconstruct a reduced representation global phylogeny of *Hemidactylus* by employing Bayesian, Maximum Likelihood, and Coalescent-based methods. Additionally, we also obtained a timetree with a concatenated dataset of two nuclear and three mitochondrial markers from 132 out of the 192 *Hemidactylus* species currently

described. Further, this timetree was utilized in R package biogeoBEARS to reconstruct ancestral geographic ranges. A time-stratified approach in conjunction with plate tectonic data was employed to explicitly test three hypotheses regarding the origins of the genus. The biogeographic reconstructions indicate that the common ancestor of *Hemidactylus* and *Dravidogecko* colonized the drifting Indian plate through transmarine dispersal from Southeast Asia approximately 58 million years ago. Subsequently, *Hemidactylus* dispersed out of India to Africa and Asia, whereas *Dravidogecko* remained in peninsular India. Thus, our result suggests an Indian origin for these cosmopolitan geckos and further marks the first instance of an "Out of India" dispersal scenario for a non-Gondwanan squamate group.

A-0221 (Oral)
Released Pet Turtle Spatial Analysis Using Citizen Science: Predictions and Solutions

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Illegally released pets have the potential to spread disease, outcompete native species and contribute to the extinction of those 'at risk' worldwide. Citizen Science (CS) strategies have proven successful in informing on distribution and numbers in creating management strategies. CS can also provide further insight (aside from spatial data) to aid in a 'One Health' approach in assessment as to the reasons for releases, i.e., pet relinquishment due to the UK financial living crisis and owner impoverishment. *Trachemys scripta* spp. are ranked globally as highly invasive and impact negatively on native populations. The red-eared and yellow-bellied slider species have proven adaptable and formidable at establishing worldwide even considering legislative measures to prohibit pet sales and keeping (EU (1143/2014) Invasive Alien (Non-native) Species Regulation). This study focused on surveying released individuals in UK waterbodies from 2019-2022 to assess the numbers, species, and distribution. Using GIS spatial analysis, correlations regarding socioeconomic factors were assessed for use in predicting future 'at risk' locations. This enables a more targeted approached for public education and prevention of illegal releases in the future. These strategies have the potential to be replicated in other locations globally to address the issue.

A-0222 (Oral)
Androgens do not Make Big Males with Large Weapons, but Control Sex-Specific Coloration and Behavior in Chameleons

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The proximate control of sexually dimorphic traits in reptiles remains largely unknown. Some, but not all chameleons, including veiled chameleon (*Chamaeleo calyptratus*), possess male-larger sexual size dimorphism (SSD), well-developed male weapons (head casques) and male-typical coloration. It is generally believed that the development of such traits in lizards is controlled by male gonadal androgens, but evidence is controversial. We conducted hormonal manipulations to test the hypothesis on androgen control of male-specific traits in *C. calyptratus*. Remarkably, early removal of gonads, a source of androgens, do not alter growth and the castrated males attained male-typical body size highly deviating from the female body size. Ontogenetic allometries of casque size on head length revealed that sexes depart considerably in casque growth later in the ontogeny; however, castrated males still follow

male-typical casque growth. The application of exogenous testosterone resulted in the manifestation of male-typical sexual and aggressive behaviors and full spectrum of male-typical coloration in both females and castrated males. On the other hand, castrated males exhibited only fainter coloration similar to juveniles. We can conclude that the ontogeny of sexually dimorphic body size and male skeletal exaggerated traits in at least some squamates is likely not controlled by male gonadal androgens, but can be driven by feminization controlled by ovarian hormones. In contrast, male-typical sexual and aggressive behavior depends on high circulating levels of male gonadal androgens. We demonstrate that a development of male-specific phenotype requires integration of several developmental mechanisms, which explains, why particular traits can be gained or lost largely independently during the evolution of chameleons.

A-0223 (Poster)
The Relationship Between, Ecology, Reproductive Strategies and Threat Status in Salamanders (Caudata)

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Amphibians are the most endangered class among vertebrates, and our understanding of salamanders (Caudata) is even more limited compared to frogs and toads (Anura) because of their secretive lifestyle. In this study, we investigated how the reproductive strategies and ecological requirements of salamander species influence their threat status and the trends in population changes. We hypothesised that species with narrow ecological preferences, or inhabiting vulnerable habitats (aquatic environments, forests, caves), having slower reproductive rates or aquatic larval stages would, on average, be more vulnerable. We collected data on threat status, population trends, habitats, distribution, and reproductive traits (egg count, egg size, developmental process, parental care) from the IUCN Red List and AmphibiaWeb databases. Phylogenetic comparative methods were employed in the analyses, considering the impact of species relatedness and controlling for it. The results confirmed that generalist species are less vulnerable than habitat specialists. Furthermore, species depositing a large number of eggs are less vulnerable compared to those having smaller clutches. However, expectations were contradicted in some cases. For instance, species occurring in aquatic habitats or undergoing larval development are less vulnerable than species with direct development, likely explained by the small clutch size, unfavourable demography, and challenging dispersion of direct-developing species. The strong positive association between threat status and population decline was to potential positive feedback loops in species decimation, leading to extinction spirals, while the huge portion of data deficient species is also alarming. Our research helps identify the most challenging species and species groups, and ecological or life-history risk factors for conservation purposes.

A-0224 (Oral)
Diversity of Karst-adapted Bent-toed Geckos in Laos and Vietnam

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The bent-toed gecko lizards, *Cyrtodactylus*, is ecologically diverse and the most speciose genus of the family Gekkonidae and the world's third largest vertebrate genus. Members of the group occupies a wide range of ecosystems, from intertidal, arboreal, swamp, trunk to granite and karst habitats with karst being the most common niche specialization. The number of species in the genus has increased more than fourfold over the last two decades and the rate at which new species are being described shows no sign of decreasing. Although *Cyrtodactylus* ranges from tropical South Asia to Indochina to the Philippines, the Indo-Australia Archipelago to the Solomon Islands in the East, most of the newly discovered come from karst habitats in Laos, Peninsular Malaysia, Thailand, and Vietnam. Of these, Laos and Vietnam have witnessed a surge in the discovery of new species during the last decade. Among 35 new species described in Laos and Vietnam, at least 21 congeners have been discovered exclusively from karst habitats in the last ten years. However, many areas where this group is distributed are still poorly studied, especially the Central Highlands in Vietnam and northern and southern Laos The vast karst landscapes likely harbor a substantial undescribed diversity, which once better investigated can help untangle the evolution mechanism of the genus on this unique ecosystem.

A-0225 (Poster)

The Phylogeography and Diversification of Lesser Antillean Island Bank Anoles

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In the late Pleistocene, climatic changes resulted in cycles of sea-level fluctuation that periodically fragmented islands into aggregate island complexes. These temporary saltwater barriers between islands within an island bank may decrease flora and fauna migration, increasing genetic divergence between populations on separate islands. Over time, these periods of isolation may result in new species-level diversity within the archipelago; however,

for species that can effortlessly disperse overseas, sea-level changes may not impact migration rates. In the Lesser Antilles, *Anolis* lizards (anoles) are distributed across island banks that vary in distance and water depth between islands, making them excellent candidates for studying how different barriers shape patterns of genetic diversity. In particular, we focus on anoles found across the St. Kitt's Bank (*Anolis bimaculatus, Anolis schwartzi*), Anguilla Bank (*Anolis gingivinus*), and Barbuda Bank (*Anolis leachi, Anolis wastti*) to test the hypothesis that populations separated by narrower and shallower marine barriers are more genetically similar to one another than populations on more distant islands or those separated by deeper water. We use a combination of mitochondrial and nuclear DNA (ddRADseq) to construct a phylogenetic tree for each species and conduct demographic modeling analyses to test competing models of population divergence between islands (divergence in allopatry versus divergence with gene flow). Our results provide new insights into the evolutionary histories that have generated the current patterns of genetic structure within each species.

A-0226 (Oral)

Impacts of Climate Change on Herpetofauna Diversity in the Qinghai-Tibetan Plateau

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Although numerous studies on the impacts of climate change on biodiversity have been published, only a handful are focused on the intraspecific level or consider population-level models. We endeavored to fill this knowledge gap relative to the Qinghai-Tibetan plateau (QTP) by combining species distribution modeling (SDMs) with population genetics and phylogenetic methods. We applied our models to 11 endemic and widely distributed herpetofauna species inhabiting high elevations in the QTP. We aimed to determine the influence of environmental heterogeneity on species' responses to climate change, the magnitude of climate-change impacts on intraspecific diversity, and the relationship between species range loss and intraspecific diversity losses under 2 shared socioeconomic pathways (SSP245 and SSP585) and 3 future periods (2050s, 2070s, and 2090s). The effects of global climatic change were more pronounced at the intraspecific level (22% of haplotypes lost and 36% of populations lost) than the morphospecies level in the SSP585 climate change scenario. Maintenance of genetic diversity was in general determined by a combination of factors including range changes, species genetic structure, and the part of the range predicted to be lost. This is because the loss and survival of populations were observed in species irrespective of the predicted range changes. In the southeast (mountainous regions), climate change had less of an effect on range size than in central and northern QTP plateau regions. This may be attributed to environmental heterogeneity, which provided pockets of suitable climates in the southeast, whereas ecosystems in the north and central regions were homogeneous. Generally, our results imply that mountainous regions with high environmental heterogeneity and high

genetic diversity may buffer the adverse impacts of climate change on species distribution and intraspecific diversity. Therefore, genetic structure and characteristics of the ecosystem may be crucial for conservation under climate change.

A-0227 (Poster)

Lighting the Way: *In Vitro* Fluorescence for Enhanced Live Imaging of Chytrid Infection Models

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The genus *Batrachochytrium* contains the only chytrid fungi capable of infecting vertebrates, and realistic infection models are needed to study their pathogenesis. Understanding the mechanism by which *Batrachochytrium dendrobatidis* (Bd) can infect and kill diverse amphibians is key to tackling this disease and preventing further loss of biodiversity. *In vitro* studies of Bd typically rely on a tryptone based growth media, which is not representative of the host environment. Here we optimised an *in vitro* cell-line based growth assay, where Bd cells were able to invade and grow in amphibian kidney epithelial (A6) or lung fibroblast (DWJ) cells. This *in vitro* growth model is more relevant to the host-pathogen system than simple growth media, while also avoiding the use of live animals. Both Bd and host cells (A6 and DWJ) were transformed to express reporter fluorescent proteins, enabling immediate and continuous observation of the infection process without the need for fixation and staining. Plasmid DNA conferring hygromycin resistance and TdTomato (RFP) expression was delivered to Bd zoospores via electroporation, and continuous antibiotic selection after recovery produced Bd displaying multigenerational red fluorescence. Host cells (A6 and DWJ) were transformed before each assay using lipofection to deliver plasmid DNA conferring enhanced green fluorescent protein (GFP) and containing an empty shRNA expression cassette. Bd RFP expression allowed easy localisation of fungal cells and identification of endobiotic growth was assisted by host GFP expression, allowing visualization of the gap in the host cell occupied by the invading fungal body. In addition to enabling enhanced live imaging, the expression cassettes and growth assay will facilitate future genetic modification and characterisation of specific genes and their effect on virulence.

A-0228 (Oral)

Low Genetic Diversity and High Population Structure in the Black-eyed Tree Frog, *Agalychnis moreletii*

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Agalychnis moreletii, the black-eyed tree frog, is a charismatic species that inhabits montane forests in Mexico, Guatemala, Belize, El Salvador and Honduras. The species is on the Appendix II of the CITES index due to pet trade (CITES 2010). In 2016 it was taken from Critically Endangered to Least Concern by the IUCN Amphibian Specialist Group, due to its large distribution range and that some populations seems to be recovering. Nonetheless, they agreed that the population trend is to decrease, and that there are several recognized threats, e.g., loss of habitat, pollution, diseases, that could lead to future declines. To understand the population status of *A. moreletii* we did field work in Mexico and Central America. We found that the species habitat varies greatly from site to site, going from natural ponds within private reserves to abandoned cattle or coffee wells surrounded by plantations or fragmented forest. We developed microsatellite and used mitochondrial markers to study genetic and evolutionary history of the species. Results show that several populations have low genetic diversity (especially the ones on the Pacific coast) as well as high inbreeding levels. There is high genetic differentiation and population structure across its distrubution range, which gives evidence that the species should be split into different Evolutionary Significant Units (ESUs) for conservation management. Data presented here challenges the conservation status of *A. moreletii* as it is currently defined by the IUCN and shows this species is far more endangered than thought when it was assessed. Changing this categorisation will increase the protection of the species and the ecosystem it inhabits.

A-0229 (Poster)

Effect of the Presence of *Batrachochytrium dendrobatidis* on Bacterial Communities of the Skin of *Agalychnis moreletii* from Guatemala

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Guatemalan amphibians suffered population declines due to infectious diseases in the 1980s and 1990s (Cheng et al., 2011). Unfortunately, there is little information about the skin microbiome of the different species and how disease and habitat destruction can impact it. In Guatemala the management and conservation of A. moreletii varies greatly from site to site. The species can be found in natural ponds within private reserves to abandoned cattle or coffee wells surrounded by plantations or highly fragmented forests. There is no data about the skin microbiome or presence of *Batrachochytrium dendrobatidis* (Bd) for this species in the country, nevertheless infected individuals have been found in Belize, El Salvador and Mexico. The aims of this study were to describe the skin microbiome of *A. moreletii* in Guatemala, as well as to document how it can be influenced by habitat fragmentation and the presence of B. dendrobatidis. We sampled four sites in Guatemala, with different habitat conservation. Results show that skin-microbiome in *A. moreletii* seems host-mediated, not changing significantly between sites or habitats. We also found that Bd has an effect on the skin bacterial composition, infected frogs harbour lower diversity of bacteria that non-infected frogs, which leaves these individuals more vulnerable to other diseases or changes in the environment. There were significant differences between the weighted unifrac distances but not for the unweighted unifrac, which indicates that the differentiation among bacterial communities between infected and non-infected frogs is due to differences in ASVs relative abundance instead of the presence or absence of certain ASV on the samples. We found 90

ASVs that corresponded to bacteria with potential bd inhibitory characteristics. All the samples contained potentially anti-Bd bacteria isolates, which corresponds to 7% of the ASV in our data set.

A-0230 (Oral)
Peninsula Effect on Amphibian Biogeography and Conservation: Insights from the Malay Peninsula

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For over four decades, biogeographers have investigated the peninsula effect, positing a decline in species richness from the mainland's base to the distal tip of a peninsula. Despite more than 90 global studies, results have been inconsistent across peninsulas, rendering the theory vague. This study aims to examine the peninsula effect on amphibians on the Malay Peninsula. We compiled previous amphibian distribution data, conducted field surveys, and assembled comprehensive species-range-based distribution data. These data were mapped using spatial resolutions of 100 km, 75 km, 50 km, 25 km, and 15 km square grids. Spatial analysis involved alternative biodiversity metrics such as taxonomic diversity, endemism, and phylogenetic diversity. Distribution data were modelled to predict potential distributions under past and future climatic scenarios. The compiled data augment the total of 169 species reported from the Malay Peninsula, a substantial increase compared to previous reports by Inger and Voris (2001). Results show a mixture of inverse and positive peninsula effects, with increasing species richness from both the base-to-tip and tip-to-base of the Malay Peninsula. Spatial analysis revealed that these mixed peninsula patterns correspond to richness hotspots shaped by previous hypotheses of peninsula geometry, habitat diversity, and climates. Predictions under past-present-future climatic scenarios demonstrated similar mixed peninsular patterns, with significant distributional shifts and movements of amphibians. Overall, insights from this assessment indicate that the peninsula effect on amphibians progressed through four stages of causal mechanisms: historical events, stochastic processes, recent deterministic processes, and anthropogenic disturbances in this peninsula. The insight from this investigation might provide a better understanding of the species diversity and biogeography of the peninsula and be better applied to large-scale biodiversity conservation and management.

A-0231 (Oral)
Island Isolation Effect on Morphology, Evolution, and Biogeography of the Genus *Bronchocela* Kaup, 1827 (Reptilia: Agamidae) in Indonesia

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Isolation is the main factor in insular biogeography. Here, we try to understand the insular biogeographical phenomenon of the morphologically highly variable arboreal lizard genus *Bronchocela* across the Indonesian Archipelago. To determine the effects of geographical island isolation on the morphological structure of the populations, 520 museum specimens were examined across the Archipelago. Both univariate and multivariate analyses were conducted on morphometric characters. We screened two mitochondrial markers comprising 16S rRNA and ND2, with intervening nuclear loci (CMOS) to obtain a robust phylogenetic hypothesis. Based on both morphology and genetics, we delimit potential biogeographic boundaries of the species composition. The previously widely distributed *B. cristatella* is considered a species complex with at least three distinct species. The phylogeny of mitochondrial and nuclear DNA using maximum likelihood and Bayesian Inference revealed at least six major evolutionary lineages of *Bronchocela* within the Indonesian Archipelago. This level of variation has probably been underestimated because of the high levels of morphological similarity brought about by the arboreal lifestyle. Our results also show the significant influence of the larger islands supporting larger-bodied lizards compared to the smaller islands, agreeing with the island theory. The coalescent-based BEAST time-analysis yielded a phylogenetic tree with two major clades. The basal clade of *Bronchocela* consists of *B. burmana* and its ancestral taxa, mostly confined to the Malay Peninsula. The geological time-scaled maximum clade credibility tree indicated that the genus Bronchocela evolved in the early Miocene epoch (~18.7 MYA) and started rapid speciation in the late Miocene. Our results provide new insights into insular isolation in a previously unstudied region, and it implies that the distribution pattern of *Bronchocela* has been largely shaped by pre-Pliocene dispersal followed by deep vicariance events. We further demonstrate that Pliocene climatic changes can profoundly affect species diversification and demography in these forest species.

A-0232 (Poster)
Honest Signaling of Antipredator Behavior in a Lacertid Lizard, *Takydromus tachydromoides*

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Several lizard species exhibit a behavior called arm-waving, where they rotate or wave their forearms as an anti-predator display. This behavior has a pursuit-deterrent function on predators by indicating the lizard's escape performance or the perception of the predator. Therefore, this behavior is assumed to be an honest signal showing the physiological state of the lizard. To verify this assumption, a field study was conducted with *Takydromus tachydromoides*, a small lacertid lizard endemic to Japan. *T. tachydromoides* has been known

to exhibit arm-waving, but no quantitative study has been made. In the present study, we approached lizards in the field, recorded the occurrence of the arm-waving, and attempted to capture them to record their sex, snout-vent length, and body temperature. The probability of performing arm-waving was positively correlated with the lizard's body temperature and snout-vent length, and males exhibited arm-waving more frequently than females. In ectothermic lizards, escape performance is generally considered to have a positive correlation with body temperature and body size. Additionally, it has been shown that escape performance decreases in gravid females, making males more likely to have a high performance. Therefore, the arm-waving of *T. tachydromoides* is considered an honest signal showing its physiological state.

A-0233 (Poster)

Unveiling the Secrets of *Hynobius* Salamander Distribution: The Role of Biogeographic Barriers

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Understanding biogeographic barriers is crucial for explaining species distribution patterns. These barriers, shaped by factors including gene flow, climate, and competition, profoundly influence ecological dynamics. Amphibians, with their limited mobility, serve as valuable models for studying such barriers. Ecological Niche Models (ENMs) offer a powerful tool for assessing environmental preferences and barriers faced by species. This study focuses on seven Hynobius salamander species in South Korea. ENMs were generated using MaxEnt software, incorporating 16 uncorrelated environmental variables. Three sets of tests were conducted for each species pair. First, we employed Niche Requirement Tests, encompassing identity and background similarity assessments, to ascertain if species pairs exhibit distinct ecological niches. Following this, Lineage-Breaking Tests were conducted to probe whether species range boundaries align with abrupt environmental shifts, potentially contributing to diversification. Finally, Ribbon Tests were utilized to examine the existence of unsuitable habitats that separate contact zones between species. The models achieved high performance in predicting habitat suitability for each species. The Niche Requirement Tests revealed distinct ecological niches among species pairs. The Lineage-breaking Tests supported the presence of abrupt environmental transitions driving diversification. Finally, the Ribbon Tests identified unsuitable habitats separating several species pairs. These findings confirm the existence of biogeographic barriers influencing the distribution of *Hynobius* salamanders in South Korea. These barriers impact species dispersal, leading to the development of distinct ecological niches. The identified barriers were physical obstacles matching rivers and mountainous ranges, highlighting their importance for understanding speciation mechanisms. Specifically, the study's comparative framework supports the underlying mechanisms of speciation and evolution in the seven *Hynobius* salamanders by corroborating the distinct distribution patterns resulting from the dispersal barriers identified in our results.

A-0234 (Oral)

Investigating the Genetic Basis of Toxin Resistance in *Erythrolamprus epinephelus* using Comparative Genomics

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Erythrolamprus epinephelus, a Neotropical snake species (family Colubridae), is one of the few recognized natural predators of toxic amphibians distributed across the Neotropics, including poison dart frogs (family Dendrobatidae), as well as other toxic frogs (such as *Atelopus* and *Rhinella*). This varied prey composition exposes *E. epinephelus* to a diversity of toxic compounds of presumable anti-predator and anti-parasitic function, which this species is somehow able to counter. Furthermore, the fact that the snake could potentially exploit various food sources with several toxins of different natures, presents an interesting and unique system to study the evolution of complex chemical defences in predator-prey dynamics. We have applied a comparative genomics approach, using whole genome sequencing data, to explore the broad genetic basis of toxin resistance in the snake across candidate genes isolated from other model systems. Functionally important genetic mutations in these candidate genes are being identified and investigated relative to their putative mode of resistance. Using established phylogenetic models, we are analyzing the signatures of selection on our functionally-relevant candidate variants and search for the evidence of selective sweeps. This is the first study that consider the evolution of the compounded toxin resistances across multiple loci/candidates in *E. epinephelus*, leading to a greater understanding of the evolution of toxin resistance in this species and in vertebrates in general.

A-0235 (Poster)
Behavioral Plasticity of Invasive *Pseudemys concinna* (River Cooter) in Response to Anthropogenic Sound Pollution

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Invasive species, with their remarkable behavioral plasticity, pose a growing global threat to ecosystems. Despite their success in diverse habitats, the impact of anthropogenic sound pollution on invasive species remains poorly understood. This study focuses on *Pseudemys concinna* (River Cooter), a cosmopolitan turtle species (invasive in many regions) thriving in urban areas. We investigated the behavioral responses of this species to natural (predator and cohabitant; crow and mandarin duck) and anthropogenic (traffic and human) sounds. Experiments, involving eggs collected from an urban reservoir and hatched in a laboratory, revealed significant differences in 'Movement' and 'Resting' behaviors in response to introduced sounds. Notably, 'Movement' behavior varied significantly between crow and traffic, and duck and traffic sounds. Analysis over time demonstrated adaptive changes, with decreasing 'Traumatized' and 'Escaping' behaviors and increasing 'Resting' behavior, highlighting the species' adaptability and learning aptitude. This study sheds light on the nuanced interactions between invasive species and urban soundscapes, emphasizing the need for further research and conservation strategies in the face of increasing anthropogenic disturbances.

A-0236 (Poster)
The Common Frog and the Changing Climate: Insights from Skeletochronology

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Climate change is expected to affect biodiversity patterns across the globe. Amphibians are some of the most vulnerable vertebrates to such changes, due to their complex life-histories. We conducted a modeling exercise to forecast the potential changes in the aging and growth patterns of the common frog (*Rana temporaria*) in the context of global warming. This is an ideal model-species because of its wide distribution across latitudinal and altitudinal ranges in Europe. Throughout its range, the common frog is threatened by fish introductions, especially in mountain lakes, and unpredictable climate patterns. We used the average age and growth coefficient as representative parameters describing the aging and growth patterns, from published studies and unpublished datasets resulting from skeletochronology. Using Generalized Least Squares (GLS) models, we found that rising annual average temperature leads to faster somatic growth and reduced average age in the common frog. Under future climate change scenarios (CMIP6 ISIMIP3b, GFDL-ESM4, ssp126, 370, 585), the annual average temperature at the sampling points (n = 61 1-sq km quadrats) is expected to rise by 2.4°C by 2070. On average, we estimate an increase by 0.08 units of the somatic growth, and a shortening by 0.7 years of the average age, by 2070, under these climate scenarios. The forecasted changes appear to be uneven, the common frog populations from the northern Scandinavian Peninsula being the most affected.

A-0237 (Oral)
Genome-wide Mining of lncRNAs Reveals Underlying Regulatory Role in Viviparity Evolution

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Reproduction in vertebrates usually involves egg-laying (oviparity) or live-bearing (viviparity). The former is the ancestral trait and it has evolved independently more than 100 times presumably from oviparity to viviparity in squamate reptiles. This transition involves a series of physiological and structural changes, including the degeneration of egg shell gland and the evolution of a placenta, and differences in the temporal and spatial expression patterns of some functional genes drive the structural transformation. Long non-coding RNAs(LncRNAs) play important roles in the regulation of gene expression, yet it remains unclear whether and how they work in the gene expression shifts during the transition from oviparity to viviparity. Therefore, we employ deep mining to identify novel lncRNAs of a closely related oviparous-viviparous pair of lizards (*Phrynocephalus przewalskii* and *P. vlangalii*). The cis- and trans-regulatory networks between lncRNAs and target genes were constructed using the transcriptomic data of the oviduct or uteri tissues across the whole reproductive periods. We found many lncRNAs that regulate genes for eggshell gland development were lost or under-expressed in viviparous species compared to oviparous lizard.

Meanwhile, we identified a number of lncRNAs involved in the regulation of placental development and embryo attachment in viviparous species, whereas most of these lncRNAs have no homologs in oviparous species and the rest showed low or no expression. These results suggest that lncRNAs may play important regulatory roles in the physiological and structural changes of the oviparity-viviparity transition. Our study is a new exploration on the gene expression regulation of the reproductive evolution from oviparity to viviparity and opens the way for further elucidation of its genetic regulatory network.

A-0238 (Oral)

Does Plasticity or Genetic Adaptation Induce Variation in Thermal Sensitivity of an Invasive Frog (*Xenopus laevis*)? A Population Level Study, from Tadpoles to Adults

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Life history traits of organisms are modulated by the selective pressures of the environment, generating variation in phenotypes. This phenotypic diversity can be observed at the interspecific level but also at the intraspecific level in populations living in different environments. Temperature is a characteristic of an animal's habitat and one of the dimensions of the ecological niche. It is a critical factor impacting all aspects of the biology of organisms, especially in ectotherms. *Xenopus laevis* is an aquatic frog that is invasive on four continents, with invasive populations inhabiting a diversity of environments. The objective of this study was to investigate the thermal adaptation ability of this species that is successfully established in dramatically different thermal environments. The use of thermal performance curves allowed to assess the relationship between temperature and locomotor performance and basal metabolic rate in individuals from two generations. Phenotypes from a F1 generation of the studied populations raised in a common garden environment were compared to the F0 phenotypes. This allowed to understand whether the observed differences among populations are plastic or genetically based. This study demonstrated that populations exhibit a different thermal dependence of their performance, and that genetic and plastic processes are involved in the thermal adaptation, highlighted by a significant genotype by environment interaction. Variation in performance depending on temperature provides an insight into how this invasive species can survive and cope with different thermal environments, especially in the context of climate change.

A-0239 (Oral)

Taxonomic Status of *Cyrtodactylus* (Reptilia: Gekkonidae) in West Nusa Tenggara Based on Morphological and Molecular Character

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Cyrtodactylus is a genus from the Gekkonidae family with the highest species diversity in the world. Indonesia is the sixth country with the largest number of the *Cyrtodactylus* genus in the world. Many species may still need to be described, and further research is needed to uncover hidden species. NTB is an underestimated province for its biodiversity, but many endemic species are found. Several species are distinguished based on certain morphological characters in each population in a region. Morphological characters in the genus *Cyrtodactylus* are a form of gene expression due to adaptation to geographic barriers. However, the distinguishing characteristics are difficult to observe, so the data obtained is often less accurate. DNA barcoding techniques can analyse changes in nucleotide bases caused by the evolutionary process. This research was conducted in January-April 2024. The method for morphological identification was observing 15 morphometric characters and 15 meristic characters. The method for molecular identification uses a marker from the mitochondrial gene, namely NADH Dehydrogenase sub-unit 2 (ND). Morphological analysis using Principal Component Analysis. Molecular analysis using Maximum-Likelihood (ML), Neighbour-joining (NJ) and Bayesian Inference (BI).

A-0240 (Oral)

Has Physical Isolation Resulted in Genetically and Phenotypically Distinct Water Snake and Garter Snake Populations Endemic to Islands in Eastern Lake Ontario?

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The origins of island biota have long fascinated biologists. Many famous examples exist of species diversification on remote marine islands. However, divergence can also occur in smaller insular systems—such as islands in freshwater lakes. Even over short geographic distances, island populations may diverge genetically and phenotypically from their mainland ancestors, especially in dispersal-limited taxa, such as snakes, which often have high home range fidelity. We seek to determine if insular populations of northern water snake (*Nerodia sipedon sipedon*) and the more terrestrial Eastern garter snake (*Thamnophis sirtalis sirtalis*) on two small islands in eastern Lake Ontario separated from the nearest land by 12 km of open water—Main Duck and Yorkshire Islands (within Thousand Islands National Park, Canada)—are genetically and phenotypically distinct from mainland conspecifics. To detect genetic differences between island and mainland populations, we use a genome-wide panel of single nucleotide polymorphism markers (SNPs) derived from reduced representation sequencing. Further, we test whether island-mainland genetic divergence is caused by geographic distance alone or is augmented by the dispersal barrier posed by Lake Ontario. We test for signatures of discordance between mitochondrial DNA and nuclear DNA groups, which could reflect sex-biased dispersal between populations or incomplete lineage sorting. Finally, we test for island-mainland divergence in head morphology while controlling for body size—which, if present, might reflect dietary divergence—and potentially colour pattern. Aside from yielding insights on the evolutionary origins of snake populations endemic to small islands in the North American Great Lakes, our findings will be useful to conservation agencies, as they may decide to manage the island populations as distinct population segments or subspecies. Determining

the status of these island snake populations may also be important as new threats arise, such as emerging snake fungal pathogens, climate change, and changing water levels.

A-0241 (Poster)
Ecological Interactions between Tadpoles and Aquatic Macrophytes

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Anuran tadpoles have key ecological roles in the aquatic systems they inhabit, affecting nutrient cycling, primary production, litter decomposition or energy exchange between aquatic and terrestrial systems. The effect of tadpoles on aquatic systems can at times scale up significantly, given the high densities they can reach. An understudied aspect of tadpole ecology is their interaction with macrophytes. Macrophytes provide spatial complexity to aquatic systems, in which they can be the main primary producers, sustaining the food web. Despite their importance in freshwater systems, the study of interactions between anuran larvae and aquatic macrophytes are scarce and have focused on how plants conform the habitat of the tadpoles. Using a combination of mesocosm experiments and field enclosures, we have studied the interaction between tadpoles of various Iberian species, and the main macrophyte species typical of the ponds of southwestern Spain. We have found that anuran species differ conspicuously in their effect on the community of aquatic macrophytes. Tadpoles feeding mainly on macrophytes can have a strong negative impact in plant richness and biomass, and also alter flowering phenology by direct herbivory. Nonetheless other species feeding on algae and detritus could enhance plant production by decreasing competition with periphyton and making nutrients more available to plants. We highlight the importance of better understanding tadpole-plant interactions, given the deep effects they can cause in pond ecosystems, altering spatial complexity, primary production and interactions between other organisms.

A-0242 (Oral)
The Wetlands and You: Inspiring Interest in Amphibian Conservation through Environmental Art

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Amphibians are the most endangered vertebrate organisms, creating a need for increased public participation in amphibian conservation. Environmental visual arts have found success in promoting engagement in scientific topics for broad audiences, making them an ideal medium to generate interest in amphibian conservation. Additionally, citizen science is one opportunity that has been widely adopted in environmental and ecological contexts towards the goal of increased participation in science; yet, it remains unexplored whether environmental visual arts can generate interest and actual participation in this format. Our study sought to leverage the broad appeal of visual art to understand (1) can engagement with an environmental visual art exhibit inspire interest, intent, and actual participation in citizen science for exhibit visitors? And (2) can creating an environmental visual art exhibit inspire understanding and engagement in amphibian conservation for student artists? To address these goals, we collaborated with six student artists in the northeastern US to create artwork highlighting anthropogenic threats to

amphibians. Paired with the exhibit, we developed a citizen science project to aid in amphibian monitoring. At the single-day exhibition, we asked visitors (n = 117) to complete pre- and post-surveys regarding their interest and intent to participate in the citizen science project. Additionally, we conducted semi-structured interviews with artists (n = 6) to understand what they learned through participating. Utilizing qualitative and quantitative analysis, we found the exhibit generated interest and intent to participate in citizen science, yet no visitors followed through by actually participating in the citizen science project beyond the exhibit. For artists, we found they gained deeper understanding of threats to amphibians and developed interest in participating in future art-science collaborations. Overall, our findings suggest that art can inspire interest in continued participation for both visitors and artists, however additional action is required to translate interest into actual, sustained participation.

A-0243 (Oral)
From the Evolution of Canalized Sex Determination Systems to the Evolutionary Conservation of Sex Chromosomes: A Review for Squamata

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Sex determination pathways in vertebrates can be induced by environmental signals, most frequently by temperature (TSD), or by genetic triggers (GSD), and two modes of inheritance are recognized: heterogametic females (ZZ/ZW) or heterogametic males (XX/XY). Recent studies show that sex determination has a multifactorial threshold and pure TSD and GSD represent extremes along a continuum that evolves via canalization of the initial trigger. Many researchers have proposed different hypotheses to explain the evolutionary forces underlying transitions among sex determination systems, but it remains necessary to evaluate such hypotheses from a phylogenetic perspective. Among vertebrates, Squamata is notable for exhibiting a diversity of sex determination systems; while some groups exhibit very conserved sex chromosomes, others show incredible lability. This characteristic makes Squamata an interesting group to test hypotheses regarding the evolution of canalized systems and its stability over time. Most studies support TSD as the ancestral state for Squamata with sex chromosomes evolving independently in different lineages. It was proposed that the evolution of canalized GSD could be explained by selective pressures favoring earlier development or development of more elaborated sexual traits. A second hypothesis — largely debated in the literature — posits that sex chromosomes tend to accumulate loci under sexually antagonistic selection and sex chromosomes containing such loci should be favored by selection, explaining transitions between GSD systems and the evolutionary conservation of sex chromosomes. Nevertheless, observations of Squamate lineages that have escaped such 'evolutionary trap' have been increasing over the years. Here we review these previously proposed hypotheses by compiling a large dataset composed of sex chromosome systems, presence of male ornaments, and timing of genital development in Squamata, and argue that sex chromosomes are not an evolutionary trap per se, but the evolution of developmental trajectories that yield very specialized males and females in their sexual roles.

A-0244 (Oral)
Hibernation Site Selection of Three Sympatric Snake Species

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Snakes within temperate ranges rely on hibernacula to overwinter. Due to the apparent scarcity of these sites in cooler climes, understanding the use and selection of this habitat feature is significant for conservation. We used a community of three sympatric snake species occurring at their northern limits to explore how they varied in their selection of hibernacula, and to investigate how associated features related to the number of individuals of each species present at the sites. We identified 28 snake hibernacula on the landscape using a combination of radiotelemetry, hibernaculum surveys, and historical records. These sites were surveyed to estimate the number of snakes using them and to collect habitat metrics at two spatial scales. All three species preferred hibernacula with larger entrances on steeper slopes at the microscale and relatively larger distances to the nearest shrub at the macroscale. At the microscale, the Great Basin Gophersnake (*Pituophis catenifer deserticola*) and Western Yellow-bellied Racer (*Coluber constrictor mormon*) selected hibernacula sites with more cover features, while Western Rattlesnake (*Crotalus oreganus oreganus*) preferred hibernacula with increased basking features. These patterns align with differences in egress behaviour that we detected, with racers and gophersnakes generally being found away from the hibernacula entrances, thereby potentially requiring more cover, while rattlesnakes were found conspicuously basking at the entranceways. However, no measured habitat features effectively explained the relative abundance of gophersnakes and racers at hibernacula, which may suggest more plastic selection of hibernacula or low detectability. In contrast, rattlesnakes were found increasingly at sites with larger entrances on southwestern and southern aspects. Documenting intra- and interspecific variations in hibernacula selection contributes valuable information for developing snake conservation plans. We caution against using hibernacula 'models' from well-studied species (e.g., Western Rattlesnakes) to extrapolate to other species with less-well known denning habits, even within the same ecosystem.

A-0246 (Poster)
Cytogenetic Analysis of Satellite Content of Madagascar Leaf-Tail Geckos

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Satellite DNA sequences, known for their diversity and rapid evolutionary rates, can be found in tandem arrays throughout the genome. In vertebrates, these satellite DNA motifs often accumulate in regions of heterochromatin, such as centromeres and telomeres. They play important roles in processes such as chromosome segregation during cell division and maintaining chromosome stability. The differentiation of sex chromosomes can lead to significant structural changes, including the accumulation of satellite DNA motifs. Despite their significance, satellite DNA motifs in reptiles have only been sporadically studied. To further investigate this, we conducted genomic Illumina DNA sequencing and PCR-amplified, microdissected W chromosomes, from the *Uroplatus henkeli* (known as Henkel's leaf-tailed gecko). We also used *in situ* hybridization to explore the distribution patterns of these satellite

motifs in the karyotypes of the closely related *Uroplatus guentheri* (Günther's flat-tail gecko) and *Phelsuma laticauda* (Gold dust day gecko). As the result we identified 17 different types of satellite DNA motifs, some of which were found to accumulate in centromeres, telomeres, or the W chromosome. Interestingly, we discovered 4 motifs that were present at the ends of all chromosomes, with 2 being common to all three species. We propose that the long-term stability of acrocentric karyotypes in geckos may be attributed to the presence of specific motifs in the centromeric regions, which act as strong meiotic drivers. This hypothesis should be further investigated in future studies.

A-0247 (Oral)
Environmental Education and Science Communication for Amphibian Conservation in Portugal

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Freshwater ecosystems provide essential services and high species diversity. Amphibians are emblematic freshwater species that rely on these habitats for survival and reproduction, which makes them particularly vulnerable to landscape changes. The negative public perception of amphibians in Portugal, often related to misinterpretation of folklore and ancient myths, but also poor public knowledge on this group, exacerbate these threats, limiting the conservation measures impact. In this communication I would like to present 1) the Ponds with Life project results, and 2) the plan of my PhD project. 1) Ponds with Life project aims to encourage the discovery, appreciation and study of ponds and its biodiversity, through scientific and educational exploratory activities and to raise awareness for their preservation. In the last 12 years we created the first Portuguese ponds inventory, with 2,034 ponds mapped, characterized, and their biodiversity inventoried. 115 new ponds were constructed with the collaboration of 384 adherent entities, from schools to governmental organizations and private individuals. The results highlight that ponds can successfully be used as a tool to increase eco-literacy in the society and provide the opportunity to promote amphibian conservation through increase appreciation of these species. This work shows that the collaboration with the society is vital to reverse the status of this threatened species and habitats. Stemming of this previous engagement, 2) my PhD work plan aims to build baseline knowledge on landscape changes in a Portuguese protected area and characterize its amphibian community to understand how they respond to habitat changes and assess the conservation actions effectiveness. To ensure the long-term success of these conservation actions, local community involvement is essential. For that reason, this project will integrate the development of citizen engagement activities, through science communication research, with the aim to develop science-based measures for the conservation of freshwater ecosystems and amphibians.

A-0248 (Oral)
A Genetic Study of Britain's Rarest Amphibian:
The Northern Pool Frog (*Pelophylax lessonae*)

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Microsatellite analysis can detect threats such as genetic bottlenecks, introgression, and low diversity, which can be detrimental to small populations such as reintroductions. Herein, I test two reintroduced populations of northern pool frogs (*Pelophylax lessonae*) in England using these techniques. By testing five microsatellite markers, I compare heterozygosity and differentiation between two English populations, and between individuals affected with Spindly-leg syndrome and healthy individuals. I also test for signs of hybridisation with other *Pelophylax* spp. The two English populations were not significantly different from each other, but they both had observed heterozygosity and allelic diversity lower than measured in Sweden. No hybridisation was detected. There was significant differentiation between healthy and diseased individuals. There was also significantly higher observed heterozygosity in diseased individuals than expected and one allele (R1Ca5) was not in Hardy-Weinburg equilibrium, suggesting that the disease may be linked to Founder Effect in the reintroduction. This may suggest the population may be suffering from disease due to founder effect during the initial translocation from Sweden. Furthermore I discuss progress with metapopulation modelling to maximise resisilence in the reintroduced population, what whole genome sequencing could unveil for the future of this species and how next generation genetic techniques could reveal differences in evolution and ecology in northern clade pool frogs.

A-0249 (Oral)

The Role of Parental Care as a Mechanism of Transmission of the Skin Microbiome in a Poison Frog

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The animal skin microbiome plays a key role in defense against pathogens in vertebrates. In amphibians, associations between skin microbiome composition, habitat pollution, and disease status have been repeatedly demonstrated in recent years. Unfortunately, we only have a limited understanding of the role of social interactions as vectors for skin microbiome transmission. We used the Neotropical poison frog *Allobates femoralis* to investigate a possible link between parental care (i.e., tadpole transport) and vertical transmission of the microbiome between parents and offspring. We carried out a series of experiments in which the hatched tadpoles were transported by their own parents, by foster parents or manually transferred by us to the provided water bodies. We separately raised all tadpoles to metamorphosis and collected skin swabs from adults, clutches, tadpoles, metamorphs, and the respective environments (substrate, water) at various time points during the experiment. Subsequently, we extracted bacterial DNA from the swabs, amplified and sequenced the V4 hypervariable regions of the bacterial 16S gene from all samples. We found differences in taxonomic composition between the experimental groups that point to ontogenic changes in microbiome composition during an individual's life. Additionally, we found strong evidence that tadpole transportation is an important source of microbiota innoculation into the early stages of the offspring. These findings provide a novel insight into the key role of parental care in the vertical transmission of the skin microbiome.

A-0250 (Poster)
Movement Ecology of the Lemur Leaf Frog (*Agalychnis lemur*)

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Amphibians are the most threatened vertebrate class on earth, with the recently updated Red List Index showing that 40.7% of species are globally threatened. To make informed conservation decisions, basic natural history information including amphibian movement patterns must be studied, to understand the implications for disease spread, gene flow and conspecific interaction. However, to date, no studies have focussed on the spatial movement patterns of the Critically Endangered Lemur leaf frog *Agalychnis lemur* and their movements are unknown outside of congregations at breeding ponds. With a high EDGE score of 5.86 and a population that has declined by 80% within a decade, A. lemur is classed as a high conservation priority. In this study, a novel radio transmitter attachment method was designed and tested on captive Lemur leaf frogs. After confirmation that the attachment method had no effect on health or behaviour of captive frogs, it was used to attach lightweight radio-transmitters to 30 wild frogs in a population in Costa Rica in June to July 2024, weighing no more than 10% of the frogs' bodyweight. During attachment, each frog was weighed, sexed if possible, had a body condition score given and were swabbed for chytridiomycosis before releasing them where found. Radiotrackers monitored the spatial movement patterns of the frogs over three to six weeks and comparisons between the movement patterns of individuals with different physical characteristics and chytrid loads were made.

A-0251 (Oral)
Informing the Conservation of a Cryptic, Threatened Lizard Using Bayesian Capture-Recapture Analysis and Expert Elicitation

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The conservation of cryptic and newly described species is often impeded by limited data. The Critically Endangered Kapitia Skink, *Oligosoma salmo*, persists in a single area of non-native habitat on the West Coast of South Island, Aotearoa New Zealand, and over half of this habitat was lost through erosion following Cyclone Fehi. The small population remains highly vulnerable to stochastic events, therefore establishing new populations is vital to reduce the species' extinction risk. Successful translocations, however, require a reliable understanding of a species' ecology. We focus on methods suited to small datasets, aiming to maximise understanding and highlight remnant uncertainties within a reduced timeframe. Firstly, we produced a Bayesian parameterisation of a hierarchical mixed capture-recapture model to establish baseline demographic information for the Kapitia Skink. Individual size and cyclone impact were modelled as explanatory variables for survival, and the model incorporated a

growth equation for imputing missing size covariates where individuals were not captured. Posterior estimates of survival demonstrate a positive relationship with species length, that curtails with probable senescence. Cyclone Fehi caused a reduction in mean survival and abundance. However, the population appeared to respond with resilience, recovering to pre-cyclone numbers in under two years. We then used the IDEA protocol expert elicitation framework to formalise the knowledge of conservation practitioner's and academics. Experts' combined experience with the Kapitia Skink and similar species enabled initial predictions of suitable physical habitat parameters, climatic tolerances, and biotic interactions. Reported confidences within each stage of the elicitation were used to quantify uncertainty. A mechanistic niche distribution map produced from the results forms a baseline for an ongoing site selection process. Future research will utilise the uncertainty emphasised in this study to design experimental translocation methods, balancing a science-led approach with the urgent needs of on-the-ground conservation efforts.

A-0253 (Poster)
Systematic and Taxonomic Survey of Israel's Land Reptile Biodiversity – and a Blind Snake Example

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Cryptic species have always posed a challenge for taxonomists. The advent of DNA sequencing has given biologists a new powerful tool for detecting and differentiating morphologically-similar species. Yet, taxonomic studies are usually carried out piecemeal, and in many regions, such as most of the Middle East, they are almost nonexistent. We are conducting a rapid genetic survey of the entire reptilian fauna of Israel and examine genetic diversity within currently recognized species to identify potentially cryptic species and describe them. Fossorial snakes belonging to the Scolecophidia commonly show cryptic diversity. To test the status of the Israeli scolecophidian, the Long-nosed worm snake (*Myriopholis macrorhyncha*), we conducted the most comprehensive phylogenetic analysis of the *M. macrorhyncha* species complex. Three mitochondrial genes (12S, 16S, and cyt-b) and five nuclear genes (bdnf, c-mos, rag1, nt3, and ame) were partially sequenced for 30 specimens belonging to eight species of the group (including three Israeli specimens). Sequences were aligned and a molecular tree was estimated by maximum likelihood (ML). Our tree for the genus shows five well-supported clades: 1) *M. longicaudus*; 2) "*M. macrorhyncha*" from Kenya, *M. hamulirostris*, *M. rouxestevae*, and *M. boueti*; 3) *M. blandfordii*, "*M. macrorhyncha*" from Ghana, *M. adleri*, and *M. macrorhyncha* from Oman and the UAE; 4) "*M. macrorhyncha*" from Iran and *M. algeriensis*; and 5) "*M. macrorhyncha*" from Israel, Jordan, and Turkey. We identify at least two lineages that represent new species and reveal a need for redefining the distributions of many species. Our molecular approach, based on an extensive taxon sampling, show that *Myriopholis* diversity has been largely underestimated. Our results highlight the importance of molecular data to understand Israeli reptile diversity.

A-0254 (Poster)
Do You See What I See? Cryptic Snakes and the Accuracy of Citizen Scientists

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Community science is an effective way of providing opportunities for the public to engage in authentic scientific research by assisting scientists in collecting and analyzing large datasets. We created Project RattleCam, the first snake-based project on the community science platform Zooniverse, which asked users to annotate time-lapse images of rattlesnake rookeries (communal nesting sites). Prairie Rattlesnakes (*Crotalus viridis*) pose a particular challenge for a community science project because analyzing images of cryptic animals can be challenging. Therefore, we aimed to determine how accurate Zooniverse users are at identifying Prairie Rattlesnake presence, abundance, and behaviors from time-lapse images. Each photograph was presented to multiple users along with a series of annotative tasks. Community scientists completed a total of 375,618 annotations for the 60,355 photos in the image set. We utilized agreement indices to assess users' annotations of the various tasks. We found that users were able to determine whether snakes were present or absent with a high level of agreement. However, disagreement increased when determining how many adult or baby snakes were present. We also found that counting baby rattlesnakes incited more disagreement than counting adults. Users disagreed most when asked to identify behaviors such as rain harvesting. Our findings can help to inform the evaluation and implementation of future community science.

A-0255 (Oral)
Invasive Lizards as Novel Hosts and Vectors of Invasive Pentastomes in Florida, USA

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Invasion ecology often focuses on the direct effects of invasive species through predation or competition with natives. However, with the rise of One Health initiatives, invaders' influence on native pathogen and parasite systems are receiving more attention. Disruptions to these systems can stem from the co-introduction of non-native parasites that spill over into native hosts, or from invaders serving as reservoirs, amplifiers, or dead-end hosts of existing parasites. In this study, we investigate an interesting combination of spillover and spillback in Florida, USA, where invasive Argentine giant Tegus (*Salvator merianae*) from South America are acting as definitive hosts for invasive snake pentastomes (*Raillietiella orientalis*) from Southeast Asia. We analyzed spatial patterns of infection using Kernel Density Estimation and Getis- We also examined potential drivers of infection intensity using a zero-inflated negative binomial model. We found that pentastome prevalence in Charlotte County (41%) was more

than double that in Miami-Dade County (17%), despite being further from the pentastomes' initial introduction site in Everglades National Park. Infection intensity was significantly associated with habitat, month, and host sex. Clusters of high infection intensities within the landscape did not overlap with clusters of high Tegu captures and supported the importance of habitat type. These findings take us closer to unraveling the transmission cycle of invasive pentastomes in novel hosts and may prove useful in evaluating risk as *R. orientalis* continues to expand its range northward into new areas.

A-0256 (Oral)
The Oldest Tadpole Reveals Evolutionary Stability of the Anuran Life Cycle

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Anurans are characterised by a complex life cycle with a marked phenotypic divergence between larval and adult stages, both connected by a metamorphic period. Despite their extant morphological diversity and ecological relevance, the origins and early evolution of anuran larvae remain enigmatic because of their absence in the pre-Cretaceous fossil record (older than 145 Mya). This contrasts with the post-metamorphic anuran fossil record that dates back to around the Triassic-Jurassic boundary (ca. 220–180 Mya). Here we report on the oldest known anuran larvae, consisting of a tadpole of the stem-anuran *Notobatrachus degiustoi* from the Early-Middle Jurassic of Patagonia (ca. 180–160 Mya). The specimen is an individual preserving the skull and most of the postcranium in dorsal aspect, and the proximal part of the tail. The hyobranchial skeleton is preserved, as well as soft parts, including eyes and nerves in their anatomical position. Cartilage imprints indicate that the larva was well chondrified, and the overall degree of ossification supports an advanced larval stage, prior to the onset of metamorphosis. The exquisite preservation of the specimen reveals that key features of tadpole evolution associated with a generalized filter-feeding lifestyle, such as the buccopharyngeal pump and the specialized gill filters were present early in anuran evolution. Notably, both *Notobatrachus* larva and adult acquired large sizes, demonstrating that gigantism also evolved among stem anurans and diversified during the most recent neobatrachian radiation. Taken together, the anatomy of *Notobatrachus* tadpole and palaeoenvironmental data of its locality demonstrate that a biphasic life cycle, in which filter-feeding tadpoles lived in ephemeral lentic environments was already present in the early evolutionary history of anurans at least 160 My ago.

A-0257 (Poster)
16S rRNA Gene Sequencing-based Comparative Study of the Gut Microbiota of Three Lacertid Species (Squamata, Reptilia) from Western Bulgaria

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In general, studies on gut microbiomes in free-living reptiles in Europe are fragmentary. A high-throughput sequencing of the hypervariable V3-V4 region of the 16S rRNA gene was applied for identification of the faecal microbiota diversity of three lizard species from the Lacertidae family. The European green lizard (*Lacerta viridis* Laurenti, 1768), the Common wall lizard (*Podarcis muralis* Laurenti, 1768) and the Meadow lizard (*Darevskia praticola* Eversmann, 1834) co-inhabit in sympatry and syntopy in a low-mountain area, located in the western part of Bulgaria. They exhibit different preferences in terms of microhabitat selection, food spectrum and trophic niche width. Species-specific core microbiota signatures differ substantially from phylum to genus level. A dynamic phyla proportion between hosts was found. In the overall dataset, the most dominant phylum was Bacillota, ranging between 42.3–86.4%, followed by Bacteroidota (5.6–23%), Actynomycetota (2.5–18.7%), Proteobacteria (0.4%-11.3%), and Veruccomicrobia (0.4–4.4%). Cyanobacteria was exclusively presented in *L. viridis* (30.8%). Each phylum was represented in its greatest relative abundance in a different lizard species. The richest alpha-diversity was observed in *D. praticola*, and the least in *P. muralis*. *D. praticola* and *P. muralis* exhibited a broader affinity in diet, however the gut microbiotas of *D. praticola* and *L. viridis* appear to be more closely related.

A-0258 (Oral)
Chromosome-level Genome Assembly Sheds Light on Evolution and Demographic History of Western Chorus Frog (*Pseudacris triseriata*)

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The Western Chorus Frog (*Pseudacris triseriata*) is a temperate tree frog species in North America. It is member of subfamily Acridinae, a clade comprising 21 species for which no annotated genome exists. It is a species of conservation concern, with many populations declining dramatically in the last few decades. We assemble the first chromosome-level reference genome from a male individual using PacBio HiFi long reads and Dovetail Omni-C data and annotate it with transcriptomic profiles of liver, kidney, eye and testis. We also assemble the first pangenome graph for genus Pseudacris with the two chromosome-level haplotypes plus assemblies of another Western Chorus Frog (*P. triseriata*) and Boreal Chorus Frog (*P. maculata*) from 10x Genomics linked reads. We examine genome synteny with another 10 frog species in superfamily Hyloidea and investigate the evolution of sex-linked regions. Finally, we compare genome-wide diversity and historical effective population sizes between Boreal and Western Chorus Frog.

A-0260 (Oral)
Updated Checklist of the Herpetofauna of Nepal

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Located in the central Himalaya and comprised a complex landscape, Nepal harbours one of the global biodiversity hotspots and a rich herpetofauna diversity. As of May 2022, a total of 57 species of amphibians and 143 species of reptiles have been reported from Nepal. As rapid taxonomic changes occurs in Nepal and surrounding countries, it is necessary to update the checklist based on newly published literature. We reviewed the newly published literature after May 2022 and relevant taxonomic databases to update the herpetofauna checklist of Nepal. As of 31th December 2023, Nepal is home to 59 species of amphibians in 21 genera, eight families, and three orders, and 150 species of reptiles in 73 genera, 20 families, and three orders. Among them, a total of 27 generic-level taxonomic changes occurred for 65 species of herpetofauna of Nepal between 2002 and 2023 (9 generic-level taxonomic changes for 26 amphibian species; 18 generic-level taxonomic changes for 39 reptilian species). In the same time period, 12 species of herpetofauna (including seven amphibian and five snake species) were newly reported to Nepal, and three reptilian species were removed from the checklist of Nepal. Lastly, the taxonomic status and distribution records of three and five amphibian and reptilian species in Nepal still remain uncertain and require future research. Amphibians and reptiles represent the least studied terrestrial vertebrate groups, and their taxonomy, particularly species from developing countries with harsh terrain like Nepal, warrant systematic studies. Updated checklist provides essential background knowledge to systematic studies, and those with uncertain taxonomic status/geographical records should be the focus of future research.

A-0261 (Oral)
City Slicker Salamanders: Examining the Behaviour of a Widespread Plethodontid Salamander Between Urban and Natural Forests

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In our modern era, there are a suite of environmental changes, like urbanisation, that challenge our planet's ecosystems. However, wildlife can persist and adapt to changes associated with urban expansion. For example, urban wildlife may exhibit different behavioural characteristics than non-urban conspecifics. Eastern Red-backed Salamanders (*Plethodon cinereus*) occur widely in Eastern North American forests across a gradient from highly urban to pristine natural areas. *P. cinereus* are also behaviourally complex and the successful survival and persistence of urban populations may be due to adaptative behavioural change. We are studying whether the behaviour of *P. cinereus* differs between urban and natural forests by conducting repeated behavioural assays in the field to quantify four behavioural traits: sociability, tendency to explore a novel environment, boldness, and aggression toward a conspecific model. We are also collecting environmental data (e.g., temperature, relative humidity, etc.) to help us explore

potential causes of behavioural differences between urban and natural populations. Fieldwork is on-going and we will present preliminary results whether salamander behavioural traits and their expression (e.g., repeatability) differ between habitat types. This work will add to our knowledge of how urban evolution is impacting amphibians. In addition, *P. cinereus* is a well-known indicator of forest health and understanding how anthropogenic activity influences their biology will also inform whether and how urbanization is impacting forest ecosystems. As the rate of urbanization continues to increase in Canada, this is critical information about how wildlife may adapt to and persist in our ever-changing world.

A-0262 (Oral)
How do Turtles Estimate Numbers: The Use of Non-Numerical Information in an Asian Freshwater Turtle

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The ability to discriminate quantities is key to many ecological functions. Evidence is mounting that numerical ability of reptiles is higher than we expected. Our previous research showed that the Asian stripe-necked turtle (*Mauremys sinensis*) can discriminate quantities up to 9 vs 10 in only a few seconds, which implied that turtles were not counting but estimating using non-numerical information that covary with the number of stimuli. In this study, we aimed to discover how turtles estimate quantities. We focused on three non-numerical forms of information: area (i.e., the total surface area of all elements), density (i.e., the number of elements per area), convex hull (i.e., the outline of all the elements). Density and convex hull are inversely related, which means that high density and high convex hull cannot be used to estimate quantities simultaneously. Thus, in Experiment 1 we presented two stimuli with identical numbers and area but one with high density and the other with high convex hull to turtles. We found individual differences in the use of non-numerical information; some turtles significantly preferred high density while some turtles significantly preferred high convex hull, and some turtles showed no preference. In Experiment 2 we presented two dot stimuli with different areas, and found that all turtles preferred the stimuli with a larger area. The ability to discriminate different areas was affected by the ratio of the two areas, regardless of actual size. Turtles with better numerical ability showed a stronger preference toward non-numerical information when numerical information was unavailable, which is consistent with studies from humans. Our research demonstrates the use of information in turtles and how information use shapes ecological decision making in turtles.

A-0263 (Oral)
What Makes a good Mum? Neural Mechanisms Underpinning Parental Care in a Lizard

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Questions of why and how animals form societies have long been of interest, but research has often focussed on broad-scale evolutionary explanations for social behaviour, rather than the

proximate mechanisms. Previous work has suggested the action of nonapeptides in the brain such as arginine vasotocin (AVT) result in simple affiliative behaviours such as prolonged parent-offspring relationships, an early form of parental care. To test the hypothesis that AVT plays a key role in parental care, we manipulated levels of this neuropeptide in White's skink (*Liopholis whitii*), a facultatively social Australian lizard. *L. whitii* is often considered a species "early" in the transition from solitary to group living, and so are perfect for understanding the neural processes dictating the origins of social behaviour. 55 wild-caught skinks were brought into captivity to give birth. Mothers were assigned to one of three treatments: AVT supplementation, AVT blockade by use of Manning compound, and a control. Pharmacological manipulations were achieved by intraperitoneal injection. We performed focal observations, collected data on space use and performed targeted behavioural assays to investigate territorial behaviour. Pharmacologically blocking AVT significantly reduces the likelihood that mother and offspring will share space. However, there was no effect of AVT manipulations on aggression, despite AVT being a known mediator of aggression in other species. The results of this study suggest that AVT does play a role in the transition from solitary to social living. The role of AVT as a mediator of aggression may have been lost in *L. whitii*, in order to facilitate its role in the tolerance of offspring.

A-0264 (Oral)
Should I Stay or Should I Go? – Behavioural and Cognitive Consequences of Delayed Dispersal in a Facultatively Social Species

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As part of a wider study disentangling the mechanisms responsible for the emergence and evolution of complex sociality, we took a group of *Egernia saxatilis* raised under two long-term social treatments (with their mother, or in isolation) and tested them in two cognitive tasks. Firstly, their abilities to regulate their own behaviour was tested using the inhibitory control cylinder task, and following this their spatial memory was tested using four ramps, one of which contained an accessible food reward. In line with the social intelligence hypothesis, we predicted that individuals reared with their mothers would have enhanced cognitive abilities. Following on from the cognitive trials, we moved all individuals into an outdoor, semi-natural enclosure and observed their social interactions for a ten-week period spanning the mating season. Again, we hypothesised that those raised with their mothers would have more beneficial social interactions. I will report our findings and discuss their implications for our understanding of the evolution of sociality.

A-0266 (Poster)
Fluctuating Asymmetry in a Highly Inbred Population of Majorcan Midwife-Toads (*Alytes muletensis*)

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Studying the fitness level of endangered species is crucial for effective conservation. Amphibians, as a highly threatened clade, require practical methods of assessment to effectively monitor their population development over the long term. In this study, I focused on the endangered Majorcan midwife toad (*Alytes muletensis*) and assessed the health of a large, captive population using fluctuating asymmetry (FA) as a proxy for fitness. Being a long-discussed index for evaluating a population's fitness level, FA analysis is a practical method that is directly related to performance aspects of fitness. Using museum collections, I compared inbred laboratory colonies of *A. muletensis* and *A. maurus* from the London Zoo to wild-collected specimens of multiple species of the genus Alytes. Across these samples, I acquired linear measurement data for bilateral structures focusing on the limbs and head. In addition to linear measurement data, I also obtained radiographs and CT scans for a subset of specimens to explore the sensitivity of measurements to different methods. My dataset of over 300 frogs allowed me to investigate the impact of inbreeding on asymmetry expression and its variation across different anuran species. I will discuss the impact of captivity, phylogeny, and body size on observed FA during my presentation. Collectively, my results add new information to the conservation implications of small population sizes in anuran amphibians.

A-0267 (Oral)
Diversity and Microhabitat Utilization of Herpetofauna at Khao Krachom, Ratchaburi Province, Western Thailand

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Tenasserim range is known as a biodiversity corridor between Indochina and Sunda subregions. Recently, several species of amphibians and reptiles were discovered from Khao Krachom, Ratchaburi, western Thailand. However, the ecology of herpetofauna (amphibians and reptiles) has not been systematically investigated in this area. This study aimed to investigate species diversity, species composition and microhabitat use of herpetofauna in Khao Krachom in three forest types, including mixed deciduous, dry evergreen and hill evergreen forests. From May 2022 to December 2023, we used drift fence with pitfall trap and strip transect surveys to collect data. A total of 90 species was recorded in the study, including 29 amphibian and 61 reptile species. The hill evergreen forest exhibited high diversity, as revealed by individual rarefaction curves and diversity indices (Shannon-Weiner, Simpson, and Evenness). For microhabitat utilization, reptiles mainly used litter whereas amphibians mainly used boulder and litter. The canonical correspondence analysis revealed that proportion of litter, number of large tree, canopy cover and number of log were the most influential factors on the community of herpetofauna. The results of this study highlight the interaction between herpetofauna and habitat structure, providing useful insights for habitat management to conserve herpetofauna in the Tenasserim range and elsewhere.

A-0268 (Poster)
Improving Monitoring Methods of Rare and Cryptic Temperate Reptiles

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Populations of many reptiles are declining rapidly leaving numerous species threatened with extinction. The critically endangered Canberra grassland earless dragon (*Tympanocryptis lineata*; CGED) is one such species having suffered recent population declines and local extinctions leaving less than 10 small subpopulations. This decline has been linked to habitat loss and degradation, extreme climatic events, and high temperatures associated with climate change but apportioning the relative influence of these stresses has been hampered by small numbers of individuals and low levels of detectability. Our study aims to address this gap by integrating historical data with data collected from reintroduction trials and outdoor enclosure experiments to determine CGED habitat and burrow use relative to environmental temperatures. We have developed and deployed 120 automated detection and monitoring (smartBurrow) systems in four experimental outdoor enclosures. These smartBurrows are able to obtain key behavioural data from this species. These smartBurrows detect PIT tags (passive integrated transmitter tags) recorded on a small programable single-board computer attached to an artificial arthropod burrow. Beta trials with this system have shown that it can detect specific individuals entering or exiting a burrow. These experiments provide robust testing of the smartBurrow technology and of the interaction between environmental temperature and the use of different vegetation densities by CGED, and whether these interactions vary between sex and among seasons. Results from this project will provide a cost-effective tool and modern approach for the automated detection of small and cryptic reptiles, as well as the ability to predict behavioural responses to changing habitat and climatic conditions.

A-0269 (Oral)

Biomarkers to Improve the Success of Reproductive Technologies for Conservation of Endangered Amphibians

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We are experiencing a global mass extinction crisis with over 40% of amphibian species threatened, including the once common green and golden bell frog (*Litoria aurea*) and Littlejohn's tree frog (*Litoria littlejohni*). These species are susceptible to the infectious fungal disease chytridiomycosis and landscape persistent threats including climate change, predation, habitat disturbance, bushfires, drought, and recreational activity. While *ex-situ* and *in-situ* conservation strategies, such as captive breeding and habitat creation are in place for these species, assisted reproductive technologies (ARTs) have a vital role to play in bolstering the conservation efforts and further research is required to increase the success of these interventions. We hypothesise that minimally invasive biomarkers of stress, reproduction and immune activation can be developed for L. aurea and L. littlejohni and integrated into decision making to inform timing of ARTs, optimise husbandry, select individuals for breeding programs, and diagnose reproductive failure. Pilot studies are currently underway to develop and validate multiplex assays for the quantification of biomarkers of stress (corticosterone), reproductive function (oestrogen, testosterone, progesterone) and immune activation (neopterin) in frog urine, using mass spectrometry. Urine has been collected from captive and wild frogs in parallel to sperm quality and gravidity assessments to determine whether a correlation exists between reproductive hormone levels and reproductive output and status. These methods will be incorporated into future studies to compare biomarkers and reproductive status and output between frogs housed in pairs versus harem groups, and into field-based

studies of both species with the addition of chytrid testing using PCR and correlation to genetic diversity, population site, weather, and water data. The integrative approach of this research will provide comprehensive data to inform conservation actions involving ARTs and track the success of current strategies, including artificial pond creation, habitat connection, and captive breeding.

A-0271 (Oral)
It's a Toad Eat Toad World: Using Gene Knockouts to Control Invasive Cane Toads (*Rhinella marina*)

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Although genetic manipulations such as CRSIPR-Cas9 confer enormous power to modify the phenotypes of invasive species, the use of this approach for biocontrol of pests faces major methodological, ecological and social obstacles. As a result, genetic biocontrols have yet to be applied successfully in vertebrates. We can avoid these obstacles by creating simple gene knockouts rather than transgenic organisms. Building on decades of research on invasive cane toads (*Rhinella marina*) in Australia, we used CRISPR-Cas9 to produce toad tadpoles that voraciously consume conspecific eggs but cannot metamorphose. These cannibalistic non-metamorphosing tadpoles are expected to prevent recruitment from toad eggs deposited into ponds, with little or no impact on native fauna. Here, we discuss the requirements that these tadpoles must meet to be considered safe and effective. We also present published and preliminary data to detail our successes, current challenges, and future research plans. We believe that this approach can serve as a roadmap for the development of genetic biocontrols without the ecological risks and logistical pitfalls introduced by transgenesis.

A-0272 (Oral)
Towards Integrating Biobanks into the Conservation Landscape

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The climate crisis currently at play worldwide has led to a long list of stressors on biodiversity in a wide array of ecosystems. Our biodiverse environs are often sensitive to seemingly small changes, with many organisms being affected by disruptions to habitat. Biobanks have the potential to advance and complement current conservation efforts, at a relatively low cost, by preserving the genetic diversity of species and allowing correction of genetic effects caused by decreasing population sizes. For example, by reintroducing sperm collected before a disturbance event, captive breeding programs can improve genetic diversity of captive and reintroduced wild populations. While these methods have been used successfully in some species, this approach is often overlooked and has experienced a slow uptake in conservation. Amphibians are currently experiencing alarming declines and provide a perfect case study for

demonstrating the value of biobanking to conservation. Following the devastating 2019/20 bushfires across the East-coast of Australia, an applied effort to collect and store sperm from a range of species was mobilized as part of an integrative effort including multiple conservation approaches. Building on this effort, we have banked sperm from isolated populations of the cryptic Littlejohn's tree frog, with the bold vision of performing genetic rescue in this species. Here, we present our progress in applied efforts to integrate biobanking into conservation projects and our vision on where this will lead to next for threatened species in Australia.

A-0273 (Oral)
Deep Learning for Monitoring Frog Reproduction: Accuracy, Abundance Correlation, and Limitations

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Monitoring reproductive activity is crucial for studying amphibian populations. Passive Acoustic Monitoring (PAM) with automated signal recognition using machine learning is an effective and scalable tool for monitoring anuran reproduction. Deep learning, a type of machine learning approach, is rapidly gaining popularity among ecologists and offers high classification performance for analyzing PAM data. However, its application in studying anuran reproduction remains underexplored, and uncertainties exists regarding the relationship between calling activity indices and abundance of breeding individuals. To evaluate the effectiveness of deep learning in monitoring amphibian reproduction, we assessed the classification accuracy of a trained model and investigated the correlations between calling intensity and frog abundance. Field recording and count surveys were conducted at two sites in Kyoto City, Japan. A convolutional neural network (CNN) model was trained to classify the calls of five anuran species. The model achieved 91–100% precision and 75–98% recall per species, with relatively lower performance on less abundant species. High calling activity was associated with greater male abundance (Pearson's r = 0.45–0.66), although correlations between calling activity and the number of pairs in amplexus were generally weaker. Our results suggest that deep learning is a valuable tool for reconstructing reproductive phenology of male anurans from field recordings, but caution is required when applying this method to rare species and when inferring actual occurrence of egg deposition.

A-0274 (Poster)
Phylogeny and Characterization of Two Frog Virus 3-like *Ranavirus* Genomes from the Korean Clawed Salamanders (*Onychodactylus koreanus*) in the Republic of Korea

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From 2022 to 2023, two novel frog virus 3 (FV3)-like ranavirus were detected in two Korean clawed salamanders (*Onychodactylus koreanus*) in Chuncheon-si, Republic of Korea, temporarily designated as Onychodactylus koreanus ranavirus (OKRV1 and OKRV2). Clinical signs included ecchymoses, edema on the head and limbs and skin ulceration. Although the case of ranavirus infections is increasing globally, only three cases of whole-genome characterization of FV3-like ranavirus were reported in Asia. We characterized the OKRV1

and OKRV2 using whole-genome analysis. To obtain the whole-genome sequence, the ranavirus was cultured on *Epithelioma papulosum* cyprinid (EPC) cells. The genome of OKRV1 and ORKV2 has a full length of 104,734, and 104,626 bp respectively, with both G+C content of 55.1% and 104 predicted open reading frames (ORFs). We found four recombination events in the two ranaviruses in the comparison with eight FV3 and three CMTV strain sequences. Hypothetical minor parents are related to North American FV3 strains (FV3 and SSME), while major parents with China FV3 strains (*Rana grylio* virus [RGV] and Soft-shelled turtle iridovirus [STIV]). In the maximum likelihood (ML) phylogenetic tree, which included a total 33 of North American, European, and Asian whole-genome of FV3, the two ranaviruses grouped with Asian FV3-like clade (RGV, STIV, and *Rana nigromaculata* ranavirus). In the molecular clock analysis using sequences of 14 core protein genes, we found that the clades of Asian and American FV3 viruses diverged around 1726 (95% HPD 1610^1831). This is the first case of FV3-like ranaviruses infection in the order Caudata in any Asian country.

A-0275 (Oral)
The Design and Implementation of Cognitive Bias Testing for Zoo-housed Reptiles

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The project aims to investigate whether cognitive bias tests, specifically attention bias, can be a useful indicator of affective state in zoo housed reptiles. Cognitive bias broadly refers to the distortive effect affective states (short term emotion) have on cognitive processes, and includes multiple targeted tests including attention, memory, and judgement bias. Research suggests that changes in cognitive function can be a reliable predictor of affective state. Affective states occur in animals during events that are important to them, e.g., when presented with stimuli that impact their survival or chances of mating. These stimuli produce specific behaviours and measurable physiological responses. Affect and mood (sustained emotional state) can impact the decision-making process, therefore determining whether a decision is optimistic or pessimistic, can give insights into an animal's mood and potentially infer their overall welfare. Attention bias was selected as no training is required, latency to consume food after exposure to a short-term stimulus (e.g., a loud noise) will be recorded. Cognitive bias tests have been validated in extensive human cognitive bias research, as well as in experimental conditions for multiple species of animals with both pharmacological and environmental manipulation. This is a novel study as this has not been investigated in reptiles, and few studies have investigated cognitive bias in a zoological environment. Currently, there are no reptile specific welfare assessment tools for captive reptiles; establishing cognitive bias test designs for reptiles could begin to bridge this gap. Preliminary attention bias test designs and data will be presented for multiple taxa.

A-0276 (Oral)
Same-same or Different? Exploring Growth Rate Disparities between the Sexes in Australian Snakes

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Sexual dimorphism, the physical distinction between males and females of the same species, is a well-documented phenomenon, and its manifestations vary widely across taxa. In many snakes, sexual dimorphism is evident in total body size and the dimensions of the head and tail. Whilst some previous research has shown that prey availability in early life significantly influences the long-term growth rates in a population of *Morelia spilota* (carpet python), very little is known on the relative impact of environmental conditions on growth compared to sex-based expectations. In this study, I reared a clutch of 10 carpet pythons from hatching to over one year old under captive conditions to examine whether differences in size are related to their sex, rather than dietary intake. I examined their length, mass, head, and tail growth profiles over this crucial rapid-growth phase while concurrently tracking food consumption. Sexual dimorphism in ontogeny can manifest in three distinct patterns: first, when sexes hatch at disparate sizes but maintain an identical growth rate, resulting in a persistent difference in size throughout ontogeny; second, when both sexes hatch at equivalent sizes, yet one sex exhibits a faster growth rate than the other; and third, when both sexes hatch at uniform sizes and maintain identical growth rate until reaching maturity, at which point one sex decelerates while the other continues to grow. Preliminary analysis indicates carpet pythons under captive conditions may demonstrate the third ontogenetic pathway, likely due to capitalisation of the over-abundance of food provided. Our data on other Australian species (including 4 elapids and 1 python) indicates the ontogenetic pathway varies among species, potentially linked to distinct evolutionary processes influencing sex differentiation. Furthermore, the methodology employed offers a novel approach to investigating whether ontogenetic growth rates can be indicative of sex and may eliminate current invasive sexing techniques.

A-0277 (Oral)
Geographic Variation in Colour and Pattern of Shore Skinks

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In ectotherms, body colour patterns can serve various biological functions, including visual camouflage and thermoregulation. The degree of influence these functions have on colour and pattern diversity within a species can vary across a large spatial scale, especially when environmental clines strongly affect biological processes. Additionally, island syndrome can play a strong role in colour variation between island and mainland populations. Here, we evaluate whether variation in colour and pattern across populations of a colour-variable skink species is affected by thermal melanism (thermoregulation), crypsis (camouflage) or island syndrome. We compared colouration and patterning in 17 skink populations across offshore islands and the mainland New Zealand. We found that brightness decreased with mean monthly maximum temperatures, suggesting a role of thermal melanism. However, of four distinct pattern types, only one was associated with microhabitat (i.e., proportion of rock), and another decreased in frequency across latitude. Additionally, islands had increased melanism, higher frequency of plain types compared to mainland sites, despite no apparent differences in environmental conditions measured between the two locations. We concluded that high level of colour variation in this species is driven by complex interactions between various selective

processes for both thermoregulation and camouflage, while not ruling out the potential influence of stochastic processes in some of the populations.

A-0278 (Oral)
Telomere Dynamics Across Life and Sexes between Liver and Blood from a Cross-Sectional Population of the Cuban Brown Anole, *Anolis sagrei*

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Classic aging theory predicts that organisms senesce faster when the probability of survival to an old age is reduced. Telomeres, short repetitive DNA sequences at the end of each chromosome, serve as protective caps against DNA degradation. Telomere length has become widely used as a biomarker of aging and cellular maintenance. Telomere attrition is believed to be negatively correlated with age due to an increase in oxidative stress caused by reactive oxygen species (ROS). However, ROS concentrations, and thus telomere shortening can vary across tissues and individual lifespan between sexes depending on the life history strategies of the organism. In the Cuban brown anole, *Anolis sagrei*, most wild males die within two years thus have increased mortality and shorter lifespan than wild females which can live up to five years. However, preliminary data suggests that telomere length does not vary between both sexes despite the difference in their reproductive strategies. This study aims to explore the telomere dynamics in the liver and blood from a cross-sectional set of captive animals. The specific goals are: 1) to determine if telomere length negatively correlates with age across 5 age classes (1 month, 7 months, 1.5 year-, 3-year- and 5-year-old animals) and 2) to determine if there are sex-specific differences in telomere length that correlate with the differences in expected lifespan between males and females. We hypothesize that shorter telomeres are apparent in older age classes and telomeres shorten faster in males than in females. In addition, we seek to characterize the tissue-specific changes in telomere length across age and sex. Our hypothesis is that telomeres of blood cells are longer than those of liver with females having longer telomeres than males. These results will further enhance our understanding on the complex mechanisms underlying telomere dynamics and the interplay between senescence and longevity.

A-0279 (Oral)
Sex Specific Variability of Behavioural Types in a Social Skink

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Males and females of the same species typically experience divergent selection pressures, leading to physiologically and anatomically distinct traits. Furthermore, selection can also lead to sex-specific differences in behaviour. Nevertheless, individuals are usually consistent in their behaviour, while there are differences among individuals, known as behavioural types. Behavioural types have been shown to influence how individuals respond to novel environments and environmental change and can also affect the rate, nature, and duration of their interactions with conspecifics. Behavioural types can vary between sexes, age groups, body sizes etc. Here, we determine the influence of sex on behavioural type in the endemic

Australian Gidgee skink (*Egernia stokesii*). We investigated this in a population of adult gidgee skinks that are permanently housed in seminatural environments at Flinders University, Australia. Since *E. stokesii* exhibits little or no sexual dimorphism, we use genetic sex markers to determine males and females. We quantified four different behavioural types: boldness, exploration, activity, and sociability. We repeatedly observed individual responses in standardised arenas and first determined whether individuals were consistent in their responses, while responses varied among individuals. We then investigated whether males and females differ in their behaviour types. We predict that males show greater exploratory and risk-taking (indicated by boldness) behaviour in comparison to females, and females are more gregarious than males, as male dispersion is observed in the species. We discuss our findings in the context of responding to environmental change and conservation efforts. This is of particular importance because sex-dependent behaviour types can affect reproductive success, a crucial factor for species persistence and survival. Furthermore, in social species such as *E. stokesii*, consistent and predictable personalities in members of each sex may lead to improved social stability within the group, thereby determining the social structure and hierarchy in the group.

A-0280 (Poster)

Does Urbanization Influence Endoparasite Community of Chinese Cobra in Taiwan?

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Urban development and expansion often lead to habitat changes for wildlife, causing a cascade effect on their populations. Previous research suggests that the Chinese Cobra (*Naja atra*) has higher mean body condition index in urban areas than in rural areas in Taiwan. Parasites, as indicators of ecological changes, are sensitive to environmental disturbances. The inability to infect intermediate host or the absence of necessary environmental condition can impede parasites from completion of their life cycles. Therefore, our objective is to utilize the endoparasite community to investigate the impact of urbanization on Chinese Cobra. In this study, snakes were collected in Taichung City, Taiwan, and parasites were examined and isolated from the guts and respiratory organs of snakes under dissection microscope. Out of the 64 snake hosts examined, we detected ten species of endoparasites in 55 individuals (prevalence 86%), including 2 acanthocephalans, 5 nematodes, 2 pentastomids, and 1 trematode. Based on the life cycles of the parasites from previous studies, we evaluated parasite transmission pathways of snake hosts, subsequently comparing parasite prevalence, infection intensity, species richness, and diversity between urban and suburban areas. Our preliminary results did not show significant effect of urbanization on the endoparasites of the Chinese Cobra.

A-0281 (Oral)

Elucidating Inter-species Variation in the Structure, Toxicity and Neutralization of Cobra Cytotoxins from *Naja sumatrana*, *Naja kaouthia* and *Naja atra*

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The Equatorial Spitting Cobra (*Naja sumatrana*), Monocled Cobra (Naja kaouthia), and Taiwan Cobra (*Naja atra*) are medically important venomous snakes in Asia. Envenoming by these cobras commonly causes extensive local tissue necrosis, and severe cases may require amputation and local tissue necrosis. The strong cytotoxic effect of cobra venoms is attributed to cytotoxins, which can be variable in structure, potency, antigenicity and neutralization among different cobra species. To elucidate the variation, this study characterized the biochemical and immunological properties of cytotoxins from the three cobra species. Transcriptomic and proteomic approach revealed that the three cobra cytotoxins were highly conserved with amino acid sequence variation at loop III. The cytotoxins from *N. sumatrana* and *N. atra* were revealed as P-type cytotoxin, containing Proline30 whilst the cytotoxin from *N. kaouthia* is an S-type cytotoxin with Serine29. The two cytotoxin subtypes demonstrated varying degree of cytotoxicity in *in vitro* assay and necrotic activity in *in vivo* mouse model, with the P-type cytotoxin eliciting higher cytotoxicity and tissue-necrotic activity compared to the S-type cytotoxin. Protein prediction model showed that both P- and S-type cytotoxins possess structural differences at loop III which may be responsible for varying degree of toxicity by assisting cell membrane penetration. Neutralization efficacy of the regional cobra antivenom, Thai *N. kaouthia* monovalent antivenom, was investigated with pre-incubation neutralization assay (cytotoxin and antivenom incubated before intradermal administration) and challenge-rescue method (cytotoxin administered intradermally and antivenom administered intravenously 10 minutes after toxin administration). Pre-incubation assay had successfully reduced necrotic lesion size at high antivenom dose (100 µg); however, challenge-rescue method failed to decrease necrotic lesion size, highlighting antivenom's limitation to extravasate onto the bite site. The study highlights the sequence, diversity of cobra cytotoxins, their role in cytotoxicity and tissue necrosis as well as their neutralization efficacy against the regional antivenom.

A-0282 (Oral)
Climatic Modelling Predicts High-Elevation Species Replacement by Expanding Lowland Species in the Himalayas

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Climate change poses one of the most serious threats to amphibians worldwide, with species inhabiting the Himalayas particularly susceptible due to their limited dispersal capabilities, high elevational adaptation, and endemic nature. Himalayan regions are experiencing a climatic warming three times higher than the global average, leading to observable shifts and decline in suitable habitats for amphibians. Our study employed maximum entropy modeling to predict suitable habitats of three Himalayan endemic amphibians

(*Duttaphrynus himalayanus, Nanorana liebigii*, and *Tylototriton himalayanus*), as well as two widespread species not native to the Himalayas (*D. melanostictus* and *Euphlyctis adolfi*).Our analyses are based on the data collected from field surveys, the literature and GBIF for two time periods, past (1970–2000) and current (2001–2020), at a resolution of 30 arc second, and using eight disconnected bioclimatic variables (Bioclim data). Our result for the climatic modeling showed Annual Precipitation (BIO12) for endemic and Isothermality (BIO3) and Annual Precipitation (BIO12) for non-endemic amphibians, emerging as principal predictors for suitable habitat. Projections of suitable habitat for the three Himalayan endemic amphibians showed 6%, 2%, and 1% declines from historic suitable habitats. The greater cause for concern is that widespread and non-endemic amphibians showed an increase of 8 to 12% in projected suitable habitat, suggesting a potential invasion towards higher elevational ranges by more adaptable widespread amphibians. In addition, we conducted behavioural experiments comparing physiological endurance of endemic *D. himalayanus* and widespread non-endemic *D. melanostictus. Duttaphrynus melanostictus* exhibited a significantly higher boldness compared to *D. himalayanus*, highlighting a potential ability to disperse to higher elevation. These findings highlight correlation between species such as *D. melanostictus*, with their widespread range and higher boldness, potentially intensifying competition with Himalayan endemic species. In conclusion, this research highlights that Himalayan amphibian conservation is imperative amid climate change that's altering habitats and introducing ecological pressures.

A-0283 (Poster)

Unraveling Phylogenetic Conflicts: Insights from Toad-Headed Lizard Genomics

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Constructing phylogenetic relationships among species forms the foundational work of evolutionary biology, with accurate relationships bearing crucial significance for delving deeper into the field. The advent of next-generation sequencing technologies has revolutionized phylogenetic studies by providing omics data, offering a wealth of informative sites that resolve previously elusive relationships. Yet, diverse data types may yield disparate phylogenetic results due to varying information content and inherent characteristics. Investigating the impact of different data sets on phylogeny is pivotal in the genome era. Focusing on the toad-headed lizard (*Phrynocephalus*), earlier studies predominantly relied on first-generation sequencing data, resulting in inconsistent phylogenetic outcomes due to different gene segments and estimation methods. Our approach involves whole genome resequencing and transcriptome sequencing, generating extensive data from numerous genomic regions. Phylogenetic reconstructions across different datasets revealed stable differences in relationships among three species in non-coding versus coding regions. Potential factors contributing to this divergence include gene flow, robust incomplete lineage sorting (ILS), and pronounced natural selection on coding regions. In addressing these complexities, our ongoing research aims to further elucidate the underlying causes of phylogenetic conflicts.

A-0284 (Oral)
What the shell? Hatching Failures under Constant 28°C Incubation occur in Southwestern Snake-Necked Turtle Eggs

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Turtle populations worldwide are in peril, with many species listed as threatened or near threatened. Our endemic species, the southwest snake-necked turtle (*Chelodina oblonga*) is under pressure from habitat alteration, increased predation by feral and invasive species, climate change and motor vehicle accidents. Higher predation rates of eggs and adults lead to low numbers of juveniles in urban wetlands. Interventions to increase juveniles in these areas are crucial to prevent local extinctions. *Ex-situ* incubation of eggs and the release of the resultant hatchlings has been used as a conservation method for several species with varying results. Very little research exists regarding *ex-situ* incubation methods for *C. oblonga*, and the effective implementation of *ex-situ* incubation programs depends on comprehensive research. This study investigated how incubation temperature and moisture levels impact *C. oblonga* hatching success. Eggs were collected from natural nests and deceased females and then incubated under varying conditions. A fluctuating temperature resembling natural nesting and a constant 28°C were tested, alongside wet and dry substrates. Hatching success was significantly higher under the fluctuating regime than the constant one. The interaction between temperature and moisture significantly affected hatchling survival, especially in the fluctuating temperature treatment, where moist conditions positively influenced survival. Post-mortem examinations revealed that most hatchlings that died in the constant treatment lacked an essential egg tooth. This study has direct implications for *ex-situ* breeding programs, providing valuable insights into enhancing the survival of the near-threatened southwestern snake-necked turtle.

A-0285 (Oral)
When Biogeography meets Forensics: Case study with Bengal Monitor Lizard (*Varanus bengalensis*)

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The Bengal monitor lizard (*Varanus bengalensis*) is a CITES-I, Near Threatened and Schedule-I of Wildlife Protection Act (1972) species due to its global illegal trade. This species is being exploited for its hemipenis marketed as "Hatta jodi" in local and e-commerce markets. Due to lack of knowledge on the population genetic structure, it was difficult to ascertain the origin of traded samples and even rescued live individuals. Thus we studied the genetic structure and evolutionary relationship of *V. bengalensis* and determined the factors that shaped lineage diversification. The findings confirm the presence of two distinct lineages within V. bengalensis, spanning the Himalayan foothills and southward of foothills: Mainland population. Divergence analyses indicate that the split between these two lineages of *V. bengalensis* occurred in the mid-Pliocene, approximately 3.06 million years ago. This divergence may be a consequence of the Shiwalik broadening and climatic fluctuations across the Himalayan foothills. The results of our study suggest the recognition of a new lineage of *V. bengalensis* from the Himalayan foothills as a distinct evolutionarily significant unit.

Himalayan region and their associated environment are renowned for driving the rapid diversification of numerous species contributing to its recognition as a global biodiversity hotspot. Environmental changes since the Miocene era have accelerated species diversification, making them valuable for studying population genetic structure and evolutionary relationships using genetic approaches. Despite this, the comprehensive assessment of the effects of climatic fluctuations on the biogeography of large-bodied monitor lizard has not been undertaken until now. This study unveils hidden genetic structuring within *V. bengalensis* within India. Thus, this study recommends determining origin of population in case of any release operations by management authorities. This study also provide a basis for identification of traded body parts easing forensic investigation.

A-0286 (Poster)

Developing Environmental DNA-based Monitoring Method for Loggerhead Sea Turtle (*Caretta caretta*) in the Boundary of its Distribution Range

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The population density of species is low and are particularly more vulnerable to rapid environmental changes at the boundary of the distribution range. Environmental DNA (eDNA) has recently gained attention for its potential as a method for monitoring rare species. The sea around the Korean Peninsula is the edge habitat of the distribution range of Loggerhead sea turtles (*Caretta caretta*) with no nesting sites. In this study, we developed and validated an eDNA monitoring method for *C. caretta*. First, we designed species-specific qPCR markers and tested them using sea turtle tissue DNA, eDNA from sea turtle aquarium, and eDNA from habitats in Japan. Second, for testing in Korean sea, eDNA sampling of sea waters was conducted once every 2 months from February to October 2023 at 10 sites in Jeju Island and Pohang in Korea. All samples with confirmed amplification in qPCR were validated by electrophoresis and sequencing. As a result, we developed species-specific markers and detected the eDNA of *C. caretta* from the aquarium and Japanese population. Also, we detected C. caretta from the eDNA samples in Jeju Island in February and August. Our results suggest a new monitoring method for turtles in Korean water, which are difficult to monitor due to the absence of nesting sites, small population size, and large movement range. The relationship between eDNA detection and actual presence and low detection rate will be refined in the 24th year of the study. However, our research could be beneficial to protect sea turtles at the edge of their distributions, which are rapidly expanding following climate change. This study was supported by grants from the National Marine Biodiversity Institute of Korea (2024M00300 and 2024E00300) funded by the Ministry of Oceans and Fisheries.

A-0289 (Poster)

The Microhabitat Choice of the Hungarian Meadow Viper (*Vipera ursinii rakosiensis*) in Kiskunság: A Preference Towards Microhabitat Transitions

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The Hungarian meadow viper (*Vipera ursinii rakosiensis*) is a grassland-specialist taxon with only three remaining populations in Hungary. These populations live in patchy habitat complexes where various grassland vegetation communities form different microhabitats. To understand the microhabitat selection of this endangered snake, we investigated (i) its preference for microhabitat types, (ii) the correlation between viper presence and microhabitat transitions, and if there is, (iii) which specific pairs of microhabitat transitions are preferred. The study is based on the last thirty years of viper observations in Kiskunság, where two of the three remaining populations live, and on the vegetation association maps of these habitats. GLMs were fitted, with viper observations as the dependent variable, and microhabitat types, distance from habitat boundaries, and microhabitat boundary pairs as explanatory variables. Results showed that 7 out of the 18 microhabitat types examined had a significant positive impact on the probability of viper presence. Closed sand steppe emerged as the most preferred microhabitat type. The distance from habitat boundaries had a significantly negative effect on the probability of viper presence. Among microhabitat transitions, the transition from mesotrophic wet meadow to closed sand steppe exhibited the highest probability of presence. These findings contribute to the understanding of the specific habitat requirements of the endangered Hungarian meadow viper and underscore the importance of vulnerable mosaic habitat structures.

A-0291 (Poster)

Historical Biogeography of the Genus *Kurixalus* (Amphibia: Rhacophoridae) in East Asia with Special Reference to the Evolutionary History of *Kurixalus eiffingeri*

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To clarify the genetic differentiation of *Kurixalus eiffingeri* distributed on Ishigaki Island, Iriomote Island, and Taiwan, phylogenetic and population genetic analyses were conducted based on SNP data obtained by multiplexed ISSR genotyping by sequencing (MIG-seq) analysis and a part of mitochondrial DNA (mtDNA) sequences. Based on both phylogenetic

trees estimated from mtDNA and SNP data, K. eiffingeri was divided into four populations (Ishigaki, Iriomote, Central Taiwan, and Northern Taiwan populations). The results of the estimation of divergence time and reconstruction of the ancestral ranges of the ancestral populations suggest that the common ancestor of *K. eiffingeri* immigrated into Taiwan from the continent approximately 4.75–6.7 million years ago. The separation between the central and northern Taiwan populations of *K. eiffingeri* was thought to have occurred because of the uplift of the central mountain range of Taiwan. The northern Taiwan population was thought to have spread to the Yaeyama Islands during the Early Pleistocene when a land bridge was formed between the two regions. The divergence between the Ryukyu and the northern Taiwan populations seemed to be caused by isolation by distance (IBD) at first. The water depth of the Sekisei Lagoon between Ishigaki and Iriomote Islands is relatively shallow (dozens of meters), suggesting that the two islands were connected to each other at the peak of the last glacial period when the sea level dropped to approximately 120 m. However, it is estimated that the Ishigaki and Iriomote populations of *K. eiffingeri* differentiated approximately 0.81–2.02 million years ago. This suggests that the genetic isolation between the Ishigaki and Iriomote populations had been maintained during the glacial periods in Pleistocene when these islands were connected by land bridge.

A-0292 (Oral)
Contrasting Estimates of Amphibian Extinction Risks Estimated by Occupancy or Abundance Data

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Assessing population trends is the essential prerequisite to identify the causes of changes and comprehend how to address and reverse declines of animal populations. Population trends can be evaluated using two different categories of data: presence/absence or abundance. Abundance measures provide a direct indication on the changes of population size of a species over time, making it the most straightforward method for evaluating population trends. Searching and counting all the individuals present at a study site generally requires much more time than just detecting a few of them, therefore collecting presence/absence data only may be an advantage under a sampling-effort perspective. However, when species experience declines, it is likely that a decrease in abundance precedes a reduction in their presence over a given area. As a result, trend estimation from presence/absence data may underestimate population declines due to the delay between reductions in population size and local extinctions. In this study, we examined the temporal trends of four amphibian species (two frog and two newt species) in Northern Italy using two different approaches: occupancy models, which use detection/non-detection data, and abundance models based on counts of egg masses (for frogs) or adult individuals (for newts). Abundance and occupancy showed on average declines for all species; however, as hypothesized, population declines were detected earlier for abundance, while occupancy showed a more linear decline over time. Abundance data indicated higher threat categories compared to occupancy data but were generally associated with larger uncertainties. While abundance data have the advantage of spotting declines earlier, occupancy data can provide more robust estimates, thus we advocate the integration of multiple measures of decline when assessing threat status.

A-0294 (Oral)
Call Properties and Potential Reproductive Function of Rain Call in the Japanese Treefrog, *Dryophytes japonicus*

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Japanese tree frog (*Dryophytes japonicus*) produces various types of calls including advertisement call and rain call. Advertisement call functions to attract mates, but the function of rain call, emitted even in the non-breeding season, was poorly understood. In this study, we comparatively analyzed physical characteristics of advertisement and rain calls, and then, tried to verify the function of rain call whether or not males respond to rain call just like advertisement call. We record both call types in 2023 and playback tests were held simultaneously, and the playback stimuli were selected in the recorded file. In temporal properties, the call duration, note duration, and note interval of advertisement call were greater than those of rain call, while the note repetition rate of rain call was greater than that of the advertisement call. The spectral properties including frequency modulation and dominant frequency didn't show significant differences between the two call types. During one minute of playback and three minutes of post-playback waiting, the frequency of orientation and approach trial of male *D. japonicus* towards the speaker were not different between two call types, but significantly more males among approaching males completed their approaches up to the speaker within one minute playback period when advertisement call was play-backed than when rain call was. Our results indicate that both call types function to evoke males' response, but males less likely approach to the males who emit rain calls.

A-0295 (Oral)
Identifying the Source Rookery of Green Turtles (*Chelonia mydas*) and Loggerhead Turtles (*Caretta caretta*) Found in Feeding Grounds in the Korea Peninsula

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Sea turtles, which are internationally endangered species, have a wide range of movements through the waters of many countries. To establish a conservation strategy for sea turtles in a particular country, it is important to understand their interaction with breeding grounds and feeding grounds. Sea turtles tend to use Korean waters as their feeding and breeding grounds. Although the nesting of *Caretta caretta* was recorded several times on the coast of Jeju Island, no further observations have been made since 2007. So, the sea turtles found in Korean waters likely hatched in other countries and moved to Korean waters. In this study, we analyzed the haplotypes of the mtDNA control region (CR; ~800 bp) of 40 *Chelonia mydas* and 50 *C. caretta*

tissue samples that were either stranded or caught by accident to determine the genetic composition, genetic diversity, and the origins of these two sea turtle species by using Mixed Stock Analysis (MSA). Based on our genetic analyses, it appears that the Korean sea turtle population shares a significant number of haplotypes with nesting populations in Japan. Moreover, their genetic diversity is comparable to that of other feeding grounds in Japan. Based on these results and MSA results, it is likely that the majority of *C. mydas* and *C. caretta* in Korean waters originate from Japan's nesting grounds. However, some C. mydas may come from the Indo-Pacific nesting areas. These results are in line with previous satellite tracking studies of these species in South Korea. To conserve these sea turtle species effectively, it may be crucial to establish international cooperation with the countries where their nesting populations are located. This study was supported by grants from the National Marine Biodiversity Institute of Korea (2024M00300 and 2024E00300) funded by the Ministry of Oceans and Fisheries.

A-0296 (Poster)

Some like it Hot: Past and Present Phylogeography of a Desert Dwelling Gecko across the Arabian Peninsula

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Deserts represent dynamic ecosystems that support communities of endemic and often specialised species. We analysed the role of present and past climatic conditions in shaping the distribution of the widespread *Bunopus* geckos in the Arabian and south-west Asian deserts. We studied their phylogeographic and demographic history to test whether the geckos colonised Arabia from Asia or, vice versa, Asia from Arabia and to identify migration corridors that have historically enabled the dispersal of *Bunopus* geckos. We generated sequence data for four genes and performed Maximum Likelihood, Bayesian Inference and time-calibrated phylogenetic analyses and ancestral area reconstruction to infer the phylogenetic and biogeographic history of the genus. We modelled the species' distribution and projected it to several past time periods spanning from mid-Pliocene to the present. We analysed contemporary landscape connectivity across the peninsula to identify dispersal corridors that enable migration and promote gene flow among *Bunopus* populations in Arabia.

A-0297 (Poster)

Unravelling the Evolutionary History of Sphenomorphin Skinks in Western Melanesia: A Phylogenomics Approach

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Western Melanesia, including New Guinea, sits at the crossroads of Asia, Australia, and the Pacific Islands and is one of the most interesting, yet understudied hyper-diverse regions on Earth. Despite the complex geological history, high biological diversity and extreme rate of endemism, the origin and relationships of most taxonomic groups in the region remain poorly studied. This is especially true for range-restricted taxa such as reptiles, and the many newly described species suggests that true diversity remains unknown. Represented by 11 genera, sphenomorphin skinks of New Guinea and surrounding islands represent a significant proportion of the region's lizard diversity. Despite high species diversity and the many recently described species, evolutionary relationships within the Sphenomorphini remain poorly understood. This study aims to address this knowledge gap by using advanced high-throughput sequencing methods to generate genetic data for representative species across multiple genera of sphenomorphin skinks from Western Melanesia. We will present preliminary data in this presentation. We have access to hundreds of tissue samples collected from across the region, representing most genera, including taxa only represented by museum specimens. DNA extraction will be performed using established protocols, and novel sequence data will be generated using the squamate conserved loci (SqCL) bait set. Maximum likelihood, Bayesian inference phylogenies, and species trees based on the multi-species coalescent method will be used to unravel the evolutionary relationships among the genera of Sphenomorphin skinks, providing insights into their diversification patterns. The wide distribution of sphenomorphin skinks creates a mosaic of isolated populations and regions with particularly high species endemism. We will use our data to test biogeographic hypotheses about the diversification of the group in the region.

A-0298 (Poster)
Phylogeography and Population Genetic Structure of the Common Butterfly Lizard *Leiolepis belliana* (Hardwicke & Gray, 1827) in Thailand as Inferred from Mitochondrial Cytochrome b Sequences

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The common butterfly lizard, *Leiolepis belliana* (Hardwicke and Gray, 1827), is among the five nominal species of butterfly lizards in Thailand. Recognized for its extensive distribution across different geographical regions, *L. belliana* serves as an ideal model for the examinations of the contributing factors on the distribution patterns of ground-dwelling lizards. Unfortunately, recent population declines highlight the urgency to acquire information pertaining to genetic diversity and population genetic structure in order to establish effective conservation plans. This study investigates the phylogeography and population genetic structure of L. belliana in Thailand using mitochondrial cytb sequences. Tail tissue samples were collected from 21 localities throughout the distribution range in Thailand. Analyses of

mitochondrial cytb sequences (n = 152; 1,071 bps) revealed a total of 51 haplotypes, indicating a remarkable genetic diversity (h = 0.965, π = 0.0640) compared to other lizard species. The phylogenetic tree revealed two distinct clades within L. belliana populations. The first clade was comprised of eastern and southern Thailand populations, suggesting a historical connection between these regions, possibly influenced by both geohistorical events and human-mediated activities. Notably, specimens from eastern Thailand exhibited an identical haplotype with those from southern Thailand. The second clade was comprised of specimens from central Thailand and also included other *Leiolepis* species, namely *L. ocellata* and *L. rubritaeniata*, which further implied the possibility of historical mitochondrial introgression. Additional investigations using nuclear molecular markers are necessary to assess the occurrence and extent of hybridization among *Leiolepis* species. Nonetheless, the results provided a comprehensive understanding of genetic diversity and population genetic structure, as well as evolutionary dynamics, of *L. belliana* in Thailand, which potentially serve as foundation for future researches and conservation efforts.

A-0299 (Poster)

Developing Genetic Biocontrol Tools for the Invasive Smooth Newt (*Lissotriton vulgaris*) Using Hormone-Induced Sex Reversal

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Invasive species threaten native wildlife and degrade ecosystems, leading to multiple extinctions in recent years. Despite preventive measures, biosecurity breaches continue to occur in many jurisdictions. Managing invasives is an international priority, but conventional control methods are seldom effective. Direct removal such as trapping and baiting are expensive, difficult to implement at large-scale, and considered unethical due to their lethal nature. Control methods that are both efficient and ethical are needed. The Trojan Y-chromosome strategy is one such method that shows promise, taking advantage of a sex-reversal mechanism seen in ectotherms to produce phenotypic females while retaining male genotype. In amphibians with a Y-chromosome for male sex-determination, larvae in early development may be sex-reversed using estrogenic steroids. Feminised individuals can be bred with wildtype males to produce genetically YY 'supermales'. Supermales can then be released into target populations as a biocontrol, as breeding with wildtype females produces all-male offspring. Subsequent generations decrease in number, eventually leading to population collapse due to lack of females. My research is laying the groundwork towards implementing this strategy in the smooth newt (*Lissotriton vulgaris*). This recent arrival to Australia is a management priority that has spread rapidly across Melbourne with potentially devastating ecological consequences. First, I am testing the efficiency of estrogenic steroids in inducing sex-reversal by exposing larvae to ethinylestradiol at various concentrations. I will then genetically sex the larvae and histologically examine the sex organs for evidence of sex reversal. Concurrently, I am mapping the developmental stages of sex organs in untreated larvae to identify the optimal stage to apply treatments. This research could potentially lead to an ethical and effective management strategy that eradicates invasives at the landscape scale without causing direct harm to individuals. Once established in the newt, we intend to apply this method to other invasive ectotherm taxa.

A-0302 (Poster)

Molecular Verification of *Dixonius* (Squamata: Gekkonidae) in Thailand

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Members of the genus *Dixonius* are widely distributed in Southeast Asia, consisting of 16 recognized species. The species discoveries of Dixonius have been continuing over the past decade using multiple lines of evidence. Currently, seven species, including *D. dulayaphitakorum, D. hangseesom, D. kaweesaki, D. mekongensis, D. melanostictus*, and *D. siamensis* were documented from Thailand. All *Dixonius* species in Thailand have been described primarily based on morphological evidence and most species lack genetic information. Herein, we aimed to investigate the phylogenetic position and taxonomic status of seven *Dixonius* species in Thailand using the mitochondrial NADH dehydrogenase subunit 2 (ND2) gene. This study presented the first genetic data of seven species from their type localities in Thailand. The phylogenetic analyses showed the monophyly of the genus with well support in each species. Interestingly, *D. siamensis* populations exhibited three genetically distinct clades consisting of the population from its type locality (central Thailand), the Cambodian population, and the other Thai population (western Thailand) with high p-distance, ranging from 8.2–13.8%. Although this study highlighted some taxonomic issues of *Dixonius*, additional samples from *D. melanostictus* and *D. siamensis* across their geographic distribution and molecular analyses should be conducted for elucidating phylogenetic relationships and true diversity of genus *Dixonius* in Thailand.

A-0303 (Oral)
Applying Detection Probability to Test Distribution Models for the Threatened Mahony's Toadlet

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We constructed distribution models for the threatened Australian frog species, *Uperoleia mahonyi* (Mahony's toadlet), using climatic, geologic, soil and vegetation map layers, and used modelled detection probability to test their suitability for predicting its occupancy, occurrence, and geographic range. *U. mahonyi* is known from a small number of sites along coastal New South Wales, Australia, on Quaternary sand-bed systems, and from associated sand-adapted vegetation communities, in a relatively high rainfall zone. All areas that it occupies feature very similar underlying geology, soil, vegetation type and climate. We conducted 798 surveys across 199 random sites within the range of *U. mahonyi* that were predicted to be "occupied" or "unoccupied" according to different distribution models. Sites were surveyed until *U. mahonyi* was detected, or until 95% likelihood of a true absence was established. We assessed the accuracy of the vegetation type, geology, soil and climate distribution models for predicting presence and absence of *U. mahonyi*. The species was detected at only 16.6% of sites, all of which were predicted "occupied" by more than one of the models. Single models performed

poorly, but generally efficacy was increased when multiple models were used in combination. The geology model consistently produced the most reliable result, and was better at predicting geographic range than site occupancy or occurrence. Our results indicate that the distribution of *U. mahonyi* is strongly linked to geology, specifically Quaternary coastal sediments, and it was found to occur only on 12 different geologic units. This in turn implies that threatened species offsetting that is reliant on assumed associations with vegetation type, such as that practiced in New South Wales where *U. mahonyi* occurs, is ineffective at achieving conservation goals.

A-0304 (Poster)

Taxonomic status of the Oriental Garden Lizard *Calotes versicolor* complex (Agamidae: Squamata) in Thailand based on mitochondrial DNA

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The Oriental garden lizard *Calotes versicolor* is one of the agamid lizards distributed in Southeast Asia and part of South and East Asia. Recently, *C. versicolor* from Southeast Asia, including northeastern India and southern China were revised and assigned to *C. irawadi*. However, the taxonomic status of this lizard in Thailand is unclear and need to be reexamined. Therefore, in this study, we investigated genetic data inferred from 430 bp of mtDNA 16S rRNA sequences and from 950 bp of mtDNA ND2 sequences to clarify the taxonomic status of *C. versicolor* in Thailand and compared with other *Calotes* species. Maximum Likelihood (ML) and Bayesian Inference (BI) analysis revealed that *C. versicolor* from Thailand is separated from Indian *C. versicolor*. Interestingly, *C. versicolor* from Thailand formed several subclades and grouped together with *C. irawadi* clade. P-distance analysis confirmed that genetic distance of *C. versicolor* from Thailand differed from Indian *C. versicolor* by ~17%, whereas genetic distance between *C. irawadi* and *C. versicolor* from Thailand were 3−6%. These results suggest the occurrence of *Calotes irawadi* complex across Southeast Asia. Therefore, the taxonomic status of *C. versicolor* from Thailand should be revised and further study on morphological character should be investigated.

A-0305 (Oral)

Exploring the Association between Body Size, Range Size and Habitat Use in the Frog Family Mantellidae of Madagascar

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Testing traits associations among species in large taxonomic groups can improve our understanding on the evolutionary processes that contributed in shaping those traits. However, shared evolutionary history can mask trait association and it is therefore worth it to be considered. With almost 500 recognized lineages showing incredible ecomorphological diversity, the frog family Mantellidae (endemic to Madagascar and the Comoro islands) has served as excellent model system to study phenotypic evolution and species diversification, but rarely the effects of phylogenetic relationships have been investigated in studying traits associations. We explored the factors driving changes in body size in mantellid frogs, selecting geographical range size, altitudinal tolerance, predominant vegetation type use (e.g., humid forest, dry forest, grassland), vegetation type generalism, and microhabitat use (e.g., aquatic, terrestrial, arboreal) as explanatory variables. The first factor has already been tested in mantellid frogs, while habitat use or the relative effect of all these traits on body size remains unknown. We inferred a new species-level phylogenetic hypothesis for the mantellid frogs of Madagascar using a Maximum Likelihood approach, we updated their distribution to infer their range size and compiled a morphological, habitat and microhabitat use database for all mantellid lineages. Using phylogenetic generalized least squares regression (PGLS), we investigated the association between mantellids body size, distribution variables and habitat use while accounting for the phylogenetic non-independence among taxa. We confirmed previous finding in identifying a significant positive association between body size and range size, however, we also identified a positive association on body size with elevation range and microhabitat. Interestingly, in multiple regression models microhabitat use shows the strongest effect on body size. These results highlight the effects of microhabitat use on the evolution of the body size and its general role on the ancient evolutionary history of the radiation of mantellid frogs.

A-0306 (Oral)
Exploring Selective Pressures Acting on Genes Involved in Immunity in Malagasy Mantellid Frogs

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Positive selection stands at the base of adaptive evolution by fixing over time a beneficial genetic mutation into a population. A measure to assess the selective pression occurring on sites, proteins or genes is a parameter known as dN/dS ratio, calculated as the ratio between the non-synonymous and synonymous substitution rate. According to its estimated value, it shows evidences of negative (< 1), neutral (= 1) or positive (> 1) selection, which allow to understand whether selection acting on that part of the genome is the likely source of new adaptive traits or whether it encodes traits that will likely be conserved. In this work, we explored the nature and strength of selective pressures acting on differentially expressed genes involved in the immune system functions in Malagasy frogs of the subgenus *Brygoomantis* (Anura: Mantellidae: Mantellinae: *Mantidactylus*). The dataset is composed by genes which were found to be differentially expressed in the liver and in the skin and that Gene Ontology

analyses suggested are related to immune system functions. The identification of these genes in Malagasy frogs is here documented for the first time. These genes can have an important role in the immunological responses to pathogens, one of the main treats to amphibians worldwide. We found evidences of positive selection acting in all gene categories here analysed, suggesting a possible role of immune system in the speciation process of species belonging to *Brygoomantis* subgenus.

A-0307 (Oral)

A Mechanistic Modelling Approach to Predict the Impact of Climate Change on the Range Dynamics of European Vipers (genus *Vipera*)

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The rapidly changing climate, together with habitat loss, is modifying the environment that the organisms experience. Previous research relying on correlative methods has predicted remarkable distributional range shifts in many taxa worldwide. However, species range dynamics depend on key species' traits such as life history and physiology that are not often captured by correlative approaches. Understanding the mechanisms that limit species distributions is likely to improve our ability to anticipate species range shifts in response to climate change and help implement conservation measures. Cold-adapted squamates are known to be more effective at low temperatures notably because of a faster metabolism. Nonetheless, they are expected to be more vulnerable to climate change and rising temperatures than warm-adapted ones, as the predicted temperature changes will augment their maintenance costs. Here, we focus on five species of the genus *Vipera*, three warm-adapted, *Vipera ammodytes, Vipera aspis* and *Vipera latastei*, and two cold-adapted, *Vipera berus* and *Vipera seoanei*, that parapatrically occur across Europe. Using a mechanistic niche modelling framework (NicheMapR), integrating microclimate and ectotherm models, we mapped their fundamental niches under current and climate change scenarios. Using laboratory-derived data on thermal and hydric requirements, we incorporated crucial parameters such as preferred body temperature, evaporative water loss, and metabolic rates in our models. This enabled the estimation of essential biological rates including activity window length, field body temperatures, and water loss under current and climate change scenarios. Our results show how changes in temperature and precipitation will drastically alter activity windows and thermal and hydric relationships across species ranges. Altogether, our study highlights the necessity of incorporating eco-physiological constraints and species-specific processes to predict species dynamics under climate change, as well as multiple species with distinct climatic adaptations to deal with the variable facets of climate change.

A-0308 (Poster)

Home Range and Movement of *Nanorana vicina* (Stoliczka, 1872) (Anura: Dicroglossidae) in Himalayan Streams, India

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Spatial movement patterns are a poorly known aspect of amphibian ecology, especially in the Indian Himalayan region. To address this knowledge gap, our research involved the radio tagging of 16 individual *Nanorana vicina*, which were tracked for an average of 63 days in two streams in Binog Wildlife Sanctuary, Uttarakhand, India. Our findings revealed that the tagged frogs exhibited relatively limited and short-distance movements, with an average movement distance of 5.9 ± 3.26 m, with approximately 90% of their total movement occurring within the stream habitat. However, we observed significant variations in the frogs' movement patterns during different seasons, including the pre-monsoon, monsoon, and post-monsoon periods ($F_{2,1000} = 14.55$, $p = 5.92E-07$). Analysis of kernel density demonstrated varying results at the 50% and 90% isopleths, ranging from 44 square meters to 2077 square meters and from 126 square meters to 8569 square meters, respectively. Additionally, when using the minimum convex polygon method, the observed range was 1.61 square meters to 43.16 square meters and 15.78 square meters to 684.99 square meters. Notably, there was no significant difference in the weight of the frogs before tagging and after tag removal ($n = 10$, $t = 1.94$, $p = 0.08$). Given the rapid environmental changes driven by both human activities and climate in Himalayan streams, species like *N. vicina*, which exhibit limited mobility and strong site fidelity, are particularly susceptible to these alterations. Our findings offer initial insights into the movement and home range of this sedentary stream frog, serving as a foundational platform for future research on this and other Himalayan species. Further studies are needed to understand factors affecting their movement and habitat use. Overall, our study emphasizes the importance of conserving streams and riparian zones for this unique frog species.

A-0309 (Poster)
Survey on Online Amphibian and Reptile Pet Shop in Korea

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The international trade of amphibians and reptiles (A&R) as pets is increasing rapidly, and may be a pathway of alien species introduction, which can reduce biodiversity. Alien A&R species that were known to be pets are frequently discovered in the wild in Korea. In this study, we identified potential wild-introduced species through the survey of the A&R pet market in Korea. We surveyed the online A&R pet markets in 2019 and 2021. Keywords such as 'amphibian/reptile pet shop' and 'exotic pets' were used to select online pet shop sites. Based on the sales name, we collected the English name, scientific name, hybridity, family, CITES, and price of each species. We excluded the species if its status was uncertain. There were 25 sites surveyed in 2019 and 78 in 2021. There was a 114-species rise to 791 (Amphibia 167, Reptilia 624) in 2021 from the 677 species (Amphibia 122, Reptilia 555) that were sold in 2019. We found only one native species, and 18 invasive species restricted by law in Korea in our search. 8 of the 11 reptiles sold in the most stores were found in the domestic wild at least once. In this study, we identified a positive correlation between the pet market and the introduction of alien species. We propose regular thorough research on trends and continuous monitoring of pet market. In addition, selling, exhibiting, and promoting in an online market accessible to anyone can affect public perception of foreign organisms. Therefore, we suggest

the need for pet market management. We also urge preparing management and control measures for invasive species.

A-0310 (Poster)
Habitat Association of the Endangered Reeve's Turtle (*Mauremys reevesii*)

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Reptile populations are declining worldwide due to habitat loss, habitat fragmentation, introduction of invasive species, environmental pollution, diseases, and climate change. The native Korean turtle species, *Mauremys reevesii*, also faces the conservation challenges. This study aimed to identify essential habitat requirements for the conservation of *M. reevesii*. We surveyed 59 localities known as M. reevesii habitats in Korea between 2022 and 2023. We measured 9 macrohabitat, 9 microhabitat, and 4 biotic factors. Using negative binomial regression analysis, we determined the optimal model for the maintenance of *M. reevesii* populations based on the AICc values. The model, which includes crops, grasslands, bare lands, and the number of log piles, was confirmed as the optimal model for sustaining M. reevesii populations, demonstrating an explanatory power of 0.96. The number of log piles inside the habitat is connected to basking sites and the development of eggs in female turtles, while the extent of crops, meadows, and barren lands around the habitat is linked to *M. reevesii* breeding sites. The construction of habitat with an emphasis on reproduction within the environment is essential for population growth and protection. Thus, improving breeding and reproduction within the habitat should be the top priority for habitat improvement, with particular attention paid to crops, grasslands, barren areas, and the quantity of log piles linked to M. reevesii's reproduction. For *M. reevesii* populations to be preserved, this strategy is crucial.

A-0311 (Poster)
Communication through Vocalizations in the Huanren Mountain Frog: A Study from an Ecological Perspective

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Acoustic communication in amphibians is essential in territory defense and mating activity, significantly influencing the survival of species. While frogs are commonly known to produce vocalizations using vocal sacs, recent attention has been directed towards species lacking vocal sacs. *Rana huanrensis* is a non-vocal sac anuran species, and there is lack of research on its vocal activities. This study aimed to classify call types using underwater recordings. We conducted the underwater recordings from February to April 2023 in Mt. Jeombong, Gangwon Province, considering the species' underwater breeding behavior. Video recordings were conducted for individual identification. The results revealed the utilization of acoustic communication underwater. We classified 7 call types based on the repetition and form of pulses and notes. The average max frequency (Hz) for each of the 7 call types was determined

as follows: 750, 1288, 1515, 1458, 1137, 1723, and 1176. This study provides a detailed classification of the vocalization types of *R. huanrensis* through underwater recordings, highlighting the importance of research methods considered the ecological characteristics of the target species. The significance of this research is communication in frogs without vocal sacs. Future studies should focus on correlating behavior recorded in videos with audio recordings to further understand the functions of each call type.

A-0312 (Oral)

Morpho-geometric and Behavioral Sexual Characterization of the Ex situ-managed Philippine Forest Turtle, *Siebenrockiella leytensis* (Taylor 1920), in Avilon Zoo, Rodriguez, Rizal

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Ex-situ setups, such as zoos, offer practical prospects for conducting animal research, especially for species that are of conservation importance and are challenging to study in their natural habitats. Here, morpho-geometric characterization and *ex-situ* observations on the critically endangered Philippine Forest turtle (*Siebenrockiella leytensis*) were conducted. This aimed to characterize morphology, confirm sexual variation, and describe the general behavioral patterns of this species. Standard morphometric measures and hourly instantaneous scan sampling (from 0600 to 2200 h) were conducted to directly observe 46 individuals in seven consecutive days. Size and shape were statistically examined to compare three groups, categorized based on anal plastron shape: U-shape, V-shape, Y-unknown. From the behavioral observations, an ethogram representing the behavioral patterns of the species within a timeframe was constructed. Notably, this is the first ethogram developed for the Philippine Forest Turtle. The results showed potential geometric basis for sexual identification, and higher frequencies of aquatic behaviors attributed by the daily movements from land to water. Preliminary analysis of the time-budgets suggests nocturnal preference of their aquatic activity between 1900 to 2200 h. A potential existence of other sex-specific behavioral traits were noted but could not be subject to statistical analysis due to limited timeframe constraint. Given the endangered status of the Philippine Forest Turtle and its endemicity, research efforts that cover the complete and thorough 24-hour observations over a long-term period in its natural habitat is highly recommended.

A-0313 (Poster)

Estimate Population Size of Capture-Translocation *Kaloula borealis* to Alternative Habitats

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As a way to ease the conflict between humans and wild animals caused by development, projects are being implemented to create and translocate alternative habitats. *Kaloula borealis*, which are designated and protected as endangered amphibians in Korea, are actively implementing capture-translocation projects to protect the species. Unfortunately, little is known about results such as maintaining stable populations after translocation. This study estimated the size of the population using the Jolly-Seber method by investigating 76 individuals in 2022 and 90 individuals in 2023 that were captured and translocated from the development site to an alternative habitat in Korea. Six surveys were conducted from May to July 2022. As a result, 7 of 76 individuals in 2022 and 7 of 90 individuals in 2023 were recaptured, and 14 unmarked individuals were captured and estimated that an average of 148 individuals survived in alternative habitat. This study confirmed that the population of capture-transition *K. borealis* maintained the population well within the alternative habitat. Further research needed to maintain the functional population size for a long-term and to confirm their survival.

A-0314 (Poster)

Sexual Size Dimorphism of Crocodile Newt, *Tylototriton panhai* (Urodela: Salamandridae) at Phu Soi Dao National Park, Thailand

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Sexual size dimorphism (SSD) between male and female are common in amphibians, and there are variations in direction and degree of SSD in Urodeles. In this research, a population of *Tylototriton panhai* at Phu Soi Dao National Park, Thailand with a limited distribution range and decreasing population trend was surveyed and studied. We analyzed morphometric data of the newts caught during July 2020 to May 2022. Adult newts (129 males, 12 females) were weighed and measured for sixteen morphometric characters. Wilcoxon rank-sum tests indicated that females were significantly heavier than males ($p < 0.0001$), and significantly larger than males ($p < 0.05$) in head length (HDL), eye-naris distance (END), femur length (FML), tibia length (TBL) and tail height (TLH). Independent sample t-tests also showed statistically significant difference between sexes ($p < 0.05$) as follows. Females had the greater total length (TTL), snout to vent length (SVL), head width (HW), internarial distance (IND), eye length (EL), humerus length (HML), radius length (RDL), and tail length (TL) than males, while males had greater cloacal width (CLW) and cloacal length (CLL) than females. Our findings on the larger body size of female *T. panhai* were supported by fecundity selection theory as well as different age at maturity between sexes. This sexual size dimorphism could be adaptive for the ability to produce offspring in *T. panhai.*

A-0315 (Poster)

Age Estimation and Sexual Dimorphism of Breeding Population of Asiatic Toad (*Bufo gargarizans*) Using Skeletochronology

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The decrease in amphibian populations has accelerated, leading to the need for research on the age structure of their populations. The skeletochronology is the method of estimating age by line of arrested growth (LAG) formed on the cross-section of bones is a way to minimize the impact on the individual and estimate age. Asiatic toad (*Bufo gargarizans*) is commonly observed throughout the South Korea as terrestrial amphibians. Currently, the ages of amphibian populations of many species inhabiting South Korea have been estimated using the skeletochronology, although information on *B. gargarizans* remain unknown. Therefore, this study was conducted to estimate age. In 2016 and 2017, February to March, we captured total of 174 individuals (148 males, 26 females) and for skeletochronology, collected 4th (longest) toe of the right hind limb. The average snout to vent length (SVL) of male was 82.8 mm, Body Weight (BW) was 60.7 g, and an age was 2.8 years. The average SVL of female was 108.4 mm, BW was 136.6 g, and an age was 2.9 years. We confirmed the LAG were stained purple. The age structure, 2-year-old males were the most abundant with 55 individuals, and females were 11 individuals, 3-year-old. Based on these results, a growth curve graph was created, and the maximum growth size for males was 83.9 mm, and females was 109.4 mm. Both males and females showed rapid growth up to 2 years old, reaching maximum growth size at 3 years old. There was a significant difference in size between male and female. Females were significantly larger than the males. Also, BW and SVL were increased with the increase in age. This study confirms the age and sexual dimorphism of *B. gargarizans*, which is important for formulating its conservation and management plans.

A-0316 (Oral)
Analysis of the Role of SPFs in Chemical Communication in Mantellidae

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Anurans uses at least three different kinds of communication systems: visual, acoustic and chemical. Chemical communication in anurans remains poorly investigates, however several compounds are known to function as chemosignals in anurans, such as peptides, full-length proteins and volatile compounds. Among the full-length proteins, the SPFs (sodefrin precursor like-factor), which belong to the family of the two-domain three-finger proteins, are known to reduce the duration of courtship in some urodeles, and homologous proteins have recently been identified also in Anura. The production and release of these compounds seems to be associated to the presence of the Sexually Dimorphic Skin Breeding Glands. In this study, we identified a set of candidate SPF genes in the skin and Femoral Gland tissues of three frogs species belonging to the family Mantellidae (Mantellinae: Gephyromantis: Phylacomantis). To study the evolution of the genes recently identified in mantellin frogs, we explored the phylogenetic

relationships of these putative SPFs proteins with the SPFs that have recently been identified in other anurans and with the SPFs which are known to function as pheromones in urodeles. Secondly, we performed a structural analysis. To do this we inferred the tertiary structure of all SPFs sequences, we computed the distances between structures and inferred a distance tree using the Neighbour-Joining method. Finally, we tried to infer the likely position of these proteins in the cell membrane, and we searched for molecular evidences that the proteins are excreted. Showing a high degree of homology, both in sequence and structure, our results enable us to suggest that SPF proteins are present also in mantellin frogs.

A-0318 (Poster)
Study on the Growth Rate of Invasive Turtles Based on Types of Diet

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The Red-eared Slider (*Trachemys scripta elegans*) and the River Cooter (*Pseudemys concinna*) are invasive alien species in the domestic ecosystem, exerting a negative impact. Both species exhibit a characteristic shift in their feeding habits upon reaching maturity. Given that the characteristics associated with their feeding habits appear to enhance reproduction across broader geographical areas, we recognized the need for further research. This study was conducted to investigate the differences in growth rates based on the specific dietary preferences of each species. The research was conducted over a period of 10 weeks, from September 27, 2021, to December 3, 2021. We comprised 15 individuals each species of manually incubated (total 30 individuals). We separate the group each 5 individual into 6 tanks, and allocated the feed source meat, pellets, vegetation. To assess growth rates, measurements of weight, carapace length, and plastron size were recorded every Thursday throughout the one-week period. The analysis was conducted using SPSS, comparing species-specific weight, carapace length, and plastron length based on different dietary preferences. The results of the growth rate analysis across individuals indicated an increase in size over time according to the feeding types; however, no statistically significant findings were observed. This study, which examined the growth rates based on dietary preferences in the juvenile stages of Red-eared Sliders and River Cooters, is deemed foundational information for managing these populations.

A-0320 (Oral)
Sleeping in the "Home Leaf" Camouflaged: Western Ghat Endemic Bush Frog changes Body Colour Intensity during Daytime Sleeps

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Colour changes in frogs are caused by multiple reasons. We investigated the reason for a Western Ghat endemic tropical bush frog to change colour intensity multiple times during day time, while sleeping. Observation and experiments were conducted in Idukki district of Kerala

in an all natural environment without causing disturbance to the animal. We used regression models to compare environmental variables measured, with colour and light data obtained from photographs. Raorchestes jayarami exhibited rapidly changing colour intensity majorly due to changing light intensity. Temperature and humidity played a minor role in colour change. The basal colour was green which remained unchanged. This whole process happened rapidly, involuntarily, sensing light through skin while sleeping. These patterns of colour change were successfully replicated further confirming our findings and conclusions. The frog also exhibited site fidelity towards their resting sites, by returning after foraging to the exact same leaf, sitting in the exact same position continuously. Ecological reason for colour change was concluded to be for background matching by reducing contrast between body and the substrate. These findings have major implications on the frog's ecology and evolution which is discussed in the current study.

A-0321 (Poster)
Comparative Shell Morphology of *Ex Situ*-Managed Philippine Indigenous Turtles (Geoemydidae) in Avilon Zoo, Rodriguez, Rizal

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Cuora amboinensis, Cyclemys dentata, and *Siebenrockiella leytensis* are three of the four indigenous Geoemydid species in the Philippines. This study aimed to compare the shell morphology and shape of the three species and their implication with their habitat distribution based on existing literature. The weight, shell thickness, shell length, and width of one hundred and six specimens from Avilon Zoo, composed of 30 *C. amboinensis*, 32 *C. dentata*, and 44 *S. leytensis*, were measured. Geometric morphometric analysis was also performed on the images of the shells. The overall carapace size and weight contributed most to the total variation followed by the overall plastron size and shell thickness. For males, significant differences in the morphometric measurements were observed among the three species. Only *C. dentata* is distinct for females, while the measurements of *S. leytensis* and *C. amboinensis* overlap. Canonical Variate Analysis (CVA) suggested that the shell shape of *C. amboinensis* and S. leytensis had the greatest dissimilarity, while *C. dentata* was closer to *C. amboinensis* than to *S. leytensis*. The terrestrial nature of C. *amboinensis* was evident from its thigh-domed, thicker shell and smoother marginal scutes that are beneficial to provide stability on land and withstand predatory threats. The flatter and more serrated shell of *C. dentata* corresponded to its preference for aquatic habitat and hiding in leaf piles and rock crevices. The larger and wide shells of *S. leytensis* correlated with its more aquatic lifestyle since this type of shell is more streamlined to reduce drag when swimming underwater.

A-0322 (Poster)
Silent Waters, Vanishing Croaks: A Closer Look at the Drastic Decline in native Anuran Populations Due to Invasive Catfish

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This study extensively explores the ecological impact of the invasive African catfish (*Clarias gariepinus*) on local anuran populations in a lake ecosystem. Over three years, our research within a regional lake development initiative aimed to elucidate the dynamics of this introduced

species and its consequences for amphibians. The investigation spanned three pivotal years: one year before the catfish introduction, establishing a baseline, and two subsequent years for post-introduction monitoring. Our primary focus was quantifying and analyzing how the African catfish modified the local anuran populations. Findings revealed a staggering 80% decline in the native anuran population post-introduction, portraying the invasive catfish as a formidable threat. This reduction extends beyond statistics, triggering consequences that upset the delicate balance of the local ecosystem. Through rigorous field surveys, systematic data collection, and sophisticated statistical analyses, we scrutinized the ecological mechanisms underpinning this decline. Our results underscore the urgent need for conservation measures to alleviate the ongoing impact and preempt further diminution in the local anuran populations. This study not only delves into the dynamics of invasive species in aquatic ecosystems but also highlights the imperative for immediate conservation actions to protect the biodiversity and ecological balance of these fragile habitats.

A-0323 (Oral)

Saving the Underworld King! Conserving a Fossorial Species that Comes Above Ground for a Single Day in a Year

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Nasikabatrachus sahyadrensis, commonly known as Purple Frog, was described in 2003 and it was the first time in 77 years a new family of amphibians had been described and hence its conservation was high on the agenda. But what exactly can one do with a species that comes above ground only for a day? A pragmatic combination of direct observations, visual encounter surveys and call surveys were used to study their ecology, distribution and threats faced by Purple frogs between 2016-2023, with a focus on its breeding behaviour, breeding sites and life history. Social Surveys and awareness campaigns towards the conservation of the species linking the species with the mythological character king Mahabali, so as to increase awareness and appreciation towards the species among the general public were done. We also held more than 200 conservation awareness workshops and sessions for over 8,000 people directly and many more were engaged through media platforms and awareness campaigns indirectly. Our study reports new insights and better understanding of their breeding behavior, mapping of the distribution range and resulting IUCN down listing, life span and threats faced including road kills, disease and climate change. Increased awareness among all stakeholders as a result of the state frog proposal and awareness campaigns. Almost half of its breeding habitats are outside Protected Areas and that's where they are more susceptible to the more severe threats including roadkills, littering due to tourism, pesticide spillover and habitat loss and we need to have a holistic approach involving all stakeholders towards conserving the species.

A-0325 (Poster)

Observation of the Asian Turtle Tick *Amblyomma geoemydae* Cantor, 1847 (Acari: Ixodidae) on the Asian leaf turtle *Cyclemys dentata* Gray, 1831 in Coron Island, Philippines

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The Asian leaf turtle (*Cyclemis dentata*) is a freshwater turtle species found in Southeast Asian countries, including the Philippines. Our understanding of its ecology in the Philippines is not yet fully understood and documented which is derived from a few studies. In this paper, we present our observation of an ectoparasite interaction between *C. dentata* and the Asian turtle tick (*Amblyomma geoemydae*) from Coron, Palawan. Our discovery serves as the second documented instance of this ectoparasite on *C. dentata* in the Philippines, extending its known distribution outside mainland Palawan. This finding contributes to the limited understanding of the turtle's ecology and underscores the need for further field-based observations, crucial for their conservation.

A-0326 (Oral)
Ecohydrological Controls on the Resilience of Snake Overwintering Habitat: Implications for Climate Change

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Herpetofauna at their northern range limit must seek refuge from harsh Canadian winters by selecting suitable overwintering habitat where they brumate for up to half the year. The Eastern Massasauga rattlesnake (*Sistrurus catenatus*) overwinters in habitats that avoid prolonged flooded conditions and remain at temperatures above 0°C to promote overwintering survival. In peatland ecosystems, snakes frequently use raised peat hummocks as hibernacula because they have great insulating and moisture retention properties. However, climate change threatens the persistence of suitable overwintering conditions in these hummock hibernacula due to increasingly variable winter temperatures that drive major freeze-thaw events and water table fluctuations. To explore the spatiotemporal availability of suitable overwintering conditions, we have instrumented hummocks in ten peatlands distributed along a 60 km stretch of the eastern Georgian Bay region for five winters (2019–2024) to measure hummock temperature, water table position, snow depth, and micrometeorological conditions. We have also collected ecohydrological characteristics at hummock, wetland and watershed scales to identify features linked to resilient overwintering habitat. This presentation will discuss the outlook of suitable overwintering habitat availability under projected climate change scenarios as well as metrics that conservation practitioners can use for assessing the suitability and resilience of overwintering habitat.

A-0327 (Poster)
Diversification of Visual Displays in Indian Dancing Frogs

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Animals communicate using a diverse array of elaborate signals that evolve to influence receiver's behaviors and are subject to environmental constraints. One such signal is the visual dance display in frogs known as the foot flag. The foot flag is an agonistic gestural display used during male-male competition for access to female mates and resources. It is produced when a frog fully extends its hindlimb out from its body and then downwards towards the substrate in an arch-like motion. We explore how foot flagging diversified by examining the kinematic signal differences in several species of Indian dancing frogs, Micrixalidae, a family that has radiated across the Western Ghats in southern India. Interestingly, all species breed in noisy environments (e.g., waterfalls and fast flowing streams) and use foot flagging as a form of intraspecific communication. These foot flag display routines can vary quite significantly between species with some species foot flagging with one hindlimb while others alternatively also use two hindlimbs at a time. Thus, this study system allows us to explore diversification of the visual display in closely related species under similar environmental conditions. We find that each species has a unique foot-flagging routine, with components that might serve as species identification. Together, our results shed light on how gestural displays can vary in a closely related group of frogs.

A-0328 (Oral)

The Degree and Pattern of within- and among Population Variability in Osteoderm Expression in *Hemicordylis capensis*

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Osteoderms are bony elements expressed in the skin of a few disparate groups of tetrapods. The cordylid lizard *Hemicordylus capensis* (Cape cliff lizard) is unique in exhibiting strong intraspecific variation in osteoderm expression: the number and size of the osteoderms vary among populations, sexes and age classes. The Cape cliff lizard has the largest distribution of the Cordylids endemic to the Western Cape of South Africa. Populations occur in areas ranging from warm lowland environments in the North, to cool montane environments in the southern part of their distribution. This offers a great opportunity to test hypotheses on the functional significance of osteoderms, evaluating their putative role in body protection, thermoregulation, water budget maintenance, and mineral storage. Here, we used micro-computed tomography to quantify the osteoderm expression from seven populations of Cape cliff lizard. Our results

indicate that the lizards occurring in the warm lowlands are the largest in size, but with the lowest osteoderm expression. The warm lowland populations are also the only populations where osteoderm expression is sexually dimorphic, with males having the highest expression. In contrast, the populations occurring in the cool montane areas are significantly smaller, but have the higher osteoderm expression compared to the warm lowlands populations. The variation in osteoderm expression seen between the lowland and montane populations potentially indicates that the osteoderm expression in the different populations may be driven by multiple ecological factors.

A-0329 (Oral)

Changes in Attitudes, Knowledge, and Practices of Cohort of Chitwan National Park Visitors towards Snakes and Snakebites: An Approach for Conservation and Pre-Hospital Care in South-Central Nepal

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Chitwan National Park (CNP) is visited by locals, tourists, students, conservationists, etc. for different purposes. This fear may progress to human-snake conflicts that challenge biodiversity conservation and public health. We aim to understand changes in attitudes and knowledge of native snakes and practices of snakebites among CNP buffer zone people and determine anthropogenic challenges to biodiversity conservation and public health. This was a cohort study conducted during September 2010. Using simple random sampling and face-to-face interviews, we carried pre-post intervention study of attitude and knowledge of cohort of 134 visitors in CNP on major venomous snakes and pythons, and their practices for pre-hospital care of snakebites. We interpreted results using descriptive statistics. A total of 37 respondents (28%) remarked "snake as enemy and harmful requiring to kill them" and 47 (35%) mentioned "snake as a useful animal requiring to conserve them". They were mostly familiar with pythons (n = 118, 88%) reflecting their frequent encounters with it during visits in the park. A total of 47 (35%) respondents reported to be bitten by snake and 11 victims (8%) used traditional practices to heal snakebite without visiting hospital. Ambivalence perception of CNP visitors leads to human-snake conflicts, local extinction of rare and endangered snake species and ultimately put these visitors at risks of snakebite death. Therefore, policy makers should implement pragmatic educational interventions to increase the use of recommended pre-hospital care to contribute biodiversity conservation and public health.

A-0330 (Oral)

How Citizen Science Data could Help Snake Conservation in the Philippines

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In addition to challenges related to habitat loss, snake conservation in the Philippines confronts significant issues arising from human-wildlife conflict and prevalent misconceptions. This study investigates the potential of citizen science as a means to enhance snake conservation in the country, utilizing data derived from the Facebook pages Philippine Biodiversity Net: Digital Library of Species (PBN), Philippine Snake ID (PSID), and Reptiles and Amphibians of the Philippines (RAP) from 2020 to 2023, alongside online surveys. A total of 63 snake species were identified through social media postings, with PBN having the highest number (74.69%; n = 47), followed by RAP (66.66%; n=42) and PSID (63.49%; n = 40). Among the identified species, 30 are endemic to the Philippines, and 14 are classified as threatened. Notably, *Lycodon capucinus* (Common Wolf Snake) (10.88%; n = 58), *Coelognathus erythrurus* (Philippine Brown Rat Snake) (10.13%; n = 54), and *Ophiophagus hannah* (King Cobra) (4.50%; n = 24) were the most frequently posted species, predominantly from the National Capital Region (NCR). Analysis of posting seasonality revealed a consistent volume of snake-related posts in all groups from January to November. Three distinct types of snake-related posts were identified: (i) for identification, (ii) education, and (iii) snake persecution. The three most heavily persecuted snake species were *Coelognathus erythrurus* (Philippine Brown Rat Snake) (21.74%; n = 25), followed by *Naja samarensis* (Samar Cobra) (13.91%; n = 16) and *Ophiophagus hannah* (King Cobra) (13.04%; n = 15). Despite minimal snake education posts (n = 60), an online survey of 56 respondents indicated that information campaigns and educational posts on Facebook significantly contributed to a positive shift in attitudes toward snakes. This underscores the importance of sustained and targeted education campaigns to dispel misconceptions, ultimately reducing snake persecution and mortality and fostering greater public engagement in snake conservation in the Philippines.

A-0331 (Oral)
Reptilian Diversity and its Estimated Species Richness in Sekayu Lowland Forest, Terengganu, Peninsular Malaysia

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Seven years of intensive field surveys documented a rich reptile community in the Sekayu lowland forest, Peninsular Malaysia (81 species). The observed species richness is valuable information for conservation efforts, but traditional methods likely underestimate the true number of reptile species richness in Sekayu. This underestimation arises from limitations in detecting rare, elusive, or cryptic reptile species. Therefore, this study focused solely on reptiles and employed non-parametric species richness estimators to gain more accurate insights into

their true diversity in the Sekayu lowland forest. This study aimed to address the underestimation of reptile diversity in Sekayu by employing non-parametric species richness estimators. These estimators offer an alternative approach to estimating the "true" species richness by requiring fewer assumptions about the underlying species abundance distribution. Nine non-parametric estimators were employed to analyze data collected during the 7-year field surveys in Sekayu. These estimators included both abundance-based (ACE, Chao1) and incidence-based (ICE, Chao2, Jack1, Jack2, MMRuns, MMMeans, Bootstrap) approaches. All estimators were evaluated via qualitative and quantitative evaluation to choose the best estimator that likely represents true species richness of reptiles in Sekayu. All estimators yielded higher richness values compared to the observed species richness, suggesting an additional seven to 16 reptile species could potentially be discovered in Sekayu. Following a two-pronged evaluation (qualitative and quantitative), Chao 2 and ICE emerged as the most suitable estimators for this study. These incidence-based estimators performed well under Sekayu's specific conditions: high species richness and extensive sampling effort. Our findings highlight the value of non-parametric estimators for reptile diversity assessments, particularly in species-rich and logistically challenging environments. This approach provides valuable insights into the likely true species richness of reptiles in Sekayu, informing future conservation efforts for this remarkable fauna.

A-0332 (Oral)

Using Local Ecological Knowledge to Understand the Status of Cantor's Giant Softshell Turtle in Kerala, India

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Effective conservation of threatened species relies on the knowledge of the ecology, population, and threats. Collecting this information for elusive species through traditional ecological surveys can be challenging and costly. Local and indigenous knowledge has become a vital tool aiding researchers in data collection to fill important knowledge gaps on species' ecology while also helping to initiate active dialogue with local communities on the sustainable conservation of biodiversity. In 2019, we developed a study to assess the status and gather ecological data on the Critically Endangered *Pelochelys cantorii* in Kerala, India. Across its distribution in South and Southeast Asia, it is threatened due to habitat loss, hunting, and by-catch. In India, it is one of the rarest and highly understudied freshwater turtles, with just 15 anecdotal records between 1975-2019. For this study, we collected local ecological knowledge (LEK) using semi-structured and informal interviews around the Chandragiri river in Kerala. We also established a community-led alert network to facilitate information exchange and initiate a long-term monitoring framework. Through LEK, we discovered the first-known breeding population of *P. cantorii* in India, identified critical habitat areas, and threats to the species. The alert network formed through this study has since reported eight by-catches, discovered the first-ever active nesting grounds of the species, and protected 9 nests with approximately 300 eggs. Despite increased awareness, threats like river damming and sand

mining persist necessitating policy reforms and collaborations between local monitoring and governmental organizations for the sustainable conservation of species such as *P. cantorii*.

A-0333 (Oral)
A Venomous Fairytale? Unveiling the Interconnection between Color Phenotype and Venom Toxicity in Adders (*Vipera berus*)

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Venoms are complex cocktails filled with potent bioactive molecules. Although for longest times being considered as static entities, newest investigations showed that venoms display remarkable phenotypic plasticity on all taxonomic levels. Especially intraspecific variation represents an important research area because of utmost medical importance. Adders (*Vipera berus*) are subject to many folklores and myths in Europe, many of which revolve around increased venom toxicity of specific color phenotypes, particularly in melanistic animals that are referred to as "hell adders". However, these supposedly dangerous correlations between coloration and toxicity have never been investigated so far. Here, we present the first bioactivity profiling of melanistic and normally phased adders from different populations from Germany. We tested cytotoxic, protease, phospholipase A_2, and hemolytic as well as coagulotoxic activities and paired this data with biochemical profiling on chromatographic and electrophoretic systems. We demonstrate that minor differences may exist between the phenotypes, but they do not translate into clinically relevant alterations and, generally, do not exceed normal biological variation. Accordingly, we conclude that contrary to popular belief, no statistically significant differences exist between color phenotypes in adders.

A-0334 (Oral)
Exploring the Impact of Climate Variability on Reproductive Timing in a Threatened Toad Population

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In the last decades, lots of species have shown extremely fast changes in phenological patterns because of climatic changes. Among animals, amphibians display some of the greatest responses, as their behaviour is highly influenced by temperature and precipitation regimes. These phenological shifts can cause a mismatch between resources demand and availability, having negative consequences on amphibian fitness. Hence, understanding phenological changes in amphibian is essential for developing conservation strategies aimed at reducing the impact of climate change. We used data of Common Spadefoot Toad (*Pelobates fuscus*) breeding migration to wetlands over an 8 years' time spam in North Italy to 1) reveal the biotic and abiotic factors related to reproductive migration, 2) evaluate possible shifts in the timing of breeding migration and 3) identify the climatic variables associated with the observed phenological shifts. Our analyses showed that toads move to wetlands at the beginning of the breeding season, on nights with high levels of precipitation and humidity and with intermediate temperatures. Moreover, even with an increase in the average temperature throughout the study period, the start of the breeding migration was postponed by approximately 12 days in 8 years, while the peak and the end of it didn't change. This counterintuitive trend emerged due to a series of consecutive hot and dry years in the study region, which postponed the rains necessary to trigger the start the migration. These results highlight that, for ephemeral pond breeders, the influence of precipitation on phenology may outweigh that of temperature, and a delay in the start of migration could cause a shortening of the breeding season, which could negatively impact species fitness. Our findings challenge the prevailing assumption that climate change will consistently drive amphibian phenology towards earlier breeding migrations, emphasising the need to closely examine the environmental factors linked to species phenology.

A-0335 (Oral)
Interactive Effects of Heat Waves and Flash Drought during Embryonic Development in the Painted Turtle

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Climate change is leading to rising temperatures and precipitation extremes worldwide. One consequence is the increased co-occurrence of heat waves and drought. While many studies have investigated the ecological impacts of thermal and hydric stress, more research is needed on their compound effects. Oviparous reptiles, including turtles, are highly sensitive to temperature and soil moisture conditions experienced in the nest. In this study, we investigated the interactive effects of flash drought and heat waves during embryonic development in the painted turtle (*Chrysemys picta*). We manipulated temperature and soil water potential during egg incubation in the laboratory, then recorded the effects on egg mass, incubation time, hatchling body size, and fitness. We found that changes in egg mass during late development were driven by the interaction between heat wave and flash drought events: heat waves amplified growth in a typical hydric environment, but intensified water loss in drought conditions. Furthermore, both heat wave and drought decreased total incubation time, and hatchling body size decreased significantly with drought, but not heat wave. Finally, we examine the interactive effects of flash drought and heat wave on survival, and consider the potential consequences on phenotypic evolution. As compound heat wave and drought events

become more frequent and intense, wild turtle populations may face negative impacts during early life stages.

A-0336 (Oral)
Aspects of the Urban and Rural Ecology of Nile Monitors (*Varanus niloticus*) in KwaZulu-Natal, South Africa

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Globally, there is unprecedented anthropogenic land use change. Little is known about how reptiles respond to anthropogenic changing land use, especially in Africa. Nile monitors (*Varanus niloticus*) remain poorly understood despite being widespread and heavily exploited. We aimed to determine if Nile monitors are successful exploiters in areas of changing land use and what factors affect their persistence. We caught Nile monitors across a gradient of urbanisation in KwaZulu-Natal (KZN), South Africa, in 2022 and 2023. We obtained morphometrics, body mass, and the capture geographic coordinates for each individual caught. We also inserted a passive integrated transponder (PIT tag) for individual identification. We recorded various habitat parameters at the capture site. We used the data to assess their habitat use, behavioural plasticity, and population dynamics. In addition, we used an online questionnaire to investigate cultural aspects, perceptions and human/domestic pet interactions with Nile monitors. We have trapped over 120 Nile monitors, mostly in urban mosaic landscapes. They were generally found close to water. They use swimming pools and storm drains in urban areas. We found hunting and selling of Nile monitors occurs in KZN despite their protected status. We documented various myths and folklore about monitors. Urban exploitation and successful management may be key to varanid population persistence with continued changing land use.

A-0337 (Oral)
A Caribbean Hotspot Threatened to Disappear: Risks for Unique Amphibian Species in the World

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The Caribbean is one of the world's major biodiversity hotspots; however, this diversity is severely threatened due to fragility and the pressures it faces. The Caribbean has some of the highest numbers of globally threatened amphibians and its key biodiversity areas (hotspots) top global lists of priority sites for conservation. In Hispaniola, the Sierra de Bahoruco National Park stands out as a biodiversity hotspot housing a diverse range of endemic amphibians. Despite its protected status, it faces alarming degradation and loss of its forest formations. Through the compilation of information based on geographical maps and spatial analyses of vegetation formations, the impacts of land use on the amphibian community's habitats were assessed. The study identified a total of three families, four genera, and 19 species, representing

25% of Hispaniola's amphibians. Humid broadleaf forests exhibited the highest amphibian diversity (84%). Species associated with these humid and cloudy broadleaf forests displayed the highest vulnerability levels, primarily due to agricultural activities, livestock farming, and forest fires, causing habitat losses and fragmentation in the protected area. Our findings indicate that ongoing habitat transformations could lead to significant declines in amphibian populations and the loss of this crucial Caribbean biodiversity hotspot. A effective conservation requires addressing these issues comprehensively, involving communities, implementing effective policies, and providing funding. The protection of key biodiversity areas is a crucial component of global efforts to conserve biodiversity. The loss of a hotspot in the Caribbean would have severe consequences for both natural ecosystems and human communities dependent on them. The conservation of these hotspots is essential for maintaining the health and resilience of ecosystems and preserving the unique biodiversity of the region.

A-0338 (Poster)
Speciation and Ecological Implications of Extraordinary Venom Gland in Genus *Causus*

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The snakes of the genus *Causus* have piqued the interest of many researchers over the years due to their unique venom apparatus morphology. *C. rhombeatus, C. maculatus* and *C. resimus* are the only members of Viperidae with venom glands that extend caudally past the end of the skull and into the neck region. However, within the same genus there are sympatric species with non-elongated venom glands. Additionally, the venom types associated with elongate venom glanded species of *Causus* are understood to be essentially the same as normal-glanded species. A few other snakes exhibit this same trend, with some species possessing lengthened venom glands sharing the same distribution with normal-glanded taxa. Little is known about how these very recently diverging lineages evolved such derived morphologies. In this paper, diffusible iodine-based contrast-enhanced computerized tomography (diceCT) was used to analyze the volume of the venom glands of *Causus* taxa alongside other snake species of the family Viperidae. Additionally, *Atractaspis* and *Calliophis* species with elongated venom glands were volumetrically compared to other snakes in their family. The snakes' respective feeding ecology, environment, and venom composition were then compared in an attempt to identify possible shared ecological pressures. If we find the venom gland volume to body size ratio to be extraordinarily larger in elongate-glanded species compared to normal-glanded species, and shared ecological pressures among elongate-glanded species, it would support the idea that a selection effect may have been present in the development of venom glands. If we find the venom gland volume to scale relatively normally with body size and fail to find common ecological pressures, it may favor genetic drift as a driver for evolution of this morphology.

A-0339 (Oral)
Validation Of Non-Invasive Sex Steroid Analysis For Eastern Massasauga Rattlesnake (*Sistrurus catenatus*)

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The Eastern Massasauga Rattlesnake (*Sistrurus catenatus*) is a small venomous snake ranging from Northern Eastern United States through Southern Canada. In Ontario, Canada, it is at its northern north range limit. It is the only remaining rattlesnake species in the province. The species is listed federally as 'Threatened.' Conservation efforts for this species follow the International Union for the Conservation of Nature (IUCN) One Plan Approach, in which an *ex situ* population supports *in situ* conservation. However, there is a need to improve breeding success within the *ex situ* population in order to ensure long-term sustainability in particular as individuals are used for reintroduction efforts in Ojibway National Prairie. Information on species-specific reproductive function is a key knowledge gap to achieve *ex situ* population viability. The goal of our research was to test whether endogenously secreted hormone metabolites of testosterone and progesterone in feces can be used to quantify reproductive characteristics in *Sistrurus catenatus*. We hypothesized that excreted reproductive hormone metabolites will vary throughout the year in a predictable pattern that correlates with reproductive seasonality in both males and females. Samples were collected during routine care from 2021 to 2023 of snakes in the Canadian *ex situ* population. Commercial enzyme-linked immunosorbent assay (ELISA) kits were used to develop progesterone and testosterone metabolite profiles. Validation of hormone metabolite recovery was performed via parallelism and recovery experiments. Individual profiles of hormone expression were then developed for 47 Eastern Massasauga. We assessed if changes in endogenously secreted testosterone and progesterone metabolites throughout the year represented statistically significant patterns. We are working with partners to integrate this tool with efforts to develop assisted reproductive technologies for the *ex situ* population.

A-0340 (Oral)
Characterization of Grey Ratsnake (*Pantherophis spiloides*) Semen

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Ex situ management of species is a key tool in efforts to protect and restore global biodiversity. However, maintaining reproduction and genetic diversity in an *ex situ* environment can be challenging for some species. Reproduction *ex situ* is hindered by limited species-specific reproductive knowledge, an inability to facilitate natural breeding in all species, and closed populations. Assisted reproductive technologies (ART) can help. In this study, we begin development assisted reproductive technologies (ART) using an *ex situ* population of Grey Ratsnake (*Pantherophis spiloides*), a federally 'threatened' species in Canada. ART

encompasses various technologies (e.g. hormone analysis, assisted insemination, and *in vitro* fertilization), but its application in squamates is hindered by limited knowledge of species-specific reproduction; hence, we focus on the essential first step of gamete preservation. Here we characterized Grey Ratsnake semen and assessed the impact of several common semen extenders, including, phosphate buffered saline, INRA-96, TES and Tris (TEST) yolk buffer (TYB), and Hepes with 10% Bovine Sera. We collected semen samples monthly from May to October 2023 from 18 individual's *ex situ* and assessed concentration, motility, rapid forward progression, and membrane integrity. We used generalized linear models to evaluate changes in refrigerated sperm quality over time in different semen extenders. Sperm collected in October and preserved in Hepes with 10% fetal bovine sera remained the highest quality over time in short-term cold storage. Further, results indicate that sperm collected in June will be highest in concentration, coincident with mating *in situ* in Canada. Our work highlights that the timing of collection and semen extender used to preserve sperm can have a large impact on sperm fertilization potential.

A-0341 (Poster)
Utilizing a Live-Streaming Camera to Investigate the Basking Patterns of Female and Newborn Prairie Rattlesnakes (*Crotalus viridis*)

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While much research has been conducted on snake thermoregulation strategies, few have looked at female snakes or variation among snakes of different sizes (Putman and Clark 2017). Additionally, studying the wild snakes over extended periods of time has proven logistically challenging (Charland and Gregory 1990). This has resulted in a knowledge gap about how these animals interact with their environment over annual cycles. Thanks to the emergence of live-streaming technologies, it is now becoming possible to conduct around-the-clock observations of reptiles for extended periods of time. The Physiological Ecology of Reptiles Laboratory has had preliminary success using a live-streaming camera to monitor rattlesnakes in California, recording new observations such as rattlesnakes chasing away other snakes that try visiting the den. I am expanding this research approach by utilizing a live-streaming camera to study basking patterns in female and newborn Prairie Rattlesnakes (*Crotalus viridis*) at a den site in Colorado with one of the largest known concentrations of rattlesnakes (Taylor, pers. comm.). Through this live-stream, rattlesnakes at the den are being monitored 24/7 over their entire seasonal activity period, something that has never been done for any animal. I am also engaging community scientists on the Zooniverse Platform by having participants review the images taken from the livestream to assist in data collection. Through this research approach, I am testing whether 1) adults and newborn snakes utilize very different basking strategies, 2) adults or newborn snakes huddle to reduce the rate of heat loss, and 3) pregnant females alter their basking patterns to facilitate the development of embryos. In addition to experimenting with a new approach to reptile behavior research, I am hoping that this research will answer pertinent questions about demographic variation in rattlesnake thermoregulation and how this may be impacted by climate change (Crowell et al. 2021).

A-0342 (Oral)
Rhythmic Response of Cave Salamanders to External Cycles and Floods

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Caves are constant environments where organisms are usually described as lacking biological cycles. However, recent evidence is emerging on the rhythmicity of cave-dwelling animals, with experimental, observational and genetic analyses. There are still many uncertainties, as some organisms may have regular or irregular rhythms, and some others seem to lack them. In this study, we analysed the activity of the European cave salamander (*Proteus anguinus*) during a two-year survey. This neotenic species is usually thought to be arhythmic and exclusively found in caves; however, recent studies have described the non-random activity in surface freshwater springs of cave salamanders that are phenotypically different from the ones found in caves. We used GLMMs and N-mixture models to test the relationship between abundance and detection probability of salamanders and both external cycles (circadian, lunar, and seasonal) and flooding events (upstream cumulated rain), analysing in two different models the surface and underground sites. With GLMMs, it resulted that cave salamanders are generally more abundant during the night. Their detection probability in springs was higher during the night, with higher moon illumination (i.e., full moon) and after upstream rains; in caves, detection probability was higher during winter. Depigmented cave-dwelling organisms are vulnerable to sunlight and they avoid it, exploiting the spring environment during the night, when ecological conditions are more similar to caves. Higher activity in springs may as well be related to food availability: floods may foster it, while the exact cause of the rhythmicity as a response to the lunar cycle is yet to be determined. Future studies to clarify these patterns are needed, and genomics may be necessary to finally disentangle the role of adaptations and plasticity. These results are in accordance with previous studies on cave-dwelling invertebrates. In conclusion, cave salamanders exhibit a rhythmic behaviour both in springs and in caves.

A-0344 (Poster)
Spying on Social Snakes using Livestreaming Cameras

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In Steamboat Springs, Colorado, USA, hundreds of Prairie Rattlesnakes (*Crotalus viridis*) gather at communal rookeries to give birth to and look after their young. Via the umbrella organization Project RattleCam, our research group is launching the first 24-hour livestream on a den of wild reptiles. Innovative technologies enable our team to continuously monitor the snakes throughout their active season with the ability to zoom in and pan to follow individual animals. The camera, powered by a solar array and deep cycle batteries, broadcasts the camera footage to YouTube in real-time, allowing researchers and the general public alike to observe fascinating interactions between rattlesnakes and other species. Community scientists contribute to the project by reporting their observations, simultaneously learning that snakes are gentle and complex animals. Long overlooked by animal behaviorists, the social lives of rattlesnakes are just beginning to be understood. These serpents receive comfort from the presence of others (Martin et al., 2023), display preferences over which other individuals they spend time with (Amarello, 2012), and actively defend their pups against threats (Graves, 1989). Livestreaming cameras now provide the most in-depth view into the social lives of rattlesnakes, allowing for the observation of novel behaviors among these social snakes. Our

preliminary observations at a California rookery of Western Rattlesnakes (*Crotalus oreganus*) have revealed social associations among female snakes as well as dominance and defense behaviors among male snakes. We have even observed interspecies interactions such as chasing behavior between Striped Racers (*Coluber lateralis*), Gophersnakes (*Pituophis catenifer*), and California Kingsnakes (*Lampropeltis californiae*). In Colorado, we expect to observe similar inter- and intraspecies interactions, enabling the construction of snake social networks and a more robust understanding of how both males and females protect the rookery from predatory threats.

A-0346 (Oral)
In the Wake of Wildfire: Unraveling The Effects of Wildfire on Western Rattlesnakes (*Crotalus oreganus*)

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As climate change drives trends towards warmer and drier environments, wildfire is increasingly prominent. Western Rattlesnake (*Crotalus oreganus*) faces heightened vulnerability in British Columbia as its habitat, located at the northern periphery of its range, consists predominantly of dry, fire-prone ecosystems. Near Osoyoos, BC, the population biology and movement ecology of rattlesnakes has been studied since 2002. In 2021, the Nk'Mip Creek wildfire engulfed nearly 200 km^2, impacting a significant portion of the study population's habitat, altering vegetation cover at denning, foraging and birthing locations. Our two-decade mark-recapture study suggests substantial population growth, from 156.0 ± 54.6 in 2002 to 689.2 ± 65.8 in 2021, with pre-disturbance λ1.17 and overwinter survivorship of 0.79. Remarkably, post-wildfire observations show no significant decline in λ (0.75), survivorship (0.74 ± 0.11), or abundance (643.1 ± 97.9). Although some individuals exhibit burn scars, overall body condition remains comparable. Post-fire radio-tracking data of 41 snakes reveals that the majority of snakes (n = 36) migrated to unburnt valleys during summer months, potentially indicating increased mortality or habitat fidelity shifts among snakes previously migrating to now-burnt areas. This research provides valuable insights into the impacts of wildfires on Western Rattlesnakes and, by extension, other snake species in northern latitudes.

A-0347 (Oral)
Life Stories of the Harlequin Toad: A Tale Told in Biological Collections

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With 88 of their 100 species critically endangered and 38 possibly extinct, Neotropical harlequin toads (Anura: Bufonidae: *Atelopus*) are among the most threatened amphibians. Most of Colombia's 40 species have not been seen in three decades. While some may be extinct,

others are likely to persist in very low abundance. This is why it is necessary to know the life history data of these species, information that can be found thanks to biological collections. Thus, through this historical tracing we can know the most suitable time to carry out field sampling. To carry out this study, 1,250 specimens of 27 Colombian *Atelopus* species deposited in biological collections were reviewed with their associated information such as stage, sex, place and date of collection. In addition, by means of data obtained from meteorological stations, a correlation was established between the reproductive season of each species, taking into account the presence of gravid females, tadpoles or juveniles, depending on the season. It was found that the intermediate period between the dry season and the rainy season is the best time to detect tadpoles. Thus, the importance of museums and biological collections to obtain key information for the planning of conservation projects is highlighted.

A-0348 (Oral)

Herpetofauna Genetic Diversity in Rey Zamuro and Matarredonda (Meta: San Martín) and Cañon del Rio Claro (Antioquia: San Francisco) Natural Reserves in Colombia

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Species delimitation in ecosystems leads to the discovery of cryptic species complex in different taxonomic groups. These biological inventories make it possible to know which organisms inhabit in a given area and thus establish plans for their conservation. In face of the constant anthropic threats to biodiversity, it is urgent to recognize which species are present on the basis of a study model that is sensitive to these environmental changes. For this reason, we postulate amphibians and reptiles groups as the study model to carry out a DNA barcoding genetic inventory in two natural reserves in Colombia, Reserva Natural Cañon del Río Claro (Antioquia) and Reserva Natural Rey Zamuro y Matarredonta (Meta). Previous collected and preserved tissues are being used for extraction, amplification and sequencing of DNA. These sequences are being deposited and analyzed in the BOLDsystem database. With the results we are obtaining, the phylogenetic diversity must be calculated with the taxa found. Additionally, morphological classification is confirmed through taxonomic keys. With the results obtained from the analysis, the phylogenetic diversity of the taxa found will be calculated. Taxonomic keys for each reserve, they will be elaborated for future research, and a book for local community of the Rio Claro community in Antioquia contributing to conservation from academic and popular approaches. We expect shared herpetofauna between both locations, as well as unique registrations according to the composition of their ecosystems and the anthropogenic factors that affect them. The DNA barcoding combined with morphological data will enlighten the presences of widely distributed and endemic species of these regions, allowing better conservation practices and contributing in key species knowledge.

A-0349 (Poster)

Range Contractions and Reduced Body Mass Predicted for Endemic Skinks of the Cameroon Volcanic Line with Future Warming

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The vulnerability of montane species to environmental change has been increasingly recognized in recent years. However, most of these species are regionally endemic with restricted distributions, limiting dispersal necessary for avoiding extinction. The outcome of threats posed for montane lizards is further complicated in species exhibiting mass–temperature relationships where body size increases with cooling temperatures, and thus with altitude, causing intraspecific physiological and behavioural differences. We aimed to identify areas suitable for montane endemic skinks of the Cameroon Volcanic Line (CVL) under current and future climates to reveal patterns of persistence and vulnerability based on an intersection of climate and body mass. Location of these studies was the Cameroon Volcanic Line. We recorded occurrences and measured body mass in the field for two CVL-endemic skink species. We supplemented occurrences with online repository records. We projected current and future habitat suitability in the region by implementing bioclimatic species distribution models-based on occurrences. We tested for elevational variations in body mass, and integrated both occurrence and body mass information in a trait-based model to estimate current and future body mass. Projected currently suitable habitat for both species was limited to higher elevation regions, which are inhabited by numerous other threatened herpetofauna. We additionally detected Bergmann clines in body mass for both species. Given this variation in body mass, trait model projections covered slightly larger geographical ranges than bioclimatic estimates. Under future warming, both models project substantial contractions in suitable areas, potentially constraining species to mountain tops. Through the trait-based approach, we further detected potential warming induced body mass reductions in projected suitable areas.

A-0351 (Poster)
Leukocyte Formula and Ectoparasites in two Populations of *Podarcis siculus* from Calabria (Central Mediterranean, Southern Italy)

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Among reptiles *Podarcis siculus* (Lacertidae) is the most widely used in ecotoxicology studies. We identified two study sites in the Calabria Region (Central Mediterranean, Southern Italy) with different pollution levels and different environmental qualities. Both are located in the municipality of Rende: the Industrial Zone (IZ) characterized by high anthropogenic impacts and low vegetation cover, and the Botanical Garden of the University of Calabria (BO), characterized by high vegetation cover and low anthropogenic pressure. Sampling involved a capture session per season (four per site) performed in the years 2022-2023; in each session,

we collected by noosing from 20 to 32 individuals, for a total of 197 individuals (108 in the BO, 93 in the IZ). For each lizards we annotated sex, age and some morphometric measurements (SVL, TL, Weight); then we performed collection and identification of ectoparasites, and finally arranged blood smears from which three leukocyte types (basophils, heterophils and eosinophils) and endoparasites were counted and identified. Lizards from the IZ showed larger sizes than lizards from BO; no association between ectoparasitic load and types of leukocytes was observed between the two sampling sites, but the IZ population showed a higher amount of leukocytes than the population from BO. In both areas, females showed more leukocytes than males. Hemoparasites were more abundant in the lizards from the BO (gamontic forms of *Karyolisus* sp. and *Hepatozoon* sp.); no correlation between hemoparasitic and ectoparasitic was observed. Ectoparasitic analysis allowed the recognition of 3 species: *Neotrombicula autumnalis, Ixodes ricinus*, and *Ophionyssus natricis* for both sampling sites; for the BO, a fourth species of ectoparasites belonging to the family Macronyssidae was observed. Lizards from the BO were characterized by more abundant infestations and higher ectoparasitic diversity than lizards from the IZ. This confirms a better environmental qualities in the BO than in the IZ.

A-0352 (Poster)
Movement Ecology and Road Mortality for a Community of Threatened Snakes in British Columbia, Canada

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In the arid valleys of south-central British Columbia, Canada, a community of snake species are facing increasing population level pressures. Western Rattlesnake (*Crotalus oreganus*), Great Basin Gophersnake (*Pituophis catenifer deserticola*), and Western Yellow-bellied Racer (*Coluber constrictor mormon*) all occupy similar grassland habitats. With the rise of development in the area, there is a concern surrounding this community of threatened species who call this increasingly fragmented world their home. As is such with many at-risk herpetofauna, direct mortality from roads is listed as a primary threat to persistence for these three species. As the global transportation sector grows, with an estimated 3.0–4.7 million km of new roads projected to be added by 2050, the global implications of these problems have habitat fragmentation and road mortality at the forefront of concern for wildlife conservation. Using our 10-year historic Rattlesnake roadkill and population datasets, our models have shown a peak estimation of 57 adult Rattlesnakes dying due to road mortality in 2017, with a forecasted population decline of 97% in 100 years relative to pre-mitigation rates of mortality. With the introduction of culverts as a mitigation measure, models have estimated a low of 17 adult Rattlesnakes dying in 2023. With roads being the primary driver of direct mortality for all three species, we expect similar results for each species. To supplement this data, this season, we used radiotelemetry to track individuals of all three species simultaneously to compare movement patterns, identify common critical habitat features, and quantify road avoidance. This in-depth autecological data provides insight into the difference in road mortality rates that are being detected between the species in our study community. All told, this work will provide insight into the movement patterns near anthropogenic surfaces and inform conservation measures for all three imperiled species.

A-0353 (Oral)
Virtual Community Tourism Supporting Amazonian Turtle Conservation

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A captivating facet of the Amazon is the Community Conservation Management (CCM), which places a specific emphasis on safeguarding freshwater turtles and is implemented throughout the Amazon territory. CCM involves voluntary monitoring of turtles and nests during nesting periods to support conservation efforts. Simultaneously, community tourism (CT) emerges as a promising avenue for promoting both income generation and active engagement in biodiversity conservation within local communities. Recognizing its growth potential, the Nova Esperança community in Manaus-Amazonas established a partnership with a socially conscious tourism company in 2018 to enhance its CT activities. Moreover, the community has actively participated in CCM since 2015. The COVID-19 pandemic prompted adaptive measures, leading to the emergence of online community tourism experiences as an alternative during periods of isolation. This article explores "Conexão Baré" online travel experiences conducted in Nova Esperança from August 2020 to May 2023. The special edition "Chelonian Release" featured the participation of researchers and students which showcased a live streaming presentation of 14 Amazonian turtle species with a focus on the key species of the CCM of Nova Esperança. Additionally, the on-line travelers had the opportunity to witness in real time as the community's residents released the hatchlings into the Cuieiras River. Over three years, twenty-one "Conexão Baré" online trips (total of 361 visitors) contributed, on average, the equivalent of 79% of a single family's total income, but, as the community is involved in CT, these funds were distributed among them. This innovative approach not only contributes to sustaining community tourism during crises but also underscores the potential of blending technology with traditional conservation efforts for income in local communities. The synergy between CCM, CT, and online experiences exemplifies a resilient model, showcasing the adaptability of community-based initiatives in the face of unforeseen challenges.

A-0354 (Oral)
Morphological and Performance Trade-Offs in Habitat Selection between Sleep Phase and Active Phase in Agamid Lizards

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Habitat use is strongly linked to morphology and performance in reptiles. Yet for several species, structural habitat may be distinct for the sleep phase, for anti-predatory or thermoregulatory benefits. The effect of these disparate habitat requirements between active and sleep phases on morphology, mediated by performance, is not known. In nine species (six genera) of agamid lizards in India, inhabiting terrestrial, semi-arboreal, and arboreal strata, we compared structural habitat in the sleep and active phase. We then examined locomotory performance (sprint speed) on dowels of varying widths, representing structures used in the sleep phase and active phase. We find sleep sites to be distinctly different (narrower) from active sites in semi-arboreal and arboreal species, but not in terrestrial species. We find performance to be maximal on structures representative of the active phase and linked to morphology. The use of specialized sleep sites likely represents an anti-predatory strategy. But the overriding influence of active sites on performance-morphology indicates a greater need to move effectively in the active phase compared to the sleep phase, when site selection and specialized escape behaviour (e.g., freezing after 'perch release') may mitigate for the lack of speed.

A-0356 (Oral)
The Effect of Urbanization and Stress on Sleep in an Agamid Lizard

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Sleep is one of the most ubiquitous behaviours in the animal kingdom and is central to several essential biological functions. Yet, how ecological factors regulate sleep is not well studied in reptiles. Further, how sleep responds to altered environmental conditions and stressors, such as under urbanization, remains to be quantified in reptiles. Using state-of-the-art biologging methods, we measured sleep-wake quantity and their circadian distribution in wild-caught rural and urban *Psammophilus dorsalis* lizards. We characterized sleep phenotype using a combination of electrophysiological (Electrooculogram-Accelerometry) and behavioral measures (response to arousal stimulus). We evaluated, i) how sleep phenotype differs between individuals from urban and rural areas and ii) how the response of sleep to stress differs between urban and rural individuals. Overall, lizards slept in a single block, in the dark phase. As compared to the baseline night, lizards showed increased wake episodes (i.e., sleep fragmentation) during the first night after stress, likely as a vigilance response. The effect of source population on sleep response to stress was weak. To our knowledge, our study is the first to quantitatively examine ecological regulation of sleep in reptiles, using robust electrophysiological measures.

A-0357 (Oral)
Into Thin Air: Investigating Evaporative Water Loss Rate in Multiple Chameleon Taxa

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As the global climate becomes rapidly more extreme and unpredictable, the relationship successful maintenance of body temperature and hydration warrants investigation. Squamates are particularly challenged by fluctuating aridity and temperature due to the nature of their integument and need to thermoregulate. Total evaporative water loss (TEWL) has served as a successful way to measure adaptations that extant organisms use to combat various environmental pressures maintaining hydration necessary for survival. However, cutaneous evaporative water loss (CEWL) may prove to be a more admissible way of measuring water loss in reptiles. Previously, research has been limited and neither have been studied in chameleons. To evaluate the accuracy of TEWL and CEWL, I measured both in 5 species of chameleons living along an environmental gradient. Using closed system respirometry with a dew point analyzer, I measured TEWL. I compared TEWL to water loss rates previously studied in lizards. CEWL was measured in the field and after a 2-month acclimation period using the AquaFlux evaporimeter. I evaluated differences in TEWL and CEWL measurements, how CEWL varies across body regions, and the plasticity of CEWL before and after individuals acclimated to lab environment. I predict that chameleons inhabiting arid environments will have lower CEWL and TEWL than those inhabiting humid environments. Furthermore, variations of water loss across the body could be attributable to variations in integument.

A-0358 (Oral)
Synchronous Population Change Sizes Promoted by Climatic Dynamics in Microendemic Frogs across Atlantic Forest Mountains

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Atlantic Forest is characterized by having complex topographical features with high levels of environmental heterogeneity, harboring the highest rate of endemic species within Neotropical region. The mountain ranges that run parallel to the Atlantic coast of Brazil, exhibit considerable variation of vegetation types allowing for a wide range of different habitats and microhabitats. Atlantic Forest has experienced marked Quaternary climatic oscillations with high rates of biome shifts with rapid forest recovery suggesting the persistence of small pockets as forest microrefugia over time, particularly in montane regions. These complex environmental dynamics led to considerable differences across the Atlantic Forest in terms of genetic diversity, as well as instances of narrow endemism. Here, we used genomic data to elucidate the evolutionary processes of three species of endemic toadlets of *Brachycephalus* genus (*B. mariaeterezae, B. olivaceus*, and *B. verrucosus*) with sky-island distribution. Population structure inferences suggest a scenario of four structured populations with admixture events. Our analyses of introgression indicate the presence of post-divergence gene flow because of episodes of introgression. During glacial periods the effective population size of populations undergone events of expansion. These results support the role of cyclical climatic changes in the population divergence and persistence in mountain tops during warm

periods followed by periods of expansion and admixture in lower elevations during cold periods.

A-0359 (Oral)
Phylogenomics Reveals the Relative Roles of Paleo-Islands and Mountain-Building in the Parallel Elevational Diversification of Two Exceptional Skink Radiations on Sulawesi (*Sphenomorphus* and *Tytthoscincus*)

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Island archipelagos and mountains represent incredible natural experiments with which to study evolution and diversification. The island of Sulawesi has a complex geographic history over the past 20 million years through discrete periods of paleo-island formation, followed by uplift of interior mountains, and finally by paleo-island fusion. We investigated and compared the evolutionary histories of two largely unstudied genera of skink lizards (*Sphenomorphus* and *Tytthoscincus*) on Sulawesi to understand the biogeographic forces that shaped their diversification. Comprehensive phylogenomic species tree and species-delimitation analyses recovered divergence times for dispersal events that were exceptionally concordant with predicted paleo-island formation and movements. We found extreme elevational stratification of lineages, with 2–7 species in each genus inhabiting a single mountain. The biogeographic histories of both *Sphenomorphus* and *Tytthoscincus* are remarkably similar, highlighting the importance of the processes that generated diversity in both radiations. We found that early divergences set the foundation of lineages that persisted across different paleo-islands regions to this day. This foundation was built upon when the Central Core of Sulawesi uplifted and further subdivided many lineages through vicariance across the newly formed mountains. This led to a rapid burst of diversification containing a huge assemblage of species primarily in the Central Core. As Sulawesi further fused these new lineages spread asymmetrically into the different regions of Sulawesi and developed unique elevation and microhabitat related adaptations. Together these results provide a detailed assessment of the relative roles of island formation and mountain-uplift in generating biodiversity.

A-0360 (Poster)
Sexual Dimorphic Skull Morphology of Sea Snakes (Elapidae: Hydrophiinae)

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Sexual dimorphism in snakes is most notable in tail shape and size, which is often attributed to roles in reproduction. Some snakes also have sexual dimorphism in skull structure, due to differences in feeding habits. Sea snakes are uniquely specialized among snakes due to their

adaptation to marine environments. The way we understand sexual dimorphism in sea snakes' skulls has focused on sea snakes on only a small sample of species, primarily using external body measurements or measurements of dried skull specimens. This research project uses CT Scanning technology to develop 3D models of sea snake specimen skeletons and take precise measurements of the internal skull bone morphology. We use multiple sea snake species including three species from the genus Hydrophis, the most diverse genus of sea snakes, but also the genus in which sexual dimorphism is least understood. If we find sexually dimorphic traits in the sea snake skull morphology across all species, this will expand our understanding of potential diet and ecology differences between the sexes. If there is no difference in skull morphology between the two sexes of any of the sea snake species, then our findings will upend the many studies and current understanding of snake skull sexual dimorphism. Overall, expanding our knowledge about sea snake morphology and differences between sexes is key to understanding this unique radiation of elapid snakes.

A-0363 (Oral)

Little Salamander, Big Watershed: Insights from Landscape Genetic Analyses of the Cascade Torrent Salamander (*Rhyacotriton cascadae*)

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Rhyacotritonidae, the torrent salamanders, are a monogeneric family endemic to the Pacific Northwest whose biphasic life cycle has evolved in the cold, fast flowing headwaters in the Cascade Range. This habitat is predicted to shrink considerably due to climate change, and two of the four species are currently being considered as candidate species for listing under the United States Federal Endangered Species Act. Despite this, basic life history traits like dispersal ability remain poorly understood, even though understanding how and where gene flow occurs across the landscape is critical for effective conservation. To address this data gap, we carried out the first landscape genetic study of the Cascade torrent salamander (*Rhyacotriton cascadae*). As the scale and extent of temporal and spatial data is crucial for landscape studies, particularly for low vagility species, we selected the HJ Andrews Experimental Forest, a Long-Term Ecological Research Site, for our study. The HJA is in the Cascade Mountains of Oregon, encompassing a 6400-hectare watershed with decades of data on landscape features like streamflow, climate, and vegetation, making it an ideal location for investigating the landscape use of a semi-aquatic organism like *R. cascadae*. We sampled 141 individuals from 21 sites, including two sites adjacent to the watershed boundaries, using double digest restriction enzyme sequencing (ddRADseq) to generate a dataset of single nucleotide polymorphisms (SNPs) to examine population structure and gene flow. Our results show that R. cascadae gene flow depends on both aquatic and terrestrial habitat, which has important implications for management that ensures continued genetic diversity within, and between, populations. We also provide the first estimates of dispersal distance and effective population sizes for the species. Our results also identified potentially important corridors for gene flow and landscape characteristics which maximize the overall potential for admixture within the basin, critical for effective conservation.

A-0364 (Poster)

Lizard Sweeps Nation: A Population Genomics Approach to Revealing the Invasion History of a Widespread Reptile

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Species introductions can serve as natural experiments that improve our understanding of ecological and evolutionary processes. The introduction of Mediterranean House Geckos (*Hemidactylus turcicus*; MHGs) to Florida in 1910 subsequently resulted in MHGs becoming one of the most widespread reptiles, colonizing 26 states across four climates. MHGs rely almost exclusively on humans for habitat and long-distance dispersal. Our lab has quantified climate-associated variation in body size, scale and integument morphology, thermal tolerances, evaporative water loss, and metabolism among H. turcicus populations across the US. Using a population-genomics approach (RADseq) based on ~500 geckos sampled across the US, our study seeks to characterize the invasion history of MHGs by (1) determining the number of independent introductions, (2) identifying major hubs of dispersal, and (3) characterizing patterns of genetic variation over their invasive range. We hypothesize that multiple introductions occurred into Gulf Coast ports, which serve as primary dispersal hubs. We further predict that the earliest established populations will exhibit the highest genetic variation (because of repeated introductions from multiple source populations) with subsequently established populations showing diminished variation because of founder effects. A weak pattern of isolation by distance is expected, rather than a typical diffusion model of natural dispersal, given colonization events are human mediated. From a biosecurity perspective, identifying hubs of dispersal and invasion pathways will help wildlife authorities identify dispersal centers that could facilitate the invasion of more harmful species. Additionally, future investigations could determine the genetic variation that underlies the observed phenotypic differences in this species.

A-0365 (Poster)
The Hydric/Thermal Nest Environment of Tuatara (*Sphenodon punctatus*), a Slowly-Reproducing Reptile with Prolonged Incubation Duration and Environmental Sex Determination

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Hydric variables within the nest microclimate of egg-laying reptiles have received comparatively less attention than thermal effects despite the importance of available soil water and the water/temperature interaction. Because the incubation of Tuatara eggs in natural nests can exceed 12 months, embryos are susceptible to both acute, extreme weather anomalies and long-term climate variation (e.g., seasonal fluctuation and El Niño-Southern Oscillation). Further, Tuatara posess a unique form of temperature-dependent sex determination (type 1b,

FM TSD), where temperatures above ~22°C (constant temperature equivalent) during the thermosensitive period produce male offspring. Therefore, species persistence requires understanding how Tuatara populations will respond to environmental change from both a maternal nest site selection and egg-stage perspective. In 2022, I collected nesting data (maternal ID, reproductive phenology, nest characteristics) at the remnant population on Takapourewa (Stephens Island), New Zealand. Further, I installed data loggers to measure hourly soil temperatures in both past and present nesting areas. I returned to Takapourewa in 2023 to continue collecting nesting data and deployed additional loggers to measure hourly soil volumetric water content, soil relative humidity, and soil temperature. In addition to Takapourewa, the project scope included collecting nesting phenology and nest microclimate data (hourly soil volumetric water content, soil relative humidity, and soil temperature) at two mainland, translocated populations in 2023. Combining these hourly time-series of *in-situ* nest measurements with historical local climate station data allows for the construction of spatiotemporal, ecophysiological models. This work continues a multi-decade investigation into Tuatara reproduction, the appropriate timescale for insight into the long-term population dynamics of these and other long-lived, egg-laying reptiles.

A-0366 (Oral)

Tetrodotoxin and Location, but Not Chytrid Fungal Infection, Influence Skin Microbiome Composition in Rough-skinned Newts (*Taricha granulosa*)

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Chytridiomycosis is an amphibian fungal skin disease caused by *Batrachochytrium dendrobatidis* (Bd) and linked to global population declines and extinctions. However, some amphibians are less susceptible to infection through intrinsic factors, including skin microbes aiding defense through resource competition and antifungal metabolite production. Amphibians can also release toxins, such as tetrodotoxin (TTX) in the genus *Taricha*, in response to stress cues to defend against disease, parasitism, and predation. Despite a previously observed negative relationship between levels of TTX concentration and Bd infection intensity, the influences of TTX concentration on host microbiome diversity and pathogen dynamics across a geographic range remains unanswered. We examined the relationship among TTX concentration, Bd infection, and skin microbiome composition in Rough-skinned Newts (*Taricha granulosa*, n = 90) from six locations in the Pacific Northwest, USA. Skin swabs were collected for Bd infection intensity quantification using TaqMan qPCR and microbiome characterization using Illumina MiSeq 16S rRNA gene amplicon sequencing, and skin punches were collected to quantify TTX concentration using Competitive Inhibition Enzymatic Immunoassays. There were significant differences in TTX concentration and Bd infection across locations, but no direct interactions between TTX concentration and Bd infection intensity or presence. Microbiome composition varied with TTX concentration and

location, but not Bd infection prevalence. Further study is necessary to determine the directionality of the TTX-microbiome relationship, that is, whether TTX concentration determines microbiome composition or if the microbiome can influence TTX concentration in Rough-skinned newts.

A-0367 (Oral)
Conservation Genetics of a Dwarf Island Reptile, the Channel Islands Gopher Snake

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Island ecosystems often host organisms distinct from their mainland counterparts in physiology, behavior, and morphology. A particular trend observed in both extinct and extant organisms on islands is a drastic increase or reduction in body size. The Channel Islands, off the coast of California, are home to several endemic species exhibiting reduced body sizes relative to the mainland; one of these is the Santa Cruz Island gopher snake, *Pituophis catenifer pumilis*. We have been collecting morphological, physiological, and genetic data from two of the Channel Islands (Santa Cruz and Santa Rosa) along with northern and southern mainland California locations, and we have demonstrated that island individuals are 30% smaller than their mainland counterparts, *P. c. annectans* and *P. c. catenifer*. The islands have experienced environmental degradation from human activity since the 19th century, but little research has been done to understand how reptile populations have been affected. In this study, we aim to contrast island and mainland populations and understand their relative potential to respond to evolutionary pressure by evaluating genetic diversity metrics. Using whole genome sequencing data from 77 *P. catenifer* individuals across islands and mainland locations, we analyze demography at the level of single-nucleotide polymorphisms (SNPs) from both nuclear and mitochondrial genomes. We estimate divergence among populations, as well as genetic diversity and effective population sizes, and assess relative levels of inbreeding. By contrasting nuclear and mitochondrial data, we provide novel information about the population demography to inform conservation and management decisions across mainland and endemic island populations.

A-0368 (Oral)
Convergence in Semi-aquatic Anolis Lizards

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Anolis lizards are a famed example of convergent evolution—however, the well-known 'ecomorphs' are only found on the islands of the Greater Antilles. The bulk of anoline diversity occurs in Central and South America, which do not have easily recognizable ecomorphs. We present a case for the recognition of a new ecomorph that includes phylogenetically-distinct species from both island and mainland—semi-aquatic anoles. Semi-aquatic habitat occupancy has evolved at least six times independently within the genus: twice on islands (Cuba, Hispaniola) and four times on the mainland. We attempted to determine if semi-aquatic anoles exhibit multidimensional convergence in morphology, ecology, behaviour, and performance. We assessed the morphology of all semi-aquatic anole lineages by measuring museum

specimens; we measured the standard 'ecomorph' linear morphometric traits and an additional twelve traits we thought might be relevant to semi-aquatic environment occupancy. Using a high-speed video camera, we recorded the swimming speed of a subset of semi-aquatics (and co-occurring non-aquatic anole species) from Mexico, Costa Rica, and Colombia. Lastly, we observed semi-aquatic anole diving behaviour using an underwater camera. We found that semi-aquatic anoles cluster in morphospace in a manner similar to the recognized Caribbean ecomorphs. Our swimming speed trials showed that semi-aquatics were significantly better swimmers than non-aquatic anole species. All semi-aquatic species tested exhibited a novel underwater behaviour we have termed 'rebreathing', in which an air bubble is sequentially exhaled and re-inhaled during anti-predator dives. This behaviour likely aids in extending dive durations, helping semi-aquatics remain submerged and safe until whatever predator caused them to dive has left the vicinity. Overall, this similarity in morphology, ecology, behaviour, and performance indicates that semi-aquatic anoles should be considered an 'ecomorph' and is a fascinating example of the power of convergent evolution.

A-0370 (Poster)
Invader vs Invader Dynamics: A Behavioral Approach to Assess Competition and Displacement among Invasive House Geckos

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The behavioral ecological character-displacement hypothesis posits that competition and behavioral interactions drive niche divergence. Species that occupy the same niche often interact making competitive displacement a critical determinant of invasive species distributions. House Geckos (*Hemidactylus* spp.) are nearly globally distributed and often human-commensal invasive lizards. Over the past century, Mediterranean House Geckos (*H. turcicus*) have established thousands of populations in the southern USA; followed by Tropical House Geckos (*H. mabouia*) decades later in southern Florida, and Sri Lankan House Geckos (*H. parvimaculatus*) arrived within the last decade in southern Louisiana and Texas. These species are similar in size and occupy nearly identical niches, leading to speculation of competitive displacement of *H. turcicus*, which no longer occurs in southern Florida and is increasingly rare in southern Louisiana. Yet, no study has documented competition among these species or even characterized any behaviors of *H. parvimaculatus*. Our study will determine if the gradual disappearance of *H. turcicus* from previously occupied regions in southern Florida and Louisiana can be attributed to competition with congeners. Specifically, we are ascertaining the competitive dominance hierarchy among these three species as a test of the behavioral ecological character-displacement hypothesis. We hypothesize competition will occur, as evidenced by dominant behaviors in staged encounters, with H. turcicus being ranked as the weakest competitor. Geckos (n ~ 20/species) were size-matched and assigned to quartets in staged encounters across all combinations of species and sexes and introduced to an arena where behavioral interactions are video recorded during periods of activity. Behaviors are quantified and categorized to assign geckos dominance ranks and will be compared via ANOVA to determine the dominance order among species. Our findings will broaden our understanding of the role of behavior as a mechanism of competitive displacement among co-occurring invasives.

A-0371 (Oral)
Comparative Phylogeography Reveals Ancient Corridors, Refugia and Cradles of Genetic Diversity in Sahara-Sahel Vertebrates

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In the Sahara, climatic oscillations between savannah and desert states for at least the last ten Million years left deep imprints on biodiversity patterns. Mountain and coastal areas have been postulated as ecological refugia and diversification centres, at least for the more mesic communities inhabiting the region, and a series of trans-Saharan green corridors connecting the Mediterranean and Afrotropics have also been suggested. However, these biogeographic hypotheses have only been based on a handful of species. Xeric taxa should present different patterns, but even less is known about these. Accordingly, this work seeks to map vertebrate diversity across the arid ecoregions of North Africa (the Sahara and Sahel) in order to consolidate and test biogeographic scenarios for the region since the Miocene. We used >8,500 geo-referenced DNA sequences and > 28,000 occurrence points from 104 vertebrates (reptiles, mammals, amphibians, and birds) to map intra-specific genetic diversity (ISD) and connectivity, and model past species habitat shifts, considering climate, hydrology, vegetation, and substrate information. By analysing the concordance between genetic and ecology-based inferences, we attempted to identify diversity hotspots, refugia and corridors, and compare spatial patterns among mesic and xeric species. For xeric taxa, the northern Sahara, together with the southwestern Sahel, was identified as the main ISD hotspot. Ecological results supported northern Sahara refugia, which extended southwards. For mesic taxa, ISD hotspots covered most Saharan highlands, the Nile Valley, coastal areas, and the Niger Delta. Refugia were mostly concordant with ISD hotspots. Ecological xeric connectivity was overall widespread, while genetic corridors primarily included the Atlantic Sahara, the Nile Valley outskirts, and the eastern Sahel. Mesic corridors included the Atlantic coast and, to a greater extent, the Central Sahara highlands. The patterns recovered by this comprehensive study should help understand the historical biogeography of the largest warm desert on Earth.

A-0372 (Poster)
Report on Abnormalities in Amphibians and Reptiles of Nepal

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During diverse herpetological surveys conducted between 2019 and 2022 across various locations in the Morang, Dhankuta, and Panchthar districts of Nepal, we meticulously documented 36 cases of abnormalities within the herpetofauna. Upon detecting any signs of abnormality, we captured the specimens, identified the specific abnormality, and promptly released them after thorough observation. Our focus was exclusively on those displaying abnormalities, and normal individuals or species were not systematically quantified. This study comprehensively explores both skeletal and non-skeletal anomalies, including microphthalmia and anophthalmia. In our findings, we recorded a total of 35 abnormal cases in amphibians and reptiles, with amphibians exhibiting a higher prevalence of abnormalities than reptiles. Among the 26 individuals representing 11 amphibian species, brachydactyly emerged as the predominant abnormality, followed by ectrodactyly, syndactyly, amelia, anophthalmia, ectromelia, incomplete tail, and microphthalmia. Notably, the Himalayan salamander (*Tylototriton himalayanus*) displayed four distinct abnormalities, adding a unique dimension to our observations. Similarly, abnormalities were observed in nine individuals of reptiles belonging to six species, showcasing seven distinct abnormalities. The most frequently observed form was brachydactyly, accompanied by amelia, bifid tail, blepharoedema, ectromelia, incomplete tail, and tail necrosis. These comprehensive findings contribute valuable insights into the prevalence and diversity of abnormalities in the herpetofauna of the surveyed regions.

A-0373 (Oral)

The Seafarer and Island Hopper from Africa: Systematics of Sub-Saharan African Natricines and the Seychelles Endemic *Lycognathophis seychellensis*

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The sub-Saharan African (SSA) natricines are a depauperate group of snakes until recently poorly studied, which in turn precluded analyses of the historical biogeography of the Seychelles endemic *Lycognathophis seychellensis*. Due to its external appearance *L. seychellensis* was initially thought to be a Lamprophid but internal anatomy was used to place it with natricines. Molecular data confirmed this placement. However, their systematic relationship within natricines was unresolved and the biogeographic origin of these snakes remained untested. I will be presenting results of a large international collaborative work which included all the known genera (7) of SSA natricine and 10 out of the 14 species and a subset of 33 L. seychellensis samples collected from five islands in Seychelles. We used a multilocus (3 mitochondrial and 4 nuclear genes) phylogeny to infer species relationships. Congruent with published phylogenies SSA natricine are sister to one of the Asian clades and *L. seychellensis* are indeed sister to SSA natricine. Within SSA natricines *L. seychellensis* is more closely related to (*Afronatrix*,(*Hydraethiops, Helophis*)), genera which are currently found in West and

Central Africa. Genetic variation among *L. seychellensis* from the five Seychelles islands is low. Fossil calibrated divergence time estimates support an overseas dispersal of the *L. seychellensis* lineage to the Seychelles from mainland Africa ca. 43–25 million years before present (Ma). Another published phylogeny using the same set of genes but including ca. 75% species estimates the dates of the entire natricine clade to be around 39 million years and SSA lineage ca. 25 (Ma). Literature review shows that most squamate diversity in Seychelles are less than 50 million years old and are of African and/or Malagasay and in one case saharo-Arabian origin. The oldest squamate lineages in Seychelles are geckos of the genera *Ailuronyx* and *Urocotyledon*, ca. 73 million years, suggesting a Gondwanan origin.

A-0374 (Oral)
Head Shape Evolution in Natricine Snakes and Systematics of Asian Natricine Lineages

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Natricine snakes are morphologically diverse and currently distributed in Asia, Africa, Europe and north-central America (NCA). They are primarily semiaquatic or ground-dwelling terrestrial snakes, but some are aquatic, burrowing, or aquatic and burrowing in habit and may be generalist or specialist in diet. Natricines are an interesting though understudied system to study using an ecomorphology framework. We used an updated published phylogeny with 80% species coverage (260 total species), and we collected natural history data on diet and habit. We quantified morphological disparity in head shape among 191 species and applied phylogenetic comparative methods to test for convergence. Natricine snakes are of Asian origin, the lineage is estimated to be 40 million years (MYA) old. The monophyletic natricines in NCA dispersed there approximately 25 MYA and radiated, with higher diversification rates observed only after 11 MYA. An independent lineage from Asia dispersed into sub-Saharan around 25 MYA where they have diversified at a constant rate but are depauperate compared to the Asian and NCA lineages. Natricine head shape is largely correlated with habit, but in some burrowers is better explained by dietary specialism. Convergence in head shape is especially strong for aquatic burrowing, semiaquatic, and terrestrial ecomorphs and less strong for aquatic and burrowing ecomorphs. The ecomorph concept is useful for understanding natricine diversity and evolution, though would benefit from further refinement, especially for aquatic and burrowing taxa. With addition of many new lineages systematics of natricine snakes particularly lineages outside north and central America have attained better resolution. However, there are several unresolved deeper nodes hence naming lineages merely based on paraphyly without trying to resolve these issues is unnecessary. Next-generation sequencing approaches could resolve the problematic nodes.

A-0375 (Oral)
Deep Divergences Among Cryptic Clades of *Epipedobates* Poison Frogs

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Poison frogs (Dendrobatidae) are famous for their aposematic species, having a combination of diverse color patterns and defensive skin toxins, yet most species in this family are inconspicuous (cryptic) and considered non-aposematic. *Epipedobates* is among the youngest genus-level clades of Dendrobatidae that includes both aposematic and cryptic species. Using mitochondrial and nuclear markers, we demonstrate deep genetic divergences among cryptic species of *Epipedobates* but relatively shallow genetic divergences among conspicuous species. Our phylogenetic analysis includes broad geographic sampling of the cryptic lineages typically identified as *E. boulengeri* and *E. espinosai*, which reveals two putative new species, one in west-central Colombia (*E.* sp. 1) and the other in north-central Ecuador (*E.* aff. *espinosai*). We conclude that E. darwinwallacei is a junior subjective synonym of E. espinosai. We also clarify the geographic distributions of cryptic *Epipedobates* species including the widespread *E. boulengeri*. We provide a qualitative assessment of the phenotypic diversity in each nominal species, with a focus on the color and pattern of cryptic species. We conclude that *Epipedobates* contains eight known valid species, six of which are cryptic. A relaxed molecular clock analysis suggests that the most recent common ancestor of *Epipedobates* is ~11.1 million years old, which nearly doubles previous estimates. Last, genetic information points to a center of species diversity in the Choco at the southwestern border of Colombia with Ecuador.

A-0376 (Oral)
Monitoring a Global Pathogen, *Batrachochytrium dendrobatidis*, Using Environmental DNA and Droplet Digital PCR

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Monitoring the prevalence of chytrid fungus (*Batrachochytrium dendrobatidis*) in wetlands is crucial for understanding and mitigating the devastating impacts of chytridiomycosis on amphibian populations. Current methods of chytrid monitoring (either by individual-level skin sampling or environmental DNA; eDNA) often experience high variability and face challenges related to sensitivity, potentially missing low-level infections that are critical for early detection and intervention. Sensitive detection methods must be explored to improve detection probability and advance disease surveillance capabilities. Droplet Digital Polymerase Chain Reaction (ddPCR) is a powerful technique that partitions a sample into thousands of individual droplets - PCR amplification of the template then occurs in each individual droplet. This method enhances detection sensitivity and allows for the absolute quantification of target DNA molecules. As a result, ddPCR technology may be a more efficient alternative to low-level pathogen surveillance than quantitative PCR methods. We explored the sensitivity of ddPCR and qPCR in detecting chytrid zoospores by determining the limit of detection (LOD) and limit of quantification (LOQ) for a well-established assay for *B. dendrobatidis*. We also investigated the extent to which inhibitory factors, such as those from environmental or skin samples, might affect DNA amplification and reliability of detection of each method. The high sensitivity of ddPCR holds promise for improving environmental monitoring of B. dendrobatidis and advancing our understanding of the disease's prevalence in wetlands. The ability to detect lower levels of pathogen will facilitate earlier detection of the disease and allow for more efficient

decision-making in conservation management. It may additionally shed light on the dynamics of *B. dendrobatidis* presence in waterbodies and reveal how environmental chytrid levels relate to infection prevalence in amphibian communities.

A-0377 (Oral)
Rethinking Genetic Management Approaches for Threatened Amphibians

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The genomics revolution has created many opportunities for improving the genetic management of threatened amphibians and thus the possibility of establishing self-sustaining populations. This includes identifying populations facing genetic threats such inbreeding depression, performing genetically informed translocations, and releasing pre-adapted individuals. Genetic management is also supported by developments in assisted reproductive technologies, stem cell and gamete cryopreservation, and genetic engineering. I will discuss some of the tools and resources required for genetic management and some recent developments in the field of genetic intervention.

A-0378 (Oral)
The Amphibian Genomics Consortium: a new initiative to advance amphibian research

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The Amphibian Genomics Consortium (AGC) was launched in March of 2023 to advance research on amphibian ecology, evolution, and conservation. We aim to build upon the efforts of existing genomics consortia by supporting amphibian-focused sequencing projects, and other types of genomics-driven research and applications. The AGC strives to foster collaborative, interdisciplinary research by uniting amphibian researchers from around the globe encompassing a wide spectrum of expertise and career stages. We have more than 250 members from 40 countries, a monthly seminar series, and an active communication channel. I will discuss the AGC's plans to facilitate amphibian genome sequencing and to move beyond the reference genome to improve tools and resources for genome annotation and functional genomics thus promoting research on this fascinating and highly threatened group of vertebrates.

A-0380 (Poster)
Amphibian Diversity in the Heart of Panay: A Glimpse into the Amphibian Composition of Central Panay Mountain Range, Antique, Philippines

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The Central Panay Mountain Range (CPMR) in the Philippines, representing the largest contiguous forest on Panay Island, was investigated to elucidate the diversity and habitat selection of amphibians. This study notably fills the knowledge gap on the linkage between amphibian composition and environmental determinants. Employing opportunistic, visual encounter, and acoustic encounter surveys within strip transects across varying habitats—lowland forest, lower montane forest, streams, and grasslands—244 individuals from 11 amphibian species (*Rhinella marina, Platymantis corrugatus, Platymantis dorsalis, Platymantis* cf. *dorsalis, Platymantis panayensis, Occidozyga laevis, Kaloula conjuncta negrosensis, Kaloula* sp., *Hylarana erythraea, Polypedates leucomystax*, and *Rhacophorus pardalis*), spanning six families were recorded. Notably, five species are endemic to the Philippines, with one under threat, and two being introduced and invasive. Platymantis dorsalis emerged as the most abundant, exhibiting adaptability across diverse habitats. A pronounced concentration of species and individual abundance was observed in the lowland forests at elevations of 850–990 m asl. As initiatives are underway to designate CPMR as a nationally protected area, this study bolsters that endeavor, underscoring amphibians' role as ecological indicators.

A-0381 (Oral)
Ex situ Management Stabilizes the Genetic Health of Canada's most Endangered Amphibian, the Oregon Spotted Frog (*Rana pretiosa*), but is it Enough?

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Retaining sufficient genetic variability for both short and long-term sustainability is a chief aim of *ex situ* programs for threatened species. Conservation breeding and reintroduction programs exist but oftentimes little is known about the genetic health of *in situ* or *ex situ* populations. We collected genetic samples from both wild and zoo populations of Canada's most endangered anuran, the Oregon Spotted Frog (*Rana pretiosa*), and compared their genetic diversity (observed heterozygosity (Ho), inbreeding coefficients (F), and effective population sizes (Ne)) using single-nucleotide polymorphisms (SNPs). We also assessed population structure to inform current breeding strategies. We found zoos have retained stable genetic variability despite the low diversity available in wild populations (maximum Ho = 0.155), but inbreeding levels remain high in both zoos and the wild and genetic diversity will be depleted from wild populations within 50 to 100 generations. Zoo populations were less differentiated from their wild source populations than the latter among themselves, indicating sufficient representation of wild populations in zoo populations. The patterns we uncover support

continued collaboration of *ex situ* and *in situ* endeavours as supplementation will likely be required for the long-term viability of the very wild populations the zoos rely on for genetic sustainability.

A-0383 (Oral)
Implications of Climatic Drying on the Nesting Triggers for a Freshwater Turtle

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Freshwater turtles are one of the most endangered vertebrate groups, with an estimated 60% of species threatened. The influence of environmental factors on the life cycles of most turtle species is poorly understood, including triggers for nesting movements. Although temperature and rainfall have been identified as triggers for nesting in some species, it is unknown if and how reductions in rainfall arising from climate change may disrupt reproductive movement. We aimed to determine the environmental factors that trigger nesting movements of Southwestern Snake-necked Turtles (*Chelodina oblonga*) in south-western Australia, a global biodiversity hotspot undergoing severe climatic drying. A citizen science program was implemented to monitor nesting behavior over a 4-yr period. Generalized linear mixed models (GLMM) were used to identify the environmental variables that best explained the number of female turtles exhibiting nesting movements. Daily nesting movements were significantly associated with decreasing average air pressure, consistent with seasonal cold frontal weather systems that bring the majority of annual rainfall to the region. The effect of rainfall on turtle nesting movements varied depending on the spatial scale of modelling. Our results indicate that the projected reductions in frequency of cold fronts and rainfall in southwestern Australia may disrupt nesting movements. This could reduce recruitment success of this turtle and further increase the need for adaptive management to improve conservation of the species. The study highlights the need for further research on the impacts of climate change on environmental triggers of nesting of freshwater turtles in drying regions

A-0384 (Oral)
Living with the Enemy: Life History, Communication, Kin Discrimination and Cannibalism in Poison Frog Larvae

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Anuran larvae generally inhabit freshwater bodies with a wide variety of sizes and abiotic characteristics (pH, salinity, dissolved oxygen, etc.). Depending on the water body in which they develop, tadpoles may have different morphological, physiological, behavioural and life history characteristics. One of the most interesting cases is that of tadpoles that complete their development in ephemeral water bodies that are formed in plant structures (i.e., phytotelmata). In contrast to large, permanent water bodies, where predators are abundant, phytotelmata are environments with few food resources, which may dry up suddenly and where there may be high levels of competition with individuals of the same and other species. This competition can also take the form of predation and even cannibalism, depending on the order of arrival of the different inhabitants. Moreover, phytotelmata can accumulate pollutants from which the larvae cannot escape, and whose effect(s) may be carried over to their terrestrial life after metamorphosis. For all these reasons, these small bodies of water scattered in the forest represent natural microcosms, ideal for investigating predator-prey interactions, the factors that determine larval survival, the role of kinship (or lack thereof) in the outcome of aggressive encounters between conspecifics, and even the impacts of anthropogenic activities. During this talk I will address these and other aspects of the larval life of a phytotelma inhabitant of the Guiana shield: the dyeing poison frog, *Dendrobates tinctorius*.

A-0385 (Poster)
First Evidence of the Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*) in Angola, Southwestern Africa

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The amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, Bd) is now distributed globally, often linked to serious population declines. The pathogen has been reported throughout Africa, but its presence in many countries lacks confirmation. Angola, located in southwestern Africa, is environmentally suitable for the pathogen, but it has not been surveyed yet. The fungus has been detected in adjacent countries such as Namibia and the Democratic Republic of the Congo, reinforcing the possibility of its presence in Angola, and underscoring the need for surveys. We surveyed localities in southweste, northwestern and central Angola

to assess the occurrence of Bd. We combined these data with data from the entire continent to model the potential distribution of the fungus in the country. We report on the first confirmed records of Bd in Angola. It was detected in four (Hyperoliidae, Phrynobatrachidae, Ptychadenidae, and Pyxicephalidae) out of seven tested families, and in the three surveyed areas. No mortality events were detected. Areas of higher suitability for the fungus in Angola are the higher elevation, and moister regions, especially the Angolan Highlands in the Central region of the country and the moister regions in the northern escarpment. These results help direct future research and priority target areas for chytrid surveys. Additional research is likely to uncover more positive records, enhancing our understanding of the pathogen dynamics in the region.

A-0386 (Oral)

Large-scale DNA-based Survey of Angolan Frogs to Uncover the Hidden Diversity of Tropical Africa

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Africa hosts the largest terrestrial tropical area among all continents, but it is the most poorly surveyed. Its large size, history of political instability, and little research in most countries, hinder the understanding of its biodiversity. Angola is a perfect representative of tropical Africa, being wide and diverse, in a transition between the central moist forests and the southern deserts. Many studies addressing evolutionary, taxonomic and ecological hypotheses in Africa lack data from this crucial region, thus filling these gaps is valuable. Angolan biodiversity is poorly studied, and amphibians are the least known tetrapod class therein. We used Angolan amphibians as proxys for Afrotropical biodiversity to create a genetic reference database, identify hidden diversity, and map the distribution of species richness. We sequenced samples collected across all provinces during 14 years (2009–2023). We identified mitochondrial lineages based on the 16S rRNA gene, and mapped their distribution. We also assessed richness and endemism patterns by 1-degree grid cells, ecoregions, and biomes. The first comprehensive genetic reference database of Angolan amphibians was produced, with over 1600 sequences, including 130+ anuran taxa from 13 families, 28 genera, around 50 endemic taxa, and around 50 candidate species. Patterns of richness distribution follow a north-

south latitudinal gradient decrease, reflecting rainfall and temperature regimes. Highest richness of endemic taxa was found along the escarpment. These results increase the reported amphibian richness in Angola from around 125 to around 160 species. New taxa will likely continue to be found as field surveys progress, especially in northern areas. Similar patterns of distribution of richness and proportion of hidden diversity are expected for other taxonomic groups and countries in tropical Africa. This dataset considerably improves the knowledge about the Angolan transition zone, and greatly contribute to taxonomic, ecological, evolutionary and conservation research at a continental scale.

A-0387 (Oral)

Bornean Frog Species Response to Poor Habitat Quality

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Frog skin properties play an important role to retain all the functional activities of the skin which work in a concert with cardiac and respiratory systems. Though frogs can adapt well in changing habitat, the interaction of the frog physiological characteristics with different environment remains poorly understood. Histopathological study was employed to investigate the response of *Pelobatrachus nasutus* populations in different habitat conditions. The findings revealed that individuals inhabited forest habitat possessed normal skin structure. While frog individuals inhabited poor habitat water quality (public recreational site and oil palm plantation habitats), possessed visible multiple skin lesions with irregular epidermal and pigment cell hyperplasia, epidermis erosion and occasionally undergone ulceration. Hyperkeratosis were detected on intact epidermis especially in the stratum corneum while other skin part showed variable skin thickness. Excessive blood vessels in the strata emphasize the need of more blood at that area. The evident of recurrent epidermal inflammation indicated epidermal injury with weak immune system to speed up the recovery and irregular hyperemia suggested reaction of microbial infection. Uneven epidermis thickness demonstrated the effect of desiccation in the affected individuals. The skin lesions indicated that infected individuals might have experienced mild to severe level of trauma, but the factors are unclear as this study did not examined the internal organs. This study also highlights the complete loss of epidermis layer for individuals at poor habitat quality suggested due to skin reaction towards chemical substances from runoff in the surrounding water body at oil palm plantation habitat and recreational sites. Overall, this study described first record of physiological disruption on the frog skin integrity in Sarawak, emphasized that this finding is very crucial to provide useful data in understanding the effects of habitat change to amphibians.

A-0388 (Poster)

Thermal Influences on Frog Communication: The Vocal Dynamics of *Staurois guttatus* and *Hylarana picturata* in Sarawak

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The vocalizations of frogs are essential for communication, particularly during the breeding seasons. This study explores how body temperature and ambient temperature influence the call characteristics of two Sarawak ranid species, *Staurois guttatus* and *Hylarana picturata*. Field recordings of frog calls were conducted and analyzed using Raven Pro software. Principal Component Analysis (PCA) was employed to identify the most significant call characteristics. These significant call characteristics were then correlated with ambient and body temperatures. Discriminant Function Analysis (DFA) was used to classify the twelve samples into four localities. The findings reveal that body and ambient temperatures play crucial roles in shaping the call characteristics of *S. guttatus* and *H. picturata*, with the call's center frequency (dominant frequency) highly correlated with both temperature. The results also indicate that the call characteristics vary significantly across different localities. This research provides a comprehensive understanding of how temperature affects frog communication and behavior, with implications for the conservation of these species. By predicting potential threats related to temperature changes, the study emphasizes the importance of maintaining suitable thermal habitats to ensure successful calling activities, particularly during mating. These insights are vital for informing conservation strategies and biodiversity management in Sarawak, a region known for its unique environmental conditions.

A-0389 (Oral)
Post Metamorphic Growth Partially Compensates for the Effects of Climate-Driven Stressors on Amphibian Physiology

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Human induced climate change and urbanization are predicted to dramatically impact landscape hydrology, which can have devastating impacts on aquatic organisms. For amphibians that rely on aquatic environments to breed and develop, it is essential to understand

how the larval environment impacts development, condition, and performance later in life. Two important predicted impacts of climate change and urbanization are reduced hydroperiod and increased larval density. Here we explored how larval density and hydroperiod affect development, morphology, physiology, and immunity at metamorphosis and 35 days post metamorphosis in the frog *Rana pipiens*. We found that high-density had a large negative impact on development and morphology, which resulted in longer larval periods, reduced likelihood of metamorphosis, smaller size at metamorphosis, shorter femur to body length ratio, and reduced microbiome species evenness compared to animals that developed in low-density conditions. However, animals from the high-density larval conditions experienced compensatory growth post-metamorphosis, demonstrating accelerated growth in body size and relative femur length compared to animals from the low-density treatments, despite not 'catching-up' in size. We also saw an increase in relative gut length and relative liver size in animals that had developed in the high-density treatment compared to the low treatment, as well as higher bacterial killing ability, and greater jump distances relative to their leg length across different temperatures. Finally, metabolic rate was higher overall but especially at higher temperatures for animals that developed under high-density conditions, indicating these animals may expend more energy in response to acute temperature changes. While the effects of climate change have direct negative effects on larval development and metamorphosis, animals can increase growth rate post-metamorphosis; however, that compensatory growth might come at cost and reduce their ability to cope with further environmental change such as increased temperatures.

A-0390 (Oral)

Morphological Variation in *Pelobatrachus nasutus* (Schlegel,1858) across Localities in Sarawak

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Pelobatrachus nasutus is a habitat generalist, occurring across fragmented landscapes. Understanding the variation in morphological traits across populations is necessary to understand the potential impact of environmental changes on species. This study investigates morphological variation within the species from localities across Sarawak, East Malaysia. A total of 26 morphometric characteristics were taken on 58 specimens available in UNIMAS Zoological Museum and IBEC Laboratory in UNIMAS. Statistical analyses using Discriminant Function Analysis and Post hoc Tukey test were employed using log transformed of the raw data. Results reveal significant increases in head length, forearm and eye sizes, as well as snout to nare length, dorsal dermal fold length. Additionally, higher number of tubercles on dorsal skin in non-protected forest was observed, suggestive of lower humidity in such environments.

A-0391 (Oral)

The Associations of Physiological Characters with Advertisement Call Characteristics of Sarawak Ranids

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Frog calling activity is a mature socio-interaction related to effective breeding activity. It is important to understand the adaptation strategy of the extant frog populations after a certain period, to assess their adaptation strategy in a changing environment. Thus, this study is carried out at the same locality and employs a similar method after a decade, to determine the effects of climate change on the structure of the vocal apparatus, tympanum, and nostril of the same anuran species. Sample collections were conducted at 15 study sites throughout Sarawak. The vocal apparatus of each frog was further processed in the laboratory employing Haematoxylin and Eosin staining techniques during the histological procedure. The diameter of the frog's tympanum and nostril as well as the internarial distance were measured and analysed. Cluster Analysis was done using Multi-Variate Statistical Package (MVSP) software in Statistics Package for the Social Science (SPSS) to determine the significant variation of the vocal apparatus structures, and the ratios between SVL, vocal apparatus, tympanum, and nostril. The findings indicate that when ambient temperature increases, the frog species' body size is smaller thus, indirectly corresponding to the smaller size of the vocal apparatus. This may lead to variations in call properties such as changes in pitch, frequency, and duration of the calling. The variation of the tympanum and nostril size may result in the ability for sound collection and auditory sensitivity, and the ability to obtain sufficient oxygen to provide energy for calling, respectively. These aspects are very crucial to securing successful reproduction and breeding activity for frog species that inhabit degrade habitats. Overall, this study is useful to understand the species adaptation strategy in response to climate change issues.

A-0392 (Oral)

Dietary Diversity of *Limnonectes cintalubang* in Western Sarawak

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Limnonectes cintalubang is an endangered frog species in IUCN Red List. Information on its diet is vital to comprehending its life history, fluctuation of population, and habitat modification impacts and to amplify conservation strategies. Standard sampling procedures involving visual encounter survey, capture, and release occurred for five consecutive days for six months along forest and stream transects. A stomach flushing procedure was carried out and prey items were identified under a low magnification dissecting microscope (Olympus SZX9). Identifying prey species would suggest the prevalence of food availability for the species at the study locality, which is also comparable with prey species encountered at the type locality of Ranchan Pool, in Serian District of Sarawak. The volume of food ingested by different sexes was measured to study the significant difference in prey volume between sexes, with the expectation that females consume a larger volume of prey as compared to males due to more energy required for reproduction. The snout-vent length (SVL) and head width (HW) of each frog individual were measured to determine the relationship between body size and diet composition, indicating that the individuals with larger body sizes consume larger prey. The findings of this study show that *L. cintalubang* has a variety of prey types in its diet indicating the possibility of a high survivorship rate in different locality apart from its type

locality. Thus, the study area at Siburan should be conserved to protect the local population of this endangered species from the intensifying rapid development in the surrounding areas.

A-0393 (Oral)
Unveiling the Role of Symbiotic Turtle Egg Microbiota on Hatching Success and its Interactions with Fusariosis Fungal Infection in a Freshwater Turtle

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During the last decades, an alarming worldwide emergence of fungal pathogens have been threatening animal biodiversity, particularly amphibians and reptiles. Concerns have increased over emerging *Fusarium* pathogens, which are among the most harmful mycotoxigenic fungi, threatening food safety, human and animal health, and have been listed as priority fungal pathogens by the WHO since 2022. In particular, species of the *Fusarium solani* species complex (FSSC) are considered highly pathogenic, due to their global distribution, ability to adapt to changing environments and their trans-kingdom pathogenicity. FSSC pathogens can be found in water environments, soil, and plumbing systems, causing infections in multiple hosts and threatening wildlife. For over a decade, fusariosis in sea turtle eggs caused by FSSC pathogens, is considered a fungal emerging disease. The consequences are hatching failure and mass hatchling mortalities and thus, threatening sea turtle populations worldwide. However, fusariosis is not only limited to sea turtles; in 2019, we observed and reported hatching failure caused by fusariosis in the eggs of the Yellow-spotted Amazon River turtle (*Podocnemis unifilis*), a turtle species inhabiting a pristine environment in the Ecuadorian Amazon. Since the host-associated microbiota is an important indicator of health, we investigated the role of the egg-associated microbiome on disease suppression. We first observed that the egg microbiota is influenced by river sand and water environment, which shapes the microbial composition of eggs and hatchlings, significantly impacting health. Moreover, after exploring the internal egg microbiome, we observed differences in microbial diversity and composition of FSSC uninfected and infected eggs, suggesting an interaction between *Fusarium* pathogens and the internal egg microbiota. Thus, concluding, the egg-associated microbiota is an important predictor of infection and hatching failure. With this prior knowledge we show the critical role of the host-associated internal egg microbiota in hatching success, pathogen resistance, and turtle health.

A-0394 (Oral)
Cold-blooded Cognition: How do Reptiles See the World?

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Animal cognition, the processes involved in obtaining, processing and responding to information are considered to be fundamental for survival. However, in comparison to mammals and birds, very little is known about the cognitive abilities of reptiles. They have traditionally been considered to be "sluggish and unintelligent creatures" (Yerkes, 1901) and have largely been ignored by the field. However, more recent research has revealed an impressive suite of cognitive abilities in this group. Examination of the cognitive mechanisms underlying the behaviour of these animals can provide crucial information about their abilities to learn about and adapt to different challenges. This talk will give an overview of recent research in reptile cognition, consider how appropriate current methodologies are for the challenges associated with working with snakes, as well as pathways for future work in the area.

A-0395 (Oral)
Multi-omics Approaches to Investigate Among-Individual Variation in Bsal Infection Dynamics and Chytridiomycosis Disease Severity

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Amidst the current biodiversity crisis, the deadly fungus *Batrachochytrium salamandrivorans* (Bsal) poses a major threat to salamanders of the world and could cause a new chytrid panzootic. Increasing host resistance is key in averting further loss of salamander biodiversity. To this end, it is crucial to investigate responses to infection, particularly at the skin level since the amphibian epidermis is the first barrier against chytrid pathogens. In the last decade, research demonstrated that several skin factors can explain observed differences in susceptibility to chytridiomycosis between species – from the presence of chytrid-inhibiting bacterial symbionts in the amphibian skin microbiota, to the recent description of epidermal glycosylation patterns that mediate Bsal attraction and virulence. However, within-species variation in response to Bsal has not been investigated, to our knowledge. Yet, characterizing the processes behind differential reactions to Bsal at the individual level may be fundamental to develop conservation strategies aimed at increasing host resistance, such as selective breeding. In this context, we used a novel and multidisciplinary approach to investigate among-individual variation in Bsal infection dynamics and disease severity in ribbed-newts (*Pleurodeles waltl*). We conducted experimental infections and custom-built an infection metric and a disease severity index to select individuals with the mildest and strongest responses to Bsal. We combined genomic and transcriptomic tools to investigate differences between these individuals. In particular, we characterized the structure of their skin microbiota through 16S sequencing, and analysed their mRNA profiles to investigate the genetic expression of epithelial glycosylation patterns and identify transcriptional signatures underlying differential responses to Bsal. Our results provide a holistic view of individual responses to chytridiomycosis and give rise to new perspectives for amphibian conservation.

A-0396 (Oral)
Rediscovery of the Mesilau Stream Toad (*Ansonia guibei* Inger 1966) (Anura, Bufonidae) and its Conservation Implications

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The Mesilau Stream Toad (*Ansonia guibei*) is a species of bufonid endemic to Sabah, Borneo and restricted to mountainous locations above 1600m in elevation. The species was only confirmed from the type locality, the Mesilau watershed on Mount Kinabalu. Unfortunately, an earthquake in 2015 resulted in massive landslides, causing extensive damage to the species' habitat at Mesilau. This event was expected to have caused significant population declines of at least 80% or even the potential extinction of the species. A survey in 2017 at Mesilau failed to locate any individuals, resulting in it being listed as Critically Endangered by the IUCN. Surveys in late 2023 to reassess the status of the species and its habitat resulted in the rediscovery of a single adult specimen of *A. guibei*. Tadpoles of the species were also recorded in the main Mesilau River and one additional tributary, which indicates the species survives and is breeding. Studies are ongoing to collect more ecological data on the species post-earthquake and determine its current distribution. The data gathered will be used to construct a robust conservation plan for the species. Nevertheless, these preliminary observations bode well for the species' future as they are resilient and capable of recovering from the damages caused by the earthquake.

A-0397 (Poster)

Conserving *Nilssonia leithii*: Assessment of the Critically Endangered Leith's Softshell Turtle Population along the Kaveri River, Melagiri, Tamil Nadu

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Leith's softshell turtle (*Nilssonia leithii*) is an understudied, large freshwater turtle species endemic to peninsular India. There are sporadic records of this species in parts of the Thungabhadra, Ghataprabha, Bhavani, Godavari, Krishna, Chalakkudy, Kaveri, and Moyar Rivers. Nilssonia leithii is classified as a Critically Endangered species by the International Union for Conservation of Nature (IUCN) and included in Schedule I of the Wildlife Amendment (Protection) Act 2022 and Appendix I of the Convention on International Trade in Endangered Species (CITES). Due to habitat degradation, commercial fishing, and poaching for meat consumption and medicinal purposes, there has been a decline in their population over the past few decades. Visual Encounter Surveys were carried out from the Tamil Nadu–Karnataka border, where the Kaveri River enters Tamil Nadu, which involved scanning of the water surface and riverbanks with the help of binoculars (Olympus 10 x 50) and a Nikon Coolpix P950 camera by two observers. The presence of turtles was confirmed when they were observed surfacing for breathing, basking on rocks, and through spoor marks on the riverbanks. Semi-structured interviews were conducted among local stakeholders to gather information about natural history, occurrence, consumption, and the community's perception of these turtles. Awareness campaigns highlighting the importance of this species were conducted

among stakeholders, schools, and the Forest Department. During this survey, 31 individual sightings were recorded in the study area. The findings confirm the presence of *N. leithii* in little or completely undisturbed stretches of the river. Disturbances within the Cauvery South Wildlife Sanctuary include human interventions such as cattle grazing and commercial fishing. Therefore, this pilot study was crucial in understanding their presence and creating awareness for local communities and department staff to conserve this threatened species and their habitats.

A-0398 (Poster)
Wood Turtle Ecology and Response to Habitat Restoration in Michigan

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Wood turtles (*Glyptemys insculpta*) are experiencing widespread population declines in the face of many threats including habitat fragmentation and loss, predation, and illegal collection. Understanding wood turtle spatial ecology and habitat selection is crucial for managing habitat and ensuring long-term population viability. We studied the spatial ecology of wood turtles in Michigan, USA to better understand how turtles use actively managed landscapes. We radiotracked 21 wood turtles to analyze home ranges, movement patterns, habitat selection, and use of restored oak-pine barrens using autocorrelated kernel density estimates (AKDE) and resource selection functions (RSF), both of which are novel methods for wood turtle research. Mean two-year AKDE did not differ among gravid females, non-gravid females, males, and juveniles. Gravid females moved significantly farther average distances from the river compared to non-gravid females, males, and juveniles. RSF reported population level preference for riparian habitats and avoidance of developed and forested upland habitats. At the individual level, wood turtles preferred mixed bog and lowland shrub and avoided emergent marsh and forested upland habitats. We found non-gravid females, males, and juveniles frequently used lowland hardwoodconifer swamp and shrub thicket. Gravid females frequently used either upland mesic forest or lowland hardwood-conifer swamp. Several individuals used the forested edges of oak-pine barrens while one female nested in the barrens and remained in upland habitat around the restoration site throughout both seasons. Reproductive females are of utmost importance when protecting species that exhibit delayed sexual maturation, long lifespans, and face many threats. We recommend focusing the timing of management actions around the movements and activities of female wood turtles in this landscape. Annual and individual variability in home ranges, movement patterns, and habitat selection for this population underscores the importance of long-term monitoring programs for turtle species and understanding space and habitat use prior to commencing management.

A-0399 (Oral)
Impacts of a Globally Used Aerial Firefighting Retardant on Amphibian Behaviour and Development

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Globally, ecosystems are experiencing unprecedented levels of chemical pollution. Aerially deployed fire retardants are used to control bushfires, which are increasing in severity and frequency due to global warming and in turn leading to more retardant being used in the environment. In a major fire season, millions of litres of retardant can be applied across the landscape and enter waterways. The product is composed of ammonium phosphate and/or sulfate, which are commonly used as fertilisers, and are harmful to ecosystems (especially in terms of eutrophication and acidification). Despite its widespread use, the impact of fire retardants on aquatic ecosystems (especially outside the United States) is virtually unstudied. This research investigated the effects of Australia's most frequently used retardant (Phos-Chek MVP-Fx) on the commonly occurring Striped Marsh Frog (*Limnodynastes peronii*) and the endangered Green and Golden Bell Frog (*Litoria aurea*). The aim of this research was to identify the effects of this chemical on these species by exposing multiple clutches of tadpoles to retardant over a 96-hour trial at 0, 400, 800, and 1,200 mg/L Phosphorus. Several assays were run to measure movement, foraging and antipredator responses, thigmotaxis, and development. Movement of both species was significantly slower at higher concentrations than low concentrations and control, yet no effect was found for foraging or antipredator responses. showing that sublethal effects occur as low as 1,200 mg/L Phosphorus. These results suggest that there are likely to be broad-scale impacts of exposure to fire retardants across trophic levels in aquatic ecosystems. Our findings show that these chemicals are not harmless as previously thought. These results will be used to inform the retardant deployment guidelines and conservation management globally.

A-0400 (Oral)

Venomous Snake Management in the United States: Policies, Procedures, and a Move Toward Humane and Ethical Standards

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Human conflict with snakes is rapidly increasing with human population growth and development rates. Translocation of nuisance snakes has become a widespread practice in the United States (US), aided by social media pages connecting people to volunteer and for-profit snake translocators. Policies regarding snake translocation likely vary among the 48 continental US states, but information and resources from wildlife agencies about the policies required is difficult to obtain. Without oversight and reporting, some translocators may unintentionally use procedures that disregard the health and survival of the snakes. In this study, we (1) obtained data on policies, permitting, and training required for translocating nuisance snakes in each US continental state, (2) conducted a survey of volunteer and for-profit snake translocators to collect data on actual procedures being performed so that we could compare this to the states' policies, and (3) conducted a case study on state-sanctioned city or county animal services divisions in the state of California to observe how their policies and procedures for managing nuisance snakes vary. We found that policies at the state level vary widely across the US, that policies at the city or county level within California also vary widely and do not necessarily match the state's policies, and that volunteer and for-profit snake translocators most often fail to secure proper permits but typically do follow best scientific practices. We call for similar research in other countries that connects stakeholders with policies and best practice information to assist them in conducting translocations legally, safely, and in the best interest

of all involved, including the wildlife agencies, snake translocators, and the snakes being translocated.

A-0402 (Poster)
The Population Genetic Structure and Introgression Event Around Two *Hynobius* Species in Taiwan Inferred from EST-SSRs Polymorphism

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Taiwanese salamanders, often confined to alpine "Sky Islands," exhibit small, isolated populations due to their restricted distribution. Their extended evolutionary history, spanning multiple glacial-interglacial cycles, serves as a valuable model for studying evolutionary processes and speciation. Focusing on *Hynobius formosanus* and *H. arisanensis*, two endemic amphibians inhabiting altitudes exceeding 2,000 meters in Taiwan, this study investigates their recent divergence. Generally, the morphological characteristics of *H. formosanus* and *H. arisanensis* include 4 toes on the forelimbs and five-toed hind legs. The color pattern of *H. formosanus* displays dark brown lichen-form marble patterns on a lighter mauve base, while *H. arisanensis* is covered by deep brown and inconspicuous white spots. On the other hand, *H. formosanus* distributes aligning with the Central Mountain Range, while *H. arisanensis* spans three ranges from east to west, with contact occurring around the south of Kashedashan. Transitional populations, presenting discordance between morphology and mitochondrial lineages, suggest potential hybridization. Utilizing twenty EST-SSR loci, we explore genetic structure, morphological variation, population genetics, hybridization potential, and historical demography. Assigning clusters through tests like sPCA, pairwise FST, and DAPC reveals five distinct groups among species. Transitional populations display evidence of hybridization, indicating asymmetric introgression. DIYABC and Bayesian skyline model analyses support secondary contact, while a lack of significant migration rates across the contact zone implies a recent cessation of gene flow. The observed asymmetric introgression between *H. formosanus* and *H. arisanensis* suggests the involvement of reproductive behaviors, possibly asymmetric mate choice. Overall, these findings unveil an introgression event at contact boundaries, offering insights into the evolutionary history and speciation dynamics of these salamander species.

A-0403 (Oral)
Spatial Ecology and Genetics of an Introduced Snake in North Wales

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Throughout time, shifts in animal ranges caused by changes in climate and environment have created isolated populations of animals, presenting a suite of genetic and behavioural challenges to small populations. In modern times, human-mediated transport of novel species and the fragmentation of habitats artificially create numerous isolated populations. Here, we use the Aesculapian snake (*Zamenis longissimus*) as a model species which has a broad natural distribution and multiple introduced populations. We investigate the behaviour of this snake in its introduced range in North Wales using radiotelemetry of wild snakes, using Autocorrelated

Kernel Density Estimators and Integrated Step Selection Functions. Our results suggest a reliance on human features of their semi-rural landscape, and defined seasonal peaks in activity. Using whole-genome sequencing, we then compared the genetic structure and health of multiple native and populations of Aesculapian snakes with the introduced populations in Wales and England. Next, we inferred the biogeographic history of Aesculapian snake populations, and found the population in Wales to be of uncertain, possibly mixed ancestry, and the population in London to have stemmed from an introduction of Italian specimens. Taken together, our results shed light on the behaviour of an introduced snake species, and uncover the contrasting genetic profiles of two introduced populations of the same species.

A-0404 (Oral)
Genetic Mapping of Color Polymorphisms in Frogs

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Genetic mapping in amphibians has been challenged by large genome sizes and a lack of genetic resources. In this talk I will discuss different strategies for obtaining genetic markers and for mapping using divergence mapping, pedigrees, association mapping, selection scans, and admixture mapping. I will illustrate the approaches on two systems: (1) *Oophaga pumilio*, the strawberry poison frog, which has extensive color polymorphisms in the Bocas del Toro Province of Panama and (2) *Ranitomeya imitator*, the Peruvian mimic poison frog, which has has undergone a mimetic radiation displaying a number of distinct color morphs. Encouragingly, simple methods aimed at identifying loci with high divergence among morphs can efficiently identify the genetic basis of color variation in these species. This type of divergence mapping is particularly efficient when morphological divergence has been driven by natural selection, which we demonstrate is the case in both of these systems.

A-0405 (Oral)
The Global Invasion of Cane Toads in Tropical Islands: Assessing their Morphology, Genetics and Diet

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The cane toad (*Rhinella marina*: Bufonidae) stands out as one of the most notorious vertebrate invasive species globally. While numerous studies have focused on its introduction in Australia, this amphibian has extended its invasive reach to various islands in the Pacific and Atlantic oceans, notably thriving in the Caribbean. Over the past 15 years, our research has delved into the populations of *R. marina* and its closely related species, *R. horribilis* and *R. diptycha*. Our investigations revealed a noteworthy phenomenon in certain islands such as Fernando de Noronha, O'ahu, and Bermuda, where populations exhibit elevated levels of malformations not observed in other regions, including the mainland. These malformations significantly impact their biology, influencing everything from feeding behavior to reproductive fitness. Additionally, our findings indicate a trend toward larger body sizes among these toads over the years, as evidenced by shifts in both snout-vent length and weight. Through analysis of stomach contents, we compiled an extensive list of food items, portraying the cane toad as a generalist feeder. Notably, some of the identified prey items comprise endangered and endemic species on these islands, underscoring the urgency of implementing population control measures in such sites. Further enriching our understanding, DNA analyses provided new insights into the invasion pathways of these toads in the American continent. The comprehensive scope of our research underscores the necessity for a collaborative global project to sample cane toad populations – especially in the Pacific region. Such an initiative would offer a holistic perspective on their morphological changes, genetic structure, and the broader impacts on local fauna. The imperative to act becomes evident, and we suggest an united effort to pave the way for effective management strategies and conservation measures on an international scale.

A-0406 (Oral)

Evaluation of Herpetofaunistic Detection Dogs in Monitoring and Conservation

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Amphibians and reptiles are of great interest to scientific research and are often target groups for nature conservation, management and landscape planning. While the detection of amphibians in spawning waters is comparatively well established, the search on land is considerably more complicated. One possibility to detect particularly hidden or inactive animals is the use of specially trained detection dogs, which can detect individuals or their tracks regardless of their habitat, lifestage or activity. Therefore, we evaluated the publications from the worldwide literature database on wildlife detection dogs for reptiles and amphibians according to the continent, target species and dog breeds used. While the use of reptile detection dogs is well documented in the literature and has been scientifically proven in many cases, the use of amphibian detection dogs is less well known and scientifically studied. Especially in Europe, there is hardly any (scientific and practical) knowledge about herpetofaunistic detection dogs. However, experience from other countries shows that well-trained herpetofaunal detection dogs can be a very useful and promising addition to conventional monitoring and can improve the effectiveness of transect searches many times over. For example, detection dogs performed better than other detection methods in 96.8% of the cases where there was a comparison of methods. In this presentation, I will give an overview on the global deployment of herpetofaunistic detection dogs based on more than 120 publications. I will evaluate their use for conservation and monitoring.

A-0407 (Oral)
Effects of Training and Environmental Parameters on the Performance of Amphibian Detection Dogs and a Comparison with other Survey Techniques

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Amphibians are of great interest to scientific research, but many populations are highly threatened and declining worldwide, making population surveying and monitoring essential. Although varieties of aquatic survey methods exist, traditional methods for terrestrial surveys are very time-consuming but often not very effective. A rather novel method to detect terrestrial amphibians is the use of wildlife detection dogs. However, to date our knowledge on their performance in both training and deployment is extremely limited. Thus, we trained four different wildlife detection dogs on a total of seven amphibian species within the contexts of our conservation projects in Central Europe. For all dogs, we investigated the effects of environmental (e.g., habitat, weather) and training factors on detection probabilities of their respective target species in over 350 trials. We then compared the effectiveness of two of the amphibian detection dogs to standard terrestrial survey methods, including visual encounter surveys on transects and artificial cover boards. Results for training performance were comparable among dogs and target species, with all dogs showing a learning curve and a final detection level of above 90%. Detection rates of the dogs were generally higher for large individuals or species. Wind force and ambient temperature appeared as important factors, with slight wind speed leading to higher detection rates compared to no or intermittent wind speed, and higher temperatures leading to a decrease in detection rates. Results of field deployments were more species-specific. In all newt studies, detection dogs were vastly superior to all other survey methods, independent of the habitat. In the toad studies, detection dogs were generally more effective, but the magnitude of the difference depended on the habitat type. Altogether, results suggest that amphibian detection dogs provide a highly promising survey method, which can certainly be transferred for detecting other amphibians in terrestrial habitats.

A-0408 (Oral)
Hydrothermal Physiology Limits the Geographic Distribution of the Mink Frog, *Rana septentrionalis*, in North America

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The cold-adapted Mink Frog, *Rana septentrionalis*, is the most aquatic species of the Aquarana clade and has a limited distribution in southeastern Canada and the northeastern United States, with a southern distributional limit north of the 43rd parallel. Several inherent factors limit this boreal frog's distribution, including low tolerance to desiccation and egg development that requires cold, well-oxygenated water. In a lab-based controlled desiccation experiment, adult Mink Frogs lost a higher percentage of body mass than Green Frogs (*R. clamitans*), corroborating results of previous studies. Rosendale et al. (2014) report that Mink Frogs have remarkably few urea transporters across different tissue types, providing evidence that the mostly aquatic Mink Frog rarely experiences levels of osmotic stress seen in

more terrestrial species. During the reproductive season, female Mink Frogs attach globular egg masses to submerged vegetation. These masses swell quickly and sink to the bottom of water bodies. Successful larval development requires cold, well-oxygenated water, as ascertained in captive breeding conditions where only eggs in well-aerated tanks developed and hatched. Mink Frogs in Maine are at the southern limit of their distribution, where they primarily inhabit ponds associated with beaver dams. These populations likely are vulnerable to climate change because of their dependence on cool water for breeding. Many cold-adapted species exhibit northward shifts in distribution because of global climate change, and the future distribution of the Mink Frog could become more compressed or exhibit a similar shift to higher latitudes.

A-0409 (Oral)
Exploring Morphological, Physiological, and Behavioral Plasticity across Tadpole Development in two Distantly Related Anuran Species

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Developmental environments vary widely within and between species, with life-long consequences across taxa. Developmental environment may be particularly important as heritable responses to changing conditions may lose adaptive value in the face of rapid ecological change resulting from climate change. An organism's capacity for phenotypic plasticity can potentially buffer the effects of a changing environment and influence the variation on which selection acts. Anurans show extensive and predictable phenotypic plasticity in size at and timing of metamorphosis in response to environmental cues experienced during development, which make them an ideal system to assess how early life experiences impact traits associated with fitness. However, research is limited that integrates phenotypic responses in the tadpole (i.e., larval stage) with metamorphic traits and later life stages. Furthermore, little attention has been paid to behavior and sensory processes, which are highly interesting to consider, given that they mediate how an individual interacts with its environment and are metabolically expensive to develop and maintain. To address these data gaps, we reared two distantly related species, wood frogs (*Rana sylvatica*) and cane toads (*Rhinella marina*), at two larval densities and measured larval duration and mass at metamorphosis, as well as behavior (sensory function, spatial-use patterns, and locomotion), morphology, and circulating hormone levels across multiple larval timepoints. Wood frogs and cane toads varied in the strength and direction of phenotypic responses in response to the higher larval density, not only at metamorphosis but also throughout the larval stage. As part of a larger comparative project across diverse anuran lineages, this research advances our understanding of how developmental strategies influence species' capacity to respond to environmental disturbance, stressors, and ecosystem changes.

A-0410 (Oral)
***Naja* Species Related Injuries Consulted to Remote Envenomation Consultancy Services (RECS) in Malaysia**

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Snake related injuries (SRI) remains an important but under-reported public health hazard in Malaysia. Previous studies have identified cobra species as the most common venomous SRI. There are two cobra species in Malaysia, namely *Naja kaouthia* and *N. sumatrana*. This is a retrospective cross-sectional study of all probable and confirmed Naja species related injuries consulted to Remote Envenomation Consultation Services (RECS) from 2015 to 2019. Data was extracted into standardised data collection form and were descriptively analysed. The clinical profile, the geographical distribution, the pattern of injury and management outcomes will be discussed.

A-0411 (Oral)
Patterns of Girdle Shape and their Correlates in Limb-reduced Skinks

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The repeated evolution of limb-reduced body shapes in squamates is considered an example of evolutionary convergence, but the changes in skeletal morphology associated with limb reduction are poorly studied. We use geometric morphometrics to provide insights into the biomechanical and developmental consequences of limb reduction and loss, quantifying and comparing the morphology of the pectoral and pelvic girdles across 90 species of limb-reduced skinks and their fully-limbed relatives. When examining the clavicle, a pectoral element that does not connect to limb bones, we find that its shape is not closely entangled with limb reduction, but it is will limb loss; when all forelimb bones are lost, it tends towards an acute anterior bend. This could indicate functional adaptations to locomotion in fine substrates, or downstream effects of the loss of all developmental modules making up the forelimbs. In contrast to clavicles, the morphology of the limb-bearing elements of both girdles (scapulocoracoid and pelvis) closely follows limb reduction, becoming more simplified and disarticulated from the vertebral column as axial undulation gradually replaces limbed locomotion. Morphological integration between girdles decreases in taxa lacking forelimb bones but retaining hindlimbs, indicating differential selection on the pectoral and pelvic regions following distinct locomotory strategies. This pattern is less clear when phylogenetic history is considered, likely because it is present exclusively in one clade (*Lerista*). We show how the functional demands of locomotion and their interaction with developmental

mechanisms can induce changes at different levels of organismal organisation, including both external and internal structures.

A-0412 (Oral)
Impact of Environmental Variation and Developmental Strategy on Diversification in Caudata

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Life exhibits a tremendous disparity in species richness. Understanding why some clades are represented by a single species, while others consist of several hundred, is a critical question in our comprehension of the evolution of organisms. Although the age of a clade may be a determining factor, recent studies suggest that differences in species richness might be better explained by variations in rates of diversification. Research has linked variations in diversification rates to changes in numerous environmental factors and life history traits, but few studies have evaluated the relative influence of various predictors on diversification. Here, we investigated the relative impacts of environmental and developmental factors on diversification rates in a highly diverse group of amphibians: the Caudata. Using a time-calibrated phylogeny for all Caudata species, we evaluated the comparative influence of paleo-temperature and continental fragmentation on diversification in deep time. We also explored the influence of feeding habitat and life cycle strategy on speciation rate in current lineages. Finally, we investigated the relationship between morphological evolution and diversification using 3D geometric morphometric on the skull and mandible of 319 Caudata species. In contrast to previous results including all amphibian species, our analyses reveal that diversification rate decreased when temperature increased in Caudata, with several episodes of mass extinction during maximum thermal period throughout the Mesozoic and Cenozoic. Moreover, our results demonstrate the fundamental influence of developmental processes on speciation, as lineages that have undergone a reduction in metamorphosis completeness shows higher speciation and morphological evolution rates. The insights gained from this research contribute to a deeper understanding of the evolutionary processes shaping amphibian biodiversity, emphasising the intricate interplay between environmental variation and life history traits in driving species diversification.

A-0413 (Oral)
Exploring Mitochondrial Genome Evolution in Insular Speckled Rattlesnakes (Viperidae: *Crotalus*) using *de novo* Assembly Methods

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Speckled rattlesnakes (genus *Crotalus*) comprise six species (*C. thalassoporus, C. polisi, C. angelensis, C. pyrrhus, C. mitchellii,* and *C. stephensi*) that inhabit the Midriff Islands and mainland of Baja California, Mexico. To complement previous work on the phylogeography and species boundaries of this group, we used long PCR and short-read Illumina sequencing to

sequence mitochondrial genomes from each species. We then reconstructed whole mitochondrial genomes using *de nov*o assembly methods (SPAdes and NOVOPlasty). When inferring phylogenetic trees for different protein-coding mitochondrial genes, we discovered two distinct phylogenetic patterns. First, from a region comprising COX 1, COX 2 and NAD 2 and second, from a region comprising ATP6, ATP8, COX 3, NAD 3, NAD 4, and NAD 4L. The two phylogenies inferred from these different regions differ most notably in the position of the species *C. mitchellii*. We explored possible explanations for this unexpected phenomenon including gene duplication, interspecific introgression, and laboratory protocols. Based on comparisons to reference-based assemblies and *de novo* assembly graphs, we found putative evidence for gene duplication. To confirm this explanation, we recommend long-read sequencing across the phylogenetically disparate regions using nanopore sequencing technology. This research highlights the importance of assembly methodology in mitochondrial genomics and provides insights into the dynamic evolutionary origins of mitochondrial diversity in rattlesnakes.

A-0414 (Oral)
Interactions and Impacts of Trawling Fisheries on Sea Snakes

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Recent decades have seen an increased emphasis on conservation of threatened, endangered, or protected species (TEPS) in Australian fisheries. While TEPS are not targeted by fishers in Australian waters, there are sufficient interactions between these species and fishing gear to raise concern about the effects of discard bycatch on population status. Sea snakes represent a protected group of mesopredators that are both understudied and present frequent interactions with trawling fishing gear in the QECOTF. In this study, we evaluate the effectiveness of a new bycatch reduction device (BRD) on sea snake catch rate in bottom trawling vessels and quantify the atvessel and post-trawl mortality of sea snakes landed as bycatch in the QECOTF. Simultaneous comparisons of a sea snake BRD and control gear (TED) will be conducted during commercial fishing operations to provide catch rates of both sea snakes and commercially important prawn with both treatments. Snakes that are landed will be assessed for at-vessel mortality and surviving snakes will be subject to a post-trawl mortality observational hold for three days. The purpose of this hold is to monitor snake health and condition for delayed consequences of trawling and give insight into post-trawl mortality snakes may experience when they are released after landing during normal commercial operations. The results of this study will provide valuable information for fishers and managers as well as handling practices that may reduce the negative consequences of interactions between sea snakes and trawling gear.

A-0415 (Oral)
Convergent Evolution and Development of Gliding Membranes in Gekkonid Lizards

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One goal of evolutionary developmental biology is to understand how convergent morphologies originate. Gliding structures, such as interdigital webbing and lateral membranes (patagia), have evolved numerous times across tetrapod evolutionary history, including several times in squamates. Despite their adaptive significance in many lineages, little is known about the origins of gliding structures. Here, we studied gliding membrane development in two distantly-related gliding gecko taxa (*Gekko kuhli* and *Hemidactylus platyurus*) to determine if developmental patterns of membrane outgrowth experience similar constraints. Through comparative embryology, histology, and cellular assays, we describe the development of gliding membranes in *G. kuhli* and *H. platyurus* and compare developmental patterns with homologous regions of the body in closely related, non-gliding taxa (*Lepidodactylus lugubris* and *H. turcicus*). Our results demonstrate both convergent and divergent patterns of gliding membrane development. Furthermore, we relate our data to recent findings concerning marsupial gliding membrane development, suggesting substantial constraint in early patagium morphogenesis across divergent vertebrate groups.

A-0417 (Oral)
Updates from the Field: Conservation of the Giant Burrowing Frog in Victoria, Australia

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One of Australia's largest and most extraordinary amphibians, the Giant Burrowing Frog (*Helioporus australiacus*) is a rare and secretive species, especially in the south of its range in Victoria. Survey success over recent decades has been limited, even at sites where the species is known. Giant Burrowing Frogs are considered to be in decline and are listed as critically endangered in Victoria, with little available information on their behaviour and ecology. It is critical that we develop an understanding of this species ecology in Victoria so we can ensure their survival into the future. The main objective of this survey program is to expand upon our knowledge and awareness of the Giant Burrowing Frog in Victoria, ensuring the species survival in the face of current and future threats. We are surveying known and suitable habitat for presence of Giant Burrowing Frogs, have established a long-term monitoring program, are establishing a captive husbandry program and investigating the genetic health across the southern populations. Methods include monitoring of known populations and field surveys for new populations, establishing captive husbandry protocols within secure zoo facilities, disease sampling, genetic tissue collections and undertaking eDNA surveys. Key results include the discovery of several new populations, first-ever collection of animals for captive breeding, collection of genetic material and chytrid samples, observations of never-before seen behaviours in the field, and use of emerging technology such as song meters and audio recognition programs to detect this cryptic species. "As we develop strategies to halt biodiversity decline in Victoria, some of our lesser-known species continue to challenge us. The Giant Burrowing Frog (*H. australiacus*) remains among Victoria's most poorly understood frog species. Critical data collection is needed to effectively assess the status of this species in Victoria" – Zoos Victoria.

A-0419 (Oral)
Turtles in Troubled waters: A Study on Illegal Turtle Trade in Northern India

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The Gangetic Plain across the North Indian state of Uttar Pradesh is one of the most important turtle priority areas (TPA) in India, harbouring over half of the species found in the country. The recent spike in the commercial exploitation of tortoises and freshwater turtles (TFTs) is worrisome. TFTs are heavily sought after for meat, pet trade, and in traditional Chinese medicines within and outside of the country. The sheer number of turtles in trade and related mortalities presents quite alarming situations and warrant some urgent actions. Under the TFT rescue and rehabilitation program of TSA Foundation in Uttar Pradesh, information on a total of 92 seizures consisting 15 species and 40,055 individuals was received from various enforcement authorities for identification, triage and rehabilitation in close to last nine years, since 2014. Indian Flapshell Turtle (*Lissemys punctata*) followed by Spotted Pond Turtle (*Geoclemys hamiltonii*) and Indian Star Tortoise (*Geochelone elegans*) represented a total 91% of animals seized. Ten threatened species have repeatedly surfaced in the country and cross border wildlife trade seizures. Quite alarmingly, three of them are 'Critically Endangered' while six are 'Endangered' as per the IUCN Red List. Seventeen districts in Uttar Pradesh have registered records of these enforcement seizures or cases of involvement of member of certain communities from these districts in turtle poaching. Broadly these have been divided into four locations which function as epicentres for such clandestine activities. Winter months (October to January) were observed to be the peak season for turtle trade which also indicates higher demand in these months. In order to curb the trafficking of turtles and their body parts, though steps are being taken to strengthen overall capacity of the enforcement agencies, the situation calls for the development and implementation of mechanisms that can strengthen inter-agency coordination and concerted conservation actions.

A-0420 (Oral)
The Special Case of Bsal in Germany – A Global Hotspot

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Wildlife-only emerging infectious diseases pose a neglected but major threat to global biodiversity, particularly amphibians. Amphibian chytrid fungi are among the most impactful pathogens ever documented. One is *Batrachochytrium salamandrivorans* (Bsal). Native to Asia, the pathogen has been introduced to Europe, with the oldest known record from Germany in 2004. Here, it primarily affects caudate amphibians. Currently, Bsal outbreaks are known in the wild from > 100 sites in Belgium, Germany, Spain, and the Netherlands, with 90% of them in Germany. Here, Bsal is established in four regions, Eifel, Ruhr area, Steigerwald and Algovia. It is undisputed that Bsal is spreading both locally and long-distance, but dispersal speed and mechanism remain little understood, as sites close to outbreaks can remain pathogen-free. Besides amphibians, vectors remain unknown. In long distance dispersal, humans should not be neglected as potential carriers or means of (independent) introduction. In Germany, Bsal mainly affects *Salamandra salamandra*, in which it causes dramatic population declines. However, fire salamanders persist at numerous enzootic German outbreak sites in low abundance. Moreover, at the 2004 site (in the Eifel), today a large, disease-free population is found. Causes for its survival remain enigmatic but potential resistance remains debateful. The highly susceptible *Salamandra atra* is of high conservation concern, but apparently populations remain pathogen-free yet. Declines of *Triturus cristatus* may be related to Bsal,

although the species is able to clear infection in the wild. Other German newt species (*Ichthyosaura alpestris, Lissotriton helveticus, L. vulgaris*) are considered tolerant and thus may act as reservoirs. Similarly, *Alytes obstetricans* can temporarily carry Bsal in the wild without symptoms. However, multi-host reservoir community dynamics are poorly understood and possible sublethal effects in these vectors remain the subject of ongoing studies, for which various sites are 'ideal' in Germany given the dramatic pathogen spread.

A-0422 (Oral)
Updates on America's Endemic (and Endangered) Sea Snake

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Among the world's >70 extant sea snakes, the pelagic *Hydrophis platurus* is the only species ever to arrive in the Americas, establishing it as the world's most widely distributed squamate. When an all-yellow population *Hydrophis platurus xanthos* was described in 2017 from the fiord-like embayment of Golfo Dulce, Costa Rica, it raised both curiosity and controversy. Investigations related to distribution, morphology, habitat suitability, behavior and ecological associations to key marine features have suggested this is a truly unique organism with a fascinating natural history. Indeed, its diel cycle and feeding strategy are in direct contrast to its pelagic conspecific, and Maxent models indicate it is adapted to water conditions quite different from the open Pacific Ocean. Early molecular work by Sheehy and colleagues suggested possible, if shallow, phyletic divergence, and more extensive studies are now underway to compare genetic and morphological data between taxa. Concerningly, this beautiful yellow serpent warrants an IUCN Red List conservation status of Endangered. Multiple surveys have confirmed geographical isolation with the entire population (estimated at < 30,000 individuals) bound to a single 260 km^2 marine area where human pressures are increasing. Questions about the value of this evolutionarily significant unit (ESU) are now at the forefront: Is the Golfo Dulce yellow sea snake worthy of protection? And if yes, what is the best strategy to accomplish that goal?

A-0423 (Oral)
Can Behavioural Hydroregulation Protect Against the Acute Effects of Drought? An Experimental Test in a Dry-Skinned Ectotherm, the Asp Viper (*Vipera aspis*)

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During extreme climate events, behavioural thermoregulation may buffer ectotherms from thermal stress and overheating. However, heatwaves are also combined with dry spells and limited water availability, and how much individuals can behaviourally mitigate dehydration risks through microclimate selection remains largely unknown. Herein, we investigated the behavioural and physiological responses to changes in air and microhabitat humidity in a terrestrial ectotherm, the asp viper (*Vipera aspis*). We exposed individuals to a simulated

heatwave together with water deprivation for 3 weeks, and manipulated air water vapour density (wet air vs. dry air) and microclimate (wet shelter vs. dry shelter) in a two-by-two factorial design. Dry air conditions led to substantial physiological dehydration and muscle wasting. Vipers exposed to dry air used more often a shelter that offered a moist microclimate, which reduced dehydration and muscle wasting at the individual level. These results provide the first experimental evidence that active behavioural hydroregulation can mitigate specific physiological stress responses caused by a dry spell in an ectotherm. Future studies investigating organismal responses to climate change should consider moisture gradient in the habitat and integrate both hydroregulation and thermoregulation behaviours.

A-0424 (Oral)
How does a Combined Heatwave and Drought Affect Hydration State and Glucocorticoid Levels in a Temperate Ectotherm?

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Heatwaves and droughts are becoming more intense and frequent with climate change. These extreme weather events often occur simultaneously and may alter organismal physiology, yet their combined impacts remain largely unknown. Here, we experimentally investigated physiological responses of a temperate ectotherm, the asp viper (*Vipera aspis*), to a simulated heatwave and drought. We applied a two-by-two factorial design by manipulating the daily temperature cycle (control versus heatwave) and the water availability (water available versus water deprived) over a month followed by exposure to standard thermal conditions with ad libitum access to water. Simulated heatwave and water deprivation additively increased mass loss, while water deprivation led to greater plasma osmolality (dehydration). Mass gain from drinking after the treatment period was higher in vipers from the heatwave and water-deprived group, suggesting that thirst was synergistically influenced by thermal and water constraints. Heatwave conditions and water deprivation also additively increased baseline corticosterone levels but did not influence basal metabolic rate and plasma markers of oxidative stress. Our results demonstrate that a short-term exposure to combined heatwave and drought can exacerbate physiological stress through additive effects, and interactively impact behavioral responses to dehydration. Considering combined effects of temperature and water availability is thus crucial to assess organismal responses to climate change.

A-0425 (Oral)
Thermal Relationships and Microhabitat Use in the Spiny Hill Turtle, *Heosemys spinosa*

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As ectotherms, reptiles rely on external sources of energy to maintain favourable body temperatures, with extensive studies conducted on physiological and biological effect in lizards and relatively little attention directed to tropical terrestrial turtles. This research aims to investigate specific questions, i) preferable microhabitats selected by *Heosemys spinosa*, ii) seasonable and individual variability in the distribution of core body temperature, and iii) thermal relationships with specific emphasis on the thermoregulatory behavior in the species. A total of five adult individuals (four females and one male) of *H. spinosa* from Sarawak, East Malaysia (Borneo) were fitted with temperature-sensitive radio-transmitters as a part of larger ecological study between April 2017 to December 2018. Core body temperature readings were taken with implanted Thermochron temperature data loggers placed inside the coelomic cavity. A total of 12,321 core body temperature readings were retrieved, representing core body temperature in the species. The highest and lowest threshold recorded were 22–33.5°C and the preferred ground temperatures recorded during the study were 24–24.4°C. Dormancy was observed in the species, whereby individuals remained inactive in refugia for 3–7 days continuously but maintained core body temperatures of 23.5–25.5°C during the period. In this study, *H. spinosa* was shown to benefit from habitat selection, by choosing shaded, dense microhabitats and burrows during hot weather. They were also observed to emerge from burrows or underground holes, starting mid-day. Based on the regression equation, $Tb = 23.56 + 0.08126\ T_a$, the slope is approaching 0 suggesting that *H. spinosa* leans towards thermoregulation. The study highlights major aspects of the life histories of a tropical terrestrial turtle that have relevance to understanding habitat requirements and hence of interest, among others, in the conservation and management of the threatened species.

A-0428 (Oral)

Evolution of Incipient Toepads in a Radiation of Ecologically Diverse Geckos

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Adhesive toepads have evolved repeatedly in a variety of clades to promote attachment to inclined surfaces in climbing species. Among amniotes, geckos are the most thoroughly studied with regard to their adhesive toepads. Even so, the evolutionary origin of these complex structures is still elusive, this being partially due to the scarcity of studies on species with incipiently developed toepad morphologies. One suggested model for the presence of incipient toepads are the bent-toed geckos (genus *Cyrtodactylus*), an ecologically diverse radiation, the climbing members of which possess enlarged subdigital scales. It is known that a few such species carry spatulated setae as microstructures on these scales. Given this, we explore the

evolution of incipient toepad morphology in *Cyrtodactylus* species from different microhabitats (ecotypes) in relation to habitat use (terrestrial, arboreal, rock-dwelling and generalists) to unravel how and under which ecological circumstances adhesive toepads evolved. We measured size-corrected subdigital scale area, examined subdigital scale shape using 2D geometric morphometrics, and subdigital microstructures using scanning electron microscopy (SEM). We reconstructed the evolution of these traits and tested whether species occupying different microhabitats differed in their subdigital scale morphology. We found that both arboreal and rock-dwelling species had relatively larger subdigital scale areas, but partly differed in scale shape. Microstructures also differed among ecotypes with spatulated setae being more prevalent in climbing species.

A-0429 (Oral)
The Constraints that Bind the Adaptive Trajectories of Signal Evolution

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Much interest has focussed on the capacity of species to adapt to new or changing selection pressures. In particular, numerous comparative studies have attempted to explain differences in species phenotypes as a function of present-day physical or social environments in which species reside. In some cases, these investigations have shown dramatic convergences among distantly related species, illustrating how common selection pressures can produce predictable (or repeatable) adaptations. In other cases, distantly related species can exhibit phenotypes that appear quite different, and despite apparent similarities in selection. Understanding why this is the case is central to our broader knowledge of how evolution operates in nature, and what accounts for the diversity we see in the natural world. I will present examples of why species communicating in similar signal environments so often differ in the manner in which they produce those signals. A special focus will be on the design and production of visual signals used by Caribbean anoles (*Anolis*) and Southeast Asian gliding dragons (*Draco*). These lizards use elaborate visual displays to advertise territory ownership and attract mates. The evolution of these signals has been subject to morphological, physiological and historical trade-offs, which I will argue have likely influenced the adaptive trajectories of most other communication systems as well.

A-0430 (Oral)
Differential Expression Analysis Reveals Molecular Mechanisms Underlying Plastic Responses to Temperature and Pond Drying in the Frog *Dryophytes arenicolor*

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Amphibians exhibit developmental plasticity in response to various conditions within their aquatic environments. Environmental factors such as competition, food availability, temperature, and pond duration play crucial roles in shaping morphological and life history traits, including body size, limb size, and time to metamorphosis. However, the underlying endogenous mechanisms governing these responses remain understudied. In this investigation, we raised tadpoles of *Dryophytes arenicolor* under different temperature and pond drying conditions. Employing next-generation sequencing (RNA-Seq) on whole brains during the metamorphosis climax, we analyzed gene expression differences and performed pathway enrichment analysis. Our findings revealed distinct sets of genes exhibiting altered expression in response to temperature or pond drying. Moderate and severe pond drying produced a change in the expression of 127 and 129 genes respectively, whereas moderate and high temperatures led to a change in the expression of 306 and 166 genes respectively. Upregulated genes in response to moderate pond drying are associated with binding, pyrophosphatase activity, and enzyme activation, while in severe pond drying, O-glycan biosynthesis is upregulated. Whereas in moderate temperature, the ErbB signaling pathway is upregulated, and binding, transport, and ligases are downregulated. Finally, high temperatures upregulate spliceosome, RNA expression, and the binding of nucleic acids, enzymes, and proteins binding, and downregulate tyrosine metabolism. It is important to point out that coding proteins probably have not been studied widely and that their interactions might not yet be known for downregulated genes associated with pond-drying conditions.

A-0431 (Poster)

Gut Composition of Anurans in Panigan-Tamugan Watershed in Barangay Carmen, Baguio District Davao City

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Anuran species were collected from three sites in Panigan-Tamugan Watershed in Barangay Carmen Baguio District, Davao City to determine their diversity and gut composition. Anurans were collected using a time-constrained search method along 15 belt transects, measuring 10 m x 10 m, at different elevations and habitat types (agroforest, dipterocarp forest, montane forest). Fourteen species of anurans belonging to five families and 11 genera were captured and recorded in January 2021. Highest species diversity was observed in the agroforest ecosystem (H' = 1.91) while lower species diversity was observed in dipterocarp forest (H' = 1.60) and montane (H' = 1.34) forests. Twenty food items were identified in the stomachs of the frogs and were categorized into: invertebrates, inorganic matter, plant matter, and amorphous substance. Prey items that made up the largest bulk of the diet of anurans belonged to Class Arachnida and Class Insecta (Coleoptera and Hymenoptera: Formicidae). Plant matter has high abundance among anurans that prefer the ground microhabitat indicating accidental

ingestion. Gut composition analysis of anurans may be attributed to abundance of food items within the Panigan-Tamugan watershed.

A-0432 (Oral)
Unraveling the Genetic Basis of Chytrid Resistance in Amphibians: Insights from Major Histocompatibility Complex Supertypes and Gene Expression Patterns

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Amphibian populations worldwide are threatened by the chytrid fungus Batrachochytrium dendrobatidis (Bd), highlighting the importance of understanding the genetic factors influencing susceptibility for conservation efforts. While Major Histocompatibility Complex (MHC) genes have been implicated in amphibian immunity, their role in Bd resistance remains contentious. This study investigates the intricate relationship between MHC variants and Bd susceptibility, focusing on Asian Bd-resistant and Australasian susceptible amphibians. Through MHC II supertype analysis and gene expression profiling, the diversity of MHC II supertypes and expression patterns of MHC II alleles underlying Bd resistance are elucidated. The findings suggest a nuanced association between MHC II supertype structures and Bd resistance, with specific supertypes positively correlated with survival. Moreover, gene expression analysis reveals similar expression patterns of MHC II alleles and hints at complex interactions between alleles in both species. This research underscores the importance of certain physicochemical properties for Bd resistance, as well as considering MHC gene expression at the allelic level, providing valuable insights into the adaptive immune response against Bd. By shedding light on the genetic basis of Bd resistance, this study contributes to ongoing efforts in amphibian conservation and disease management.

A-0433 (Poster)
The New Handbook of Zoology - Reptile Volume 1

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The traditional series Handbook of Zoology (De Gruyter eds., Berlin) already exists for more than 100 years. The last reptile volumes were published in 1963 (in German language) and are outdated. Ulrich Joger took the task to edit two new reptile volumes (in English language). The first volume is now ready. It contains 10 chapters on general anatomy of reptiles (osteology, cardiovascular system), development and reproduction, fossil reptiles (especially archosaurs), crocodylians and chelonians. More than 150 figures illustrate the volume. It is available both online and as printed book. The second volume (on lepidosaurs, reptile skin structure, venom, sensory organs and thermobiology) is in preparation and should appear in 2025.

A-0434 (Oral)
The Snakes of Syria

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The snake fauna of Syria consists of 40 species belonging to eight families (Typhlopidae, Leptotyphlopidae, Boidae, Colubridae, Psammophiidae, Atractaspididae, Elapidae, and Viperidae). Previous and new records are listed in a new book (Aidek et al., 2023) with maps and photos. Altogether, 587 localities were mapped. Biogeographically, Syria lies at the crossroads of several major regions. Several Palearctic species reach their southernmost limit of distribution in Syria. On the other hand, some Ethiopian or Saharo-Arabian species reach their northernmost limit here. About equal numbers of species are shared with Turkey and with Jordan. The Syrian-Lebanese Mountains harbor some endemic species, such as *Montivipera bornmuelleri* and *Elaphe druzei.*

A-0435 (Oral)
The Impact of Mountain Ranges and Behavioural Traits on the Historical Biogeography of Neotropical Torrent Frogs (Anura: Hylodidae)

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Mountains offer unique systems for studying biodiversity origins and traits associated to a mosaic of landscapes. The Serra do Mar, a mountain range of the South American Atlantic Forest, harbors high levels of endemism, attributed to its complex topography. This intricate landscape may promote trait diversification. In frogs, visual signals serve as an alternative mode of communication, having evolved in response to environmental noise constraining acoustic signals. Several visual signals are performed to attract mates or defend territories. However, signal conspicuity may also attract predators and parasites, constraining lineage dispersal. Our aim was to reconstruct the evolutionary history and explore the influence of visual signaling on montane dispersal on Hylodidae, a frog family endemic to the South American Atlantic Forest with a remarkable diversity in the Serra do Mar. We hypothesized that: (1) Hylodidae originated within Serra do Mar; (2) visual signals were an ancestral condition, with some lineages losing this trait; and (3) the presence of visual signals constrained dispersal through mountain habitats. We reconstructed ancestral ranges using a dated phylogeny of 38 species using BioGeoBEARS. Also, we performed trait-dependent models to evaluate the impact of visual signals on highland/lowland species. The most recent common ancestor of Hylodidae likely inhabited the Serra do Mar. Some ancestral populations would reach Southern Mantiqueira, originating *Crossodactylus*. Diversification occurred within the Serra do Mar through sympatry for Hylodes, Phantasmarana and Megaelosia alongside independent dispersals to Southern Mantiqueira. Also, visual signals were an ancestral condition, with subsequent independent losses in six lineages. However, visual signals did not influence Hylodidae dispersal across highland-lowland environments. We suggest that diversification in Hylodidae was driven by Tertiary-Quateary geologic and climatic events. While visual signaling is an ancestral condition in Hylodidae, we suggest that alternative strategies could facilitate its persistence in heterogeneous mountain habitats.

A-0436 (Oral)
Impact of Early Developmental Temperatures and Corticosterone on Brain Mitochondrial Activity and Learning in an Australian Lizard

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Learning is highly sensitive to environmental conditions, including to early thermal environment and the exposure to prenatal glucocorticoids. These factors have been shown to exert significant effects on metabolic rate and mitochondrial activity, which in turn play critical roles in neural development and synaptic plasticity, ultimately shaping the learning abilities of individuals. Here, we investigated the interactive effects of prenatal temperature and corticosterone (CORT) – main glucocorticoid in reptiles – on spatial learning and brain mitochondrial activity in the Delicate skink (*Lampropholis delicata*). We first manipulated prenatal environment by supplementing eggs with CORT or a Control vehicle and then incubating them in one of two thermal regimes: cold (23 ± 3°C) or hot (28 ± 3°C). Then, we subjected juveniles to a spatial learning test for 40 days after which mitochondrial activity in the medial cortex was measured. Preliminary results show an effect of early environment on spatial learning that is related with mitochondrial activity in the brain. These findings deepen our understanding of the mechanisms underpinning learning and underscore the multifaceted nature of prenatal influences on cognitive development.

A-0437 (Oral)
Bridging the Gaps in Ecophysiology: The Need for a Collaborative Approach

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The vulnerability of reptiles and amphibians is intricately linked to their ecophysiological aspects, making it crucial to understand the dynamic interplay between organisms and their changing environments. This talk addresses the gaps in interdisciplinary collaboration among ecologists, physiologists, and related fields, especially in developing vulnerability metrics for herpetofauna. Drawing from personal experiences as an early career ecophysiologist in Brazil, the world's most biodiverse country, I highlight the advantages of conducting collaborative ecophysiological research. With insights from a collaborative network of over 100 collaborators, I explore the challenges and benefits of such extensive efforts, from managing ego and data ownership to the creative development of low-cost alternatives to standard protocols due to limited funding. By sharing these experiences, I aim to inspire researchers to embrace collaborative efforts, fostering a collective approach to address the challenges posed by global environmental change. In conclusion, this presentation seeks to provide the initial stepping stone for the Symposium: "Bridging Ecological and Physiological Frontiers in EcoPhysiology: Global Implications Unveiled". Advocating for a paradigm shift towards collaborative ecophysiological research, the talk emphasizes bridging disciplinary gaps for a comprehensive understanding of herpetofauna vulnerability. By sharing practical insights and challenges, the aim is to ignite a collective commitment among researchers, fostering collaborative solutions to safeguard reptiles and amphibians amidst the escalating challenges of global environmental change.

A-0438 (Oral)
Finding Water: A Frog Perspective

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The dependence of most frog lineages on free water for maintaining hydric balance is well-established. However, water-searching behaviors exhibit diverse patterns, sometimes even contrasting among related and congeneric species. In this presentation, I will share a compilation of laboratory and field observations, supplemented by physiological research conducted by other authors, which have stimulated my interest in this topic. Subsequently, I will present data indicating the complexity of water-searching behavior from multiple perspectives. Firstly, I will address whether a given frog species engages in water-searching behaviors at all. When the response to this question is affirmative, questions emerge concerning the degree of dehydration or overall physiological conditions necessary to trigger such behavior. Additionally, the behavioral mechanisms underlying water search efficacy seem very different. Lastly, we know little about the nature of potential sensory mechanisms responsible for water detection, although smell seems important at least in some forms. The interplay of ecological and phylogenetic factors seems crucial in this context, emphasizing the need for further empirical investigation. However, important aspects such as the influence of body mass on water-searching behavior and the impact the cost of searching, require deeper exploration.

A-0439 (Oral)

Case Study of Altering Community Perceptions of Monitor Lizards (Varanidae, *Varanus* spp.) among the Santhal Tribes of Birbhum, West Bengal, India

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The "Santhals" are one of the numerous indigenous tribes of India inhabiting several parts of the central and eastern Indian states including West Bengal. Our case study has been conducted in five Santhal villages of the Birbhum district of West Bengal. In spite of the availability of modern food sources and medicines, the tribal communities still significantly utilize and exploit various local wildlife species, especially the Bengal monitor (*Varanus bengalensis*) and the Yellow monitor (*V. flavescens*). We explored and documented the utilization patterns, traditional beliefs and taboos related to these species, both of which are nationally protected under the Wildlife (Protection) Act of India, 1972. In addition, *V. flavescens* has been evaluated "Endangered" and *V. bengalensis* as "Near Threatened" in the IUCN Red List. Moreover, apart from the regular utilization patterns, the Santhals participate in annual hunting festivals, traditionally known as "Bandla Porob". Semi-structured questionnaire surveys were conducted among the hunters of the tribal communities in five villages. The results provide several direct proofs of local people utilizing monitor lizards for medicines and food. Based on this specific evidence, we designed awareness workshops for the tribal villagers. The main objective of the workshops was to create a widespread perception among the villagers regarding the importance of biodiversity and its sustainable conservation, with a focus on monitor lizards that play a crucial role in their ecosystems.

A-0440 (Oral)

Maternal-fetal Communication during the Evolution of a Placenta in Skinks

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During the transition from oviparity (egg laying) to viviparity (live birth), placentas arise to support the embryo during development. Placentation has evolved more than 100 times independently in reptiles and relatively recently in some lineages, making reptiles a great system to study this evolutionary transition. A major outstanding question in the evolution of a placenta, is how does maternal-fetal communication evolve. To understand the evolution of maternal-fetal communication, we compared placental gene expression patterns of oviparous and viviparous skinks, and cultured uterus with and without fetal membranes (specifically the chorioallantoic membrane or CAM) *in vitro*. Gene expression analysis identified that approximately 70% of expressed signalling genes are shared by both species. However, live-bearing fetal tissues were significantly enriched for 50 gene ontology terms. We compared gene expression between uteri with and without co-culturing with fetal membranes using RNAseq approach. We identified 28 uterine genes upregulated and 15 down-regulated by the presence of the CAM. Gene ontology analysis showed that genes involved in extracellular organization and tissue development were over-represented in our upregulated gene list. To validate the gene-expression date we performed immunohistochemistry on one of the up-regulated genes, the calcium transport protein calbindin 1 (CALB1). CALB1 localised to luminal and glandular epithelial cell in the uterus co-cultured with the CAM, consistent with where it is expected to function. Our results show that fetal tissue can influence gene expression of maternal tissue to support embryo development during pregnancy.

A-0441 (Oral)
Isolated Adder (*Vipera berus*) Populations: Utilising Genomics to Identify and Assess the Effects of Barriers to Gene Flow, across Fragmented Landscapes

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Reptile populations throughout the UK are under continuous pressure from human encroachment, leading to increasing habitat fragmentation, isolation of populations and population declines. The result is scattered, small pockets of suitable habitat which harbour genetically isolated populations at increased risk of inbreeding and ultimately reduced fitness. Adder (*Vipera berus*) populations in the UK and across Europe consist of small genetically isolated populations, once part of larger populations which have become fragmented by human activities and structures such as roads, agricultural land, and cities. Utilising low to medium coverage genomics we identify barriers to gene flow between adder populations, both natural (e.g., marine straits) and man-made. We also assess the genetic health, diversity, and structure of genetically isolated adder populations. We highlight the genomic consequences of inbreeding by identifying homozygotic runs, often going unnoticed in populations as they progress towards or have recently experienced genetic bottlenecks. Our results will better inform future conservation efforts and guide methods from a genomic perspective not only for adders in the UK, but reptile populations globally as human encroachment continues.

A-0442 (Oral)

Green Snakes in Green Places: Green Pit Viper Ecology in Different Habitats in Thailand

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Despite being of high conservation and human medical concern in many parts of Southeast Asia, focused and comprehensive natural history and ecology study of green pit viper (genus *Trimeresurus*) remains scarce. Thailand displays relatively high diversity (> 15 species) of this group, with a single species evaluated as "Endangered" by the IUCN and new species being described or split in recent years. I summarize nearly a decade of ecological study of green pit vipers in northeast (*T. albolabris, T. macrops*, and *T. vogeli*) and west (*T. kanburiensis*) parts of Thailand at a university campus, national park, and UNESCO biosphere reserve, with preliminary work in southern Thailand focusing on *T. venustus*. Also discussed is detection probability, occupancy, and behavior preliminary study of the terrestrial viper Calloselasma rhodostoma in the southern region at Thailand's largest university campus. Lastly, I discuss challenges and future opportunities for viper ecological study in Thailand. Green pit vipers are some of the most frequently encountered serpents in Thailand, displaying remarkable diversity as well as use and persistence of a variety of habitats. Knowledge of basic natural history and ecology has the potential to inform future conservation and snakebite management efforts of this unique group of organisms.

A-0443 (Poster)
Niche Conservatism Posing Double-Edge Effects for Allopatric Speciation of *Diploderma* Tree Lizards in Taiwan

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Allopatric speciation was a widely accepted hypothesis for species distributed across geographic barriers. During the process, niche conservatism and lack of dispersal ability collectively promoted the enforcement of genetic differentiation. However, secondary contact would occur at the edges of distribution boundaries during climatic or geological events, leading to a reduction in genetic divergence between closely related populations. In this study, we aimed to investigate the speciation process of *Diploderma* lizards in Taiwan from a view of evolution in bioclimatic niches. Deep mitochondrial differentiation was detected among intraspecific and interspecific populations due to geographic isolation from the steep topography. Seven lineages were identified based on the population structure analysis and species delimitation using ddRAD-seq data. This includes two potential new species within *D. brevipes* and *D. polygonatum*, recommended for elevation to species status. Differences in gular spot ornamentation and male dorsal coloration may serve as diagnostic traits. In the case of *D. brevipes*, niche conservatism between the two allopatric lineages supported the allopatric speciation mode. In contrast, niche divergence detected between paired lineages in the original *D. polygonatum* hinted at ecological adaptation during the speciation process. The estimation of historical distribution modeling exhibited overlapped ranges during warming periods, leading to a chance of secondary contact. In three cases of close lineages with niche conservatism, historical gene flows were detected between pairings, supporting the previous prediction that hybridization may have occurred. The evolutionary pattern of *Diploderma* species represents a case of allopatric speciation, where niche conservatism does not

necessarily strengthen the separation process but rather facilitates reconnection and gene flow among divergent clades during the initial stages of speciation. Our findings also exhibited the underestimation of the species diversity of *Diploderma* in Taiwan, increasing the total number of species from five to seven.

A-0444 (Oral)
Navigating Climate Change for a Lizard Endemic to a Brazilian Semi-Arid Environment

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Ecological niche models (ENMs) are crucial for understanding species distribution and identifying areas maintaining climatic stability over time (i.e., thermal refugia). Human-induced global climate change underscores the importance of such refugia, which directly impacts species distribution, especially for ectothermic species relying on the environmental temperature to keep their metabolism active. *Tropidurus cocorobensis* is an endemic, heliothermic, and generalist lizard from Caatinga, a heterogeneous semi-arid domain characterized by low and irregular precipitation patterns and high temperature and solar radiation. Despite its endemism, there is no information concerning temporarily stable (refugial) and unstable (recently colonized) regions for its occurrence, nor future predictions of local thermal suitability in different climate change scenarios. Using ENMs, we assessed Caatinga's past, present, and future thermal suitability for T. cocorobensis, identifying potential changes in its thermal refugia over time. Our results indicated Depressão Sertaneja Meridional (DSM) and Campo Maior Complex (CMC) as climatically stable Caatinga Ecoregions, serving as climate refugia for T. cocorobensis. While DSM covers much of the species' current distribution, CMC lacks occurrence data. Contrastingly, the Chapada Diamantina Complex, a known habitat for the species, was not recovered as a climate refugia nor was suitable for future scenarios, therefore representing a climatically unstable area. Future projections indicate a potential expansion of climate refugia in the species, possibly linked to its generalist habits. However, the optimistic outlook for this species may not mirror the overall well-being of the Caatinga domain since generalist species often fill niches left by specialists unable to adapt to stressful environments. Future studies should prioritize comparing the climatic refugia of specialist and generalist species envisioning a comprehensive understanding of the ecological dynamics within the Caatinga ecosystem. This approach will be crucial for formulating effective conservation strategies amid the ongoing challenges of climate change in this domain.

A-0446 (Poster)
Decline of *Pseudophryne* Species in the Alpine Region of Australia

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Amphibians have suffered widespread global declines, with Australia be no exception. While considerable research effort has quantified the severity and timing of declines in some species, other species have received much less attention, with the potential for unrecognised declines. Two such species that have anecdotally declined, yet population status has not been investigated, are Bibron's Toadlet (*Pseudophryne bibronii*) and Dendy's Toadlet (*Pseudophryne dendyi*). We undertook extensive surveys across historically occupied sites and uncovered evidence of widespread declines in upland populations, with coastal population appearing stable. This pattern of decline is analogous to the declines of other *Pseudophryne* species in which chytrid fungus has been implicated, suggesting this pathogen may have contributed.

A-0447 (Oral)

Sparks Among the Snakes? A Potential Genetic Explanation for Unusual Color Morphs in *Daboia russelii* (Shaw & Nodde, 1797) and *Lycodon aulicus* (Linnaeus, 1758) from India

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Along with the well-documented color polymorphisms of various snakes bred in the pet trade, more and more reports of color aberrations in snakes encountered in the wild are being published. This is likely a consequence of the increased activities of snake rescue teams around the globe and the resultant higher level of snake awareness among local human populations. We found unusual color morphs in two vipers, *Daboia russelii*, and a wolfsnake, *Lycodon aulicus*, in India. These snakes display a strongly abnormal coloration, with near-leucistic and unpatterned vipers and a nearly unpatterned wolfsnake. Yet each of these snakes possesses striking vertebral lines. The uniformly brown *L. aulicus* has a normal neck band but the expected transverse banding pattern is missing. The coloration of the vertebral scale row and its two adjacent scales creates a longitudinal pattern of a dark brown vertebral line framed in a cream color, beginning 11 scales beyond the parietals and extending two thirds the body length. In contrast, the line pattern in the vipers begins at the neck and consists of three un- or lightly pigmented scales along the vertebral line, framed by a single row of dark scales on either side and extending more faintly onto the posterior part of the body. While the primarily white viper from Gujarat retains the dark lateral rings that typically offset different shades of brown in normal phenotypes, the body of the subadult from Goa is a patternless light brown. The patterning is strongly reminiscent of a genetic modification in the pathway controlling chromatophore development that has been called spark/spark in ball pythons (*Python regius*). Detailed genetic studies of this phenomenon would be ideal, but the uniqueness of these color aberrations in these two species makes such work impractical – but it reveals nature as a sometimes-eccentric painter of lines.

A-0448 (Poster)
An Integrative Approach for Assessing Vulnerability and Resilience of Agamid Lizards to Climate Change and Habitat Fragmentation

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To persist in the face of climate change, organisms must evolve, acclimate, or disperse. However, dispersing to favourable climate niches is especially challenging for tropical ectotherms since they often inhabit highly fragmented habitat islands surrounded by inhospitable habitat matrix. In my dissertation, I will use an integrative approach, combining thermal physiology, landscape genomics, and simulation modelling to assess the vulnerability and resilience of agamid lizards endemic to the Southwestern rainforests of Sri Lanka in the face of climate change and habitat fragmentation. For my first chapter, I will identify the extent to which agamid lizards thermoregulate and the range of temperatures they are exposed to. Sri Lanka is a tropical island and biodiversity hotspot, with much of this biota restricted to the southwestern rainforests. This ecosystem has experienced decades of anthropogenic habitat fragmentation caused by large scale plantation agriculture, and increasingly, the effects of climate change. The combined effects of forest fragmentation and climate change present a major challenge to the persistence of agamid lizards and other flora and fauna in the southwestern rainforests of Sri Lanka. We hypothesize that lizards that behaviourally thermoregulate will show thermal specialization, while those that do not will display thermoconformity. We also hypothesize that thermal specialists will have a lower capacity than thermoconformers to cross hot and inhospitable habitat matrices surrounding forest fragments. This study will help answer fundamental questions around the role of behavioural thermoregulation in the ability to respond to climate change across fragmented landscapes. We will also integrate our thermal physiology results into landscape genomic models and eco-evo-demographic individual-based simulation models to more deeply investigate the synergistic effects of climate change and forest fragmentation on Sri Lankan rainforest lizards.

A-0449 (Oral)
Evolutionary Diversification of Nuchal Glands, Unusual Defensive Organs of Asian Natricine Snakes

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Venomous snakes use their venoms both for feeding and defense, but the primary role of those toxins is to subdue prey. Most snakes do not possess organs that contain toxins used only for defensive purposes. The single exception is the nuchal or nucho-dorsal glands that are found in several natricine snakes distributed in South, East, and Southeast Asia. These organs were first described in *Rhabdophis tigrinus* of Japan in 1935, and similar organs were reported in nine additional Asian natricine species in 1938. Since then, little attention had been paid to these peculiar organs until our international team began a research project on the nuchal gland system in the mid-1990s. This project initially focused on the morphological, behavioral, chemical, and physiological features of the nuchal glands of *R. tigrinus* and has revealed a

series of novel characteristics of this system. One is the sequestration of skin toxins of toads consumed as prey and the subsequent redeployment of the toxins for the snake's defense. To date, we have confirmed similar organs in at least 19 species of Asian natricine snakes. Our previous molecular phylogenetic analysis indicated the monophyly of those species and a single evolutionary origin of the glands. Nonetheless, the anatomical structure of the glands is quite diverse, and a dramatic evolutionary shift in the toxin source, from toads to fireflies, has occurred in some species. Furthermore, we recently discovered a new type of gland in an Indonesian species, which has led us to reconsider the single evolutionary origin of the structures. I will briefly introduce the unique defensive system of *R. tigrinus* and review the morphological and geographic diversity of the glands, as well as the evolution of associated behavioral and ecological attributes.

A-0450 (Oral)

Climatic Drivers of Chytrid Prevalence in the Critically Endangered Admirable Redbelly Toad from Brazilian Atlantic Forest

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Global warming is driving shifts in rainfall and temperature patterns, and projections indicate an increase in frequency and intensity of climate anomalies. These changes influence wildlife disease dynamics, affecting pathogen development, host behavior, physiology, and disease susceptibility. Understanding the intricate interplay between climatic anomalies and emerging pathogens in amphibian is essential to inform conservation efforts targeted towards this highly threatened vertebrate group. We therefore investigated the seasonal climatic fluctuations and climatic anomalies affecting infections by the waterborne chytrid, *Batrachochytrium dendrobatidis* (Bd) in the microendemic and Critically Endangered amphibian species *Melanophryniscus admirabilis*. We found links between high Bd prevalence, monthly low rainfall and rainfall deficit. Additionally, an increase in Bd prevalence was associated with temperatures exceeding historical averages. These findings suggests that climatic anomalies play a crucial role in Bd transmission and infection status among toads, probably due their aggregation behavior in few available pools during drier and warmer periods. Despite the current low prevalence of Bd and infection loads, the projected escalation of climatic anomalies might render *M. admirabilis* uniquely susceptible to synergistic interactions between Bd and extreme climatic conditions. The insights gained from this study can improve the conservation efforts and underscore the intricate relationship between climatic anomalies and chytrid infection, shedding light on potential vulnerabilities within threatened amphibian populations.

A-0451 (Oral)
Thermal Biology of the Skink, *Eutropis multifasciata* across Habitats

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The Common Sun Skink, *Eutropis multifasciata*, is a live-bearing member of the Scincidae, distributed across pan-tropical regions of Southeast Asia. This study investigates its thermal ecology in two geographically distinct regions: the northern region (Ipoh, Peninsular Malaysia) and the southern region (Kota Samarahan and near Bintulu, Sarawak, East Malaysia), and comprises a comparison between the surface body temperatures of telemetered individuals and environmental temperatures. The aim was to investigate thermoregulation in forested and oil palm plantations across two geographical locations. Substrate and ambient temperature have a significant impact on body temperature. Furthermore, the fixed effects of substrate temperature ($r = 0.868$; $P < 0.001$) and ambient temperature ($r = 0.645$; $P < 0.001$) are shown to be statistically significant. The equations derived from the linear graph indicate that the slope tends towards one and the intercept tends towards zero. The results indicate that the focal species exhibits thermoconforming through behavioural means, via thigmothermy and secondary heliothermy. The generalised linear model investigates the relationship between ambient and substrate temperatures and their impact on body temperature. An estimated increase of 1ºC in ambient temperature was shown related to a corresponding increase of body temperature by 33%, while for substrate temperature was 53%. These studies indicate the profound effect climate change may have on the survival of small ectothermic vertebrates in the mid-term.

A-0452 (Poster)
Microhabitat Utilisation Pattern by *Eutropis multifasciata* (Scincidae) Across Landscapes

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The Common sun skink, *Eutropis multifasciata*, is found across various microhabitats in forested areas and plantations throughout south-east Asia. Differences in habitats contribute to the microhabitat preferences of the focal species. Utilising radio telemetry techniques aids in determining the behaviour of the terrestrial ground-dwelling skink in different landscapes. Observations of the telemetered species under study led to the classification of eleven distinct microhabitat types. Obtaining this data presents a considerable challenge, as experts can only predict outcomes by observing basking individuals. There are differences in how the targeted species use microhabitats between the Perak and Sarawak sites, which is not influenced by latitudinal variations, but by unique local habitat features. Males exhibited a greater propensity to occupy a slightly wider range of microhabitat types compared to females, potentially to

enhance their opportunities for mate selection. Based on the significant influences of ambient and substrate temperature, the study predicted the utilisation of microhabitats by terrestrial skinks. The local habitat variation and level of precipitation across regions permit to observation of differences in microhabitat utilisation. Individuals in oil palm plantations of the southern region predominantly occupied the exfoliating barks of oil palm tree trunks. This behaviour can be attributed to the absence of dense vegetation on the forest floor, and is presumably linked to an increase in predation risk. Conversely, those from the northern site were found primarily in association with subterranean microhabitats, particularly during periods of high precipitation. *E. multifasciata* demonstrates a remarkable tendency for microhabitat adaptability, endowing them with the unique ability to switch between the forest floor, oil palm tree, and subsurface, based on the availability of microhabitats and climate. This adaptability may have contributed to the success of the species in terms of its vast geographical range.

A-0453 (Oral)

Ecomorphology of the Locomotor Apparatus in the Genus *Cyrtodactylus* (Gekkota, Squamata)

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Adaptive radiations garner considerable interest from evolutionary biologists. Lizard radiations diversifying along structural niche space often exhibit distinct changes in body and limb proportions. One prediction is that terrestrial species inhabiting open habitats will have relatively longer hindlimbs, associated with faster running speeds, while scansorial species will have relatively shorter limbs to keep the centre of mass closer to the substratum. Alternatively, terrestrial species in densely vegetated habitats could benefit from relatively shorter limbs to prevent entanglement with more frequently encountered obstacles, whereas scansorial species could benefit from longer limbs promoting greater limb spans and static stability. *Cyrtodactylus*, an ecologically diverse gekkonid genus, includes numerous specialists with narrow structural niches, but the degree of morphological diversification exhibited by these specialists is largely unknown. We investigated associations between locomotor morphology and structural microhabitat use in *Cyrtodactylus* to test if either of the opposing predictions can be corroborated for this radiation. We measured body length and relative limb dimensions of 87 species, covering multiple independent transitions among structural microhabitat preferences. Using these data, we reconstructed the phylomorphospace and tested for

associations between structural microhabitat niche and limb morphology. We found strong separation between structural niche groups in accordance with the second hypothesis, although overlap is evident among functionally related niches such as those of granite and karst specialists.

A-0454 (Oral)
Protecting the Evolutionary Trajectory of the Endemic and Vulnerable Confused Robber Frog (*Oreobates berdemenos*)

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The Confused Robber Frog (*Oreobates berdemenos*) is a direct-developing frog endemic to the Southern Andean Yungas of Argentina. It is categorized as Vulnerable by the IUCN, with habitat loss and the climate crisis being its main threats. Through integrative spatial and molecular analysis, we aim to reconstruct the natural history of *O. berdemenos* and define priority conservation areas based on its genetic diversity and ecological niche. We generated 56 new sequences for the Cytochrome-b mitochondrial gene and 29 for the nuclear RAG-1 gene. Genetic structure was assessed with Geneland and visualized using a haplotype/allele network. Genetic diversity for each delimited population was obtained, and its historical demography was analyzed through neutrality tests and mismatch distribution analysis. Finally, we constructed current and past (LGM) Ecological Niche models for *O. berdemenos* to be used as a framework to interpret its evolutionary history. Our results indicate four main priority areas for the conservation of *O. berdemenos*. These correspond to the four genetically distinct populations inhabiting current adequate areas, all showing high genetic diversity and strong genetic structure between them. In particular, the western population is highly structured and isolated from the northern, central, and southern populations. This population also showed evidence of demographic expansion in the past and corresponds geographically with a high suitable area during the LGM, potentially representing a glacial refugee. In conclusion, the natural history of *O. berdemenos* indicates its sensitivity to climate change as a driver of genetic divergence, with individuals persisting in high suitable areas and possibly expanding, colonizing, and diverging to other areas during more benign periods. In this regard, our results emphasize the necessity of protecting high suitable areas and dispersal routes (connectivity) between them to ensure the maintenance of the intraspecific diversity of *O. berdemenos*.

A-0455 (Oral)
Use of Radio Telemetry in Studying Thermoregulation and Spatial Biology of *Tropidophoru sebi* (Reptilia: Scincidae)

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The Baleh Water Skink (*Tropidophorus sebi*) is the focal species of this study, aimed at understanding its life history through investigating its thermal and spatial ecology within the logged forests of Upper Baleh, central Sarawak, on Borneo. Utilizing temperature-sensitive

radio-transmitters, we monitored seven adults (four females and three males). We discovered mean body temperature (T_b) of 25.47°C (SE ± 0.54) for females and 26.09°C (SE ± 0.45) for males. Using the 100% Minimum Convex Polygons (MCP) method, home range size was estimated to be 28.69 to 212.32 m². Notably, the study documented the smallest home range size for a gravid individual. Microhabitat occupancy data reveal that the skinks are primarily found near streams (33.1%) and under vegetation debris (31.2%), followed by banks and under bank debris (29.3%). A Principle Component Analysis (PCA) was utilized to identify influential factors driving microhabitat selection, with distance from the water body (1.748) and canopy cover (1.186) emerging as the most significant components. This study contributes essential insights into the thermal and spatial aspects of *T. sebi*, enhancing our understanding of its ecology, and provide a foundation for developing conservation measures for herpetofaunas inhabiting lowland rainforests of the tropics.

A-0456 (Oral)

Observations on Free-ranging Bornean Earless Lizard, *Lanthanotus borneensis*

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The Bornean Earless Monitor, *Lanthanotus borneensis*, the sole living representative of the family Lanthanotidae and an endemic of Borneo, has been the topic of intense interest by researchers, conservationists and the general public in the past decade. Threats resulting from poaching for the exotic pet trade has increased the need to document the life history of the species. However, due to its rarity as well as cryptic morphology and lifestyle, few field observations have been made in the past. In the present study, radio telemetry was employed to study microhabitat utilisation, movement and thermal biology of two populations of the species. The focal species was found to be a stream obligate, restricted within riparian and other aquatic zones. It was demonstrated to be a thermoconformer. Ambient temperature was strongly correlated to body temperature and more strongly, between substrate temperature and body temperatures, supporting thigmothermy as the primary means of thermoregulation. Incidental observations of this species were collected to increase knowledge on the natural history of the species. This includes notes on diet and defence strategies. Opportunistic observations were made of predation on a small species of crab (*Borneosa kapit*), and a cockroach of the family Blaberidae. Defensive strategies observed included: i. Body contortion in refugia, claws used to cling to substrate to prevent extraction; ii. 'Death roll'; iii. Flattening of body; iv. Faecal excretion; and v. Escape. In addition, the cultural significance of the species was evaluated. The documentation of such knowledge suggests its cultural significance for the Iban tribesmen of central Sarawak. The ecological information collected during the course of this study are expected to be useful for the conservation and management of this and similarly threatened species of Borneo's lowland rainforests.

A-0457 (Oral)

Long Term Monitoring and Conservation of Nesting Sea Turtle Populations in Paloh Conservation Areas, West Kalimantan, Indonesia

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Sea turtles are distributed in coastal West Kalimantan but incidental sighting suspected that in some areas there is a population decline of nesting sea turtles due to overharvesting of eggs. Understanding the population at each location helps improve conservation initiatives, thus the aim of this research is to present data on population trends of landing and nesting turtles in the coastal areas of Paloh in West Kalimantan where monitoring is carried out since 2008 by the West Kalimantan Natural Resources Conservation Center and the Wahana Bahari Supervisory Community Group. Monitoring is concentrated along the coast at Tanjung Belimbing Nature Tourism Park (TWA) and Sungai Belacan Beach and Tanjung Api from 2008–2023. The results of the research show that Green Turtles (*Chelonia mydas*), Hawksbill Turtles (*Eretmochelys imbricata*), Olive Ridley Turtles (*Lepidochelys olivacea*) and Leatherback Turtles (*Dermochelys coriacea*) landed and laid their eggs during fifteen reproductive seasons. No recorded of Olive Ridley Turtles and Leatherback Turtles landing and laying their eggs at TWA Tanjung Belimbing Beach in 2019–2023. Meanwhile, at Sungai Belacan and Tanjung Api beaches, all four sea turtles were recorded landing and laying eggs during five consecutive reproductive seasons of 2019–2023. The highest number of landing and nesting in all beach are green turtle and hawksbill turtles. There is a trend that population of landing and nesting of both species is declining along the years caused by poaching of turtle eggs, predator threats (monitor lizards, dogs and pigs), bacterial egg rot, and habitat destruction.

A-0458 (Oral)
A Multifaceted Approach to Studying Data Deficient Species: A Case Study of the Glossy Grass Skink (*Pseudemoia rawlinsoni*)

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Conservation planning should be founded on detailed and current information about a species' distribution and ecology, but such knowledge is lacking for most species. Data deficient species are a major research priority because, by definition, we know very little about them. In this presentation I outline the multifaceted approach we took to resolve data deficiency in a poorly known lizard, the glossy grass skink, in south-eastern Australia. We combine ecological niche modelling, field surveys of habitat preference and population sizes, life history data from museum specimens, detectability surveys and phylogeography to improve our knowledge of the species and its conservation.

A-0459 (Oral)
How to 'Trick' An Entire City into Helping you find Snakes: Leveraging Snake-callout Data for Research

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When humans encounter snakes on their property, they typically call a professional snake catcher to relocate the snake. In doing so, snake catchers play a vital role in mitigating human-snake conflict. The research potential of this process is becoming increasingly realised. Our objectives were to (i) improve our understanding of the biology of venomous snakes in southern Victoria, (ii) identify the predictors of human-snake encounters, and (iii) ultimately demonstrate the research potential of data derived from snake callouts. We collected data on the life-history and ecology of snakes removed from people's homes while conducting an ongoing snake relocation program in the regional city of Ballarat (Victoria, Australia). The majority of snakes relocated were Lowland copperheads *Austrelaps superbus* (Serpentes: Elapidae), and our study thus focused on this species. We obtained data on the morphology, thermal ecology, microbiology, reproduction, and diet of more than 200 wild lowland copperheads. We also obtained a range of landscape and human perception data on each encounter to explore where and when snake encounters occur. We found that lowland copperheads prey primarily upon ectothermic vertebrates (especially frogs), and that prey size is poorly correlated with snake size, suggesting an active and opportunistic foraging strategy. They are sexually dimorphic, with mating events and births concentrated in February and March (late summer-early autumn). Human-snake encounters occurred primary on the peri-urban areas of the city, in close proximity to water sources. Requests for snake relocations typically occur for snakes sighted within 20 m of a human dwelling, and occurred at or close to the hottest part of the day. Wild snakes are elusive and hard to sample in large numbers for most research purposes, but when incidental snake observations are systematically reported to a snake catcher, a significant research potential exists in the relocation process.

A-0460 (Oral)

Banded or Striped? Significant Colour Dimorphism of a Bridal Snake In Borneo

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Stripes and bands are common colour patterns in snakes. Some species are known to exhibit colour polymorphism and that includes expressing it in the bands and stripes. Bridal snake, *Dryocalamus* is a medium-sized arboreal snake in South to Southeast Asia and most species of

the genus are banded, but including two striped species. In Borneo, banded *D. subannulatus* and striped *D. tristrigatus* occur sympatrically and the two species are similar morphologically except for their colour patterns. We hypothesized the two species in Borneo exhibit a significant colour dimorphism of one species and conducted morphological and genetical analysis to test the hypothesis. Morphological examinations revealed that *D. subannulatus* and *D. tristrigatus* are not distinguishable in Borneo by scalation. Mitochondrial phylogenetic analysis and nuclear SNP analysis showed *D. subannulatus* and *D. tristrigatus* from Borneo formed clades or clusters by region not by species. *Dryocalamus subannulatus* and *D. tristrigatus* in Borneo are morphologically and genetically indistinguishable and Bornean *D. subannulatus* should be treated as a colour morph of *D. tristrigatus*. This is a rare example within snakes that show sympatric distinct banded/striped dimorphism. Relative abundance of banded/striped morph of the genus is probably different depending on region, and any ecological factor may contribute it.

A-0461 (Oral)

Ontogenetic and Intraspecific Variability in the Postcranial Skeleton of the Tuatara (*Sphenodon punctatus*) and implications for Fossil Rhynchocephalians

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Once diverse and widespread, the clade of Rhynchocephalia is represented today by a single extant species from New Zealand, *Sphenodon punctatus* (Tuatara). Although several studies have focused on its skull anatomy, there has been little systematic evaluation of its intraspecific and ontogenetic variation, especially for the postcranial skeleton. The anatomy of the tuatara is important for comparative studies of fossil rhynchocephalians and in understanding the evolutionary history of this clade. To study its postcranial anatomy, we CT-scanned and segmented 33 specimens of different ontogenetic stages, from hatchlings to adults. The specimens were then measured for statistical analyses to study allometry and variation, and bone development (i.e., ossification patterns and morphological changes) was qualitatively described. In our analysis, we found clear patterns of ossification, with the vertebrae being the first elements to fully develop, followed by the pectoral girdle, appendicular skeleton, and lastly, the pelvic girdle. Therefore, skeletal development shows a positive correlation with ontogeny. Size variation shows little to no correlation with ontogeny at least at later developmental stages, with late-stage juveniles, subadults, and adults sharing similar size ranges in most skeletal elements. Some elements, such as the humerus, ulna, and femur, show negative allometry to the presacral vertebral length, whereas pectoral elements show positive

allometry. The principal component analyses (PCA) show that most of the variation across ontogenetic stages occurs due to size differences between post-hatchling juveniles and the other categories (PC1 = 89% of the variance). When comparing other principal components, the adult specimens morphospace is always slightly removed from all other ontogenetic categories, but there is still overlap between them. Sphenodon occupies a morphospace separated from all fossil rhynchocephalians, including closely related taxa (sphenodontines) such as *Navajosphenodon* and *Sphenofontis.*

A-0463 (Oral)
A Win-Win Approach to Human-Wildlife Conflict: Working with Communities to Benefit Snake Conservation and Mitigate a Neglected Tropical Disease

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Snakebite envenoming is recognised by the World Health Organisation as a Neglected Tropical Disease, with ~5 million bites globally causing ~100,000 deaths per year in addition to long-term health and socioeconomic problems. Although much effort has been put into reducing the snakebite burden in a very few countries, many countries which have relatively high incidence of bites yet have received far less attention, including Uganda. Uganda alone sees an estimated 14,000 venomous snakebites per year, resulting in 650 deaths, 750 amputations (with severe socioeconomic implications for manual labourers and their families), and 3,000 cases of Post-Traumatic Stress Disorder. But while the impact on human health and wellbeing is undeniable, this human-wildlife conflict also has negative implications for the animals too; the IUCN Red List identifies "persecution and control" as the main threat to Ugandan snakes. Since this problem arises from people killing snakes to avoid bites to themselves, their families, or the wider community, finding solutions to snakebite envenoming is likely to benefit both sides of the conflict. Although most current work on snakebite envenoming focuses on improving treatments, the healthcare infrastructure in Uganda often makes such treatments unavailable, meaning a vital part of reducing the impact of snakebite is improving prevention of bites. This can only be done sustainably with the tight involvement of the local communities involved. In this talk, I will present a case study of how community engagement approaches can provide a powerful tool to mitigate human-wildlife conflict and provide simultaneous benefits both to wildlife conservation and human health and wellbeing.

A-0464 (Oral)
Softshell Turtles all the Way Down: Evolution of Turtle Shell Modifications

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Turtles are subject to unique evolutionary constraints on their body plan as a result of the evolution of their shells, which form their main antipredator mechanism. However, in the face of such constraint turtles still show adaptive modifications of shell shape and structure. Here, we investigate the evolutionary relationships and history of two unusual and major shell modifications in turtles: shell hinges and skin-covered shells. Shell hinges have resulted in the

various 'box turtles', which are so-named due to the ability conferred by the hinge to close the shell completely and prevent potential access by predators. Skin-covered shells have resulted in a lighter-weight shell and may be accompanied by shell reduction as well, such as in the leatherback seaturtle. Both of these modifications have seemingly evolved multiple times across the turtle tree of life, but despite much research on these traits in particular groups we still have a limited understanding of the broad evolutionary patterns across all turtles. Using a phylogenetic comparative approach, we estimate how many times hinges and softshells have evolved, infer the evolutionary history of these traits, and also test hypotheses concerning the ecological attributes that are associated with shell modifications. Understanding how and when the basic structure can be substantially modified provides insights into how organisms can maintain adaptive evolution in the face of tight constraints.

A-0465 (Oral)
Adaptations to Fasting in the Face of Global Changes

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In general, at least at some point in life, all animals need to feed. The habitats and the food types vary in complexity and can associated with seasonal variability. These associations are in function to animal activity, food and/or water availability, and ambient temperature. After a food and digestion period, a fasting moment occurs. This time can be brief or extended, depending on whether the animal feeds frequently or infrequently. Extended fasting periods are part of some species or populations' life history tactics (hibernation, aestivation, migration, molting, reproduction, development, and long fasting bouts). Global changes can profoundly affect an organism's phenotype, fitness, reproductive success, and life span. To manage these changes, the organism must optimize the time and resource allocation trade-offs. Some amphibians and reptiles can reduce their metabolic rate by 60–90% and fast for over a year. Food deprivation, for example, causes lower development in some juvenile amphibians. The atrophy of the gastrointestinal tract after months or years of fasting is present in several species, too. Visceral degeneration facilitates the coordination of metabolic conservation. In another way, some organisms present a solid response to fasting (supporting the response of the antioxidant system - AOS), preventing oxidative stress damage and change to return to feed. Molecular mechanisms are undergoing several changes, such as nutrient distribution, enzymatic pathways, and protein expressions that help the organism survive during food deprivation. Thus, evolutionarily, adaptations to fasting have been consolidated during the life histories of various species, making them adaptable to some environmental changes. However, extreme events can bring a new world to these species, and not all can resist it.

A-0466 (Oral)
Exploring the Utility of Geographic Range in Understanding Patterns of Squamate Speciation

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Understanding patterns of biological diversity and the processes that shape those patterns is perhaps the fundamental pursuit of ecology and evolutionary biology. Recent progress in this endeavor has stressed explicitly linking putative microevolutionary (subspecific) controls to macroevolutionary (superspecific) phenomena (e.g., testing correlations between intraspecific

population subdivision and speciation tip rates). However, because speciation rates will correlate with the amount of taxonomic over- or undersplitting of species-level units, the phylogenetic tip-units employed can fundamentally influence investigation outcomes and, ultimately, the factors implicated in shaping biodiversity. Still, the macroevolutionary consequences of tip-unit choice have not been rigorously explored despite this complication. Using sympatry among close relatives as a heuristic, we assess the impact of collapsing allopatric sibling species on macroevolutionary speciation rates in scaled reptiles (Squamata). We also explore the theoretical utility of using geographic range in disentangling distinct facets of the speciation process.

A-0467 (Oral)
Non-Species-Specific Calls of Geckos are Sexually Selected Indicators of Male Quality

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Gekko japonicus species group is a group of geckos consisting of < 37 species distributed in East and Southeast Asia including Japan. Previous studies have shown that many species can discriminate species by the species-specific pattern in courtship calls, while several species have lost regular patterns in the calls, making it impossible to recognize species by the calls. Communication signals, including animal calls, usually cease to be used for communication when they lose their function and no longer convey information. Despite this, the males of the patternless call species still emit a call in the courtship with conspecific females and its reason is unclear. We hypothesized that the patternless calls are specialized in intraspecific mate selection and convey information about the quality of the males as a mate. To test this, we examined the correlation between male traits indicating mate quality and call traits, and evaluated the female preference toward calls using four *Gekko* species, two having species-specific calls and the remaining two having patternless calls. Bite force of males was measured as a trait indicating mate quality. Male calls were recorded and female preferences toward the calls were quantified by playback of the higher and lower dominant frequency calls of conspecific males. No correlation was detected between bite force and dominant frequency in males of the pattern call species, and females of these species showed no preference for the dominant frequency of the calls. In contrast, males of the patternless call species with a greater bite force called at a lower dominant frequency, and the females significantly preferred lower dominant frequency calls. These results suggest that the patternless call species use the frequency of male courtship calls to inform mating quality, and that the females of these species select mates by preferring lower calls.

A-0468 (Oral)
Utilizing Snake Rescue Data to Understand Snake-Human Conflict

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A crucial aspect of understanding snakebite is the overlap between the snake and human activities. However, there is a heavy reliance on research into venom and on snake-human conflict models that depend on hospital bite data. There is also an absence of any data regarding where within the confines of rural landscapes snake-human conflicts occur. An issue with collecting these data is the lack of a simple and efficient methodology that can be replicated with little error. Some studies have developed a methodology to estimate high-risk areas of snake conflict, although these do not typically use distributional information on snakes. One opportunity to collect such data is via snake rescue calls. When snakes are caught during rescue calls, data derived from these events can potentially provide a large amount of relevant information. The following study looks to utilise rescue data collected from July 2020 to October 2022 in Hooghly, West Bengal, India. We combined the rescue data along with climatic data for the same period to test the correlation of environmental patterns to rescue patterns in both a spatial and temporal context. The results from this study help provide further context to the snake-human conflict present in the region and show the value of using a low-cost method of collecting snake-human conflict data via snake rescue calls.

A-0469 (Oral)

An Overview of 21st Century Systematic Studies on the Snake Fauna of the Western Ghats, India

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The Western Ghats Escarpment of southwestern India (8-21N, 73-77E; 2,695 m asl, 1,600 km) is a mega-diverse region of late Cretaceous origin with habitats ranging from dry to wet montane forests along latitudinal, longitudinal and elevational clines. From snakes described by Linnaeus (1758), the history of inventory here dates back > 250 years! Since the turn of this century, the timeline of new snake descriptions is: 2007, *Lycodon flavicollis* (Anaikatti), *Xylophis captaini* (Kottayam); 2011, *Dendrelaphis ashoki* (Anaimalai), *D. girii* (CastleRock); 2012, *Calliophis castoe* (Amboli); 2013, *Boiga flaviviridis* (Brahmapur, but recorded in Western Ghats); 2016, *Melanophidium khairei* (Amboli); 2017, *Rhabdops aquaticus* (Amboli); 2018, *Uropeltis bhupathyi* (Anaikatti); 2019, *Boiga thackerayi* (Humbarli), *Proahaetulla antiqua* (Agasthyamalai); 2020 *Ahaetulla borealis* (CastleRock), *A. farnsworthi* (Bhadra), *A. malabarica* (Brahmagiri), *A. sahyadrensis* (Castle Rock), *A. travancorica* (Peppara), *Rhinophis karinthandani* (Lakkidi), *R. karinthandani* (Mananthawady), *Xylophis mosaicus* (Eravikulam); 2021, *Craspedocephalus peltopelor*, *C. travancoricus* (both Peppara), *Xylophis deepaki* (Marthandam); 2022, *Oligodon tillacki* (Kurduvadi, but found in Western Ghats); 2023 *Sahyadriophis uttaraghati* (Amboli), *Uropeltis tricuspida* (Munnar). From 2000 to 2023, 25 new species, two new genera (*Proahaetulla, Sahyadriophis*), one new subfamily (Xylophiinae) were described. These belonged to Uropeltidae, Pareidae, Natricidae, Elapidae and Colubridae. This equates to more than one new species an year. During 2000–2006, no new snake was described, while in 2020 as many as eight were described. Most of these were stand-alone findings but some (*Ahaetulla, Craspedocephalus*) resulted from comprehensive, range-wide

sampling-based revisions. Our collective on-going work would aim to describe new species in taxa ranging from the iconic king cobra, *Ophiophagus* to a few unassuming fossorial uropeltid snakes, all from the Western Ghats. It is hoped that future studies would further enrich the Western Ghats snake fauna.

A-0471 (Oral)
Do Small-Scale Ground-Mounted Photovoltaic Systems Affect the Land Use of Amphibians and Reptiles within Anthropogenic Areas?

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Green energy systems have changed the structure of the anthropogenic landscape which affects the resources and conditions of the fauna living in it. The ground-mounted photovoltaic systems (PV systems) are commonly built in deserts, and grasslands in some countries. Taiwan, however, faces the challenge where limited area could be utilized. In addition, many designated sites lie beside paddy fields and rural villages. The PV systems could change the distribution and behavior of amphibians and reptiles due to alterations in environmental conditions such as temperature and humidity. Therefore, this research examines whether different land uses affect the utilization of amphibians and reptiles. The study site was located in Fenglin Township, Hualien County, Taiwan. Sixty-six hectares of PV system, SF Power Corporation, is located among the mosaic landscape including artificial forest, paddy fields, farmlands, and orchards. Transect line survey was conducted from June 2022 to November 2023 to search for amphibians and reptiles at night. The preliminary result suggested that frogs, lizards, and snakes were active among different land use in different seasons. The frogs, lizards, and snakes were most active in paddy fields in spring, orchards in summer, PV systems in fall, and not many individuals remained active in winter. Small-scale PV systems potentially contain advantages and disadvantages for amphibians and reptiles. Solar panels can provide shade and warm environment that benefits amphibians or reptiles to remain active in cold seasons. The distribution of the amphibians and reptiles, however, suggests that amphibians and reptiles are scattered around the anthropogenic landscapes. Indicating that most individuals frequently move around the area which could increase energy consumption and decrease the survival rate. Through habitat management, the PV systems may act as ecological buffer zones to preserve local biodiversity and provide better conditions for the living fauna.

A-0472 (Poster)
Observations on the Thermal Biology of the Malayan Box Turtle, *Cuora amboinensis*

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As ectotherms, turtles are assumed to depend on environmental temperature to regulate body temperature, critical for physiological processes. The Malayan Box Turtle, *Cuora amboinensis* is a small, semi-aquatic species, largely restricted to standing water bodies of south-east Asia. The species is currently listed as Endangered in the IUCN Red List due to its heavy exploitation for food and the pet trade. However, its ecology has not been studied in detail, and consequently, little is known of its conservation and management needs. The current study was conducted in the campus of Universiti Malaysia Sarawak, in Kota Samarahan, Sarawak, East

Malaysia, to test for the possible effects of ambient, substrate and water temperatures on body temperature of the focal species, as well as to better understand strategies used for thermoregulation, using radio-telemetry. The results of regressions of external temperatures on the surface temperature of the turtle versus substrate temperature ($R = 0.988$; $P < 0.05$), water temperature ($R = 0.837$; $P < 0.05$) and ambient ($R = 0.816$; $P < 0.05$) indicate thigmothermy as the primary mode of thermoregulation, while heliothermy too was important as a secondary strategy. These findings contribute to the knowledge of the biology of *C. amboinensis*, and potentially, to future management strategies.

A-0474 (Oral)
Monitoring Seasonal Cycles of Physiology and Behavior in Big Lizards using Biologgers and Body Scan

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This presentation will address the annual cycle of energy metabolism (expenditure and reserve) that supports the physiological oscillations that occur in environments driven by predictable seasonal climate variations. In this case, many species concentrate energy investments for reproduction in a single phase of the year, when resources are abundant. The tegu Salvator merianae is among the largest lizards in South America and has a robust annual cycle of metabolism and behavior. These tegus reproduce only during spring, a phase characterized by high levels of motor activity, heart rate and egg production. During this season, the highest blood concentrations of hormones, both sex and related to energy recruitment, are observed. This peak of activity is preceded by profound metabolic depression in hibernation during the mild and dry winter. It will be shown that the minimally invasive approaches used (muscle biopsy samples, body composition scans, blood samples, temperature and locomotor activity dataloggers) allowed long-term monitoring of the same individuals, for at least one year. Cellular mechanisms of thermogenesis (mitochondrial activity) and body composition (fat, lean and mineral mass) to support the costs of reproduction, as well as their hormonal signaling, of this species will be the main topics covered here. Financial support: FAPESP-SP-Brazil; NAU-USA; CNPq-Brazil.

A-0475 (Oral)
Revelation and Escape, the Role of Flash Colours in Antipredator Behaviour for a Frog

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Flash colours are concealed, bright or contrasting patches, revealed during movement. They are associated with antipredator behaviours, evolving repeatedly and independently across a wide range of taxa. The prevailing hypothesis on the function of flash colours posits that sequential revelation and concealment of colour in movement will affect a predator's search image, reducing the probability of detection during escape. However, testing of this hypothesis is limited and the function of flash colours in this context remains poorly understood. We conducted two experiments using a naïve predator (day-old chicks) to determine if deployment of flash colours during escape reduces detection or impedes an attack. Our model prey was based on Green and golden bell frogs (*Litoria aurea*), a species known for diurnal activity, with spectral reflectance data collected from both males and females used to select the flash colour for the experiments. These data were also used in visual modelling we conducted to

ensure the targets would be visible to an average avian predator. Contrary to expectation, neither of the experiments confirmed that deployment of flash colours increased latency to detection, with one experiment showing a significant decrease in latency suggesting flash colours provide an advantage to the foraging predator rather than the prey. In these experiments, deployment of flash colours in isolation was not a successful anti-predator tactic, possibly because their effectiveness is dependent on other factors of movement such as speed, distance, and trajectory. Environmental factors (availability of cover), or the possibility that they are used in combination with other antipredator tactics should also be considered. This perplexing result highlights the need for further investigation into the function of flash colours in predator–prey interactions.

A-0476 (Oral)
Hibernation during Dry Winter does not Depend on the Hydration State in a Neotropical Lizard

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The availability of water and food and temperature are critical factors that influence physiology and survival of animals, acting as selective pressures within the capacities and tolerance of organisms. Several animal species reduce their metabolic demands to save energy to face cyclic phases of reduced water and/or food availability. The Tegu, *Salvator merianae* is a large lizard common in South America that exhibits notable seasonal physiological oscillations, characterized by high metabolic activity in spring and summer, followed by gradual reductions in autumn and minimal activity in winter. Tegus are abundant in the southeastern region of Brazil, where winter coincides with the dry season. There is clear evidence that the metabolic reduction in these lizards is independent of ambient temperature, but the influence of water availability on this phenomenon has not yet been explored. Therefore, this presentation will focus on our recent findings comparing hydrated and dehydrated male and female tegus during the autumn, winter and spring. Monthly assessments included plasma osmolality, hematocrit, ammonia and urea concentrations, body mass, body temperature, activity rate, and exploratory behaviors. The lack of effect of the hydration state on the winter metabolic depression in tegus will be discussed in an ecophysiological and evolutionary context. Financial support: FAPESP-SP-Brazil; CNPq-Brazil.

A-0477 (Oral)
Too Much or Too Little Information in Animal Coloration?

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Elaborate coloration in animals are a fascinating expression of phenotypic variation. Many hypotheses have been proposed to explain this but at the core, conspicuous colours and patterns and are thought to have evolved and be maintained because they have ecological function or are indicators of biological information. Here, I'll present data, wherein we explore potential information content in the colours and patterns of lizards and anurans. Males of the Indian rock agama (*Psammophilus dorsalis*) dynamically change colours during social signalling, and predation trials in the wild indicate that these conspicuous colours are risky. Despite expectations of their utility as social signals, we find that colours during aggression only predict testosterone levels but not body performance. In the gecko *Cnemaspis mysoriensis*, males

express both chemical and visual traits that receivers can perceive. Both these traits are correlated with parasite load, but surprisingly, females only utilise one modality when assessing males. At the much broader phylogenetic scale, I will present our exploration of whether body and iris colours and patterns in anurans are correlated with habitat (aquatic, terrestrial), habit (nocturnal, diurnal), or biology (parental care). Despite the expectations of an association between animal form and environment or function, we find that the myriad colours and patterns across anurans globally are mostly uncorrelated with the ecology of the species. Overall, through these multilevel explorations of information content in the colours of lizards and frogs, we are left with an interesting conundrum – are striking colours less functional that we think they are?

A-0478 (Oral)

A Review of Geographic Variation in Japanese Fire-Bellied Newt *Cynops pyrrhogaster*

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The geographic differentiation of Japanese fire-bellied newt *Cynops pyrrhogaster* was studied based on external morphology and reproductive behavior in the 1960s and allozyme variation in the 1980s and 1990s. As a result, it has been reported that the species can be divided into several distinct local populations. In the last two decades, the geographic variations have been investigated by mitochondrial DNA sequencing, microsatellite maker, and SNP analyses, and considerable light has been shed on the actual situation of variations in this species. In this presentation, we will review the recent studies of geographic variations in the Japanese fire-bellied newt, that have revealed the state of hybrid zones, reticulate evolution, and cytonuclear discordance among the local populations.

A-0480 (Poster)

Paleotemperature-Dependent Diversification in *Hemidactylus* Geckos Supports the Metabolic Theory of Biodiversity

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Understanding the causes and consequences of diversification processes is one of the central themes of macroevolutionary research. The slowdown in diversification rates over time has been reported in many animal groups. This slowdown can be caused by decreased speciation or increased extinction rates. Several abiotic and biotic factors have been identified that can cause a slowdown of diversification rates, such as temperature, time, and diversity dependence. Surprisingly, the prevalent cause of diversification rate slowdown and how it affects the speciation and extinction rates is unclear. *Hemidactylus* is one of the most speciose gecko genera with a global distribution. The lack of a global phylogeny has limited the understanding of the macroevolutionary dynamics of this group. We mined GenBank to assemble the latest chronogram of this group with improved taxon coverage (~75%) to understand the tempo and mode of diversification. We detected a slowdown in the net diversification rate of *Hemidactylus* towards the present without any significant rate shift. In order to investigate the potential causes of this slowdown, we tested several time-dependent, temperature-dependent,

and diversity-dependent models of speciation and extinction rates implemented using the packages Rpanda and DDD. The paleotemperature-dependent models overall performed better than time or diversity-dependent models. The best model suggests a dependence of speciation rate on paleotemperature and a constant extinction rate through time. Our study is thus one of the few that provides empirical support for the Metabolic Theory of Biodiversity, which suggests that speciation rates positively depend on temperature for ectotherms and a slowdown is expected during cooling in the Cenozoic climate.

A-0481 (Oral)

The Drivers of the Contrasting Diversity and Distribution Patterns between two Sister Genera of Geckos: A Case Study using *Hemidactylus* and *Dravidogecko*

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The asymmetry in the Tree of Life has attracted much attention in the last decade, and investigating such patterns might give us insights into the processes that shape biological diversity through space and time. The gecko genera *Hemidactylus* and *Dravidogecko* display extreme disparity in species richness (192 vs eight species, respectively) and distribution (cosmopolitan vs endemic to the Western Ghats in India respectively) despite being sister groups. In order to test potential hypotheses regarding this contrasting pattern, we mined GenBank to assemble a chronogram of these groups with improved taxon coverage (~85%). We gathered data for three biotic and abiotic factors that differ significantly between *Hemidactylus* and *Dravidogecko* from different databases (GBIF, WorldClim, ReptileDatabase and published literature) — dry vs wet (mean annual precipitation across the range), presence vs absence of tubercles, and body size. We employed trait-dependent dispersal models implemented using the BioGeoBEARS package to test these characters' effect on dispersal. Trait-dependent diversification models (BiSSE, HiSSE and QuASSE) were employed to test if these characteristics differentially affect diversification. The results suggest a strong correlation between bigger body size and higher dispersal rates, while the diversification analyses show higher speciation rates associated with tubercles and dry habitats. Our study thus postulates that the evolution of relatively bigger body size might have allowed *Hemidactylus* to disperse more, whereas adaptation to drier habitats along with presence of tubercles elevated the diversification rates, giving it a competitive advantage over its sister group *Dravidogecko*. This study highlights the importance of comparative studies in elucidating the causes of such extreme asymmetry within the Tree of Life.

A-0483 (Oral)

Detection of Pathogens in Amphibians in Brandenburg, Germany

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Amphibian numbers in the state of Brandenburg, Germany appear to be in decline in recent years. In order to evaluate whether infectious agents might play a role in the population dynamics of various species in the region, amphibians along fences and in their habitats were sampled in 2023 and tested for five pathogens by real-time PCR. A total of 310 skin swabs

from four anuran and two caudata species were sampled at 32 locations and screened for *Batrachochytrium dendrobatidi*s (Bd), *B. salmandrivorans* (Bsal), ranaviruses, bufonid herpesvirus 1 (BfHV1), and ranid herpesvirus 3 (RaHV3). Bd was detected in 27 (8.71%), BfHV1 in 103 (33.23%) and RaHV3 in 2 (3.23%) samples. Neither Bsal nor ranaviruses were detected in any of the samples. Bd was found in *Bombina bombina* (45.83% positive) and *Pelophylax esculentus* (23.19% positive). BfHV1 was detected in *Bufo bufo* (90.53% positive), *Pelobates fuscus* (20% positive), and *Triturus cristatus* (10.53% positive). RaHV3 was found in a *Triturus cristatus* (1.8% positive) and a *Pelophylax esculentus* (1.4% positive). BfHV1 appears to be very common among toads in eastern Germany, while Bd is common in specific species, and RaHV3 was found sporadically. Although BfHV1 and RaHV3 have previously each only been found in single species (*Bufo bufo* and *Rana temporaria,* respectively), both were found in samples from other species during this study. Additional studies are needed to confirm this expanded host range as well as to evaluate the impact of each of these infectious agents on the amphibian populations studied. Since amphibian population in the study area have decreased markedly in recent years, understanding the possible role of infections in the health of these animals is an important component of conservation efforts.

A-0484 (Poster)

Species Differences and Factors Influencing Chytrid Infections in Northern Germany

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The invasive fungi *Batrachochythrium dendrobatidis* (Bd) and *Batrachochytrium salamandrivorans* (Bsal) are emerging pathogens threatening amphibian populations in various parts of the world. Monitoring their distribution, evaluation of particularly vulnerable species, and understanding factors that influence the distribution are important tools for developing mitigation strategies. In this study, skin swabs were collected from three different amphibian species- 130 Water frogs (*Pelophylax* spp.); 78 Common toads (*Bufo bufo*) and 147 Smooth newts (*Lissotriton vulgaris*) at four locations in Schleswig-Holstein, Germany, during the spawning seasons 2022 and 2023. Samples were tested for Bd and Bsal via PCR. The Bd prevalence differed significantly ($p < 0.0001$) between the species (50.0% Water frogs; 1.28% Common toads and 0% Smooth newts). The detection rate varied significantly ($p < 0.0001$) between the locations (2.33% to 36.27%) as well as between the months of sampling (0% in March to 40.16% in May). The prevalence decreased from 2022 (19.40%) to 2023 (17.53%), but not significantly ($p = 0.6535$). Bsal was not detected in any of the samples. There was a stark difference in Bd detection rates even among sympatric animals, reflecting differences in susceptibility between the individual species. Further studies are necessary to determine the prevalence of chytrid fungi in other species, areas and time points and to investigate the causes for the observed differences. The differences noted in detection rates between months may be associated with amphibian behavioural ecology, such as migration and reproductive behaviours and deserve further study.

A-0485 (Oral)
Are Sea Snakes Limited to Specific Aquatic Environments?

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While we know that over 70 species of sea snakes occur in aquatic environments from the east coast of Africa to the west coast of America (a few specimens also found on the West coast of Africa), the question remains - what kind of environment do the different species prefer? Some studies suggest that sea snakes require freshwater and specific water temperatures and may have problems with high salinity. For a long time, it was commonly believed that sea snakes only inhabited shallow waters and were mainly found in coral reefs. There was even a humorous belief among divers that sea snakes couldn't open their mouths wide enough to bite divers, except in the earflap or between the fingers. In this presentation, I will challenge these ideas and provide case studies demonstrating that sea snakes are more opportunistic than previously thought.

A-0487 (Oral)
And the Snakes Shall Inherit the Earth: Ecophysiological Modeling Suggests Rattlesnakes Will Be Resilient to Climate Change

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Global climate change is impacting wildlife in complicated ways, with many populations suffering or going extinct due to increased temperatures. However, some organisms live in areas that are much cooler than their preferred temperatures, suggesting that rising temperatures could benefit these animals by increasing their annual activity periods, energy acquisition, and other variables. Using body temperature data from free-ranging male Western Rattlesnakes are four sites in coastal California, we show that habitat thermal quality will rise due to climate change and snakes will enjoy more time near their preferred body temperatures. In addition, we are currently analyzing body temperature data from a high-elevation population of Prairie Rattlesnakes, focusing on pregnant and non-pregnant females. We will discuss how factors including sex, body size, habitat temperature, elevation, and other factors impact body temperatures and projected energy budgets of rattlesnakes.

A-0488 (Oral)
Squamate Skin: An Oft-Overlooked Hydroregulation Organ

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The amniotic egg and protective skin were key to the evolution of terrestrial life. Reptile skin therefore has a reputation for being water-tight. However, their skin is an oft-overlooked hydroregulation organ that is capable of losing water for thermoregulatory and other functions. Cutaneous evaporative water loss has historically been difficult to study due to methodological constraints. Recent advances in technology have facilitated comparative studies that accurately quantify plasticity in water loss across the skin. I will present an overview of several projects showing how squamate skin permeability to water varies among body regions, among species, and is impacted by ambient conditions, hydration, and acclimation.

A-0489 (Oral)
Too Few Rock Geckos? Field Ecology of the Saxicolous *Cnemaspis nigridia* in Sarawak

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With the application of genetic identification, the endeavour of discovering and delineating species (lineages and species complexes) has been the main pivot in systematics. The south-east Asian *Cnemaspis* group, despite being species rich elsewhere, had a mere five described species from the island of Borneo in 2017. In an effort to document the distribution and natural history of the species in Sarawak, we reported of underestimated diversity within the Bornean lineage. Based on a combination of morphological and mitochondrial NADH dehydrogenase subunit 2 (ND2) data, we described three new species inhabiting limestone formations in Serian District and Mulu District, Sarawak, east Malaysia. Further work is ongoing. To better understand the thermal and fine-scale microhabitat requirements of these geckos, we conducted field study on *Cnemaspis nigridia* in Gunung Gading National Park, Lundu District, western Sarawak, using temperature-sensitive radio transmitters. A generalized linear model indicates thermoconformity in the species, with a mean T_b of 24.8°C, and a range of 22–27°C in the months of June and August 2023. The availability of suitable microclimates appears to play an important role in determining the placement of these geckos in space and time. The species were found utilizing shallow or deep locations within granite scree structures, that were cooler than ambient temperatures outside. This study highlights the importance of investigations of microhabitat requirements of saxicolous species in order to enhance both our understanding of the evolutionary history and biogeography in Borneo and Southeast Asia, and derive information appropriate for their conservation and management.

A-0490 (Oral)
Spaghetti and Sausages: A Nonadaptive Radiation of Australian Blindsnakes

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The Australo-Papuan blindsnake genus *Anilios* comprises 47 recognised species, of which 46 species are distributed in Australia. Blindsnakes are thought to be morphologically and ecologically conserved, however, no study has extensively quantified their morphological and ecological variation. In this study, we used phylogenetic, ecological, and morphological data to investigate if the *Anilios* blindsnake radiation can be considered adaptive or nonadaptive. Analyses based on linear and 2D geometric morphometrics revealed the main axis of morphological variation is the ratio between body width and length. Variation in body shape ratios negatively correlate with increase in aridity and soil bulk density. We found low geographical overlap across the phylogeny, suggesting that species are generally distributed in allopatry. Ecological niche similarity decreased with relative age of speciation events, suggesting closely related species have a high degree of ecological niche conservatism. Based on these lines of evidence, we argue that the Australian blindsnake radiation is a nonadaptive radiation. Our study offers insights into how phylogenetic niche conservatism can also drive speciation in a morphologically conserved group on a continental scale.

A-0491 (Oral)
Habitat and Salt Tolerance in Stem-Lissamphibians and other Paleozoic Limbed Vertebrates

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It is now clear that the ancestors of tetrapods were coastal, marine taxa. These, however, are stem-tetrapods, and there is less consensus about the habitat of stem-lissamphibians (extinct taxa that are more closely related to lissamphibians than to amniotes, but that are not part of Lissamphibia). Indeed, a controversy on the degree of marine influence in the paleoenvironment represented by many Paleozoic stegocephalian-bearing fossiliferous localities has persisted for decades. Many authors have equated the absence of a typical stenohaline marine fauna with freshwater environments, but this ignores continental salt lakes and the many transitional environments (deltaic, estuarine, lagoonal, and some epicontinental seas that receive much freshwater influx, like the Baltic Sea) that separate typical marine environments from freshwater environments. This is problematic because it seems plausible that many of the late Paleozoic sediments that have been preserved were deposited on coasts in deltas and estuaries. An updated dataset and new analysis based on a literature review shows that the case for a marine origin of stegocephalians has strengthened, especially through additional discoveries or reinterpretations of fossils that suggest marine influence in various classical vertebrate-bearing Permo-Carboniferous localities, and a recent analysis of stable isotopes in Late Devonian localities. Similarly, some recent studies confirm the marginal-marine habitat of other taxa (such as horseshoe crabs, eurypterids and microconchids, often erroneously reported as "Spirorbis" in the older literature) often associated with early amphibians. These data suggest that the ancestors of lissamphibians remained fairly salt-tolerant until at least the Early Permian, less than 300 Ma ago.

A-0492 (Oral)
Early Evolution and Paleobiogeographic Distribution of Pipimorphs Reflects the Opening of the South Atlantic

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Pipimorpha and its crown-group Pipidae possess one of the most extensive fossil records among anurans, which extends into the Early Cretaceous in both Laurasia and Gondwana. This is probably linked to the highly aquatic lifestyle of pipids, which is probably also characteristic of early pipimorphs. In South America, pipids are currently represented only by *Pipa*, but the fossil record documents an evolutionary radiation of Shelaniinae (a taxon endemic to South America) in the Cretaceous; shelaniines seem to have become extinct in the Eocene. Fewer pipimorph fossils are known from Africa. Our recent redescription of the mid-Late Cretaceous (Coniacian–Santonian) taxon Pachycentrata taqueti from In Becetèn (Niger) partly fills this gap. Our new phylogenetic analysis of Cretaceous and Paleogene pipimorphs shows that this taxon diversified in a West Gondwanan block until about the mid-Cretaceous, but after that, pipimorphs show two distinct evolutionary radiations, one in South America (Pipinae), and the other (Xenopodinae) in Africa. This pattern appears to reflect the breakup of West Gondwana simultaneously with the opening of the South Atlantic during the Cretaceous. This probable vicariant pattern yields slightly different ages for the South Atlantic opening depending on the accepted topology. The tree constrained to reflect the topology of extant taxa supported by molecular data shows a last dispersal between both continents before the Cenomanian (more than 100 Ma), whereas the unconstrained topology that reflects only morphological data is compatible with a more recent last faunal dispersal among pipids. Under this unconstrained topology, the fossil record is too poor to give a reliable minimal age for this last dispersal, but molecular dating analyses suggest that this event harks back to the Mesozoic.

A-0493 (Oral)
Solving the Island Paradox: Integrating Genomics, Functional Morphology, and Wall Lizards

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Island populations often face genetic challenges because of limited genetic diversity due to founder effects, inbreeding, genetic drift, and sequential bottlenecks. Despite this, they are often found to thrive, reaching high densities and adapting to the environment. This is paradoxical, as low genetic diversity can lead to inbreeding depression, harming fitness and adaptability. This raises the question: how do island populations, despite their genetic impoverishment, manage to persist, adapt, and thrive? Populations of the Italian wall lizard, *Podarcis siculus*, offer a compelling system for investigating and elucidating this "Island Paradox". The species is native to mainland Italy and also occurs on a large number of Mediterranean islands, where it displays remarkably high population densities despite reduced genetic diversity. Here, we aim to unravel the mechanisms underlying the island paradox using *P. siculus* as our model system. Our study will involve examining the demographic history and genetic diversity levels of both island and mainland populations using whole-genome

sequencing data, as well as assessing levels of inbreeding depression through comprehensive functional morphological analyses. Preliminary results show that lizards from the island populations have higher proportions of their genome in runs of homozygosity, indicative of inbreeding. Additionally, they also show reduced reproductive performance. Furthermore, we will explore whether purging of highly deleterious alleles may have alleviated the burden of inbreeding depression in these lizards using both genetic and phenotypic insights. Lastly, we will quantify whether relaxed selection masks the detrimental effects of inbreeding. By employing island populations of *P. siculus* as our study system, we can leverage their unique evolutionary history and biology to shed light on how island populations manage to overcome genetic constraints.

A-0494 (Oral)
The Tadpoles of Borneo

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Despite the pivotal role tadpoles play in the life-cycle of frogs, they have been largely overlooked in herpetological research. Numerous countries and regions lack comprehensive inventories and detailed descriptions of their tadpole fauna. Addressing this knowledge gap, we commenced in 2003 compiling an inventory of Bornean tadpoles. Achieving complete coverage proved impossible, however, our efforts resulted in the documentation of larvae from 99 distinct species. In this presentation, we present a broad overview of the Bornean tadpole diversity. We particularly highlight the diverse and amazing ecomorphological guilds and their habitats. Beyond the scientific results, we comment on challenges encountered during the study of tadpoles in Borneo's unique ecosystem. We share insights into the "Tadpoles of Borneo" project and lessons gleaned from it. This presentation aims to underscore the importance of including these often-neglected aquatic larvae in broader conservation and biodiversity management strategies.

A-0495 (Oral)
Reproductive State Impacts the Thermal Ecology of Female Rattlesnakes at a High-Elevation Site

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Temperature is a primary factor influencing development of organisms, and the fluctuating daily and seasonal thermal regimes of temperate climates may challenge the ability of

viviparous reptiles to optimize body temperatures during gestation. Testing how viviparous reptiles navigate temperate thermal conditions (e.g., with long winters, cold nights, and/or highly fluctuating temperatures) is a powerful way to understand how they behaviorally use specific microhabitats for thermoregulatory benefits. We assessed the thermal ecology of pregnant and non-pregnant female Prairie Rattlesnakes (*Crotalus viridis*) inhabiting a high-elevation, montane shrubland in northwest Colorado throughout their short summer active season, addressing the thermal consequences of microhabitat selection with a particular focus on thermoregulation of pregnant females at communal rookery sites. We deployed operative temperature models to collect data on the thermal quality of microhabitats used by the snakes, and we calculated their thermoregulatory accuracy by comparing a snake's field-active body temperatures with preferred body temperatures of snakes in a thermal gradient. Pregnant females chose rocky, hilltop rookeries that had higher thermal quality due to higher and less variable nighttime temperatures compared to microhabitats in the surrounding prairie. Due to site choice and lower preferred temperatures, pregnant females thermoregulated more accurately than non-pregnant females. This was most pronounced during the night, when pregnant females at rookeries maintained higher body temperatures than non-pregnant snakes in the prairie. Our results support the hypothesis that one major reason that female rattlesnakes at high-latitudes and/or high-elevations gestate at communal, rocky, hilltop rookeries is that, relative to prairie microhabitats, they provide more stable conditions for thermoregulation.

A-0497 (Oral)

A Critical Assessment of the Factors Driving Satellite Behavior in Anurans

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Satellite behavior, where non-signaling individuals near conspecific signalers intercept mates attracted towards the signal as an alternative reproductive tactic, seems to be limited to a relatively small number of species of anurans. At the most fundamental level, it has been recognized that reduced competitive ability leads to individuals resorting to non-signaling strategies, but which drivers promote satellite behavior in some species, but not in others, is unclear. Focusing on anurans, we evaluate current evidence supporting the role of signaling costs proposed to select for the evolution of satellite behavior. Energy conservation and increased predation risk by eavesdropping enemies have long been considered important drivers of this alternative tactic, but other ecological factors and their interplay have received limited attention. Ultimately, we offer a conceptual framework that identifies intrinsic and extrinsic factors modulating intrasexual competition, predation risk, and nutritional constraints to promote satellite behavior. By broadly examining the literature on satellite behavior, we critically assess the ecological factors proposed to modulate this behavior and the current evidence to support such effects in disparate taxonomic groups. Considering the role of phenotypic plasticity and fluctuating ecological environments in driving satellite behaviour, we provide a new perspective that incorporates dynamic variation in selective pressures. We propose that ecological crossovers, for example, can provide valuable opportunities to examine the expression of satellite behavior. We highlight current gaps and fertile future research venues to deepen our understanding of satellite behavior and the role of eavesdropping predators in shaping this recently ignored alternative reproductive tactic.

A-0498 (Oral)

Behavioral Strategies used by Frogs in Northern Borneo to avoid being Parasitized by Frog-Biting Midges

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The advertisement calls of anurans are subject to eavesdropping by illegitimate receivers such as parasites. Here I report on the selective pressures that act on anuran advertisement calls and calling behavior from frog-biting midges (Corethrellidae: Diptera) from northern Borneo. Frog-biting midges feed on blood and can be vectors of trypanosomes and thus are predicted to have a significant influence on the design of frog advertisement calls and calling behavior. I use quantitative bipartite host-ectoparasite networks and acoustic playback experiments to explore this unusual relationship. In studies ranging over 15 years, midges were collected directly from calling frogs and with traps broadcasting frog advertisement calls and pure tones. Nine species of frog-biting midges were found to bite 23 species of frogs. Frogs with advertisement calls below 4 kHz were bitten more, suggesting a significant cost to calling in these species and an upper limit in the hearing threshold of most midges. At the species level, the specialization of midges as well as their frog hosts was highly variable. Experimental studies using sound traps broadcasting at high rates, high amplitude, and 4 m above ground were more attractive. Furthermore, since frog-biting midges are only active at night, frogs calling in the late afternoon, before sunset, never attracted frog-biting midges. Thus, reduced call rate, calling more quietly, calling higher above ground, and calling during the late afternoon are behavioral strategies that reduce the incidence of parasitism in Bornean frogs.

A-0499 (Oral)
The Lampe Collection and the Herpetological Heritage of the Zoological Museum of Wrocław

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Johann Ludwig Christian Carl Gravenhorst (1777–1857) was a prominent German herpetologist and entomologist who spent most of his career at the University of Breslau in Prussian Silesia (now Wrocław, Poland) where he established a Zoological Museum based on his own large private collection. The oldest part of the collection was derived from the collection of Johann Bodo Lampe of Hannover, which was purchased by Gravenhorst in 1804. This had been studied by Johan Gottlob Schneider (1750–1822) in the late 18th century, and at least 25 species covered in his Historiae Amphibiorum (1799–1801) were represented by Lampe material. Much of this material was also documented by Gravenhorst in his important 1829 and 1851 monographs based on the collection. We attempted to use a combination of published and unpublished sources, as well as a thorough search of the collection in Wrocław, to identify any surviving specimens from the Lampe collection. However, much of the collection was destroyed in 1945 when the city of Breslau, including the Zoological Museum, was besieged and bombed by the Soviet Army. As a consequence, most older specimens are unlabeled and accompanied by little or no data. Nonetheless, we were able to locate one

specimen of *Scincus sepiformis* (= *Tetradactylus seps*) that appears to unambiguously originate from the Lampe collection. We also identified several additional putative Lampe specimens, located many specimens from the period of Gravenhorst's curatorship and found evidence to explain how and why some of the Lampe collection is present in the Museum für Naturkunde, Berlin (ZMB) today. A surviving copy of the 1818 herpetological catalogue of the Breslau collection in the ZMB archives augments much later catalogues still extant in the Museum of Natural History, University of Wrocław (MNHW) and provides a snapshot of the collection shortly after its founding as a university museum.

A-0500 (Oral)
Global Exposure Risk of Anurans to Increasing Drought and Warming

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Species exposed to prolonged drying are at risk of population declines or extinctions. A key missing element for assessments of climate change risk is the sensitivity of species to water loss and their microhabitat preference, or ecotype, as both dictate the risk of environmental drying. Here, we identified globally where water-sensitive ectotherms, i.e., anurans, are at risk to increasing aridity and drought, examined which ecotypes are more sensitive to water loss from 238 species, and estimated how behavioural activity is impacted by future drought and warming scenarios through biophysical models. Under an intermediate and high emission scenario, 6.6 and 33.5% of areas occupied by anurans will increase to arid-like conditions, and 15.4 and 36.1% are at risk of exposure to a combination of increasing drought intensity, frequency, and duration by 2080–2100, respectively. Critically, increasing arid-like conditions will increase water loss rates and anurans in dry regions will almost double the water loss rates under a high emission scenario. Biophysical models showed that during the warmest quarter of the year, the combination of drought and warming reduced an anuran's potential activity by 17.9% relative to the current conditions compared to warming alone which reduced potential activity by 8%. Our results exemplify the widespread exposure risk of environmental drying for anurans, posing a serious challenge for the lives of water-sensitive species beyond the effects of temperature alone.

A-0501 (Oral)
A Peek into the World of Indonesia's Protected Amphibian: Bleeding Toad (*Leptophryne cruentata*) Population and Habitat Insights

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Indonesia is home to the bleeding toad (*Leptophryne cruentata*), the only protected amphibian species classified as Critically Endangered by the IUCN Red List. Information regarding the population and habitat characteristics of this species is notably scarce. The primary objective of this study is to analyze the population and habitat characteristics of the bleeding toad. This study represents a comprehensive effort conducted across 11 habitat sites within the Gunung Gede Pangrango National Park. The surveyed locations encompassed both previously identified habitat sites and newly discovered locations. Population data were gathered utilizing the Visual Encounter Surveys (VES) method, with observation periods conducted both during the day and at night. Habitat characteristic data were collected by measuring various parameters including air temperature, humidity, water temperature, pH, current speed, river width, river depth, and canopy density at each habitat site. Across these sites, a total of 911 individuals were encountered. The daytime population abundance ranged from 0.15 ± 41 indiv/100m, while during the night, it ranged from 2 ± 52 indiv/100 m. The habitat of the bleeding toad is confined to altitudes ranging from 1,281 to 1,892 m above sea level (mdpl). The environmental conditions within this habitat exhibit specific characteristics, including air temperatures ranging from 15.81 ± 20.86°C, humidity levels averaging between 79.34 ± 98.73%, water temperatures ranging from 15.80 ± 21.49°C, pH levels between 6 and 7, current speeds ranging from 0.04 ± 1.33 m/s, river widths varying from 0.5 ± 12.5 meters, river depths spanning from 0.01 meters to 0.8 meters, and canopy densities averaging 33.33 ± 100%. This study offers an updated assessment of the present population and habitat characteristics of the bleeding toad. It reveals that these toads tend to have a widespread distribution but are very limited to the mountain ecosystem.

A-0502 (Oral)
Realising the Potential of eDNA as a Biomonitoring Tool for Sea Snakes

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Sea snakes constitute a distinctive component of Australia's biodiversity, they are uniquely aquatic and have special significance in Indigenous cultures. However, our limited understanding of their distribution and ecology hinders essential conservation management efforts under environmental stressors. North West Australia is a global hotspot of sea snake diversity and endemism containing approximately 25 species, two of which are listed as

Critically Endangered and one as Endangered on Australia's EPBC Act (1999) and the IUCN Red List. Current survey methods of trawling and netting provide biased underestimates of species diversity. Environmental DNA (eDNA) presents a fantastic opportunity to non-invasively survey these cryptic animals. However, previous eDNA studies have had mixed success in detecting reptiles, which poses challenges for developing a reliable and efficient survey method using this approach. This talk will report the preliminary results of a project that aims to improve eDNA detection of sea snakes to fill knowledge gaps critical to assessing their conservation status in North West Australia. This project aimed to 1) quantify the rate of eDNA shedding and decay for sea snakes in aquaria, 2) develop and validate sea snake metabarcoding eDNA assays; and 3) survey sea snake assemblages across North West Australia. This project provides insights into the specific challenges of using eDNA to detect a novel and ecologically important group of marine organisms for conservation.

A-0503 (Oral)
Tortoises Drifting back and forth across the Indian Ocean

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Before humans arrived, giant tortoises occurred on many islands in the west of the Indian Ocean. We combined ancient DNA, phylogenetic, ancestral range, and molecular clock analyses with radiocarbon and paleogeographic evidence to decipher their diversity and biogeography. Using a mitogenomic time tree, we propose that the ancestor of the extinct Mascarene tortoises (*Cylindraspis* spp.) spread from Africa in the Eocene to now-sunken islands northeast of Madagascar. From these islands, the Mascarenes were repeatedly colonized. Another out-of-Africa dispersal (latest Eocene/Oligocene) produced on Madagascar giant (*Aldabrachelys* spp.), large (*Astrochelys* spp.), and small (*Pyxis* spp.) tortoise species. Two giant (*Aldabrachelys abrupta, A. grandidieri*) and one large (*Astrochelys rogerbouri*) species disappeared c. 1,000 to 600 years ago, the latter taxon was discovered during our investigation. From Madagascar, the Granitic Seychelles were colonized (Early Pliocene), where *Aldabrachelys gigantea* evolved. Aldabra was repeatedly reached from the Granitic Seychelles during the Late Pleistocene. The Granitic Seychelles populations were eradicated by seafarers and later reintroduced from Aldabra. Our results underline that integrating ancient DNA data into a multi-evidence framework substantially enhances the knowledge of the past diversity of island faunas.

A-0504 (Oral)
Conservation Breeding of *Leptophryne* Frogs in Indonesia

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The genus *Leptophryne* consist of three species, all of which are native to Indonesia - *Leptophryne cruentata* (CR, protected), *L. javanica* (EN, not protected), and *L. borbonica* (LC, not protected). *L. cruentata* and *L. javanica* have narrow distributions, both being endemic to Java Island, while *L. borbonica* is widely distributed throughout SE Asia. The Bleeding toad *L. cruentata* is the only protected amphibian in Indonesia. Population monitoring has been carried out by several researchers since 2007 and regularly by the national park authorities but never published. Being restricted to two volcanic mountain ranges, *L. cruentata* is susceptible to several threats, such as habitat disturbance by tourists, chytrid fungus, and volcanic eruptions. In accordance with the 2021–2030 Action Plan by IUCN to understanding ecology of *L. cruentata*, conservation breeding is necessary to safeguard this species from extinction. The Herpetological Conservation Breeding Laboratory (HCBL) was established as a collaborative effort by IPB University, Indonesia Herpetofauna Foundation, Chester Zoo, and IUCN Asian Species Action Partnership, to initiate conservation breeding efforts for the critically endangered Bleeding toad. Due to the high risk of trials with *L. cruentata* (CR), and a lack of literature on the husbandry of this genus, we have started captive management trials with model species – the Hourglass toad, *L. borbonica*. If successful, this will be followed by *L. javanica* and ultimately *L. cruentata*. This presentation will describe the process of establishing HCBL, starting from capacity building up to collection and introduction of the frogs.

A-0505 (Oral)
Geographic Variation in Color Polymorphism of the European Adder (*Vipera berus*) across its Distribution

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Color polymorphism, including melanism, within species and populations is shaped by multiple selection pressures that can vary geographically, such as climate and predation pressure. The thermal melanism hypothesis predicts that darker coloration is beneficial to animals in colder regions, due to enhanced thermoregulation. The predation pressure hypothesis predicts that melanistic individuals are exposed to a higher predation risk, because they are more visible to predators. Additionally, land cover might affect both thermoregulation opportunities and predation risk by mediating exposure of animals to solar radiation and detection probability by predators. Here, we investigated geographic variation in color polymorphism of the European adder (*Vipera berus*) using > 7,000 citizen observations across the entire species' distribution. We predicted that the proportion of melanistic individuals increases in colder regions, declines in areas with a higher relative predator abundance, and

that these patterns are mediated by the presence of forest cover. We found strong support for the thermal melanism hypothesis, and limited evidence for the predation pressure and the landcover mediation hypothesis. For example, the correlation direction between altitude and melanism varied depending on the geographic region and the proportion of forest cover. Combined, our results emphasize the large potential of citizen observations by providing novel insights concerning large-scale biogeographic patterns of morphological divergence in coloration and melanism.

A-0507 (Oral)

Enigmatic and Endangered: Understanding the Ecology and Evolution of Little-Known Sea Snake Species

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Sea snakes are an ecologically diverse group comprised of more than 70 species of true marine reptiles, occurring among various marine habitats globally. Diverse inter-specific ecologies mean species may experience and respond to natural and human-mediated threats differently. Thus, studies with a species-specific focus are important in generating critical baseline information to form the foundation for determining appropriate conservation action particularly for those species occurring in remote areas, which are rarely observed, let alone studied. In this presentation, we first expand on the findings about the evolutionary history of the enigmatic Lake Taal Sea Snake, *Hydrophis semperi*. This endemic freshwater species is isolated in the present-day Lake Taal (Philippines), which closed off from the sea in 1754. Using whole genome sequencing data, we estimate the timing of its divergence from marine congeners and model the historical trajectory of its effective population size. We show that *H. semperi* is most closely allied to the marine *Hydrophis melanocephalus* and have diverged in the last 550,000 years, predating the formation of Lake Taal. We also show that *H. semperi* experienced a steep decline in its effective population size concordant with the early stages of the formation of its habitat, which may have exposed the existing population to potential selection pressures from drastic geological reconfigurations and extreme transition from a marine to a freshwater habitat. We then look on the latest efforts towards establishing a mark-recapture program for the Critically Endangered Short-nosed sea snake (*Aipyusurus apraefrontalis*) and Leaf-scaled sea snnake (*Aipysurus foliosquama*) in Exmouth Gulf and Shark Bay, Western Australia. Here, we present on the initial steps in filling substantial data deficiencies in both species' distribution, ecology, and conversation biology by estimating their population trajectories and projecting future distributional ranges and potentially suitable habitats.

A-0508 (Oral)

Does Habitat, Foraging Mode and Body Form Influence the Evolution of Dorsal Scale Microstructure Morphology and Geometry?

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The evolution of scale microstructures in snake taxa is crucial towards understanding the ecophysiological adaptations of their skin. Despite the rich diversity and ecological adaptations observed across snake taxa, our understanding of scale microstructure evolution remains surprisingly superficial. Most studies to date have employed 2D imaging techniques, which fall short of capturing the complexity and functionality of these microstructures. Only two investigations have used 3D data, but have not explored 99% of snake biodiversity. Consequently, little is known about the functional evolution of scale microstructures across this diverse group. In this study, we investigate the impact of habitat, habit and predation mode on the evolution of scale microstructure morphology in snakes, using a 3D dataset that includes 630 species, representing 380 of 530 described genera from 23 of 27 families across diverse morphotypes and ecological settings. Our work integrates novel confocal 3D surface metrological techniques, detailed quantification of surface microstructures with physics-based interpretation, and modern phylogenetic comparative methods to investigate the functional evolution of scale microstructure morphology. We test how ecological characteristics of the sampled species, such as habitat use, habit, and foraging mode, and the phylogeny have influenced microstructure evolution. The research reveals both the effects of phylogeny and distinct micro-morphological patterns correlated with specific ecological niches, demonstrating the role of environmental adaptation in shaping the evolution of snake scale morphology. This investigation introduces a new analytical tool for the field, offering fresh insights into the physiological adaptations in the context of their ecological roles and evolutionary biology of snake microstructures from a functional perspective.

A-0509 (Oral)
Geological Context for the Islands and Archipelagos of the Indian Ocean Basin

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From a geological and geophysical perspective, the islands and archipelagoes of the Indian Ocean basin (e.g., Aldabra Atoll, Andamans-Nicobars, Comoros, 'granitic' Seychelles, Madagascar, Mascarenes, Sri Lanka, Socotra) comprise a wide range of landmass types. Notably, the variation is greater than is the case for islands in the Atlantic and Pacific oceans, as well as those in the seas that adjoin them. Crucially, each has strongly imprinted the herpetofaunas they host. The presentation will outline the various geophysical processes (solid and fluid) that led to the formation of the various Indian Ocean landmasses and their subsequent geological histories. It will thus provide context for the mechanisms that have moulded the hosted herpetofaunal assemblages.

A-0510 (Oral)
Does a Marine Ancestry Constrain the Evolution of Scale Microstructures and Tail Morphology in Australian Elapids (Hydrophiinae)?

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Australia's unique ecosystem, shaped by ~60 million years of isolation, provides the setting for a prime example of adaptive radiation in elapids (Hydrophiinae). These snakes diversified from a marine ancestry ~25 million years ago, evolving into a plethora of forms to fill various ecological niches from terrestrial, arboreal to fossorial, even a clade that has re-invaded into marine habitats. Despite this ecological diversity, almost nothing is known on the evolution of scale microstructures and tail morphologies, given that both integument and skeleton show adaptations for different habitats in snakes. Furthermore, the relationship between scale microstructure evolution and vertebral morphology remains to be poorly understood. Considering their Asian terrestrial origin, does the marine ancestry of the hydrophiines impose a constraint on the evolution of scale microstructures and tail morphologies? In this study, we describe the evolutionary dynamics of scale microstructures and tail morphology within hydrophiines, focusing on how a marine origin might have constrained the evolution of scale microstructures and tail osteology in Australian hydrophiines. Using a comprehensive dataset encompassing scale microstructure surface metrology and tail vertebral characteristics across this diverse group of snakes we employ phylogenetic comparative methods and multiple trait evolutionary models to test for relationships between scale morphology and vertebral adaptations in response to niche use. We expect to find co-evolution between habitat types and morphological traits, including convergent evolution of tail and scale morphology among basal and derived marine-adapted elapids and distinct morphological adaptations in terrestrial and semi-aquatic lineages.

A-0511 (Oral)

The Contemporary Distribution of Scincine Lizards does not Reflect its Biogeographic Origin

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We elucidate the systematic relationships and historical biogeographic patterns in the subfamily Scincinae, a group of lizards that primarily inhabits the Afro-Madagascan and Saharo-Arabian regions with isolated lineages in Europe, North America, East Asia, India, and Sri Lanka. The contemporary distribution of these lineages on the historical Laurasian and Gondwanan landmasses make scincines an ideal system to study the roles of vicariance and

dispersal on the geologic scale of tens of millions of years. To conduct our biogeographic analyses, we first estimated a time-calibrated species-tree of scincine genera using seven nuclear loci (~6k base pairs). We also constructed a lineage-through-time plot to assess the timing of diversification within scincines. Our analyses estimated strong support for the monophyly of Scincinae that is further comprised of a strongly-supported Gondwanan clade nested within a broader Laurasian group. While most of the extant, genus-level diversity within the Gondwanan clade was accrued post-Eocene, the majority of the Laurasian lineages diverged during the Paleocene or earlier, suggesting large-scale extinctions in these regions. Counterintuitively, scincines from India and Sri Lanka have distinct biogeographical origins despite a long tectonic association between these landmasses, suggesting at least two independent, long-distance, trans-oceanic dispersal events into the subcontinent. Our biogeographic analyses suggest that scincines likely originated in East and Southeast Asia during the late Cretaceous (ca. 70 Ma), and eventually dispersed westwards to Africa and Madagascar, where their highest extant diversity occurs. Our study demonstrates the concomitant roles of dispersals and extinctions in shaping modern-day assemblages of ancient clades such as scincine lizards.

A-0512 (Oral)

Environment Predicts Amphibian Chytrid Lineage Distribution and Zones of Recombination in South Africa

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The amphibian-infecting chytrid fungus, *Batrachochytrium dendrobatidis* (Bd), is widespread throughout Africa and is linked to declines of populations and species across the continent. While it is well established that the lineage of Bd encodes traits which determine disease severity, knowledge around how lineages are distributed according to environmental envelope is unclear. We here studied the distribution of Bd in South Africa based on the two lineages found, BdGPL and BdCAPE, in terms of their genome and environmental envelope statistically associated with their distribution. We used Bd surveillance data from published studies, as well as data collected during fieldwork from across South Africa, Lesotho, and eSwatini with samples collected along a transect spanning most of South Africa from Lesotho to the west coast. We utilized lineage-typing qPCR to resolve the spatial distribution of BdGPL and BdCAPE across South Africa and used the resulting surveillance data to create a predictive ecological niche model for Bd lineages in South Africa. Phylogenomic analyses were performed on isolates sourced from across the transect. We show that BdGPL demonstrates a strong isolation by distance suggestive of stepping-stone dispersal, while BdCAPE showed two distinct clusters within their genomic structure that appear geographically and temporally clustered, indicating two separate invasions. Our predictive niche model revealed that the two lineages tended to occur in different ecotypes; BdGPL was associated with lower altitude, arid regions while BdCAPE occurred across cooler, higher altitude environs. Niche predictions identified a zone of lineage contact, where genomics identified inter-lineage recombinants. We argue that this zone of recombination should be prioritized for disease surveillance as it is a

potential hotspot for the evolution of variants of amphibian chytrid with novel traits that may be epidemiologically relevant.

A-0513 (Oral)
Do Changes in Invasive Host Density alter *Ranavirus* Dynamics in an Ecosystem?

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Invasive species are one of the main drivers of biodiversity loss and the decline of wild populations, contributing, amongst others, as vectors and reservoirs for pathogens. Ongoing invasions of the African clawed frog (*Xenopus laevis*) have implicated the species as a potential vector for pathogens of global concern, including *Ranavirus*. Yet, the impact of *X. laevis* presence and density in shaping *Ranavirus* dynamics in natural ecosystems remains unclear. In a riverine system with an established *X. laevis* population and active Ranavirus infections, we investigated how reducing invasive host density, consistently over seven years, affected *Ranavirus* prevalence and load. Additionally, we expanded *Ranavirus* screening to the broader host community (amphibians and fish), to analyse the potential role of *X. laevis* as a vector for native species. No relationship was observed between infection rates in *X. laevis* and the decrease of host density over time. Furthermore, the invader presented the lowest prevalence of all tested species confirming a diminished reservoir function when compared to the endemic fish species, that showed the highest *Ranavirus* prevalence and signs of disease development. At the same time, *Ranavirus* was ubiquitously distributed, even in streams without *X. laevis*, suggesting that the invasive species may not be involved in the origin of the pathogen in this ecosystem. Overall, our results indicate that *X. laevis* might not be the key player influencing *Ranavirus*, and decreasing its density may not strongly impact the pathogen, especially when other competent species are present in the system. We suggest that factors such as host composition may play a more significant role in *Ranavirus* dynamics than host density.

A-0514 (Oral)
Unravelling the Invasion History of the Non-Native Alpine Newt *Ichthyosaura alpestris* in the UK

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The spread of invasive species to regions outside of their typical, native range has been fuelled by globalization and trade, with human-facilitated introductions being a primary driver of invasion by non-native species. More than half of wild amphibians in the UK are invasive or non-native. The alpine newt, *Ichthyosaura alpestris* is native to mainland Europe, and has become well-established at various locations in the UK. The alpine newt pattern of invasion in

the UK suggests both primary introductions from its native range, and translocations from established sites of invasion. This research utilises population genomics, namely Single Nucleotide Polymorphisms (SNPs), to answer various questions about the invasion history of these non-native amphibians in the UK. In addition to these genomic tools, anecdotal evidence is also employed to better understand the pattern of invasion and subsequent spread of alpine newts across the country. Results provide an insight into the genetic variation within these populations, with clear population structure also evident. Population structure analyses provide evidence for human-assisted movement of newts within the UK and results are consistent with multiple independent introductions. Such findings support the idea that human-mediated translocation plays a central role in the movement of alpine newts around the UK. To further explore the role of human-assisted dispersal, we will draw from social science methods to understand the potential motivations and drivers behind these translocations. This research illustrates how genomics can be used in conjunction with historical data to better understand the invasion history of non-native organisms.

A-0515 (Oral)
Epigenetics and the Role of Fear in Shaping Animal Welfare

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Human impacts to animal welfare go beyond handling and rearing and include many fear-like behavioral and physiological responses that our mere presence may elicit. By scaring animals, humans (and other stressors) may pose negative welfare impacts to animals without any direct contact. Empirical evidence for the welfare impacts of fear is limited, in part and fear effects are likely chronic, manifesting cumulatively over the course of animal lives in ways that are hard to measure. This talk will highlight new research that is developing epigenetic measures of lifelong welfare in amphibians and reptiles to evaluate the chronic welfare impacts of fear. DNA methylation (DNAm) is a powerful epigenetic biomarker of aging that also estimates one's 'biological' age, which incorporates stress history experienced throughout life. Methods for developing DNAm-based models of lifelong welfare will be discussed, and two current projects using DNAm to measure chronic effects of fear in Southern California herps will be outlined. The talk will show how recent advances in epigenetics can be leveraged to develop composite welfare assays that consider the chronic an cumulative effects of fear.

A-0516 (Oral)
Ecology, Range and Conservation Status of Amphibians in the Democratic People's Republic of Korea

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Determining the range, behavioural ecology, and conservation status of species in areas where surveys and samplings are difficult to conduct is a challenge, such as in the Democratic People's Republic of Korea (DPR Korea). This study reports on the estimated presence, range, and status of all amphibian species in DPR Korea through genetic sampling, field surveys, call recordings, photographic identification, and a literature review. Further, the threat levels for most species were estimated based on the IUCN Red List Categories and Criteria. The results demonstrate the presence of 18 native species and the suspected presence of *Karsenia koreana* and three *Onychodactylus* species. Molecular analyses confirmed the first record of *Rana uenoi* and the presence of *Dryophytes japonicus* around Pyongyang. Based on distribution and modelling, a contact zone within *Rana* and *Onychodactylus* is expected along the Changbai Massif, a biogeographic barrier between ecoregions that acts as a barrier to dispersion. The species richness was higher in the lowlands and at lower latitudes, with up to 11 species, while northern regions were characterised by half the species richness. The combination of landscape models and known threats resulted in the recommendation of 10 species as threatened at the national level. This number was anticipated based on the high threat level to amphibians in bordering nations, and globally. While the ecology of species in DPR Korea needs further studies, species relying on agricultural wetlands such as rice paddies are not under imminent threat due to the enduring presence of extensive agricultural landscapes with low chemical use and mechanisation. The maintenance of such landscapes is a clear benefit to amphibians, in contrast with industrialised agricultural landscapes in neighbouring nations. In comparison, the status of species dependent on forested habitats is unclear and threat levels are likely to be higher because of deforestation.

A-0517 (Oral)

Revelation from Snake Venomics: Present and Future Directions of Translational Research on Venoms and Antivenoms

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In snakes, the development of venomous phenotypes facilitated the shift of predatory mechanism from a mechanical one (constricting) to a biochemical method (envenoming) for efficiency. Snake venoms contain diverse proteins whose structures are finely chiselled over millions of years in evolution; hence, high variability is anticipated within and between species. Venomics, an approach powered by proteomics (on the secreted product), transcriptomics (on venom gland), and genomics (on body tissue), is the approach to comprehensively unravel venom compositions and mechanisms, with subsequent applications in snakebite treatment, biodiscovery, and conservation. Identifying snake venom variability is critical to the use of a certain antivenom product, especially in situations where species- and locale origin-specific antivenom products are unavailable. The finding also allows haessing conserved and divergent toxins across various snake species to develop "universal antivenom". Experimental products have shown promising results against diverse snakes from various geographical regions, suggesting the possibility to end the global problem of antivenom shortag. Furthermore, venomics allows a deeper quest into the structures, antigenicity, activities, and functionality of bioactive molecules derived from snake venoms. This paves the path for toxin-spired drug

discovery, diagnostics development, and small-molecule inhibitor design and use as adjunct therapy to antivenom. Notwithstanding, venomic methods varied widely between different laboratories—this potentially creates massive (and messy) information that complicate data comparison and interpretation. Updates in mass spectrometry utilization, databases and bioinformatic tools are essential to overcome technical limitations, and to address non-standardized practices as well as biased interpretation of -omic data in the field. Difficulty in obtaining venomic samples due to strict regulations, and limited funding due to the neglected status of snake venom research, are among other pertinent issues that impede the progress of venomics. Genuine international collaboration and support are needed in this regard to unleash the potential of snake venomic research.

A-0518 (Oral)
Venom as a Dual-Use Material: On the Note of Biosafety and Biosecurity

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Venoms are evolutionary innovation developed in various lineages of animals as tools for predation, digestion and defence to ensure their survival. Snake venoms are most extensively studied, apparently for their medical significance in the following aspects: (a) the genetic, biochemical, and physicochemical properties of snake venoms; (b) the mechanisms of action and potential uses therefrom; (c) the management of snakebite envenoming as in developing diagnostics, antidotes including antivenom, and strategic protocol of treatment. Venoms are complex mixtures of pharmacologically active molecules, and these potentially useful bioactive molecules may be, nonetheless, subjected to manipulation and misuse. This raises the question of whether venom is a material of dual use, and if yes, how its use can be safeguarded for good in medically motivated research. In practice, while the risk may not be comparable to contagious microbials and warfare toxins, personnel involved in venom handling and research should still adopt a vigilant attitude in line with the concept of biosafety and biosecurity. Biosafety defines practices to prevent the unintentional release of the potentially dangerous materials, while biosecurity specifies measures to prevent deliberate acquisition and malicious use of these materials. In snake venom research, the latter is probably of a greater concern, and hence laboratories should consider instilling a modified biosecurity program that emphasizes measures for risk mitigation. In this regard, it is vital that all researchers and associated personnel are aware of and practicing the responsible use of venom-related materials and data.

A-0519 (Oral)
Increasing Salinity Stress Decreases the Thermal Tolerance of Amphibian Tadpoles in Coastal Areas of Taiwan

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Global warming is the main cause for the rise of both global temperatures and sea-level, both major variables threatening biodiversity. Rising temperatures threaten to breach the thermal limits of organisms while rising sea-level threatens the osmotic balance of coastal animals through habitat salinization. However, variations in thermal tolerance under different salinity stresses have not yet been thoroughly studied. In this study, we assessed the critical thermal maxima (CTmax) of amphibian tadpoles in different salinity conditions. We collected tadpoles of *Duttaphrynus melanostictus, Fejervarya limnocharis* and *Microhyla fissipes* from coastal areas and housed them in freshwater, low, and high salinity treatments for seven days of acclimation. The CTmax, survival rate, and development rate of tadpoles in high salinity treatments were significantly lower than that of the two other treatments. The negative effects of high salinity on tadpoles are probably due to energy acquisition and allocation, and the dehydration induced by salinity stress. Our results indicate that physiological performances and heat tolerances of tadpoles are negatively affected by salinization. The present results suggest that global warming can lead to negative dual-impacts on coastal animals because of reduced thermal tolerances at elevated salinity. The impacts of global warming on anurans in coastal areas and other habitats impacted by salinization may be more severe than predicted and it is likely to cause similar dual-impacts on other ectotherms.

A-0520 (Oral)
Body Size and Condition, not Allochrony Affect Temporal Reproductive Patterns in a Prolonged Breeding Anuran

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Individual phenological life-history variations in context of seasonal conditions are well documented in fishes and birds. However, amphibians, a group heavily affected by habitat loss and fragmentation, have received relatively little attention regarding research on life-history variations. Here we present three years of data on the timing of reproductive activity in a suburban green toad population. We found annually consistent patterns of reproductive activity and investigated whether these were caused by allochrony or individual traits. Body size (a proxy for age) and body condition significantly affected the timing of reproduction. However, most individuals showed considerable overlap in their reproductive timeframe, refuting the existence of allochronic subpopulations. Our findings may indicate life-history adaptations in the direction of a faster lifestyle in response to hazardous environments. We propose to focus further research efforts on phenological variations in the context of environmental conditions,

and that phenological variations should be considered more strongly in amphibian conservation efforts.

A-0521 (Oral)
Global Warming and Rice Production, How Far can the Breeding Phenology of Korean Amphibians Bend to Accommodate Change?

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Climate change is affecting the behaviour of most species, and especially the breeding phenology of ectotherms as their activities are highly constrained by the environment. In addition, impacts can be amplified in species that have to contend with human activities that are themselves impacted by climate change, such as agriculture. This is the case of amphibians breeding in agricultural wetlands such as rice paddies or lotus farms. Rice plantation and flooding are related to the expected growth season of rice as determined by farming practices, and so is the access to breeding habitats for amphibians. Here, climate warming is expected to result in amphibians breeding earlier, however, rice is planted later every year as it grows faster with warmer temperatures. The breeding phenology of amphibians spawning in rice paddies will, therefore, be impacted by the combination of climate change and farming practices, and we predict a delay in breeding phenology, although only if the species' breeding phenology is plastic enough to adapt. We tested this prediction for five species at 21 independent sites over a five-year study period in the Republic of Korea. Against our expectations, the Japanese treefrog (*Dryophytes japonicus*) and the Black-spotted frog (*Pelophylax nigromaculatus*) were not significantly impacted by agricultural practices, likely breeding in rain-fed water bodies in the proximity of agricultural wetlands. In opposition, the Suweon treefrog (*D. suweonensis*), the Yellow-bellied treefrog (*D. flavi*ventris) and the Gold-spotted frog (*P. chosenicus*) saw a delay in their breeding phenology, matching with the shift in agricultural practices. Our results suggest that the five focal species display different behavioural plasticity in response to changes in their breeding environment, and that not all species are able to adapt to climate change - especially when its impact is strengthened through the modification of agricultural activities.

A-0523 (Oral)
Spatial Distribution Model for the Probability of Utilization of Pig-Nosed Turtles (*Carettochelys insculpta*)

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The unchecked use of natural resources can pose a serious threat to species' survival and negatively impact ecosystems, potentially affecting both the economy and human life. One species in particular that requires attention is the pig-nosed turtle (*Carettochelys insculpta*), which is the sole surviving member of the Carettochelyidae, and only found in rivers in Southern New Guinea and the northern regions of Australia. It is crucial to develop a spatial distribution model to determine the probability of *C. insculpta* utilization inside and outside priority areas, to safeguard the crucial areas necessary for its life cycle. This research utilizes Ecological Niche Modeling at The Metaland Ecology Lab to assess utilization probability and identify potential conservation risks. The results of the utilization probability model distribution in the South Papua Province reveal varying proportions, with the highest and lowest probability utilization classes detected in several regencies, including Boven Digoel (55% and 39%), Merauke (50% and 27%), Mappi (46% and 26%), and Asmat (44% and 22%). Additionally, the probability of utilization is influenced by multiple factors, with the greatest contributions stemming from occurrence water (41%), euclidean distance settlement (21%), euclidean distance road (14%), land cover (13%), river density (6%), and slope (5%).

A-0524 (Oral)

The Taxonomic Status of the *Trachylepis* Skinks of Namibia

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Members of the mabuyine skink genus *Trachylepis* are among the most diverse and ubiquitous surface active (terrestrial or climbing) lizards in Africa and surrounding areas, with at least 97 species. Several species groups within the genus have proved to be especially challenging to resolve due to under-sampling, morphological conservativeness, and misidentification of genetic samples. Southern Africa is an area of high diversity and endemism for *Trachylepis*. A recent study has revised the genus in Angola, which harbors 24 species. Changes to the taxonomy of the Angolan *Trachylepis*, as well as other revisionary actions, necessitate a reevaluation of the species occurring in neighboring Namibia. We recognize 14 confirmed species of *Trachylepis* and five of possible or probable occurrence in Namibia. *Trachylepis ansorgii, T. chimbana*, and *T. varia* are excluded from the Namibian fauna; *T. spilogaster* and its sister species *T. attenboroughi* are both present; populations previously assigned to T. sparsa should now be assigned to *T. punctatissima*; and most populations formerly assigned to *T. punctulata* should be assigned to *T. triebneri*, which is resurrected from synonymy, while the presence of *T. punctulata* sensu stricto remains to be verified. *Trachylepis bouri, T. hilariae, T. ovahelelo and T. wilsoni* all also approach the Namibian border in Namibe Province, southwestern Angola and may be expected to occur in parts of the northern Kunene Region. Verification of the presence of the unconfirmed species will require new sampling along the border with Angola, greater genetic sampling, and a reevaluation of existing museum material. Resolution of these issues will help to clarify the extent to which the lower Kunene River serves as a biogeographic barrier. Despite high *Trachylepis* endemism in adjacent Angola and South Africa, *T. acutilabris* appears to be the only strictly Namibian endemic in the genus.

A-0526 (Oral)

The Evolution of Traits Associated with Latitudinal Range in Globally Distributed Opportunistic Generalist Ranid Frogs

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Climate diversity emerges as a significant driver in shaping the evolution of traits associated with latitudinal gradient in true frogs Ranidae. Here, we demonstrate that the northern climate harshness is most likely to have induced the independent evolution of latitudinal ranges, as the trait is convergent among the Nearctic and Palearctic species present in subarctic environments, as well as the opportunistic ranids distributed in the temperate. We integrated meta-analysis and phylogenetic comparative methods to examine the latitudinal range trait in global Ranidae, in conjunction with essential climatic variables dating back to the Last Interglacial period. Our phylogenetic-based regressions showed an independent impact of annual precipitation on the pattern of latitudinal ranges across Ranidae lineages, especially during the Last Glacial Maximum. We also observed a pattern of diversifying selection for latitudinal ranges across ranid lineages. Range ancestral reconstruction demonstrated that latitudinal range trait was prevalent among opportunistic species, such as *Pelophylax ridibundus* and other Eurasian subarctic species, such as *Rana amurensis*, c. 30.0 Mya, and highly accumulated to Nearctic ranids, such as *Aquarana catesbeiana*, c. 12.0 Mya. As a generalist species, *P. ridibundus* exploits resources and reproductive opportunities of closely related species, displaying natural adaptation to new and modified habitats. Our findings indicate that the latitudinal trend of *P. ridibundus* across the Western Palearctic is evolutionarily comparable to that of globally invasive species, such as *A. catesbeiana*. Additionally, we highlight that mapping trait evolution and its correlation with latitudinal ranges can assist in identifying species with invasive characteristics.

A-0528 (Poster)
Habitat Selection of the Dyeing Poison Frog (*Dendrobates tinctorius*) across Polytypic Populations

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Populations of the dyeing poison frog (*Dendrobates tinctorius*) are characterized by great phenotypic variation among them, especially in terms of aposematic color and pattern. A recent study has also revealed interpopulation variation in body size, sexual size dimorphism, and reproductive strategies. Here, apart from describing general habitat selection of this species, we investigated if and how differences in average body size across populations affected habitat selection by males and females. We found that habitat selection was broadly similar among populations, with frogs generally selecting for proximity to tree falls, dead woody material

(such as fallen/rotting branches, fallen palm bracts, etc.), presence of water pools (phytotelmata and other small bodies of water), and avoided areas with extensive ground vegetation and little canopy cover. We found limited evidence for fine-scale differences in habitat selection between sexes, with males showing a stronger selection for proximity to water pools (compared to females) in two out of six populations. These differences might be related to various factors, such as differences in frog morphology and habitat composition, which need further investigation. Our findings increase our knowledge concerning habitat selection by the dyeing poison frog, which can be useful for the conservation of this emblematic species.

A-0529 (Oral)
Clito-Hiss, Voluptuous Vaginas, and Handsome Hemipenes – Understanding the Processes that Shape Genital Evolution in Snakes

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Genitals are rapidly evolving traits, key to reproductive success as shown by the huge diversity in female and male snake genitalia. Research bias towards males means there are large gaps in understanding around the functionality of the female genitalia even when investing the 'lock-and-key' theory and sexual selection, leading theories in snake genital co-evolution. I will present my final PhD findings on the genital morphology and neurology in female and male snakes. We describe ontogenetic variations in male and female genitalia such as size, shape, ornamentation, and texture in the Northern Pacific Rattlesnakes (*Crotalus oreganus*). We also describe variations of hemiclitores hemipenes histology and interspecific variation of morphology and neuroanatomy of female genitalia, providing evidence towards sexual mechanic sensation in snake reproductive anatomy. Dissection, histology, diffusible contrast-enhanced micro-CT, and 3D morphometric genital shape analysis revealed new insights into the influence of sexual maturation and evolution on genital morphology, reproductive traits, and sexual selection in snakes. The findings from this research will have implications for understanding evolutionary processes that drive genital diversity, which intertwines a broad spectrum of snake reproductive traits.

A-0531 (Oral)
Species Diversity, Breeding Ecology, and Life History Variation in Japanese Hynobiid Salamanders

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In Asia, a family Hynobiidae is most speciose one and especially high species diversity in Japan, with 51 species. Further, all the species, except for one, are endemic to Japan. The genus *Hynobius* is largest in the number of species with 43 species. One of the reasons why Japanese Hynobius so much diversified could be explained by the diverse breeding habit and life history.

The Japanese species of *Hynobius* are divided into two breeding habits, one is lotic-breeding and the other is lentic-breeding. The species of the two breeding groups tend to separate their breeding sites and seasons, which must have gained by their past speciation events. Then, probably they have been interfered by each other especially in the selection of breeding site and season, which causes the present allopatric and sympatric distribution in the Japanese *Hynobius*. Other than breeding ecology, the Japanese *Hynobius* are quite differentiated in life history. Especially length of the larval life is diverse from within one year to three years, which also causes speciation and present species diversity in Japan.

A-0532 (Oral)
Herpetofauna Trade in House Pets in Greater Jakarta, Indonesia

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The trend towards pets from cats and dogs has evolved towards exotic pets, such as reptiles and amphibians. This causes herpetofauna to become popular pets especially as they are considered attractive because of varied shapes and colors (morph). For more than 10 years, there has been no recent research regarding conventional trade in herpetofauna through traditional markets and pet shops in greater Jakarta. In addition, there is a possibility that more herpetofauna is sold through online. The aim of this research is to compare the trade of amphibian and reptile in traditional market place (including pet shops) and popular online market from June to October 2023. We visited the traditional market and pet shop survey and retrieve online data using web scraping application. We noted name of species, stock, price, other shops/online shop media, and the dominant animals sold. There is almost no difference between the number of species sold in the traditional market and online market. Most of the online shop registered in the market place app has no actual shop whereas most of the pet shop also sell herpetofauna thorough online market. The result recorded 104 species of the herpetofauna were traded on traditional market place (68 species of reptiles and 36 species of amphibians) and 117 species (106 species of reptiles and 11 species of amphibians) at the online markets. *Trachemys scripta* (Red-eared slider) is the most sold species in traditional market place and popular online market.

A-0533 (Poster)
Unexpected Female Biased Parasitism of Anuran Chigger Mite on *Buergeria otai* Regulated by Physiological and Environmental Factors

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Parasitic association represents a strong selective force capable of influencing life history traits, behavior, and eco-morphology of host. Several patterns emerged as consequences of host-parasite interaction including sex-biased parasitism, a widespread phenomenon resulting to sexual difference susceptibility to parasitic infestation. Sexual differences on infection levels can be attributed to behavioral or physiological factors. In the case of male-biased parasitism, immunocompetence handicap hypothesis is considered as the main explanations which suggest

that hormonal status can influence host's susceptibility to parasites. Furthermore, it can alter the behavioral patterns of host and increase the possibility of parasite encounter. Another hypothesis for male-biased parasitism considers the female hosts as poor resources due to parasite competition with the offspring of host. Although sex-biased parasitism in mammal hosts was well documented in previous studies, there has been limited research exploring this pattern in amphibians. In this study, we focus on the sex-biased pattern of an anuran chigger mite, *Endotrombicula* sp., associated with its host *Buergeria otai*, a rhacophorid frog endemic to Taiwan. Monthly surveys were conducted from May 2023 to February 2024 in two localities, Zhiben river (Taitung Country) and Meilun river (Hualien County). In this study, we hypothesize that the anuran chiggers will exhibit male-biased parasitism due to both androgen-induced immunosuppression and lekking behavior during mating season. Nevertheless, our findings revealed that the intensity of chigger infection is significantly higher on female individuals than males. Although we did not find any sexual bias on prevalence of chiggers, we constantly observed a high level prevalence of mite infection in Zhiben river, which may results from a higher water temperature of Zhiben Hot Spring. We deduced that larger female frogs are preferred host to anuran chiggers, leading to female-biased parasitism. Further investigation is highly recommended to examine the underlying mechanism of female-biased parasitism on this frog.

A-0534 (Poster)

Call Repertoire and Acoustic Niche Partitioning of the Genus *Micrixalus* in the Central Western Ghats, Karnataka, India

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The anuran family Micrixalidae has 24 species all endemic to the Western Ghats, India partitioned into 5 groups based on their morphological similarities. They exhibit unique foot-flagging behaviour mediating male-male agonistic interactions during the breeding season along with vocalization to attract mates. We recorded call repertoires, sound pressure, weight, and size of seven *Micrixalus* species, namely, *M. candidus, M. elegans, M. niluvasei, M. uttaraghati* (of the *M. elegans* group) as well as, *M. saxicola, M. specca*, and *M. kottigeharensis* (of the *M. saxicola* group). The size of *M. elegans* group ranged between 14.7–18.4 mm in snout-vent-length (SVL) and *M. saxicola* group ranged between 18.1–23.0 mm. Peak frequency (Hz), call duration (s), and pulse rate were significantly different between the two groups as well as within groups. For the *M. elegans* group, the peak frequency ranged between 4565.00–6459.96 Hz, the call duration ranged between 0.19–3.78 s, and the pulse rate ranged between 3.77–19.8 pulse/sec. For *M. saxicola* group, the peak frequency ranged between 4995.70–6115.40 Hz, call duration ranged between 0.29–4.42 s, and pulse rate ranged between 7.18–23.19 pulse/sec. Our analysis shows that there is a groupwise negative correlation between size and peak frequency corresponding to the overall norm that larger frogs call with lower peak frequencies. Both groups occur in continuous noisy environments along streams, but the *M. elegans* group was in slow-flowing streams with less background noise (43.8–51.75 dB), whereas the *M. saxicola* group was in the middle of fast-flowing streams with relatively higher background noise (43.8–67.23 dB, SVL vs dB, $r = 0.72$, $p < 0.001$) suggesting niche differentiation. We observed context-dependent calls in *M. niluvasei, M. uttaraghati*, and *M.*

candidus in the presence of one or many calling males. we suggest these are territorial or encounter calls during aggressive interactions with males.

A-0535 (Oral)
The Vulnerability of a Ranidae Tadpole under Herbicide-Polluted Farmlands

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Amphibians are experiencing a global decline, and pesticide use is considered a major contributing factor. Heavy pesticide use creates widespread contamination in agricultural environments, leading to unintended exposure of non-target species to these chemicals. The permeable skin of amphibians allows easy absorption, making them vulnerable to chemicals. Current risk assessments of pesticides mainly focus on adult frogs and often overlook the diverse life stages and physiology of amphibians. This can lead to underestimating the impact on amphibian larvae. This study investigated the effects of two commonly used herbicides, Glufosinate and Glyphosate, on the survival, physical development, and behavior of *Hylarana latouchii* tadpoles. Results showed higher herbicide concentrations increased mortality, lowered activity and heat tolerance, and reduced jumping ability in froglets. Early-stage tadpoles were more susceptible, experiencing growth delays and later metamorphosis. Conversely, late-stage tadpoles metamorphosed faster but emerged with smaller body size. Furthermore, we revealed genotoxic effects in *H. latouchii* tadpoles exposed to both herbicides, with more herbicide concentration the higher DNA damage observed in red blood cells. In overall, these findings suggest that even low-concentration herbicide exposure, while not directly lethal to tadpoles, can still have several detrimental effects and significantly reduce their fitness for survival. Considering both lethal and non-lethal effects is crucial for accurate environmental risk assessments. Future studies should explore the interactions between herbicides, amphibian species, developmental stages, and other factors.

A-0536 (Oral)
Genomic Scans for Selection in the Common Kingsnake Species Complex

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The common kingsnake (*Lampropeltis getula*) species complex is widespread through North America, ranging from the Atlantic to Pacific coast across most of the southern US and northern Mexico. We previously demonstrated that the complex is composed of three distinct lineages that have gone through multiple rounds of isolation and secondary contact, with asymmetric gene flow among lineages. To identify how lineages maintain their identities in the face of recurrent and ongoing introgression, we sequenced whole genomes from 41 individuals across the range. We examined patterns of genomic differentiation within lineages and across pairs of lineages spanning each boundary to identify genomic regions with higher than expected divergence. We find that highly-divergent regions of the genome as measured by Fst generally have low raw divergence between populations (dxy) and low nucleotide diversity within lineages (pi). This pattern suggests that lineage identity may be more driven by local selection and recurrent selective sweeps rather than barriers to gene flow between lineages. We

are currently using genome-environment association methods to determine if there are signatures of selection associated with climatic and environmental variables, and if these signatures are associated with particular loci.

A-0537 (Oral)
Another New Species of the *Cyrtodactylus annulatus* Complex (Squamata: Gekkonidae) from Maratua an Adjacent Island to Borneo, Indonesia

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The region of Borneo is interesting in its diversity of gekkonid lizards of the genus *Cyrtodactylus*. Until now, it is known to harbor 14 described species. Herein, we described a new member of this genus from the adjacent island of Maratua. *Cyrtodactylus tehetehe* sp. nov. is named after the specialty of the traditional cuisine of the Derawan Islands (sticky rice with coconut milk and a little salt wrapped in sea urchin skin, Echinoidea species). The new species forms a tight phylogenetic clade with Philippine taxa allied to *C. annulatus* and is sister to the Palawan species *C. tautbatorum*, a biogeographic surprise, given that *C. jambangan* and *C. annulatus* occur closer geographically, in the Sulu Archipelago. The new species can be distinguished from all other congeners by a combination of characters including maximum SVL, number of supralabials, infralabials, longitudinal dorsal tubercle rows, paravertebral tubercles, ventral scale rows, subdigital lamellae on fourth toe, by having tubercles on ventrolateral body folds, a single precloacal pore and enlarged precloacal scales, lacking tubercles on upper arm, enlarged femoral scales and respective pores, precloacal depression, and transversely enlarged median subcaudals.

A-0538 (Oral)
Sex-steroid Hormones of Sex-reversed Dragons

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Sex steroid hormones, like testosterone, drive reproductive physiology and influence sex-specific behaviour. For species with genetic sex-determination, sex-specific behaviours are additionally influenced by inherited sex-chromosomes, and occasionally, mateal influences during development. In species with sex-reversal, sex-chromosomes and phenotypic sex become uncoupled, providing unique insights into the relative contributions of genetic and gonadal factors to the final phenotype. Intermediate traits seen in sex-reversed individuals indicate genetics can partly override gonadal factors, but the mechanisms remain unknown. Genetics may directly control hormone production, or regulate the expression of genes related to hormone reception or brain development. The bearded dragon *Pogona vitticeps* experiences unidirectional sex-reversal with high incubation temperatures, resulting in fertile females with male-type ZZ sex-chromosomes. Sex-reversed ZZ females show increased aggression and

boldness over their concordant (ZW) sisters, and some intermediate morphological and metabolic traits. We measured concentrations of the sex-steroid hormones testosterone and estradiol in all three sex classes across three timepoints, hypothesising that their greater aggression might be driven by higher, male-like, testosterone concentrations. We also quantified testosterone and estradiol in egg yolks from both female types, a possible avenue by which SR ZZ females might influence offspring phenotype. We found no difference in endogenous testosterone levels between ZZ and ZW females. However, we found that both ZZ and ZW females had lower levels of endogenous testosterone than ZZ males. Estradiol levels were similar across all three sex-classes and with time. Variation in yolk hormones was explained partly by mother's identity, but not mother's genotype. These results imply that behavioural differences between SR ZZ and ZW females are not due to differences in testosterone or estradiol production. We suggest that future studies could examine the role of differences in genotypic sex-linked gene expression, or glucocorticoid production, in creating the sex-reversed phenotype.

A-0539 (Oral)
Influence of Ecological Pressures on the Evolution of Scale Micro Morphology in Viperidae

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Originating 30–40 million years ago, the Viperidae family is found on most continents, excluding the polar regions. They occupy varied environments, from deserts to rainforests, and adopt different lifestyles, including arboreal and terrestrial habitats. To date, only limited studies have illustrated that dorsal and ventral scale microstructures in viperids are functional, demonstrating habitat- or behavior-specific specializations. However, the form and function of scale microstructures across the family's extensive diversity remain largely unexplored. Furthermore, most prior research on scale microstructures predominantly utilized 2D data, which is insufficient for elucidating the functional and adaptive evolution of these microstructures, thereby leaving a notable gap in understanding their ecological adaptations. This study employs 3D surface metrology and contact angle measurements to thoroughly examine the impact of habitat (deserts, dry forests, wet forests) and habit (arboreal, terrestrial, aquatic) on the evolution of scale microstructures in viperids. We analyze 130 species from 36 genera, covering a broad spectrum of morphotypes, lifestyles, and environments. Our research aims to identify functionally significant morphological and geometrical adaptations in microstructures, potentially evolved in response to diverse ecological demands and specializations. Additionally, we expect to investigate if habitat and habit-based convergence within Viperidae are reflected in their microstructural form and geometries.

A-0540 (Poster)
Risk Factors of Ranavirus Spreading and Pathology in Amphibians in Galicia, Spain

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Ranaviruses can be transmitted between hosts both via direct and indirect contact, in which humans might contribute to the translocation of contaminated material, thus causing new outbreaks of the disease. The potential role of water sports in the human translocation of ranavirus was evaluated in a reservoir with a history of ranavirosis, located in Pontillón de Castro (Spain). Sampling of 234 boats was carried out using swabs during the spring Spanish Canoe Championship. Boats were tested for the presence of ranavirus DNA by quantitative real time PCR (qPCR), and showed 9.40% positivity. In addition, immunohistochemical analysis of 16 amphibians - frog *Pelophylax perezi* (n = 6) and newts *Lissotriton boscai* (n=9) and *Triturus marmoratus* (n = 1) - collected during an outbreak in the Pontillón reservoir and qPCR positive for the common midwife toad virus (CMTV), was performed using an anti-CMTV primary antibody. The results showed that the three amphibian species were susceptible to CMTV infection, with liver, kidney, and spleen as target organs of the virus. CMTV also presented specific tropism for the nervous system of both newt species and the intestine of *Pelophylax perezi*. With these studies we provide evidence that human-related water sports could be a source of ranavirus contamination in areas where human traffic from water sports is high; and we also provided the pathological study of ranaviral disease in three species not studied by immunohistochemistry so far, with relevant results for future studies on pathogeny.

A-0541 (Oral)

Can Parasites cause Host Population Divergence? Lessons from a Widespread and Well-studied Australian Skink (the Sleepy Lizard or Shingleback)

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Parasites are predicted to change their distributions under climate change. Some parasites may increase their ranges and the incidences of infectious disease may rise. The consequences to wildlife, agriculturally important species, and also humans, are unclear. Understanding how parasites may drive host population divergence of immune genes can provide a crucial window onto the early stages of evolutionary divergence and how species may adapt to parasites. This information can hence inform our understanding of what effects the movement of parasites might have in a wider context. Here we examine if two ticks, at a location continuously studied since 1982, have caused divergence in their host - a well-known Australian lizard *Tiliqua rugosa* (the Shingleback or Sleepy lizard). These two ticks form a parapatric boundary across which we have sampled and genotyped lizards at SNP markers to see if small regions of the lizards' genomes may show evidence for divergence across the tick boundary. I will discuss the results (not analysed at time of abstract submission) and how these regions will later be

compared to the whole genome of the host lizard to understand if these regions represent immune loci.

A-0542 (Oral)
The International Trade of Amphibians and Reptiles of Indonesia

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Amphibian and reptile of Indonesia traded Internationally is listed in the annual quota list published each year by the Republic of Indonesia's Ministry of Environment and Forestry as the management authority of CITES. Quota were based on reports from various organizations and recommendations from the local forestry officers which will be approved by the National Research and Innovation Agency (BRIN) as the scientific authority. In 2024, harvest quota was given for international trade of 27 species of amphibians (all species not listed in the Appendix of CITES) and 182 reptiles either listed in Appendix II or in non-appendix of CITES. Several species are under heavy scrutiny due to the high number of allowed harvest. We examined four species listed in Appendix II due to its significant number, the Ricefield frog *Fejervarya cancrivora*, the Tokay gecko *Gekko gecko*, the Reticulated python *Malayopython reticulatus* and the Pig-nosed turtle *Carettochelys insculpta*. Except for the later, the species are considered as abundant, live in human-made habitats, distributed widely in Indonesia, and not protected by Indonesia Laws. Harvesting of these three species is mostly conducted on open access land. It is expected that the population can withstand the continuous harvest in the allowable catch. On the other hand, the Pig-nosed turtle is distributed only in Papua and eastern part of Australia. Harvest of this species is only accessible by member of tribe having traditional landownership. Pig-nosed turtle is protected by Indonesian laws and quota is given after species is listed as hunting animal. Given that harvesting has occurred for over two decades, there is a need to monitor the harvest of Pig-nosed turtle harvest while preserving the economic advantages for local communities.

A-0543 (Oral)
Mexican Amphibians and their Current Status in Relation to Emergent Infectious Diseases

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Mexico´s high biodiversity also makes it a significant location for wildlife diseases research. The country has 424 amphibian species, and after decades of conservation and surveillance efforts we have data for over 140 Mexican species in relation to their current status in relation to infectious diseases such as chytridiomycosis. Currently, Mexico is one of the countries with the highest prevalence worldwide (~46%). Historically, Bd has been registered in samples from Baja California as far back as 1894, and from the early 2000 the amount of research on this area has increased. We analyzed already published and newly generated data from tropical zones and protected areas. Some of the general patterns are that high altitude temperate areas from Central Mexico are the most threatened, having a higher prevalence and infection intensity from Bd than other geographic zones. Taxonomically, the families Hylidae and Ambystomatidae have the highest prevalence. Also, there is evidence that the synergy between

anthropogenic land use modification and diseases is causing populations to go extinct. To date, Bsal presence has being surveilled and not detected in Mexican amphibians, while ranavirus reports are scarce and isolated. Considering that we are a country with a high amphibian biodiversity that spans through two biogeographical regions, it is important to continuously have an updated assessment and share it to the scientific community of the world.

A-0544 (Oral)
A Systematic Survey of Ophidiomycosis in Snake Populations inhabiting Northwest Iowa

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A chilling number of emerging fungal diseases are being discovered and some are the causing major loss of wildlife. In addition to declines of amphibians due to chytridiomycosis and North American bats due to white-nose syndrome, are reports of severe skin infections in North American snakes due to Ophidiomycosis, otherwise known as snake fungal disease (SFD). Visible signs of SFD include crusty scales and skin ulcers, and prolonged infections can lead to necrotic skin, emaciation, and death. Very little was known about SFD transmission, its impact on declining species, or its prevalence in Iowa. We sampled 207 snakes representing six species in northwest Iowa from spring 2019 through fall 2020. We swabbed the skin of each snake that had visible symptoms and sent those samples to the Iowa DNR for testing. We also did mark-recapture by injecting personal identification transmitters under the skin of 168 adult snakes. Recaptures of marked animals allowed us to estimate the population size as between 414-528 animals. 10 out of 27 snakes with visible symptom tested positive for SFD.

A-0545 (Poster)
Ontogenetic Variation in Procoagulant Venom Effects and Antivenom Efficacy of *Vipera ammodytes meridionalis*

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The Nose-horned viper *Vipera ammodytes meridionalis* is a medically significant viper subspecies distributed in southern Europe, which is considered one of the most dangerous snakes in Europe. However, whether ontogenetic variation in venom effects occurs in this subspecies and whether possible ontogenetic variation impacts antivenom efficacy is yet unknown. In this study, we used a coagulation analyzer robot to compare the procoagulant activities of *V. a. meridionalis* venom on human plasma between seven neonate and their adult parents. We also examined the efficacy of three antivenoms: ViperfavTM, ViperaTAb®, and Inoserp Europe across two age classes. While both neonate and adult *V. a. meridionalis* venom produced procoagulant effects, the effects produced by neonate venom were more potent than that of adult venom. Although all three examined antivenoms displayed effective neutralization of both neonate and adult *V. a. meridionalis* venom, they generally showed higher efficacy on adult venom than neonate venom. The ranking of antivenom efficacy against neonate venom, from the most effective to the least effective, were: ViperfavTM, Inoserp Europe, ViperaTAb®; for adult venom, the ranking were: Inoserp Europe, ViperfavTM, ViperaTAb®. Our study reported ontogenetic shift in procoagulant venom of *V. a. meridionalis* for the first

time, which not only has significant implications in clinical treatment, but also provides linkage between toxicology and natural history of this subspecies.

A-0546 (Oral)
Moving Lizards to Mitigate against Climate Change: A Trial Translocation of Endangerd Pygmy Bluetongue Lizards in South Australia

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The Endangered Pygmy bluetongue lizard is under threat from climate change. These lizards spend most of their life inside or at the entrance of vertical burrows dug by spiders, and only persist in unploughed land in the agricultural belt (Mid-North) in South Australia. The lizards have now in a limited distribution in a few isolated remnant fragments of a once more extensive native grassland habitat, predominantly located on private land. In the longer-term, research suggests the Pygmy bluetongues' geographical range will contract significantly under a number of climate change scenarios, but that suitable habitat will be available south of the current range. We have time to determine how to undertake translocations to increase success, with the goal of understanding how to move the species to areas further south. In 2020 we conducted a trial translocation moving over 100 lizards from the northe, mid, and southern edge of their range to an area outside the current range but at the same latitude as the southemost population. Additionally, some lizards of mixed parentage were also moved. Here, I will discuss if lineage type (source locality and mixed or pure) influences survival, health (e.g., body condition) and reproduction following translocation following four years of the translocation.

A-0547 (Oral)
Body Temperature of the Bornean Keeled Pit-viper, *Tropidolaemus subannulatus*

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The Bornean Keeled Pit-viper, *Tropidolaemus subannulatus* is a relatively common and widespread species of venomous snake of medical importance in south-east Asia. Nonetheless, knowledge of its biology had remained largely unknown, representing a challenge for both conservation and management on one hand, and public health on the other. A total of 21 snakes were encountered at Kubah National Park, Sarawak, East Malaysia (Borneo), during the study period (June 2018 to October 2021). Seven of these were qualified for tracking, based on mass and other telemetric limitations, and five (three females and two males) tracked between October 2019 and January 2020. Each individual was implanted with a temperature-sensitive radio-transmitter to locate individuals and internal body temperature. Thermal studies showed a wide temperature variation, between 22.97°C and 30.56°C, with a mean of 26.01°C. Unlike in temperate regions, reptiles of the tropics may be less linked to ambient temperature considering forest in the tropics are dense over large areas, offering thermal gradients. Ambient temperature appear to have significant influence on core body temperature but is weakly correlated ($P < 0.001$, $r = 0.671$). The present population was found to spend much of the observation time on the canopy and in other arboreal habitats with varying vegetation density. As vegetation density is theorized to correlate negatively to ambient temperature, it may be

associated with the vertical movement of the species in search for optimal microhabitat to achieve optimal temperatures.

A-0548 (Oral)
Observation on the Life Cycle and Ecology of the Tadpoles of *Kalophrynus palmatissimus*

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We studied the morphology, larval development and ecology of the tadpoles of *Kalophrynus palmatissimus* (Lowland Grainy Frog) from the egg stage. Given the Endangered listinng of *Kalophrynus palmatissimus* in the IUCN Red List, under criteria B1ab(iii) and its designation as a Protected Species under the First Schedule of the Wildlife Conservation Act, 2010 (Act No. 716), this investigation holds substantial importance in documenting the morphological development and ecology of the species. Egg collection took place in October 2023 and January 2024 from a pond located in Compartment 15 of Ayer Hitam Forest Reserve, Puchong, Selangor, Malaysia. The species takes 23–33 days to metamorphose under natural conditions. Tadpoles favour shallow ephemeral ponds with an abundance of leaf litter, tending to seek shelter and conceal beneath them. This study provides insights into the phenotype and ecology of the species' larval development to metamorphosis. These findings contribute novel information on the lifecycle, morphology, and habitat preferences of *Kalophrynus palmatissimus* tadpoles, thereby of use in future conservation and management strategies.

A-0549 (Poster)
The Field Herper: Discovering Reptiles and Amphibians for Fun

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Engaging in the pursuit of locating reptiles and amphibians is regarded as a recreational endeavor by certain individuals. For enthusiasts of herpetofauna, known as herping, this

activity constitutes an enjoyable pastime. Despite primarily yielding cherished memories from extensive travels to various locales, it inadvertently generates valuable scientific data contributing to the advancement of scientific knowledge. The objective of this article is to present data derived from herping tourism endeavors. Herping excursions were conducted employing random searches at two sites: Situgunung Lake and Cipariuk Waterfall. These locales are prominent tourist destinations situated within the Gunung Gede Pangrango National Park in Indonesia. The outcomes of the herping tourism endeavor yielded significant findings, notably the discovery of an amphibian species that holds protected status in Indonesia. A total of 10 herpetofauna species were documented, comprising five amphibian species and five reptile species. Among these, the Bleeding toad (*Leptophryne cruentata*), classified as Critically Endangered, was identified as the sole protected amphibian species in Indonesia. Additionally, the Forest Dragon (*Gonocephalus kuhlii*) was identified as a reptile species with Vuerable status. Furthermore, three endemic amphibian species native to Java were observed: the Bleeding toad (*L. cruentata*), Kuhl's Wart Frog (*Limnonectes kuhlii*), and Java Flying Frog (*Rhacophorus margaritifer*). The findings obtained underscore the informative value of recreational herpetofauna activities for the scientific community. Furthermore, this recreational pursuit can serve as a citizen science initiative, offering a valuable means of elucidating the presence and distribution of wildlife. Such endeavors offer an expedited approach to gathering data on wildlife, circumventing the protracted processes typically associated with formal scientific research.

A-0550 (Oral)

Climatic Drivers of Chytrid Prevalence in the Critically Endangered Admirable Redbelly Toad from Brazilian Atlantic Forest

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Global warming is driving shifts in rainfall and temperature patterns, and projections indicate an increase in frequency and intensity of climate anomalies. These changes influence wildlife disease dynamics, affecting pathogen development, host behavior, physiology, and disease susceptibility. Understanding the intricate interplay between climatic anomalies and emerging pathogens in amphibian is essential to inform conservation efforts targeted towards this highly threatened vertebrate group. We therefore investigated the seasonal climatic fluctuations and climatic anomalies affecting infections by the waterborne chytrid *Batrachochytrium dendrobatidis* (Bd) in the microendemic and Critically Endangered amphibian species *Melanophryniscus admirabilis*. We found links between high Bd prevalence, monthly low rainfall and rainfall deficit. Additionally, an increase in Bd prevalence was associated with temperatures exceeding historical averages. These findings suggests that climatic

anomalies play a crucial role in Bd transmission and infection status among toads, probably due their aggregation behavior in few available pools during drier and warmer periods. Despite the current low prevalence of Bd and infection loads, the projected escalation of climatic anomalies might render *M. admirabilis* uniquely susceptible to synergistic interactions between Bd and extreme climatic conditions. The insights gained from this study can improve the conservation efforts and underscore the intricate relationship between climatic anomalies and chytrid infection, shedding light on potential vulnerabilities within threatened amphibian populations.

A-0551 (Oral)
Adaptive Evolution of Cottonmouth (*Agkistrodon piscivorus*) Venom Coagulotoxicity

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Snake venoms are complex phenotypes used to incapacitate prey. Deconstructing the functional effects of venom variation and of individual venom components provides an unparalleled window into how complex molecular traits are honed by natural selection. Yet, most work on venom function is done using *in vitro* methods such as enzyme assays or in laboratory mouse models, obfuscating the native killing functions of venom as it flows through target prey tissues. Larval, genetically engineered zebrafish function as a living, transparent microfluidic chamber in which many aspects of basic biological function can be directly measured. We have used zebrafish as a model system to test the hypothesis that cottonmouth (*Agkistrodon piscivorus*) venom is adapted to stopping key biological functions of blood flow and heartbeat in fish. Further, we investigate how the venom kills using fish with fluorescently labeled thrombocytes, as well as *ex-vivo* clotting assays using whole trout blood. Cottonmouth venom is exceptional in its ability to aggregate fish thrombocytes to form a mobile thrombus in blood vessels. Our results suggest the possibility of fish-adapted paralogs of aggregation factors in the venom of fish-eating snakes. Feeding on deeply diverged prey such as fish versus rodents can exert divergent natural selection on venoms, generating the endless variations in venom we observe among snake species.

A-0552 (Poster)
Ambient Temperature and Toxic Diets impact Snake Venom Resistance in a Desert Rodent

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The Geographic Mosaic Theory of Coevolution states that spatially-variable factors (abiotic or biotic) alter the shape of natural selection and lead to hot spots and cold spots of coevolution. Ambient temperature variation is commonplace across species' distributions, and likely exerts several types of pressures on species, manifest through physiological limitations, thermal constraints on activity or available niche, or altered biological community composition. Rodents are the main food source of many venomous snakes, and because snake populations can be quite dense snake predation can be the largest source of rodent mortality. Interestingly, ambient temperature has appeared frequently as a correlate of intraspecific venom variation in snakes. We investigated the possibility that temperature and venom adaptation could be linked by physiological impacts on prey venom resistance. We studied serum-based venom resistance in the Desert woodrat (*Neotoma lepida*) treated differentially with both ambient temperature variation as well as differential intake of toxic phytochemicals common in their natural diets. We hypothesized that venom resistance would be highest at the warmer temperature and lower when challenged with toxic diets. Temperature dependent venom resistance and trade-offs in resistance to plant and snake toxins suggest a complex selection mosaic maintains diversity in this plant-herbivore-predator system.

A-0553 (Oral)
How Tadpoles Deal with a Salty Environment

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Most tadpoles live in freshwater and have limited ability to maintain plasma salt / water homeostasis in brackish water. In adults, increased environmental salinity alters plasma levels of hormones, which then act on several target organs to maintain homeostasis. The extent to which tadpoles may use similar physiological mechanisms is not well understood. We examined mineralocorticoid signaling in tadpoles, as this system is well known to regulate salt / water homeostasis in adult amphibians and other land vertebrates. First, we measured expression of the mineralocorticoid receptor (MR) by quantitative PCR (qPCR) and found MR expression in each tissue examined. We next used CRISPR to produce frogs mutant for MR to examine its role in osmoregulation. We found no effect of low-salt conditions on growth and development in MR mutant tadpoles. We also used candidate gene analysis and RNA-seq to search for genes regulated by MR in tadpole organs important for osmoregulation. One candidate gene, sgk1, was regulated by MR in tadpole skin and kidney, but its regulation was in the opposite direction as that known from mammals. Also, several genes identified by RNA-seq analysis were found to be false positives by qPCR. These results suggest that mineralocorticoid signaling has little to no role in salt / water homeostasis in tadpoles. The current and previous studies have failed to identify specific roles of any hormone in salinity tolerance. Future work should address: 1) what hormones change plasma level in response to salinity in tadpoles and 2) what hormone(s) may have a physiological impact on salt / water balance. Such knowledge will help determine how tadpoles tolerate salinity, how some species tolerate salinity better than others, and how some populations to adapt to increased salinity.

A-0554 (Oral)
Patterns in Lizard Adhesive Toe Pad Shape Evolution

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Gecko and Anolis lizards possess highly diverse adhesive toe pads, which have been gained and lost multiple times throughout evolutionary history. Their unusual combination of convergent and divergent morphological evolution has been useful as a model for understanding the evolution of complex structures, including repeated convergent adaptation. Previous students have organized taxa into groups based on their external morphologies. To investigate how this diversity evolved, we use geometric morphometrics to quantify toe pad shape. Using a variety of evolutionary modeling tools, we have found parallel differences in toe pad morphology across families. Significant parallel differences in toe pad shape suggests parallel evolution across families. We also found significant support for patterns of early burst evolution across families yet late burst patterns within genera. suggesting toe pad morphology evolved more rapidly early in the diversification of geckos, but may have followed divergent patterns within genera.

A-0555 (Oral)
Habitat Suitability of Komodo Dragon (*Varanus komodoensis*) in Flores Island, Indonesia

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Komodo dragons (*Varanus komodoensis*) are an endangered and protected species found not only in Komodo National Park, but also throughout Flores Island and its surrounding small islands. In Flores Island, Komodo dragons inhibit four of the eight districts located in the southern, western, and northern parts of the island. This study aims to assess the habitat suitability of Komodo dragons in the Flores Island region. The methodology involved a survey to determine the coordinates of Komodo dragon presences and habitat suitability data analysis using Maximum Entropy (MaxEnt) software. MaxEnt analyzes the multivariate relationship between Komodo dragon presence (Y) and environmental variables (X). The environmental variables used include bioclimatic factors, distance from the coastline, elevation, distance from rivers, distance from roads, slope, Normalized Difference Moisture Index (NDMI), Normalized Difference Vegetation Index (NDVI), and distance from settlements. The results indicate that suitable habitat for Komodo dragons covers an area of 18,479.37 ha, comprising low suitability habitat of 12,634.90 ha, medium suitability of 5,164.41 ha, and high suitability of 680.07 ha. These suitable habitats span across all districts on Flores Island, with West Manggarai district exhibiting the largest habitat suitability. The total suitable habitat area is 10,130.89 ha (54.76%), with 6,497.91 ha of low suitability, 3111.08 ha of medium suitability, and 521.89 ha of high suitability. The suitable habitats mainly consist of dryland forests, savannas, and mangrove areas, providing potential sites for the introduction or reintroduction of Komodo dragons to ensure the continuity of their population.

A-0556 (Oral)
Frogs in New South Wales show Relatively Stable Pond Occupancy over a 20-Year Period

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Anurans are typically considered to exhibit a metapopulation structure, with extinctions and colonisations of breeding ponds providing a dynamic pond occupancy structure and population studies have found 2% to 25% extinctions of ponds per year. In 2023/2024, I surveyed 28 ponds to detect if pond extinctions were evident in eight species of frogs after surveys conducted 15-20 years previously. Occupancy remained widespread ranging from 5 to 22 of the ponds. *Pseudophryne australis* remained stable at 5/5 sites and *Mixophyes fasciolatus* showed no pond "loss". Other species were lost at from 1/8 to 7/22 of their original ponds, but equally all colonised at least one new pond. Overall pond occupancy declined for *Litoria fallax* (-2), *Litoria peronii* (-4) and *Uperoleia fusca* (-3), remained steady for *Limnodynastes peronii* and *Pseudophryne australis* and increased for *Adelotus brevis* (+3), *Litoria tyleri* (+6) and *Mixophyes fasciolatus* (+2). Species that showed declining occupancy were actually common species with long calling seasons and may have declined because of the dry conditions in the 2023/2024 survey season. Further surveys in a better season are likely to provide better detections. Two increasers, *A. brevis* and *M. fasciolatus*, are species that suffered significant declines due to chytrid and appear to be recovering over time. Overall, pond use generally changed little overall after 15-20 years and when recorded numbers were only ever 2-3 individuals. Even a 1% annual change should have produced much greater extinction rates. This indicates relatively stable pond occupation and any future significant pond extinction events likely not a result of natural changes in pond use.

A-0557 (Oral)
Short-Term Movements of Pig-Nosed Turtle (*Carettochelys insculpta*) in the Kao River, Boven Digoel District, South Papua, Indonesia

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Carettochelys insculpta (Pig-nosed turtle) belongs to the Carettochelyidae family and is the only remaining species of this family in the world. This turtle is one of the larger species with a limited distribution in southern New Guinea, Northern Australia and southern Papua (Indonesia), spreading from Merauke to Kaimana. Kao River is one of the rivers where pig-snouted turtles are found in Boven Digul district, southern Papua, Indonesia. For many years, the eggs of pig-nosed turtle were heavily harvested for trade and most of information in Indonesia regarding this species related to this harvest. There are few reports on the ecology of this species, if any, mostly studied in Australia. This study aimed to observe short term movement patterns and home range of a population of pig-noised turtle in Kao river using low cost GPS tracking device as opposed using the expensive commercial satellite tracking. From November 2023 and December 2023, we tracked 6 adult (1 male and five female) *C. insculpta* in the wild, each for 3 days with number of daily movements between 87.26–672.88 m. We collected data on home range size (ha) and did not find differences in size between males and females using either the Minimum Convex Polygon or the Kernel Density Estimation methods. The average of home range sized is 7.55 ha (MCP), 4.35 ha (50% Kernel density) and 8.34 ha (100% Kernel density). We also collected data on overall and daily movement distances for

turtles of both sexes and found that turtles were more likely to be found on the riverbank than in the centre of the river. Analysis showed no differences between sexes on overall and daily movements because as only a male individual was found in this study.

A-0558 (Oral)

The Systematics and Biogeography of the *Limnonectes hascheanus-limborgi* Complex in Peninsular Malaysia

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Limnonectes hascheanus and *L. limborgi* are two closely related species that are herein referred to as the *Limnonectes hascheanus-limborgi* complex. In the past, *L. hascheanus* was the only species reported to be present in Peninsular Malaysia until a 2014 reported the presence of *L. limborgi* in the country. This study aimed to ascertain the status of both species in Peninsular Malaysia through an integrated approach, combining morphological, bioacoustic and molecular data. The result indicated that in Peninsular Malaysia there two different lineages of *L. hascheanus-limborgi* complex that can be separated genetically, by their male advertisement calls as well as external morphology. Both lineages differs by having a high genetic distance of 3.4–6.9% based on both mtDNA 16S rRNA and nuDNA Tyrosinase genes. One lineages has the morphotype that is assignable to *L. hascheanus* that was described from Penang Island. Populations from Kedah, Langkawi Island, Perlis and some specimens from Bukit Larut are also genetically and bioacoustically similar to topotypic specimens of *L. hascheanus* from Penang Island. The second morphotype differs from the former and is most similar to *L. limborgi* from Myanmar. Populations from Fraser's Hill, Genting Highlands, Tioman Island,Terengganu and some specimens from Bukit Larut are genetically closer to it and considered synonymous. Analyses of the calls also revealed differences in both lineages with *L. haschenaus* having a call pattern with no offset of single note whereas recording from Fraser's Hill and Genting Highlands composed of two types of notes. Other differences can also be observed from various call parameters. Last but not least, variations were observed between Peninsular Malaysian and Myanmar populations of *L. limborgi* that suggests the possibility of cryptic species within this species. Therefore, further studies are still needed to confirm whether *L. limborgi* from Peninsular Malaysia is distinct species from the 'true' *L.* limborgi from Myanmar.

A-0559 (Oral)

Understanding Color and Body Pattern in Indonesia's Only Protected Amphibian: the Bleeding Toad (*Leptophryne cruentata*)

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Individual recognition is one of critical component within population estimation for conservation efforts. Despite its significance, the utilization of this approach in amphibian population estimation remains limited. This constraint primarily stems from insufficient foundational data pertaining to variations in body coloration and patterning. Hence, this investigation aimed to analyze change in body pattern and coloration of the Bleeding toad (*Leptophryne cruentata*). The study involved examining 54 individuals within the Gunung Gede Pangrango National Park, accounting for various temporal and habitat-specific color settings. Adobe Photoshop was employed for analyzing color variations, while ImageJ facilitated the assessment of pattern change. The findings revealed that the color transformation of the bleeding toad was affected by temporal factors, while it remained unaffected by the background coloration of its habitat. Notably, the bleeding toad exhibited a distinctive dorsal pattern. The pattern and colouration of the dorsal bleeding toad varies, with 87% having a red and yellow combination. There is a rounded and y-shaped pattern on the dorsal portion that is present in almost all individuals. This finding highlights the potential utility of individual recognition for population assessment and conservation initiatives targeting this species.

A-0560 (Oral)
Characterizing Salt Tolerance of Amphibian Embryos: Cellular Adaptation, Plasticity, and Energetic Trade-Offs

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Increased salinity in freshwater environments due to anthropogenic factors is an emerging threat to natural populations of amphibians, and embryonic stages are the most vulnerable to mortality with increasing salinity. To better understand cellular mechanisms underlying salt tolerance, we challenged embryos of the South African clawed frog (*Xenopus laevis*), a salt-tolerant species, and wood frog (*Lithobates sylvaticus*), a salt-intolerant species, along a gradient of salinities. We hypothesized that salt-tolerant embryos will be better able to adjust their epidermal landscape to reduce salt permeability either by reducing the number of ionocytes and increasing the number of mucus-secreting cells. To test this hypothesis, we exposed *X. laevis* and *L. sylvaticus* embryos to one of four salinities (150–200, 560, 1500, 3000 uSi/cm) from fertilization through Nieuwkoop-Faber stage 42/Gosner stage 20. Scanning electron microscopy revealed that the *X. laevis* embryonic epidermis has an extra mucus-secreting cell type and a higher proportion of ionocytes in the epidermis than *L. sylvaticus*, suggesting increased osmoregulatory machinery in the epidermis. Both species showed an increase in the number of goblet cells with higher salinity, but *X. laevis* displayed greater increases in mucus secretion and decreased apical area of two ionocyte subtypes that likely reduce salt permeability. Both species increased oxygen consumption rates and reduced total embryonic length with increasing salinity, but *L. sylvaticus* exhibited a greater percent change in these traits and reduced developmental rate. These findings support the idea that embryos can alter cellular differentiation and mucus secretion in response to saline conditions, but the greater salt tolerance of *X. laevis* relative to *L. sylvaticus* involves

evolutionary adaptation of the embryonic epidermis and more extensive cellular plasticity. Future studies will compare salt tolerance abilities of embryos across phylogenetic groups and ecotypes to better understand the eco-evo-devo of salt tolerance of this critical lifestage of amphibians.

A-0561 (Oral)

Predicting Habitat Suitability for the Japanese Giant Salamander (*Andrias japonicus*) using Species Distribution Model: A Major Key for Conservation Measures

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Understanding the ecological and geographical distribution of species is crucial for conservation biology. Species Distribution Models (SDMs) represent powerful tools that enable the construction of species' habitat suitability and identification of environmental predictors influencing its distribution. The Cryptobranchidae family host the largest amphibians of the Earth (up to 1.8 m) and with some taxa highly endangered or extinct. With its large size, its benthic behaviour and slow mode of life, the Japanese giant salamander (*Andrias japonicus*) is an original top predator in lotic ecosystems. Their populations face declines but knowledge regarding the general ecology of this species remains little known, particularly concerning habitat and climate suitability due to a lack of global analyses at the scale of the distribution range. This is yet particularly needed as Japan experience major climatic changes which may further endanger local populations. Our study aims therefore to generate SDMs to (1) establish habitat suitability (i.e., probability of presence) of the Japanese giant salamander in Japan and (2) identify the primary environmental predictors contributing to the selected model. To this end, we collected hundreds of presence data points of giant salamanders across Japan and built maximum entropy (MaxEnt) models with fine scale (1 km²) environmental data. Our findings help to delineate the suitable areas for conservation across Japan and to disentangle among the key landscape, anthropogenic, topographic and climatic variables that explain the distribution of this species. Altogether, these results advance our understanding of the ecology of the Japanese giant salamander and provide valuable insights for conservation decisions regarding this emblematic yet imperilled species.

A-0562 (Oral)

The Decline of the Populations of the Endemic and Endangered Lizard *Liolaemus lutzae*: are we Witnessing the Extinction of a Species?

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The liolaemid lizard *Liolaemus lutzae* is endemic to the narrow coastal sandbank habitats covered by herbaceous vegetation along 200 km of Rio de Janeiro state coast in Brazil. The increasing rate of degradation of its habitat and extirpation of populations in areas where it formerly occurred, resulted in its being included as critically endangered on the Brazilian list of threatened fauna and in the IUCN global list. In 2022 and 2023, we carried out a new monitoring evaluating the of population stocks in 25 beach habitats throughout species distribution, comparing with data of the previous monitoring carried out by us for the same populations in 2006/2007. The methodology to estimate an index of each population size (No. individuals registered along transects/unit time = minute) in 2022/2023 followed that carried out in 2006/2007 in terms of sampling locations, effort as extent, duration, and transect replicates (four) with active search; season, weather conditions and period of day in search, and of habitat quality for each area (index of degree of habitat degradation in each area). Our 2022/2023 monitoring data showed that there was a marked and statistically significant reduction in lizard densities (non-parametric pairwise Wilcoxon signed-rank test; W = 133, P = 0.00015) compared to 2006/2007 and that, population densities were significantly and negatively affected by the degree of corresponding indexes of degradation factors existing in each area (Simple Regression; $R^2 = F1,15 = 8.808$; $R^2 = 0.328$; P = 0.00958), which increased in all areas between the two monitoring sampling-periods. We identified a potential additional population extirpation in one of the locations where no individuals were recorded in the 2022/2023 samplings. We concluded that all *L. lutzae* populations are currently under marked decline as result of the extensive destruction of their habitats what is potentially conducting this species to extinction in the near future, if mitigation measures are not carried out.

A-0563 (Oral)
Regrowth and Resilience: Unveiling the Impact of Reforestation on Costa Rica's Herpetofauna

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Deforestation and forest fragmentation have profound impacts on wildlife, precipitating a considerable loss in biodiversity. On the flip side, reforestation initiatives demonstrate diverse levels of resemblance to primary forests, evolving over time. Significantly, as they age, secondary forests begin to offer a sanctuary for species typically found in untouched forests, thereby underscoring their value as wildlife refuges and key players in biodiversity preservation. This narrative unfolds in the context of a detailed comparison involving herpetofaunal diversity across three contiguous ecosystems in Costa Rica. These range from the pristine primary rainforests of Braulio Carrillo National Park, an untouched primary forest in the Central Volcanic Mountain Range, to lands stripped of their forest cover. Adjacent to the park, a reforestation endeavor spearheaded by the Eco-Vida Trust has transformed about 37 hectares of land previously allocated to agriculture and livestock into the Lapa Verde wildlife refuge. This area, now a crucial buffer zone within the San Juan La Selva biological corridor, has been nurtured back to life over 25 years, with the secondary forests there now aged between 15 and 25 years. The study meticulously gathers and analyzes data spanning from 2012 to 2023, encompassing herpetofaunal occurrences, assembly patterns, climate variances, and forest coverage in primary forests, secondary reforested zones, and deforested areas. The insights gleaned elucidate the nuanced impacts of reforestation and forest maturity on herpetofaunal composition and regional microclimate. Moreover, the investigation casts

light on how deforestation contributes to climate change and affects micro-endemic herpetofauna, accentuating the critical importance of preserving rainforests and advocating for reforestation in mitigating global climate change. Through this lens, the study also underscores the value of herpetofaunal assemblages as robust indicators of environmental health.

A-0564 (Oral)
Amphibians of the US West: Biogeography, Biodiversity, Threats and Conservation Actions

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Advances in our understanding of amphibian biogeography, biodiversity, and threats in the western United States are providing new connections between people and nature. Over 120 amphibian taxa occur in the western United States (hereafter US West), an area spanning ~50 degrees latitude and ~60 degrees longitude from the Rocky Mountains to the Pacific Ocean, inclusive of Alaska and Hawaii. US West amphibian conservation programs address three ecological priorities: 1) sustainability; 2) restoration; and 3) resistance and resilience to disturbances. Sustainability challenges include adaptive management to address recently recognized species and populations as molecular genetics reveal new taxa and evolutionary isolates (isolated populations with unique genetics). Restoration goals are recognizing multiple habitat types used across the complex life history of aquatic-breeders, including for foraging, overwintering, migrating, and dispersing. Designs for managing amphibian ecological resistance and resilience to habitat disturbances are on the rise, especially with regard to wildfire, climate change, and land-and-water uses across the vast government lands in the US West. Rescue of species and populations on the brink of extinction from rarity, habitat loss, and threat factors including disease is involving novel partnerships between US States, regional zoos, and scientists with headstarting, rehabilitation, reintroduction, translocation, and strategic planning programs. The societal values of amphibians to people are being elevated as our complex US West biogeography and biodiversity are recognized, novel threats to endemic species are realized, and amphibian roles in ecosystem composition, functions, and processes are discovered. The building of these societal ties to US West amphibians is occurring in parallel to a new appreciation of the associations between US West Indigenous People and native amphibians. Tribal art and stories illustrate human-amphibian connections to historical events and monthly-to-seasonal patterns in nature. Blending recognition of amphibian cultural and ecological ecosystem services provides a new foundation for conservation approaches.

A-0565 (Oral)
Headwater Stream Management for Amphibians in the US Pacific Northwest Forests

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Moist coniferous forests in the US Pacific Northwest are managed for multiple aims including wood production, ecosystem restoration, and conservation of late-successional and old-growth forest species. Management approaches for aquatic-riparian ecosystems within these forests have focused on retaining water quality and aquatic species. Headwater basins in these forests are a transitional zone between uppermost fish distributions and reaches dominated by stream-associated amphibians. The objectives of the Density Management and Riparian Buffer Study of Western Oregon, a Before/After/Control/Impact experiment, were to: 1) characterize headwater aquatic-vertebrate assemblages and habitats in managed forest headwaters; and 2) assess effects of alternative streamside buffer widths with upland thinning for forest restoration on aquatic vertebrates and their habitats. After 30 years of implementation, results provide insights for application of riparian buffer widths for system restoration and conservation with upland timber harvest. We examined aquatic-vertebrate densities and habitats at 43 stream reaches across eight study sites with data from pretreatment surveys and surveys in years 1, 2, 5, and 10 after a first thinning treatment, followed by years 1, 5, and 11–12 after a second thinning treatment, along with unthinned controls. Streamside buffer-width treatments included a streamside retention buffer (6 m), a variable-width buffer (minimum width 15 m), and a one tree-height buffer, ~70 m buffer. We found two unique headwater ecosystems within these forests: distinct low- and high-flow systems and associated fauna which may warrant discrete management consideration for conservation. Some species showed reduced densities in stream reaches with narrower buffer widths during intermediate time steps of the 30-year study, but no significant buffer-width effects were detected on species' densities during the final analyses through 11–12 years after a second thinning treatment. Due to heterogeneous site conditions, local disturbances, and forest practices, mixed-width buffers may provide a precautionary approach to ensure ecosystem integrity within watersheds.

A-0566 (Oral)

Parthenogenetic Reproduction in Reptiles: Exploring Origins, Distribution and Diversity in Egg Formation Mechanisms

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Reptiles exhibit a diverse array of sex determination and reproductive modes, with females of some species able to reproduce without sperm through parthenogenesis. Facultative parthenogenesis, where a female in a population can reproduce both sexually and asexually, has been reported in many lizards and snakes. It is typically associated with normal meiosis, which additionally involves a likely fusion of nuclei of an egg and a polar body, resulting in a sometimes substantial loss of heterozygosity. Obligate parthenogenesis, the exclusively asexual reproduction, has evolved several times, primarily through interspecific hybridization. The resulting hybrid complexes often include both diploid and triploid lineages, with offspring genetically identical to their mothers (clones). We showed in three parthenogenetic gecko lineages, three lacertids and an agamid that in the parthenogenetic hybrids the eggs are also produced by meiosis. Nevertheless, only germ cells that undergo the premeiotic endoreplication ensure that chromosomes in both diploids and triploids pair with their identical copies and pass to later meiotic stages. On the other hand, we observed non-duplicated, diploid oocytes in late meiotic stages in xantusiid night lizards providing the evidence that obligate parthenogenesis in this lineage may have evolved through the fixation of facultative parthenogenesis. In this talk, we will provide a comprehensive review of current knowledge on

the phylogenetic distribution, cytological mechanisms, preadaptations and constraints of parthenogenesis in vertebrates.

A-0567 (Oral)
How did Snakes Adapt to the Mechanical Constraints Associated with Headfirst Locomotion

Marion Segall and David Gower
Natural History Museum, Cromwell Road, London SW7 5BD, UK

Many snakes can actively burrow in various substrates such as sand, mud, leaf litter, soil, etc. using their head. Yet, the unique anatomy of their hyperkinetic skull should make this activity nearly impossible. We expect the shape of the cranial bones of burrowing snakes to be adapted in two ways: it should (1) provide a solid support to be able to dig efficiently and (2) prevent any damage in soft, sensory tissues. Because each environmental substrate has its own mechanical properties, we expect to find a gradient of morphological adaptation that follows the gradient of mechanical properties of the substrates. We compared the shape of the braincase of 90 species of alethinophidian snakes and found differences depending on their preferred substrate. We then tested whether this difference in shape was adaptive using a mechanical experiment mimicking headfirst burrowing. In addition, we used an experiment to measure the mechanical properties of each substrate to determine whether the morphological and biomechanical responses we measured in snakes are adapted to their physical environment.

A-0568 (Oral)
Is the Braincase of Snakes really Protecting their Brain?

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The braincase of snakes is a multifunctional anatomical structure: it provides a solid support for locomotion while also housing and protecting the brain and associated structures. As such, it experiences potentially antagonistic selective pressures: from the inside, the brain pushes against the endocranium to grow and take as much space as possible and from the outside, the braincase must be able to undergo high stress caused by headfirst locomotion, especially in dense substrates. Snakes use different sensory modalities depending on the cues available which in turn, depend on the substrate. These differences in sensory modalities should impact braincase morphology. On the other hand, mechanical stress experienced by the braincase is also related to substrate properties. We compared the shape of the inner (endocranium) and outer (exocranium) part of the braincase of 90 species of alethinophidian snakes that live in different substrates. We assessed whether shape variation of the two braincase layers is related to substrate physical properties, and tested the prediction that living in dense substrates is correlated with lower shape disparity and stronger integration (covariation) between the endo- and exocranium, due to high mechanical stress. Our hypothesis was that protecting the brain by reducing the stress on the endocranium was the primary driver of morphological evolution and has induced a strong covariation. On the other hand, species that face less mechanical constraints would present more morphological variation and a weaker covariation. Finally, we examined the link between the shape of various sensory parts of the braincase and physical properties of different substrates.

A-0570 (Oral)

Recent taxonomic changes in *Trimeresurus* and their conservation implications

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Assessment of conservation needs and implementation of action crucially depends on taxonomic information. several new species of Asian pitvipers of the Trimeresurus group, which include many morphologically similar species, have been described in recent years. This potentially increases the species richness of vipers in certain areas, which has been suggested to be an effective proxy for prioritising regional conservation action. I will review these changes and the implications for the assessment of viper conservation priorities in Asia.

A-0571 (Oral)
Mapping Frog Genomic Diversity across Eastern North America: Does Historical Climate Stability Predict Current Variation Within Species?

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Genomic variation within species is key for adaptation and survival in changing environments. Determining what factors influence that variation is thus an important goal for managing wildlife populations and conserving biodiversity. Amphibians are lacking from many comparative studies of genomic variation because they have large, complex genomes, and few studies have characterized genomic diversity across geographic space in a comparative framework. In this study, we generated new genome-wide sequence data for 46 frog species sampled across eastern North America to investigate the influence of historical processes and contemporary landscape on within-species variation. For two years (2022–2023), we launched a large-scale fieldwork effort across 30 states in the USA, producing > 1,900 holistic specimens from > 40 species, which are searchable via the Arctos collection management system and available for loan from the Museum of Southwestern Biology, University of New Mexico. For each individual, we preserved and archived multiple parts, including cryo-preserved tissues (heart, lung, liver, skin, muscle, blood), thin blood smears, and whole organisms in ethanol. We supplemented these samples with 906 frozen tissues through loans from 23 other natural history collections to fill in geographic sampling gaps. We used a double-digest Restriction Associated DNA (ddRAD) sequencing approach to generate genome-scale data for ~2,200 frogs, with an average of 48 individuals per species. In this talk, we demonstrate the use of these data for mapping genomic diversity within species, identifying potential 'hot spots' of diversity across species, and testing predictions about the role of historical climate stability on current patterns of genomic variation. These data will ultimately be linked to their specimen catalogue numbers in Arctos and made available to the research community via open-access databases. This resource will help address pressing questions about the determinants of genomic diversity, a fundamental component of biodiversity needed to ensure population persistence.

A-0572 (Oral)
Forging Paths to Inclusive Herpetology through Exploring Barriers and Harassment of Marginalized Groups within the Field

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Recent movements such as Me-Too and Black Lives Matter have catalyzed actions to safeguard marginalized identities, bringing attention to the need for inclusive strategies. Recent studies focused on increasing diversity, equity, and inclusion in science fields have revealed alarming rates of discrimination, harassment, isolation, and inaction by coworkers and supervisors reported by women and minorities. This study examined the challenges and barriers reported by women and minorities in herpetology, focusing on the issues of harassment, accountability, and accessibility. We explored the experiences of underrepresented individuals within herpetology, shedding light on the realities that may hinder professional growth and participation. Our results revealed higher rates of harassment and discrimination reported by women and minorities, coupled with a trend of dissatisfaction with reporting outcomes. A critical examination of accessibility issues further underscores the perception that the field is not equally accessible to all communities. Our study builds on other work emphasizing the urgent need for accountability mechanisms to address and rectify instances of harassment, and fostering an environment that encourages diversity and inclusion for future generations of herpetologists.

A-0573 (Oral)
50 Shades of Metamorphosis: Impact of Life Cycles Variation on Morphological Diversity in Salamanders and Newts

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Salamanders and newts show the largest variation in life cycle types among tetrapods. Interestingly, they have independently evolved different life-cycles and thus distinct ontogenetic trajectories multiple times. Some species have complex life cycles with bi-phasic development, allowing them to exploit different environments (aquatic-to-terrestrial) during morphologically different ontogenetic stages. Other species exhibit direct development, lacking free-living larval phases, and hatch directly as terrestrial adult-like juveniles. Paedomorphic species are completely aquatic, keeping aquatic larval traits even if they are reproductively active. Interestingly, some species have a facultative life cycle associated with phenotypic lability in variable habitats. The variety of reproductive strategies ranging from an obligate life cycle adapted to permanent environments, to fast and/ or plastic facultative life cycles adapted to ephemerality of the larval habitat represent an ideal system to test how

developmental strategy may foster morpho-functional diversity. As such, we can test whether development can be a driver of biodiversity. In this presentation, we will focus on different parts of the head as their morphology is impacted by the changes in feeding strategy during ontogeny. The head is an interesting structure as it is ontogenetically and functionally complex. It houses and protects the principal sensory organs and the brain and is crucial in acquiring nutrients required for survival. We use interdisciplinary approaches combining functional morphology, developmental biology, diversification analyses and statistical modelling to disentangle the factors driving diversity at different ontogenetic stages. Our results show that life cycle complexity can, depending on the anatomical structure, constrain or alternatively facilitate the evolution of morphological structures and their diversity. As such life cycle complexity can strongly impact the pattern of morphological diversification across species.

A-0574 (Oral)
Impacts of Enviromental Change on Habitat Selection and Movement Patterns in a Declining Turtle Species

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Wood Turtles (*Glyptemys insculpta*) are thought to be declining throughout their range in the northeastern U.S. and southeastern Canada and are currently a Species of Greatest Conservation Need in the state of Maine, USA. At our study sites in central Maine, we radio-tracked 27 adult turtles for 1–6 years each to characterize habitat selection, seasonal migration patterns, home range sizes, and flood displacement events with the goal of understanding environmental influences, such as changing weather patterns, and other threats in a rural landscape that is dominated by mixed use areas and agriculture. We identified significant differences among years in overwintering stream emergence dates (but not return dates), and we suggest that weather may influence migration timing. An analysis of habitat selection during the terrestrial phase of their annual cycle also yielded interesting patterns, including substantial utilization of human-altered areas. Lastly, our analysis of flood events showed that Wood Turtles were often displaced downstream following rain events of just 2 cm or greater, and that larger rain events caused a larger proportion of the population to become displaced. Increasing frequency and intensity of winter flood events, such as predicted under various climate change scenarios, could play an important role in movement patterns with some paradoxical outcomes for sensitive populations. Collectively, our results have implications for managing turtle populations in changing environments and on working landscapes where humans and turtles coexist.

A-0575 (Oral)
Morphological Adaptations of the Olfactory System of Subterranean Lizards

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Convergent evolution, a key concept in evolutionary biology, exemplifies the development of independently morphological adaptations across diverse lineages due to natural selection constraints. Subterranean lizards face unique challenges in their habitats, leading to the independent evolution of morphological adaptations such as elongated bodies and reduced limbs, enhancing their excavation capabilities. While extensive research has been conducted on the optic system of subterranean vertebrates in recent decades, revealing a consistent trend of reduced vision across various groups, little attention has been given to their olfactory capabilities. It is highly probable that subterranean vertebrates heavily rely on efficient olfaction for foraging and mating, suggesting a potential development of specialized olfactory organs to compensate the reduced vision. Given the independent colonization of subterranean environments by reptiles, our project seeks to understand the variation in olfactory organs along the reptile phylogeny, examining potential co-variation and the influence of ecology on olfactory adaptations within a convergent context. To address this gap, we employ diceCT data to explore the olfactory organs of subterranean reptiles and their terrestrial counterparts. Utilizing an exceptional dataset composed of approximately 20 independent subterranean lineages and their closely related terrestrial species, our research focuses on assessing potential morphological adaptations in the olfactory system, particularly the relative volume of the olfactory bulb and the vomeronasal organ. While some lineages show a significant increase in the volume of their olfactory organs, indicative of potentially efficient olfactory capabilities, the pattern is not fully convergent throughout the lizard phylogeny. Among various interesting findings, we observe remarkable morphological diversity in the olfactory apparatus of lizards. Ongoing investigations, including a histology-based approach, aim to provide further insights into understanding this pattern.

A-0576 (Oral)
Cold-Blooded Care: How do We Know How a Reptile is Feeling?

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Recent research into the cognitive capabilities of reptiles has revealed striking new evidence of sophisticated capacities in a variety of species. Such findings have important implications for the welfare of reptiles in captivity, particularly in relation to their ability to suffer. This talk will present some recent research on the cognitive abilities of reptiles, alongside novel methods to assess their welfare and will consider the implications of the findings in relation to their captive care.

A-0577 (Oral)
Thermal Ecophysiology of Threatened and Endemic Lizards from Restingas of Northeastern Brazil

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Reptiles depend on the environmental temperature to keep their metabolism active. Thus, studies on their thermal ecophysiology are crucial to understanding climate change impacts at the species level, especially for endemic species living on narrow distributions and temperature ranges. Here, we aim to describe the thermal ecophysiology of three threatened and endemic lizards from Brazilian restingas (*Glaucomastix abaetensis, G. itabaianensis*, and *Tropidurus hygomi*) by i) establishing their thermal limits, ii) evaluating interspecific ecophysiological differences, and iii) testing differences between Bahia and Sergipe's populations. We collected the specimens in four areas of the Sergipe and Bahia states from November 2022 to May 2023. The variables were Tpref, Vtmin, Vtmax, Ctmin, Ctmax, and Topt. We obtained thermal data for 193 specimens: 48 *G. abaetensis*, 17 *G. itabaianensis*, and 128 *T. hygomi*. The species demonstrate remarkable differences as to thermal characteristics, with *T. hygomi* exhibiting the lowest average Tb, Tpref, VTmin, VTmax, CTmin, CTmax, WT, and Top when compared to *G. abaetensis*, and higher standards of CTmax and WT than *G. itabaianensis*. The highest temperatures of CTmax and Topt are documented for the Teiidae in comparison to Tropiduridae family. Simultaneously, the lowest Tpref has usually been documented in Tropiduridae. Thus, these results corroborate previous studies, which point to phylogenetic responses on ecophysiological traits, highlighting that thermoregulatory behavior can influence thermal responses.

A-0578 (Oral)
Integrating Ecology, Physiology and Development to Address the Impacts of Climatic Changes in the Herpetofauna

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The increasing rates of decline in terrestrial biodiversity associated with climatic changes and the loss of natural habitats encourage the implementation of research programs dedicated to identify responses to environmental changes that contribute to elaborate proposals for conservation actions. Multidisciplinary approaches likely contribute for such discussions, especially when integrating different organismal levels and time scales, such as ecology, evolution and development. Developmental processes integrate environmental signals with genetic information when establishing phenotypes. The field of Developmental Evolution (EvoDevo) recognizes that dynamic environments may induce new phenotypic variants in natural populations by activating alternative developmental pathways mediated by the plasticity inherent to ontogenetic processes, a perspective that likely contributes also for analyses of implications of climatic changes on biodiversity. In this talk, I will synthesize some studies that investigated associations between phenotypic patterns (physiology and morphology) and climatic/environmental variables in representatives of Lissamphibia and Lepidosauria from South America. Then, I will discuss how results from experiments performed in the lab to identify plastic developmental responses to variation in environmental parameters may be combined with studies in ecomorphology and ecophysiology to evaluate possible effects of accelerated climatic changes in the biodiversity.

A-0580 (Poster)
Microplastic Pollution Changes the Intestinal Microbiome but not the Morphology or Behaviour of a Freshwater Turtle

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Humans produce 350 million tonnes of plastic waste per year, leading to microplastic pollution and widespread environmental contamination – particularly in aquatic environments. This subsequently impacts aquatic organisms in myriad ways, yet the vast majority of research is conducted in marine, rather than freshwater systems. In this study, we exposed eggs and hatchlings of the Chinese soft-shelled turtle (*Pelodiscus sinensis*) to 80-nm polystyrene environmental microplastics (PS-MPs) and monitored the impacts on development, behaviour and the gut microbiome. We demonstrate that 80-nm PS-MPs can penetrate the eggshell and move into developing embryos. This led to metabolic impairments evidenced by bradycardia (decreased heart rate) which persisted until hatching. We found no evidence that microplastic exposure affected hatchling morphology, growth rates, or levels of boldness and exploration , yet we discuss some potential caveats here. Exposure to microplastics reduced the diversity and homogeneity of gut microorganisms in *P. sinensis*, with the level of disruption correlating to the length of environmental exposure (during incubation only or post-hatching also). Thirteen core genera (with initial abundance >1%) shifted after microplastic treatment: pathogenic bacteria increased, beneficial probiotic bacteria decreased, and there was an increase in the proportion of negative correlations between bacterial genera. These changes could have profound impacts on the viability of turtles through life. Our study highlights the toxicity of environmental MPs to the embryonic development and survival of freshwater turtles. We provide insights about population trends of *P. sinensis* in the wild, and future directions for research.

A-0581 (Poster)
Ecological Adaptation Evolution of Temperature Sensing and Olfactory Gene Families in *Hemiphyllodactylus yunnanensis*

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We studied the evolution and adaptation of thermoreceptor and olfactory receptor genes at the genome and transcriptome levels of the gecko, *Hemiphyllodactylus yunnanensis*. The transient receptor potential (TRP) gene family was identified from the chromosome level genome of the species. It was found that TRP genes were generally conserved in evolution, and results of domain analysis indicated that intron loss may be caused in late differentiation. The evolutionary changes of TRPA1 were related to the evolution of temperature regulation in the species. MCOLN2 makes the importance of its lysosome function more favored in the evolution of thermal adaptation. TRPV1, TRPV2, TRPV4 are involved in noisioception, and these genes are subject to positive selection, which is key to survival. Then, we obtained the gene sequence of olfactory receptor (OR) gene family through genome data, and found that the main mechanism of gene clusters to produce homologous genes is tandem replication. In the

selection pressure analysis, five positive selection sites were detected, OGG5 was subjected to disproportionation selection, and four orthologous groups were relaxed by selection pressure, which means that some of these genes lost function. Furthermore, RNA sequencing technology was used to investigate the expression patterns of liver, skin, brain and nose of *H. yunnanensis* under temperature stress. The results showed that the greater the temperature difference, the more differentially expressed genes. TRPM8 and PKD1L2 were differentially expressed in the four tissues, suggesting that these genes may have extensive and important functions in various tissues. GO enrichment results are mainly related to cellular processes, biological regulation and metabolic processes. The high temperature and low temperature pathways in KEGG enrichment results indicate that these pathways can enhance the stress resistance of *H. yunnanensis* under temperature stress.

A-0582 (Oral)
Correlates of Extinction Vulnerability and Biogeographical Variation in Amphibians on Oceanic Land-Bridge Islands

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Identification of key factors that render certain species with higher vulnerability to fragmentation is vital for elucidating processes underlying extinction and targeting conservation priorities. However, past evidence was primarily from trait-based responses of species in newly formed patches, providing few inferences on the delayed species responses mediated through landscape features. To bridge the gap, we surveyed amphibians on 37 islands in the Zhoushan Archipelago, China, and on the adjacent mainland. We considered the proportion of islands occupied as a measure of species' vulnerability to long-term isolation and related it to nine species' traits to achieve the best correlates. We also explored biogeographical variation in amphibians by relating four biogeographical variables to the probability of occurrence of each species on islands through logistic regression analyses. Model selection identified that species with lower natural abundance, smaller clutches, and the combination of larger eggs and smaller clutches have a lower occupancy frequency on islands. Moreover, these three variables were also substantially important in the model-averaged analysis. The probabilities of occurrence of five species showed positive correlations with island area, and that of Hyla chinensis was negatively related to distance to the mainland. Area was not an important predictor for another five species, which only inhabited larger islands. By contrast, two species were widely distributed on islands, showing no correlations with any biogeographical variables. Our study stressed that amphibians were non-equally vulnerable to long-term fragmentation. Moreover, area-related extinction predominantly limited species distribution, especially for those with low natural density or 'slow' life-history strategies. We highlight that, to achieve effective conservation, management efforts should not only focus on species with extinction-prone traits but also the landscape features which threaten the persistence of populations. Particularly, conserving large islands is more beneficial for supporting populations than multiple isolated islets.

A-0583 (Oral)
First Evidence Supporting the Sensorial Function of Cephalic Appendages in Terrestrial Snakes (Family Viperidae)

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Several species of vipers and a few other snakes carry enigmatic, horn-like structures on the tip of their snout and/or above their eyes. The exact function of these remarkable appendages remains a mystery. Cephalic appendages in other groups are associated with special sensory and mechanosensory roles, hinting at potentially similar functions for vipers. If true, then viperid horns should be innervated by functionally specific cranial nerves, such as the trigeminal nerve for mechanosensation. Here, we tested whether the rostral horn protruding from the Horned viper (*Vipera ammodytes*) could serve a sensorial function. To do so, we used the diffusible iodine-based contrast-enhanced computed tomography (diceCT) scanning technique as the basis for 3D soft-tissue reconstructions in and around the snake's rostral appendage, with special attention for neural tissues. Identifying cranial nerve branches serving the rostral horn would be consistent with sensory capability, and the specific nerve(s) identified would indicate the likely sensory modality. Our preliminary results show that V1 branch of the trigeminal nerve fans out into the rostral horn of *V. ammodytes*, probably making it a highly sensitive structure. This finding constitutes a first for non-aquatic snakes. We are currently employing a combination of traditional and digital histological imaging, scanning electron microscopy, and (in the near future) behavioural experiments to further explore the nature of the information captured and relayed by the horn's neural system. To also assess whether this phenotype may be more common than once appreciated, we are looking for similar nervous tissue arrangements in other horned species of vipers.

A-0584 (Oral)
Boa Evolution and Diversification on Caribbean Islands

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The boa genus *Chilabothrus* comprises 14 species distributed across the Greater Antilles and Lucayan Archipelago of the northern Caribbean, with islands containing between one and four species in sympatry (but not always syntopy). Although a relatively modest radiation, the genus has an enormous range of body sizes, spanning three orders of magnitude in mass, and species occupy nearly the full range of habitat types found on these islands. Two morphotypes are recognized, a small specialist and a large generalist, which co-occur across much of the region. Previous work has shown that these morphotypes probably evolved repeatedly *in situ* from generalist ancestors, suggesting a deterministic trajectory across the radiation. But no study to date has included all recognized species (there are now 55% more species recognized than there were just 10 years ago) and previous studies have produced contradictory phylogenetic topologies. Using mode molecular and statistical methods, I illustrate the evolution of this genus across the Greater Antilles and compare diversification of *Chilabothrus* to the two other genera found in the Caribbean: *Boa* and *Corallus*. Together these boas provide significant insight into evolutionary outcomes shaped by islands and island habitats.

A-0585 (Poster)

Metabarcoding Clarifies the Diet of the Elusive and Vulnerable Australian Tjakura (Great Desert Skink, *Liopholis kintorei*)

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Accurately quantifying the diet of species has implications for our understanding of their ecology and conservation. Yet, determining the dietary composition of threatened and elusive species in the wild is often difficult. This study presents the first dietary assessment of Tjakura (*Liopholis kintorei*) using non-invasive sampling of scats and high-throughput sequencing techniques. The tjakura in Uluru consumed 48 invertebrates, 27 plants, and two vertebrate taxa. Fruit flies (*Leucophenga* spp.), beetles (*Harpalus* spp. and *Omorgus* spp.), mosquitos (Culicidae spp.), termites (Termitidae spp.), spiked mallow (*Malvastrum americanum*), bush tomatoes (*Solanum centrale*), and wild turnip (*Brassica tournefortii*) comprised the majority of the diet. Analysis of similarity revealed that food items did not differ significantly between tjakura age groups, seasons, or time since the last fire, however, adults, hot season, and fire scar of 2018 showed a relatively higher prey diversity. These high similarities in diet composition between age classes and fire scars indicate potential intraspecific competition when food resources are scarce. The diet diversity and potential plasticity observed in this study reflect a dietary ecology influenced by food availability rather than preference. Our study demonstrates that scat DNA metabarcoding is an important complementary tool to conventional scat analysis or indigenous knowledge as most food items we identified were previously not recorded through those methods.

A-0586 (Oral)
Monitoring the Welfare of Three Floodplain Turtle Species across large Spatial and Temporal Time Scales and Evaluating the Impact of Human-Induced Environmental Change

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Field studies that assess wild populations are constrained by many factors and often assess individual or population health over short timeframes. This is problematic because the impact of changes, be they human-induced or environmental, may take years or decades to manifest,

especially in long-lived species such as turtles. In addition, fluctuations in population condition may simply mimic naturally changing environmental conditions, and creating a link between animal welfare and human induced change can be difficult. Over the past 16 years we have been monitoring the individual and population health of three freshwater turtle species. The turtles live in a river-floodplain system in south-eastern Australia where the environment has undergone marked change in line with a drying climate and water extraction. We generated metrics for individual and population level welfare based on data on body condition, recruitment, and relative abundance. We used state-space and hierarchical occupancy modelling approaches to evaluate changes in metrics over time and the influence of environmental, site, and management covariates on populations trends. The large open study system, sparse catch data, longevity of the species and their propensity to disperse made it difficult to assess population health. However, our long-term data set has generated multiple lines of evidence that landscape-scale flooding positively affects individual turtle body condition, recruitment, and population size. As flooding has been reduced by river regulation and climate change our findings indicate that human-induced changes to the environment are influencing population welfare. Conservation strategies that repair the natural flow regime should promote population recovery.

A-0587 (Oral)

Large-Scale Movement of a Floodplain Turtle and the Impact of Water Management on Habitat Use

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Like most places in the world, Australia's waterways are highly modified. Flow in the Murray-Darling Basin, Australia's largest catchment, is the most regulated. In this system water is shared across three states and is controlled by a series of dams, weirs, and creek line regulators which reduce river-floodplain connectivity. The Broad-shelled Turtle, Murray River Turtle, and Eastern Long-necked Turtle are distributed throughout the Basin. Environmental water management typically targets the Eastern Long-necked Turtle - the species considered most vulnerable because of its association with ephemeral floodplain habitats. However, turtle species predominantly associated with mainstem habitats may also utilise floodplain habitats for foraging and dispersal, especially during periods of flood. We investigated the extent to which water regulation, including flow manipulation and barriers to movement, influence the habitat use and dispersal of Murray River Turtles. Using an array of over 70 acoustic receivers, we monitored the movements of 30 tagged Murray River Turtles over a four-year period (2020–2024). The study was conducted in a forested 66,000-ha river-floodplain system situated on the mid-Murray River in south-eastern Australia. Movements were recorded in the main stem of the river as well as throughout the floodplain forest. Males are highly mobile undertaking large-scale movements over both short and long-time frames, e.g., one individual moved 100 km between receivers during a two-year period, and another was recorded moving 35 km over 35 days within the study system. Importantly, males were found to utilise ephemeral creek lines and floodplain wetlands in response to forest inundation and the opening of creek line regulators. Our results highlight the importance of river-floodplain connectivity

to the dispersal of Murray River Turtles, and the need for inclusion of this species in water management plans.

A-0588 (Oral)
Stress, Seabird Snacks, and *Sphenodon* Sperm: Reproductive Fitness in Male Tuatara is Influenced by Immune Stress and Diet

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The theoretical trade-off between immune and endocrine investment in mating animals has received mixed empirical support, particularly in reptiles. We investigated the relationship between male sexual characteristics, diet, and immune response to stress in an island population of tuatara (*Sphenodon punctatus*) across two mating seasons. Tuatara, the last living Rhynchocephalians, are promiscuous with a highly skewed mating system in which males face strict competition for access to mates and post-copulatory competition for fertilisation success. We found that the viability and swim speed of tuatara sperm were negatively associated with the ratio of heterophils:lymphocytes and with male body condition. Additionally, sperm swim speed was negatively associated with spine area, mite load, and the total number of circulating white blood cells, but was positively associated with tick number, likely a function of social dynamics in this system where larger male size predicts greater spatial overlap with potential rivals and an increased tick load. As the production of sexual characteristics may be costly for male tuatara, we also investigated the effect of diet on sperm quality. We did not identify an association between diet and sperm viability. However, sperm swim speed was negatively associated with carbon-13 and positively associated with nitrogen-15. We suspect that these results reflect the influence of seabird-based nutrients in this island ecosystem, particularly poly-unsaturated fatty acids, and antioxidant damage on tuatara sperm. In total, these results provide evidence of a trade-off between pre- and post-copulatory sexual characteristics and the immune and endocrine systems in male Tuatara.

A-0589 (Oral)
Mapping Diversity and Distribution of Amphibians and Reptiles in China with Implications for Conservation

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China harbors one of the most diverse vertebrate species of the world, with nearly 600 amphibians and over 500 reptiles being recorded and identified. In particular, many new species had been documented and accumulated over the past two decades. To this end, with the rapid identification of new species, it is important to generate a comprehensive distributional map showing amphibian and reptilian diversity in China. In this study, we complied one of the most comprehensive databases on amphibians and reptiles in China by inventorying the occurrence points, range maps, morphological trait information and other features of each species. Based on the database, we mapped the spatial multi-dimensional biodiversity features of amphibians and reptiles in China (including taxonomic, functional, and phylogenetic) for different species groups (including all, endemic and threatened). Our results showed that southern and southwestern part of the country were always the hotspots for both

taxonomic groups. We also discussed the conservation effectiveness of current protected area network in covering both taxonomic groups. To archive this goal, we propose and discuss the effectiveness of a new index in conservation planning, the so-called conservation gap index that are expected to partially, if not fully, remove the issue of spatial dependency when conducting macro-ecological researches. Our conservation planning showed that, sustainable management of less-protected habitats, including farmlands and grasslands, can reduce the area requirement of strict protection for reaching the '3030' conservation goal.

A-0590 (Oral)
Effects of Translocation and Head-starting on Giant Gartersnake (*Thamnophis gigas*) Behavior and Survival

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Conservation translocations are increasingly used to repatriate populations to areas from which they have been extirpated or to establish new populations. For some species, repatriation to portions of their former range from which they have been extirpated is a necessary component of recovery. The U.S. and California Threatened Giant Gartersnake (*Thamnophis gigas*) has been almost completely extirpated from the southern two-thirds of its historical range, and translocation will be necessary to recover populations in these areas. To understand how Giant Gartersnakes might respond to translocation and head-starting, we conducted a small-scale translocation experiment within the Natomas Basin, Sacramento, California, USA, from robust populations inhabiting restored wetlands and canals associated with rice to recently restored wetlands that did not contain Giant Gartersnakes. We found that adult movements and home ranges were within the ranges observed for resident snakes, and that translocated snakes generally selected similar microhabitats to resident wetland snakes. Nonetheless, survival of adult Giant Gartersnakes was lower following translocation than for resident snakes. Survival of head-started individuals, however, appeared high from the time of release into brumation. Identifying mechanisms leading to reduced survival and sustaining establishment efforts will be key to successful conservation translocations, and ultimately recovery, of this species.

A-0591 (Oral)
A Balancing Act: Seasonal Plasticity in Nutritional Responses in Desert Lizards

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For all animals, consumption of specific macronutrients, and not just total calories, can affect their physiological processes. For instance, whether or not animals consume sufficient proteins will affect their investment in reproduction, while sufficient consumption of carbohydrates is essential for maintenance and building fat stores for lean seasons. Substantial evidence from lab-based studies suggests that animals can choose foods rich in the limiting nutrient, and thus optimize for the ratio of macronutrients consumed, but such evidence is sparse from field studies. Additionally, very little is known about how much of this nutritional plasticity stems from behavioural (food choice) and physiological (post-ingestive) mechanisms. In this field-

based study, we examined the seasonal plasticity in nutritional composition of intakes as well as fecal matter of the Indian spiny-tailed lizard (*Saara hardwickii*), a predominantly herbivorous desert agamid inhabiting the Thar desert, to understand how animals regulate food consumption to match proximal biological demands, especially in extreme environments with limited resources. From field observations and elemental analysis of foods consumed, we found that the lizards consumed more nitrogen (a proxy for proteins) during their breeding season, and more carbon (a proxy for carbohydrates and lipids) before the winter season when they hibernate. The lizards achieved this by consuming insects only during the short breeding season, while resorting to herbivory during the rest of the active period. These changes in nutritional intakes were complemented by the changes in nutrients retained, such that the ratios of carbon to nitrogen in lizard feces were higher in the breeding season (higher N retention), whereas they were lower before hibernation (higher C retention). Our results show that in extreme environments such as the deserts, lizards can meet their seasonal nutritional demands both behaviourally, by preferentially eating specific foods, and physiologically, by preferentially retaining specific nutrients, across seasons.

A-0592 (Oral)
Investigating Trypanosomes of Herpetofauna in Southern Africa

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Species of *Trypanosoma* from African anuran and reptile hosts are of the least understood taxa in the genus. Research on this parasite group has not kept up with the pace of research on the hosts, in spite of the potential of aquatic and terrestrial trypanosome clades to provide insight into the evolutionary history of the genus, as well as complementary information for biomedical studies of medically and economically important species of *Trypanosoma*. The ecological interactions and phylogeny of aquatic trypanosomes are currently not well-understood, mostly due to their complex life cycles and a deficiency of data. This study aimed to address the gap in our knowledge of trypanosomes infecting African amphibian and reptile hosts, and to create a platform for future research on African trypanosomes. Frogs, lizards, snakes, tortoises, and freshwater turtles were collected from various localities in South Africa and screened with a combination of microscopy and molecular techniques. Descriptions of these trypanosomes with morphological and molecular data were provided to establish the current species diversity and phylogenetic relationships of the trypanosomes infecting African herpetofauna. This study described three new species of *Trypanosoma*, along with the redescription of five species. Ultimately, this study shows that the diversity of trypanosomes is higher than previously thought, and further research is necessary to expand our understanding of the true diversity and ecology of trypanosomes infecting herpetofauna.

A-0593 (Oral)
Phylogenomic Insights on the Diversity and Evolution of Palearctic Vipers

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Despite decades of molecular research, phylogenetic relationships in Palearctic vipers (genus *Vipera*) still essentially rely on a few loci, such as mitochondrial barcoding genes. Here we examined the diversity and evolution of *Vipera* with ddRAD-seq data from 33 representative species and subspecies. Phylogenomic analyses of ~1.1 Mb recovered nine major clades corresponding to known species/species complexes which are generally consistent with the mitochondrial phylogeny, albeit with a few deep discrepancies that highlight past hybridization events. The most spectacular case is the Italian-endemic *V. walser*,

which is grouped with the alpine genetic diversity of *V. berus* in the nuclear tree despite carrying a divergent mitogenome related to the Caucasian *V. kaznakovi* complex. Clustering analyses of SNPs suggest potential admixture between diverged Iberian taxa (*V. aspis zinnikeri* and *V. seoanei*), and confirm that the Anatolian *V. pontica* corresponds to occasional hybrids between *V.* (*ammodytes*) *meridionalis* and *V. kaznakovi*. Finally, all analyzed lineages of the *V. berus* complex (including *V. walser* and *V. barani*) form vast areas of admixture and may be delimited as subspecies. Our study sets grounds for future taxonomic and phylogeographic surveys on Palearctic vipers, a group of prime interest for toxinological, ecological, biogeographic and conservation research.

A-0594 (Oral)

Welfare Considerations and Challenges During Lizard Translocations: A Case Study

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There are welfare implications through all stages of a conservation translocation, however relatively little information has been published concerning translocation welfare for reptiles, especially lizards. Most translocations involve the movement of either wild caught or captive reared individuals, with more being known about the source population when they are reared in captivity. In reptiles, the majority of translocation articles focus on predatory species at the top of the food chain. Here, I will use a case study of a wild-to-wild translocation of a prey species, the lesser night gecko, in Mauritius. I will describe the translocation process, from planning through to release and post-release monitoring. I will highlight the areas where welfare was a key factor in our decision making and where information to make decisions was lacking. I will also illustrate the challenges faced during the translocation and the impacts they may have had on welfare.

A-0597 (Oral)

Unveiling Overlooked Mechanisms Shaping Vulnerability of Amphibians and Reptiles to Extreme Temperature Events

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Ongoing climate change increases the frequency and magnitude of thermally extreme weather events. Extremely high temperatures have a direct impact on the individual survival and population dynamics of amphibians and reptiles. While extensive research has focused on unraveling the temperature tolerance of various taxa, many behavioral and physiological mechanisms enabling amphibians and reptiles to mitigate individual exposure or enhance population resilience to temperature extremes remain underexplored. This knowledge gap hinders a comprehensive understanding of climate change impacts on amphibian and reptile

populations. This contribution aims to spotlight these overlooked mechanisms, shedding light on alternative ways that can significantly mitigate the impacts of extreme temperature events and charting promising directions for future research in this field.

A-0598 (Oral)
Common Toad (*Bufo bufo*) Declines Coincide with Land Use and Temperature Driven Phenology Shifts

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The current biodiversity loss includes the loss of common and more widespread species. Minor reductions in population sizes of common species impact ecosystem functioning and services. The Common Toad (*Bufo bufo*) makes up a significant portion of the biomass in a variety of ecosystems within its range and plays a vital role in both terrestrial and aquatic ecosystems. Over 40 years of citizen science data suggest toad populations to be declining across Flanders, Belgium, of which the causes are unclear. We aimed to quantify the decline of these populations, link this with the surrounding landscape and investigate the potential phenological shift due to climate change. Having sufficiently long time series for 111 locations, we used generalized additive models to statistically infer declines across these locations. The outcomes were linked to the surrounding landscapes of each location using QGIS and linear models. Finally, we studied shifts in migration phenology and linked the extent and consistency of phenological changes to meteorological data. Our results demonstrate a significant decline in 43.2% of the populations, which contrasts with an increase in only 3.6% of the populations. Surrounding land use, and in particular the proportional area of agricultural fields, was significantly associated with population decline. Shifts in migration phenology can influence demography through their negative impact on recruitment and survival, while it also affects population and community dynamics by changing resource availability and the trophic interactions. We observed a significant and consistent phenological advancement of 3.1 ± 0.1 days per decade across Flanders, which is closely linked to the increase in average winter temperature. We discuss our results for this decrease in commonness of the common toad in light of anthropogenic landscape changes and climate change.

A-0599 (Oral)
The (Onto)Genetic Basis of Correlated Evolution: Aposematism in Poison-Dart Frogs

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It is common for multiple traits to evolve in a correlated fashion, resulting in complex, integrated phenotypes. Although correlated evolution can, in principle, arise solely due to selection on specific combinations of independently evolving traits, if the correlated traits share

a common ontogenetic basis, then selection can more effectively produce concerted phenotypic change by directing the evolution of developmental modules rather than individual traits. The developmental relationships between traits can therefore be a major influence on the evolutionary dynamics of complex phenotypes. Although development has been identified as an important player in the evolution of traits with obvious ontogenetic connections, such as different limb or skull bones, its role in less obviously connected suites of traits has not received as much attention. In this talk, I present initial results and future directions of a project aimed at understanding the role of ontogeny in the correlated evolution of predator avoidance traits in poison-dart frogs, namely coloration, toxicity and body size, through a combination of morphological, population genetic, and functional genomic approaches.

A-0600 (Oral)
Return to Round Island: Reintroducing a Prey Species in the Presence of Native, Threatened Predators

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At the 2020 World Congress in New Zealand, I interviewed 25 conference participants about an upcoming reintroduction in Mauritius. Four years later, following their recommendations, we have reintroduced the Lesser Night Gecko (*Nactus coindemirensis*) to Round Island Mauritius, and have a small but growing population. Round Island was the last remaining refuge for several endemic reptiles driven to extinction elsewhere by invasive species. In the last 30 years, it has provided source populations for reintroductions of predatory reptiles across the outer islands of Mauritius, improving the resilience of key members of the ecosystem. However, due to invasive herbivores on the island, much of the habitat and refugia for prey species on the island was lost, potentially leading to the extinction of the lesser night gecko. The species persisted on neighbouring islands where less vegetation was lost and predator populations were suppressed. In November 2022, we translocated 120 Lesser Night Geckos into four soft-release enclosures on Round Island, designed to limit dispersal and prevent predation by native reptiles. Here I will give details on the planning, capture, translocation, release and post-release monitoring, and explain the preliminary estimates of survival. I will expand on how this information will be used to inform management of the species and future translocations of prey species to Round Island.

A-0602 (Oral)
When Becoming a Flag Species Becomes the Sole Means of Avoiding Extinction. The Case of Mexican Ambystomatids

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The Mexican ambystomatids, which include the well-known Axolotl, have long captivated the interest of biologists and historians alike. This complex exhibits a remarkable diversity in morphology associated with various developmental life history strategies, encompassing populations and individuals capable of undergoing metamorphosis, those retaining a larval, aquatic lifestyle (paedomorphosis), and those displaying both traits. These salamanders inhabit a diverse range of aquatic ecosystems, including ponds, rivers, lakes, and wetlands. Extensive molecular analyses using multi-locus datasets have revealed genetic clusters within the Mexican Ambystoma velasci salamander complex, showing a mix of paedomorphic and metamorphic taxa. This suggests that geographic isolation has driven lineage divergence more than specific life history strategies. Population genetic studies have found gene flow between adjacent metamorphic and paedomorphic populations regardless of taxonomic identity. However, recent faster-evolving molecular markers indicate contemporary isolation for most species and populations. Widespread species show limited genetic diversity and low population connectivity, increasing vulnerability to environmental pressures and reducing resilience to risks. Anthropogenic threats endanger Axolotl populations, potentially leading to species-wide collapse. The desiccation of lakes in Mexico over centuries has significantly reduced their surface area, with remaining water often sustained artificially by effluents from water treatment plants. This process has expanded agricultural land but caused irreversible loss of aquatic ecosystems and biodiversity. Urgent conservation actions are crucial to prevent Axolotl extinction and maintain ecosystem integrity. Recognized as an umbrella and flagship species, Axolotls play a vital role in preserving the Xochimilco ecosystem. Conservation efforts involve education, ecotourism, and protected areas, with local salamander populations designated as flag species, indicating their importance in signaling environmental stress and their potential to avoid extinction.

A-0604 (Oral)
Adventures With a Pretty Large Genome: Unveiling the Genetics of Adaptation in Poison Frogs

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Despite the great advancements in vertebrate genomics over the last decade, the phylogenetic breadth of amphibian genomic resources remains limited, in part due to the size and repetitive content of amphibian genomes. Among frogs, the genomes of some members of the family Dendrobatidae have proven especially challenging, being up to 12Gb long and 88% repetitive, which has led to severely fragmented assemblies. In this talk, I will share my experiences participating in two dendrobatid genome assembly efforts, as well as working with the resulting assemblies on projects aimed at understanding the molecular basis of adaptative phenotypes in poison frogs and other amphibians, including aposematic coloration, neurotoxin resistance, and bitter chemical perception.

A-0605 (Oral)
Outlook for the Future of Amphibians in Bhutan

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This article explores Bhutan's commitment to amphibian conservation and its unique approach to preserving biodiversity and cultural values. Bhutan's diverse ecosystems serve as habitats for numerous amphibian species, and its philosophy of Gross National Happiness emphasizes environmental preservation. Bhutan's legislative milestones have transformed its forest property-rights system, ensuring the protection of wildlife, including lesser-known amphibian species. Dedicated research has reshaped the understanding of the country's herpetofaunal diversity, emphasizing the need for more inclusive research on all amphibians. The article discusses the ecological significance of amphibians in nutrient transport, ecosystem balance, and medicine. Bhutan's devotion to amphibian conservation reflects its cultural and environmental identity and its embrace of local knowledge, scientific exploration, and community engagement. Amphibians play an integral role in Bhutan's ecological symphony.

A-0606 (Poster)

One Hundred Years of Infection of *Batrachochytrium dendrobatidis* (Bd) in the Amphibian Population of India

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Chytridiomycosis, caused by the chytrid fungus *Batrachochytrium dendrobatidis* (Bd), significantly contributes to the global decline of amphibians. According to the GAA2 report, this disease poses a significant threat to 600 threatened species. Our research aims to elucidate Chytridiomycosis dynamics within India's amphibian population, particularly notable given India's status as a hotspot for amphibian diversity, harbouring 472 species, 41% of which are threatened, with nearly 60% being endemic. Our study includes 5802 samples, with 802 historical (1911–2020) and 1900 contemporary (2021-2023) samples across India, ensuring representation across demi-decades from diverse species of Anura, Caudata, and Gymnophiona orders. Our analysis revealed the presence of Bd in 119 out of 802 (14.83%) historical (museum) samples. Bd has been present in India for over a century, with the earliest positive detection dating back to 1912 in a Bufo himalayanus specimen from Himachal Pradesh, India. Bd prevalence was higher in earlier years, but after the 1970s, there was no discernible increase in prevalence spanning multiple decades. There have been no documented amphibian declines associated with Bd in India. Our results support hypotheses proposing an Asian origin of Bd, backed by phylogenetic studies and frog trading data indicating peak trading from India between 1963 and 1983, before the trade ban after 1985. Contemporary sample processing and Bd's geographical and chronological presence in India are still under investigation. Furthermore, we seek to characterize Bd's genetic lineage and variation over time in India, considering host immunity and pathogen virulence. Lineage identification is crucial given the challenge of culturing Bd in the lab, especially in asymptomatic regions like India. Our study sheds light on the earliest occurrences, historical prevalence, geographical spread, and chronological aspects of Chytridiomycosis in India's amphibian population. Understanding the disease's trajectory can inform conservation strategies for amphibian populations in India.

A-0607 (Oral)

Of Toads and Tolerance: Quantifying Intraspecific Variation in Host Tolerance and Resistance to a Lethal Pathogen

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Due to the ubiquity of disease, hosts have evolved strategies of disease resistance and tolerance to defend themselves from further harm once infected. Resistance mechanisms directly limit pathogen growth while tolerance mechanisms limit the damage caused by the pathogen. Testing for intraspecific variation in host populations is important for informing decisions about captive breeding, translocation, and disease treatment. Here, we test for intraspecific variation in Boreal toad (*Anaxyrus boreas boreas*) tolerance and resistance against the fungal pathogen *Batrachochytrium dendrobatidis* (Bd). Boreal toads have severely declined in Colorado (CO) due to Bd, but populations in western Wyoming (WY) appear to be less affected. We used a common garden experiment to expose individuals from four populations (2 in CO; 2 in WY) to Bd and monitored for two months. We used a multi-state model to estimate survival and transition probabilities between infected and cleared states to reveal the dynamic process that traditional approaches fail to capture. We found that WY toads are tolerant to Bd infection with higher survival probabilities than those in CO when infected with identical pathogen burdens. WY toads also had lower probabilities of reinfection, suggesting resistance. Our results provide new insights into the study of host defenses, how scientists measure host tolerance and resistance, and demonstrate that describing an entire species as 'tolerant' or 'resistant' is unwise without testing for intraspecific variation.

A-0608 (Poster)
Tangled Timelines and Anomalous Anurans: Discordant Patterns in Mito-Nuclear Divergence Estimates and Substitution Saturation Between Anurans (Order Anura) and Squamates (Order Squamata)

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Evolutionary studies on anurans and squamates have typically utilized a mix of mitochondrial data (mtDNA) and nuclear markers to deduce divergence dates and thus inform historical biogeography. However, the use of mtDNA in such studies has been questioned due to its rapidly evolving nature. In this study, we aimed to quantify the extent of mito-nuclear discordance in both anurans and squamates in terms of divergence estimates, and to test whether this pattern of discordance is congruent between the two groups. Bayesian phylogenetic analyses and divergence dating were performed in BEAST 2.7 using large secondary nucleotide datasets covering > 80% of all families. Three independent runs were conducted for the mitochondrial, nuclear, and a concatenated mito-nuclear dataset for each group. Substitution saturation was estimated by plotting observed against expected genetic distance for each codon position of each dataset. Our results indicate heavy saturation in the 3rd codon position in the mtDNA dataset in both groups, leading to an underestimation of divergence dates for basal nodes (crown group ~ 170 mya in squamates and anurans), and an

over-estimation of younger nodes. The nuclear datasets predict older estimates (~200 mya in squamates, 180 mya in anurans), although there was substantial saturation observed in the anuran nuclear dataset. Estimates from the mito-nuclear matrices were heavily skewed towards the mitochondrial tree in both groups, demonstrating its bias in estimating phylogenies. Interestingly, the degree of mito-nuclear discordance was markedly lower in anurans, likely due to nuclear substitution saturation. Such strikingly differing results firstly call into question the use of mitochondrial data and mito-nuclear matrices in herpetological phylogenetic analyses, while also highlighting an issue with divergence dating in frogs using large nuclear datasets. In light of these results, we recommend revisiting past studies that relied on mtDNA and mito-nuclear matrices, and calculating substitution saturation before subsequent time-tree analyses.

A-0609 (Oral)
Selection on Visual Opsin Genes in Diurnal Neotropical Frogs and Loss of the SWS2 Opsin in Poison Frogs

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Amphibians are an ideal model for studying the evolution of visual systems because their biphasic (aquatic and terrestrial) life history and ecological diversity expose them to a broad range of visual conditions. Although most amphibians are nocturnal, those that have experienced a shift to diurnality are active when the light spectrum is broader (350–700 nm) and brighter; therefore, it is possible that their visual systems are evolutionarily adapted for better color vision. In our study, we examined 366 sequences of four visual opsins genes (RH1,

LWS, SWS1, SWS2) across 116 anuran species, focusing specifically on three diurnal clades well-known for their conspicuous colors and chemical defenses (i.e., aposematism): poison frogs (Dendrobatidae), Harlequin toads (Bufonidae: *Atelopus*), and pumpkin toadlets (Brachycephalidae: *Brachycephalus*). Employing complementary approaches, we detected site-specific and branch-site combinations of selection patterns using methods implemented in HyPhy and PAML. Our results reported positive selection on 44 amino acid sites across all the opsin genes we examined, of which one in LWS and two in RH1 have been previously identified as spectral tuning sites in other vertebrates. Given that anurans have mostly nocturnal habits, the patterns of selection revealed new sites that might be important in spectral tuning for frogs, potentially for adaptation to diurnal habits and for color-based intraspecific communication. Furthermore, we provide evidence that SWS2, normally expressed in rod cells in frogs and some salamanders, has likely been lost in the ancestor of Dendrobatidae, suggesting that under low-light levels, dendrobatids have inferior wavelength discrimination compared to other frogs. This loss might follow the origin of diurnal activity in dendrobatids and could have implications for their behavior. Finally, our analyses show that assessments of opsin diversification in across taxa could expand our understanding of the role of sensory system evolution in ecological adaptation.

A-0610 (Oral)
Evolution of Snakelike Phenotypes in the Herpetofauna: Ecological Associations and Developmental Mechanisms

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Snakelike morphologies evolved multiple times in Tetrapoda, and are characterized by elongated trunks and reduced or absent limbs. A classical example of snakelike animals is observed in the clade Serpentes, but this phenotype also evolved in other tetrapod lineages, including Amphisbaenia (Lepidosauria) and Gymnophiona (Lissamphibia). Evolution of snakelike phenotypes often occurred in association with the use of specific ecological settings. Here we present results using large datasets composed by all major Squamata lineages to report ecomorphological relationships in snakelike bodies that are exclusive to specific lineages as well as phenotypic evolutionary patterns that seem recurrent even among phylogenetically distant clades. Evolution of snakelike phenotypes in the herpetofauna involved changes in developmental pathways, especially those related to limb and trunk development. The axial morphology of snakes, amphisbaenians and caecilians is characterized by an increased number of vertebrae that are all associated with ribs, and remarkable changes in developmental pathways related to Hox-H1Myf5 seem to challenge definitions of molecular convergence and parallel evolution. Molecular signatures in genes involved in limb development also suggest that limblessness evolved in different lineages through distinct changes in molecular pathways. Finally, comparisons of mitochondrial genomes enable integration between ecology and development, and we report results from analyses of selection regimes related to fossoriality and limblessness during the recurrent evolution of snakelike phenotypes in the herpetofauna.

A-0612 (Oral)
Using Numerous Contact Zones to Delimit Species and Calibrate a Reference-Based Taxonomy in a Challenging Lizard Group

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What happens where divergent populations meet? Is there evidence of reproductive isolation and restricted gene flow or do they gradually intergrade into each other? Assessing where populations sit along this continuum is useful for species delimitation in sexually reproducing organisms, as nearly all species concepts agree that populations that remain distinct in sympatry represent species. Furthermore, by sampling many contact zones one can understand how divergence across genomes and phenotypes correlate with contemporary gene flow. This information can then be used to calibrate thresholds of divergence that inform a reference-based taxonomy when working with allopatric or poorly sampled populations. Here we aim to resolve species boundaries in Heteronotia geckos using RAD sequencing and dense geographic sampling to assess contemporary gene flow across 30 contact zones. We then assess how gene flow between populations correlates with genomic divergence, thus calibrating divergence thresholds to inform taxonomic decisions for populations that lack contact zone sampling. This species delimitation approach combines direct assessment of evolutionary independence among candidate species while also calibrating a reference-based taxonomy to apply more broadly. Among other lessons, we highlight how accurate species delimitation of taxonomically difficult animal groups might often require data from contact zones.

A-0613 (Oral)

The Pervasive Threat of Ranavirus Infection on Herpetofauna: Prevalence and Genetic Diversity of Ranavirus (Family Iridoviridae) in Ectothermic Vertebrates of Asia

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Ranavirus can infect all classes of ectothermic vertebrates, causing significant morbidity and mortality and the World Organization for Animal Health (WOAH) has listed it as a notifiable disease. Ranavirus disease is considered a globally emerging infectious disease linked to mass mortality events. Surveillance work is, however, limited in Asia. To understand the disease burden and the lineages involved in the southern China region, we conducted a systematic surveillance of the ranavirus across the Guangxi Zhuang Autonomous Region (GAR). We used a multifaceted approach involving systematic screening of amphibians and other potential hosts, phylogenetic analyses, prevalence estimation, and co-infection assessments. Over one thousand individuals were sampled across 25 sampling sites, including both nature reserves and disturbed habitats. We found 92 from 18 species of ectothermic vertebrates (14 amphibian species (13 anurans, and a caudate), 3 fish species, and 1 reptile species (testudines) to be infected with ranavirus. *Rana nigromaculata* ranavirus and tiger frog virus were identified using phylogenetic analysis based on the major capsid protein (MCP) gene. Our results point towards potential interspecies and interclass transmission of these ranaviruses. We also found evidence of a co-infection with ranavirus and *Batrachochytrium dendrobatidis* that can be highly detrimental to host populations; possibly the first such documentation in Asia. Infection

rates in wild frog species have reached 100% in some areas, even within nature reserves. Our findings also indicate that fish and frog culture facilities and pet farms are frequently infected, serving as likely vectors for the regional and global spread of ranaviruses. We observed that cutaneous ulceration and hemorrhages are two common clinical signs associated with ranavirus infection. The knowledge generated suggests the need for additional systematic surveillance, stringent biosecurity measures, and control of international animal trade to prevent further transmission and protection of biodiversity and aquaculture industries across Asia.

A-0614 (Oral)

Transoceanic Dispersal: Insights from *Sphenomorphus dussumieri* Duméril & Bibron, 1839 (Reptilia: Squamata: Scincidae)

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Skinks of the genus *Sphenomorphus* are one of the most speciose genera of lizards, with 115 presently recognized nominal species. Their range extends across tropical Asia and this makes them an ideal group for studying their speciation and biogeographic patterns. At present, five species of Sphenomorphus are reported from India. Of these, four species are from Northeast India, and one is from peninsular India, namely southwestern parts of the Kerala state. Hence, a disjunct distributional pattern among the four species in Northeast India and the one from peninsular India is observed. Such disjunct distribution could have arisen through onset of seasonality and aridification events that resulted in fragmentation of suitable habitats. We generated a multi-locus phylogeny of *Sphenomorphus* lizards from across its distribution and performed divergence dating to understand how this disjunct distribution could be explained. We also conducted an ancestral range evolution analysis to understand how dispersal and vicariance events could have led to the current distribution of the Indian Sphenomorphus species. Our results show that the peninsular India endemic, *S. dussumieri* is nested within a clade consisting of *Sphenomorphus* species primarily distributed in the Sunda region. The analysis using a DEC+J model framework suggests transoceanic dispersal of the ancestral stock of *S. dussumieri* moving from the Sunda shelf to peninsular India. This is the first instance of a peninsular Indian endemic skink originating as a result of long-distance transoceanic dispersal. This is at a time when sea levels were relatively low.

A-0615 (Oral)

Long-Term Habitat Degradation affects Nest Site Selection Behaviour by a Freshwater Turtle (*Chelodina oblonga*) in Western Australia

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Freshwater turtles are one of the most endangered vertebrate groups with > 60% of species threatened globally. Terrestrial nesting habitat degradation is a major threat to freshwater turtles, but the characteristics of nesting habitat remain poorly understood. This study investigated the nest site selection of the southwestern snake-necked turtle (*Chelodina oblonga*) to improve the conservation prospects for this species in an urbanized wetland area. In total, 235 depredated and 86 non-depredated nest sites and 320 non-nest locations were surveyed at Bibra Lake, Western Australia, during the Austral spring–summer, 2018–2023. A suite of environmental variables was measured at nest sites and non-nest locations. Analysis of similarities was used to determine whether nest sites and non-nest locations differed in their environmental characteristics. Generalized linear mixed models were used to identify environmental variables that best explained the nesting preferences. The environmental characteristics of nest sites differed from those of non-nest locations, with turtles nesting mainly in remnant natural habitat with greater canopy cover. Turtles generally avoided nesting in modified environments such as lawns and impervious surfaces. Factors influencing nest site selection are probably associated with the conditions necessary for regulating incubation temperatures and ease of nest excavation. This study suggests that modification of terrestrial vegetation around wetlands is adversely affecting freshwater turtle recruitment by removing or altering preferred nesting habitat. Protection and restoration of natural habitats fringing urban wetlands is important for the conservation of remnant freshwater turtle populations, and local partnership projects can help to achieve this.

A-0616 (Oral)
Phylogenomic Analysis of the Frog Genera *Occidozyga* and *Phrynoglossus* (Dicroglossidae: Occidozyginae) from Myanmar and Thailand

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Many frog groups have not yet been adequately studied, and mitochondrial lineages indicate high cryptic species diversity within these groups. Two such groups are the genera *Occidozgya* Kuhl & Van Hasselt, 1822 and *Phrynoglossus* Peters, 1867. Both genera can be distinguished by morphological and ecological characteristics and are classified by some authors as monophyletic sister taxa whereas others consider *Phrynoglossus* as a synonym of *Occidozyga*. Their phylogenetic relationships have not been clarified yet and recent studies indicate a high level of cryptic species within the two groups. So far, only mitochondrial genomes and a few nuclear markers are available for these genera. The rise of genomics has enabled the use of thousands of loci to gain insights into evolutionary relationships. Here, I present an updated phylogeny based on scaffold-level assemblies of nine different mitochondrial lineages, currently assigned to the Occidozyginae including three *Occidozyga* (*O. lima*), five *Phrynoglossus* (*P. magnapustulosa, P. martensii, P.* cf. *martensii* and *P. myanhessei*) and one *Ingerana* (*I. tenasserimensis*) lineage. A reference genome was assembled for *P. myanhessei*. Illumina short reads of the remaining lineages were mapped against this reference. Both

mitochondrial and nuclear data for all lineages were analysed. The analyses indicates that *Occidozyga* and *Phrynoglossus* are monophyletic sister taxa both in their mitochondrial and nuclear genomes. I discuss the taxonomic and biogeographic consequences of these phylogenomic results.

A-0620 (Oral)
Newtcap: An Efficient Target Capture Approach to Boost Salamandrid Systematics

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Salamanders have large and complex genome, which makes them one of the most difficult groups of animals to study in genomics. Sequencing their whole genome is therefore costly in terms of money, as well as in terms of computational tasks. Fortunately, reduced representation sequencing can provide solace when facing such issues. We present NewtCap: a sequence capture bait set that targets c. 7,000 coding regions across the genomes of all true salamanders and newts, which are together generally referred to as the Salamandridae family. We show the potency of the bait set by testing its efficacy in 30 species that belong to 17 different genera . Next, we outline the potential of NewtCap by; 1) re-building the Salamandridae species tree using more nuclear markers compared to earlier studies in order to demonstrate the phylogenomic power, 2) studying individuals from different Lissotriton species and their interspecific hybrids with the intention to highlight the possibility of detecting hybridization, 3) showcasing the use of the method in a phylogeographic context through building a phylogenetic tree of *Taricha* species, and 4) explaining how the approach can be used in population genetic studies and conservation by comparing the DNA of *Triturus ivanbureschi* samples originating from wild postglacial populations versus wild refugial populations versus captive-bred populations. We show that NewtCap will be an important resource for feasible, reproducible, and affordable genomic studies of salamandrids.

A-0621 (Oral)
Population Genetics Provides Insights into the Impact of Climate Change on the Genetic Structure and Distribution of Asian Warty Newts

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Assessing population vulnerability to climate change is essential for informing management and conservation strategies. Amphibians are particularly vulnerable to the impact of climate change. Here, we integrated population genetics and ecological niche modeling (ENM) to assess the effects of future climate change on the distribution and genetic structure of two Asian warty newts (*Paramesotriton deloustali* and *P. guangxiensis*) in northern Vietnam. Population genetics revealed three primary groups (West, East + Cao Bang [CB], and Quang Ninh [QN]). CB exhibited discordance between mitochondrial DNA and nuclear DNA single-nucleotide polymorphism data. Furthermore, gene flow within the populations was restricted, particularly within the West and QN groups. Spatial distribution analyses of genetic clusters conditioned by environmental variables predicted that the East + CB group's genetic clusters would expand, whereas those of the West and QN groups would decrease. The introgression of genetic structures probably reduces the vulnerability of the East + CB group to climate change. ENM analysis revealed that these newts are susceptible to climate change, resulting in a reduction in their suitable habitat areas across all scenarios. We also observed a shift in the suitable distribution toward higher altitudes. Our results suggest that the mountainous areas of northern Vietnam could serve as potential shelters for these newts from the adverse effects of future climate change.

A-0622 (Oral)

Gastroesophageal Intussusception and Sectioned Stomach in the Japanese Giant Salamander, *Andrias japonicus*

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Emesis is a defensive response to the accidental swallowing of foreign, unsafe objects and is widely observed across many vertebrate classes. In amphibians, the ability to vomit only develops at metamorphosis for frogs, whereas both larval and adult salamanders can vomit. Frogs occasionally invert their stomachs during emesis, referred to as gastroesophageal intussusception (GEI). However, GEI and the mechanism of regurgitation remain unexplored for most amphibians, and to our knowledge, there have been no reports of GEI from salamanders. Here, we present the first published report on GEI in salamanders from the Japanese Giant Salamander (*Andrias japonicus*). We dissected seven specimens of A. japonicus and found GEI in two individuals. The inversion of the stomach resembled that of frogs during emesis, suggesting that *A. japonicus* is also likely to vomit by inverting their stomachs. Their stomachs were structurally divided into three sections. We measured the gastric wall thickness at four points in each section, for a total of 12 points for each individual. The gastric walls in Sections 2 and 3 in the caudal region were significantly thicker than in Section 1. In the individuals with GEI, gastric inversions occurred at the section boundaries, with significantly thicker gastric walls at one measurement point within section 2 than in normal individuals. Different gastric-wall thicknesses between the sections may have prevented recoveries from gastric inversions in the GEI individuals. To observe the stomach morphology of terrestrial salamanders that typically prey on terrestrial invertebrates, we also dissected the preserved specimens of *Ambystoma jeffersonianum, A. maculatum, Hynobius kimurae, H. nebulosus*, and *Onychodactylus japonicus* We found their stomachs were uniform without distinct sections, suggesting that stomach sectioning may only exist in fully aquatic species, presumably because sectioned stomachs are essential in holding and digesting live prey in the stomach.

A-0623 (Oral)
Long-Term Injury Records Reveal Teeth as Weapons for Intense Male-Male Combat in Japanese Giant Salamanders

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Biting is a common male-male combat tactic across jawed vertebrates, in which teeth or bony beaks serve as weapons. Because biting can cause severe injuries in some species, bite scars provide critical information about the degrees and patterns of fights. Amphibians have a remarkable diversity in tooth morphology and arrangement. However, the functional ecology of amphibian teeth is poorly studied. For example, unlike aquatic suction-feeding frogs that lost teeth, aquatic salamanders that suction-feed prey retain numerous sharp teeth, suggesting that selection might have favored the retention of teeth as weapons. Here, we analyzed long-term injury records of one of the fully aquatic, suction-feeding salamanders (Japanese Giant Salamander, *Andrias japonicus*) to examine the previously unexplored potential of amphibian teeth as weapons for male-male combat. The majority of the injuries were missing toes and limbs, which most likely occurred during intraspecific combat. We explored associations between injuries and independent variables such as sex, body size, body condition, and stream sections. We also investigated possible injury-pattern biases along the lateral and longitudinal axes. We found that males had more injuries (47.5% vs. 27.0% of females), larger individuals had more injuries, and there was no association between injuries and body condition after controlling for sexual differences in body condition. In addition, we found that salamanders had more injuries on the right and posterior sides of the body. The lateral asymmetry in injuries is likely associated with turning asymmetry during combat. Our results revealed the intense male-male combats of giant salamanders, providing clear evidence that their teeth serve as essential weapons. Our research highlights the function of amphibian teeth as weapons, which is likely to be a vital selective agent shaping its remarkable diversity. Combats via biting in amphibians may be much more common and severe than currently known.

A-0625 (Oral)
Behavioural Responses of Reptiles to Fire

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Earth's rapidly warming climate is propelling us towards an increasingly fire-prone future. While fire causes mortality of animals across vast portions of the globe, scientists are only beginning to consider fire as an evolutionary force in animal behavioural ecology. Fire is a lethal threat; thus, there is likely strong selection for animals to recognise the olfactory, auditory, and visual cues of fire, and deploy fire avoidance behaviours that maximise survival probability. If fire defences are costly, it follows that intra- and interspecific variation in fire

avoidance behaviours should correspond with variation in fire behaviour and regimes. Species and populations inhabiting ecosystems that rarely experience fire may lack these traits, placing 'fire naive' populations and species at enhanced extinction risk as the distribution of fire extends into new ecosystem types. We tested the behavioural responses of a range of Australian lizards with evolutionary exposure to different fire regimes and different life histories with the aim of teasing apart how exposure to fire may result in altered behavioural responses to this fatal threat.

A-0626 (Oral)
Predatory Crows Innovate to Overcome an Invasive, Toxic Prey

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Human-induced environmental changes create significant challenges for native animal communities. The ability for native taxa to deal with these challenges is highly dependent on the rapidity of change and the extent to which native taxa can respond. Where adaption via selection is too slow, behavioural responses can allow animals to deal with problems more rapidly. The introduction of invasive species presents native taxa with sudden, novel challenges and behavioural shifts are often the initial response to overcome them. In Australia, invasive cane toads present a unique challenge: they are highly successful invaders that possess a toxin that kills many native predators when consumed, causing population declines. However, native Torresian crows (*Corvus orru*) have been observed safely consuming toads by avoiding toxin glands, an example of rapid behavioural innovation. We investigated this behaviour in long-exposed crows (10+ years exposure to toads) in captive based cognition trials, testing behavioural responses to both toxic and non-toxic prey items. We similarly tested how fast behavioural innovations emerged for successfully preying on invasive toads in naïve crows ahead of the cane toad invasion front. Trials demonstrated behavioural variation to successfully prey on toads and revealed susceptibility to toad toxin in naïve, but not long-exposed crows.

A-0627 (Poster)
Magnificent Tree Frogs Aggregate under Eco-Sociological Conditions

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Aggregation behaviour is wide-spread across the animal kingdom, influenced by environmental or social factors. Compared to other vertebrates, grouping outside of the breeding season is rare in frogs. One exception is the Magnificent tree frog (*Litoria splendida*), a large anuran found in the wet-dry tropics of Northern Australia, which commonly aggregates in rock crevices or caverns. They inhabit environments with extreme wet and dry seasons, which can be challenging for frogs with a permeable skin because of the risk of desiccation. We asked what factors (environmental and/or social) cause Magnificent tree frogs to aggregate using both field-based and captive experiments. Field experiments revealed that by aggregating, frogs increased humidity within a refuge, thereby reducing desiccation risk. This result was duplicated in captive experiments, where frogs grouped under dry-season, but not

wet-season, conditions. Interestingly, under dry season conditions, frogs preferentially grouped with individuals they were familiar with, indicating social reasons are also a factor in aggregating. This suggests grouping is likely a socio-ecological driver, reducing water loss while potentially minimising conflict by selecting familiar conspecifics.

A-0629 (Oral)
Development of an Axenic Tadpole Model: A New Powerful Tool to Study the Amphibians Microbiome

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Immunocompetence comprises the collection of innate and acquired host factors that determine host efficacy in controlling infectious disease. The host microbiome has been increasingly recognized to play a key role in immunocompetence in vertebrates. Recently, the amount of studies concerning the amphibians microbiome has been increasing, largely driven by its potential role in the chytridiomycosis pandemic. However, despite evidence of how early life deeply impacts the development of the microbial communities, the study of the tadpole's microbiome has been severely neglected. The development of axenic animal models (i.e. animals that harbor no cultivatable organisms) provides a powerful tool in studying the role of an organism's microbiome. While previous efforts have yielded models featuring gnotobiotic larvae, the absence of a fully axenic tadpole model has persisted, primarily due to technical challenges in hatching and growing tadpoles in a sterile environment. In our study, we now developed an effective and non-lethal disinfection technique to produce *Discoglossus pictus* larvae completely devoid of their microbiome through a combination of mechanical, chemical and antimicrobial treatments applied on eggs collected within 12 hours after spawning. We then reared sterile tadpoles in a sterile or microbially contaminated environment enabling a comprehensive comparison of their developmental trajectories and microbiome compositions against untreated control tadpoles. By successfully establishing this novel, we contribute to the advancement of microbiome research in amphibians by providing a reference tool for future investigations into the dynamic interplay between an amphibian host and its microbial inhabitants.

A-0630 (Oral)
Occurrence of Amphibians in Saline Habitats: An Updated Review and Evolutionary Perspective

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Due to their permeable skin and eggs, amphibians have long been discounted from occurring in saline environments. Ten years ago, Hopkins and Brodie (2015) reviewed the literature on amphibians occurring in saline habitats and found 144 different species inhabiting these environments, concluding that amphibians may have a wider capacity to tolerate salinity than originally thought. Since then, an explosive number of studies have documented the occurrence of amphibians in saline habitats around the world, and the underlying ecological, physiological,

and evolutionary mechanisms. Here, we provide an updated review on the occurrence of amphibians in saline habitats, adding at least twenty additional species (mostly in Asian and European coastal habitats) to the original list. Over one hundred new studies have also been conducted, providing additional sightings and understanding of this global phenomenon; detailed descriptions of environmental salinity and experimental tolerance; and physiological and evolutionary mechanisms. In light of this new information, we revisit the evolutionary perspective first outlined by Hopkins and Brodie (2015), specifically reviewing the updated state of our knowledge on (a) the genetic nature and (b) origins of salt tolerance; (c) the nature of selection in osmotically stressful environments; and (d) the limitations of salt tolerance. The breadth and depth of our knowledge addressing these topics has increased dramatically, at least for some anurans, and we present the results of meta-analyses on anuran salt tolerance and case studies in Europe and North America to demonstrate so. However, our understanding of how most amphibians tolerate salinity is still in its infancy, and more work needs to be done on understanding how populations evolve in osmotically stochastic environments in the wild. We identify these knowledge gaps and suggest a path forward to better understand the capacity for amphibians to adapt and survive in an increasingly salinized world.

A-0631 (Oral)
Integrative Taxonomy of the *Hemidactylus mabouia* Complex

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The African Tropical House Gecko, *Hemidactylus mabouia*, is one of the most successful invasive species of gecko in the world, with established populations in South, Central and North America, the Caribbean and the East Atlantic Islands, Asia and Australia. In continental Africa, the species has been historically understood as being one of the continent's most ubiquitous reptiles, with an almost pan-African distribution. Its wide distribution on the continent and proximity to human settlements has likely resulted in the disinterest in it that most herpetologists seem to have — too common to be interesting, "just another boring house gecko!". Recent molecular studies have however shown that *H. mabouia* is a species-complex comprised of more than 20 species level lineages. The nominotypical form occurs in West and Central Africa and all the invasive populations outside Africa belong to this lineage, but the East and Southern Africa populations represent an impressive number of locally endemic species that have so far gone unnoticed. Using an integrative taxonomic approach, combining molecular data with the morphological analysis of hundreds of specimens from across the range of the *H. mabouia* complex, we were able to identify 24 new species of *Hemidactylus* and map their distributions. These results refine our understanding of the biogeography of Sub-Saharan

Africa and are an important reminder that how even some of the most ubiquitous species deserve integrative taxonomic studies.

A-0632 (Oral)
Australian Frogs: Fighting Fungus, Fires, & Floods

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Climate change is intensifying the frequency and severity of extreme weather events, such as droughts, storms, fires, and floods, with major impacts on global ecosystems. The impact on wildlife may be compounded when these extreme events occur in close succession. With over 40% of species currently threatened with extinction, amphibians represent the most threatened class of vertebrates. Australian frogs have been identified as facing heightened risks from climate-driven impacts, likely driving nationwide declines. Despite this knowledge, the broadscale effects of climate change induced extreme weather events on frog species are not well understood. We use citizen science data to investigate the broadscale impacts of severe wildfires and floods in New South Wales (NSW) on frog species richness and spatial occupancy. Employing a Before-After-Control-Impact (BACI) study design, we leverage data from the FrogID platform to assess broadscale species richness changes and individual species' spatial occupancy changes following severe wildfires and floods in NSW. We reveal no significant changes in frog species richness in areas affected by the 2019-2020 'Black Summer Bushfires' but show significant declines following the 2022 extreme flooding events in the immediate year following each respective event. The results demonstrate the short-term resilience of amphibian populations following climate-induced megafires, but also highlight the vulnerability of amphibian communities following extreme flooding. These results emphasize the urgent need for more research and conservation efforts that address both the short and long-term impacts associated with rapid climatic shifts. This study contributes to a growing body of literature focused on the impact of climate-induced disasters on biodiversity and offers insights into how various frog species cope with severe environmental changes.

A-0633 (Oral)
Bd and its Influence on Physiological Traits in the Alpine Tree Frog (*Litoria verreauxii alpina*)

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With many frog species, sub-clinical infection with Batrachochytrium dendrobatidis (Bd) can impact the physiology of the host. Sub-clinical conditions of Bd has been shown to interfere with the water balance of the host, and during this incubation stage, cause a myriad of complications including reduction in thermal tolerance limits, lower respiration rates, reduced body mass, slowed growth rates, and a reduction in locomotion. To this end, we investigated the sublethal effects of Bd infection on amphibian physiology, exploring both locomotory performance and thermal range in the endangered alpine tree frog (*Litoria verreauxii alpina*) following infection with Bd. *L. v. alpina* adults are highly susceptible to Bd with prevalence increasing to almost 100% during the breeding season and the species having little to no immunity to the disease. A total of 60 frogs were used with 30 control and 30 Bd infected individuals being tested for critical thermal maximum (CTmax), critical thermal minimum

(CTmin), and jumping performance for 6 weeks during the infection progression. We found for both CTmax and CTmin, infection status nor infecfion load did not influence the critical thermal range, however all individuals did show a decrease in CTmin over the experimental period. Jumping performance showed interesting results as infected individuals had an increase in jumping over the course of the experiment, while control individuals showed no significant change. This finding lends support to other findings of terminal investment within this species, suggesting that infected individuals may allocate more resources to essential functions such as locomotion in response to sublethal infection when recovery is not possible.

A-0634 (Oral)

Vampire in the Slow Lane: Investigating the Identity, Host Associations, and Historical Biogeography of the Asian Turtle Tick *Amblyomma geoemydae* (Cantor) (Acari: Ixodida: Ixodidae)

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Knowledge of the biology and evolutionary history of ectoparasites is crucial to the study of wildlife parasitology and veterinary entomology. The systematics and biogeography of many species in the ixodid tick genus *Amblyomma*, including interspecies relationships and the evolution of host specificity, remain unresolved and little studied. Additionally, some species of *Amblyomma*, such as the Asian turtle tick *A. geoemydae*, exhibit morphological variation across their range and may in fact represent complexes of cryptic species. This paper attempts to investigate the taxonomic identity and biogeographic history of the Asian turtle tick, while also describing recently discovered host associations from southern China and Southeast Asia. To this end, a phylogeny of *A. geoemydae* was constructed using morphological characters and mitochondrial genetic markers. Our results revealed the presence of an undescribed new species of turtle tick closely related to *A. geoemydae*, indicating that *A. geoemydae* sensu lato, as commonly understood, is a cryptic species complex. We further argue that the *A. geoemydae* clade is a sister group to the clade that gave rise to sea snake and land snake amblyommines. And using Taiwan specimens of *A. geoemydae*, we investigated the potential role of mountain ranges as intra-island geographic barriers, finding an absence of genetic structure indicating a continuous gene flow within the island. Our research has provided fresh insights concerning the evolution and host associations of A. geoemydae across its geographic range.

A-0635 (Oral)

Recent Discoveries of Reptile-Associated Mites and Ticks (Acari) from Taiwan and the Philippines

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Like other terrestrial vertebrates, reptiles serve as hosts to myriads of micro- and macroparasites. Among these, ticks and mites are the most common ectoparasites associated with reptiles, occur worldwide, and often possess interesting morphological and physiological attributes. The host specificity of mites and ticks ranges from polyxeny and oligoxeny to monoxeny, a strict one parasite-one host association. Because of their parasitic nature, reptile-associated acarines play an important role in disease vector ecology and the dynamics of blood-borne wildlife diseases. However, despite their diversity, these acarines remain little studied in Taiwan and the Philippines, particularly with respect to their natural history. In this paper, we present new discoveries concerning the geographic distribution and hosts of reptile-associated ticks belonging to the ixodid genus *Amblyomma* (bont ticks), based on museum and field collections. In addition, we discuss potentially new species of reptile mites ectoparasitic on members of the genera *Diploderma, Takydromus, Gekko*, and *Pinoyscincus* that were collected during our expeditions in Taiwan and the Philippines. We also provide an overview of the natural history of reptile-associated acarines in Taiwan and the Philippines, while highlighting subjects requiring further research. Our results have contributed to an overall understanding of the diversity of reptile-associated mites and ticks, with a focus on their geographic distribution, host associations, and roles in disease transmittal.

A-0636 (Oral)
Frog Virus 3 Promiscuous Interactions with Amphibian Hosts, Bacteria and *Batrachochytrium dendrobatidis*

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The ranavirus Frog virus 3 (FV3) and FV3-like viruses are notoriously promiscuous pathogens that can cross host species barriers and infect numerous ectothermic vertebrates from fish and amphibians to reptiles and even mammalian cells. Our previous study revealed that quiescently

persisting FV3 in macrophages of asymptomatic *Xenopus laevis* adults could be reactivated into a vigorously replicating pathogen causing systemic infection by stimulation with heat-killed bacteria or the TLR5 ligand flagellin, which is a bacterial product. These intriguing results suggested a role for secondary bacterial and possibly fungal infections in initiating sudden deadly disease outbreaks in amphibian populations with detectable persistent asymptomatic ranavirus. Here, due to increasing reports of co-infection occurring between FV3 and the chytrid fungus *Batrachochytrium dendrobatidis* (Bd), we have investigated the potential direct interaction between these two pathogens. Our study by qPCR, conventional and immunofluorescent microscopy demonstrates the unexpected ability of FV3 to bind, promote aggregation, productively infect the amphibian host, and significantly increase Bd growth *in vitro*. To obtain further evidence of the relevance of these *in vitro* data, we used *X. tropicalis*, the *X. laevis* sister species that is susceptible to FV3 and Bd infection. FV3 water exposure of previously Bd-infected adult *X. tropicalis* did not result in viral infection but significantly increased Bd loads and decreased host's survival. Besides extending FV3 promiscuous ability to fungi, these findings suggests that its interaction with Bd has negative consequences for the host by increasing Bd load and pathogenicity.

A-0637 (Oral)
Why Nest There? Nest Site Selection and Fate in an Endangered North American Turtle

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Wood turtles (*Glyptemys insculpta*) are endangered on the IUCN Red List and have been proposed for federal listing under the U.S. Endangered Species Act. Wood turtles are a long-lived species with delayed sexual maturity, a low nest success rate and reduced early life stage survival. The goal of our study during the 2022 and 2023 field seasons was to determine female nest site selection and nest fate. Specifically, our objectives were to (1) identify nest site characteristics that may influence site selection, such as canopy openness, substrate particle size and soil organic matter; and (2) relate these characteristics to nest fate. We conducted surveys during peak nesting hours to identify nest locations. Canopy openness was calculated using Gap Light Analyzer software, substrate particle size using soil sieves, and percent organic matter through loss on ignition. Fate was determined for each individual egg per clutch. In total, we identified 21 nests. Our results show that there is a significant difference in nest site selection between canopy openness, organic matter, and particle size between nests and control sites. Furthermore, females appear to be choosing areas with more open canopy, small substrate particle sizes (< 0.2 mm), and low organic matter in the soil. In total, 17 of the 21 nests (81%) were predated and out of the four viable nests, 22 of the 138 viable eggs (16%) emerged successfully. Our data suggest that microhabitats contain key characteristics that females assess when selecting nest locations and provide insights on nest success in a species undergoing range-wide population declines.

A-0638 (Oral)
The Urban Brown Anole: Sleeping Sites and Nocturnal Escape Responses

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The adaptiveness of sleep-site selection and fidelity varies between taxa; however, the risk of predation while sleeping is likely to be an important selective pressure. In this study we recorded sleep-site selection and short term site fidelity in a suburban population of Brown anoles (*Anolis sagrei*): there was no influence of sex or size on sleep-site selection, but males showed a tendency to perch higher when sleeping than did females. Male anoles also showed higher sleep-site fidelity (52%) than did females (24%) over two nights. When disturbed at night, anoles perched on natural surfaces were more responsive to a simulated predatory attack and fled sooner than did those perched on anthropogenic surfaces. The adaptiveness of using anthropogenic surfaces as sleep-sites in urban areas may be mediated by the presence or absence of nocturnal predators.

A-0639 (Oral)
Unravelling an Evolutionary Mystery: The Balanced Lethal System in *Triturus* Newts

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A balanced lethal system is a deadly hereditary disease that causes the loss of fifty percent of offspring every generation. The most infamous example concerns the chromosome 1 syndrome affecting the salamander genus *Triturus*: the Crested and Marbled newts. All adults possess two forms of chromosome 1, known as 1A and 1B. Yet, according to the rules of Mendelian inheritance, 50% of offspring are homozygous, possessing either 1A or 1B twice (and lacking the other version). Such individuals die roughly halfway embryological development – 50% of *Triturus* eggs never hatch! We determine: (1) the extent to which 1A and 1B vary across all *Triturus* species in terms of gene content; (2) to what genomic regions in unaffected salamander species *Triturus*' 1A and 1B correspond; and (3) how the phylogenetic history of 1A and 1B compares to that of the rest of the *Triturus* genome. We show that *Triturus*' 1A and 1B (1) are mostly conserved across the genus; (2) form two distinct, consecutive blocks in the genomes of both *Lissotriton* and *Pleurodeles* newts; and (3) share a phylogenetic relationship that is distinct from that of the rest of the *Triturus* genome. We provide a hypothesis on the origin of the *Triturus* balanced lethal system.

A-0640 (Oral)
Evolution and Development of the Frog Feeding Apparatus: Novelty, Convergence, and the Re-Evolution of Lost Traits

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The frog feeding apparatus is a complex organ system that undergoes dynamic reorganization during the life cycle of anurans and displays remarkable morphological and functional diversity across clades. The components of this system include the stomodeum of embryos, the oral disk of tadpoles, and the jaws, true teeth, and tongue of frogs. A subset of these elements, including the unique jaw cartilages and keratinized mouthparts of tadpoles, represent poorly studied evolutionary novelties. Other organs, such as true teeth, are highly labile, being repeatedly lost, and sometimes regained, across the frog tree of life. Using an evo-devo framework, my lab is

characterizing the developmental-genetic basis for the formation of tadpole and frog feeding structures across species and exploring the underlying mechanisms that may be responsible for the origin of novel traits, convergent trait loss, and the re-evolution of lost structures.

A-0641 (Oral)
Insights Into the Biogeography and Body Size Evolution of Geckos (Gekkota: Squamata) Using a Large Supermatrix Phylogeny

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Geckos are a diverse clade with more than 2,300 described species that have spread across the globe. Although many phylogenetic analyses have dealt with biogeographic patterns in geckos, they are either confined within a certain geographic region or confined within a certain gecko clade. Therefore, a global view of gecko biogeography is still lacking. Islands represent an interesting environment for evolution where many taxa reach extremely small or large body size. However, this pattern has never been summarized in geckos, at least not in a large and global phylogenetic context. For this study, I have mined GenBank extensively for all available sanger sequence data in geckos and, combined with previous published squamate phylogenies, generated a large supermatrix with 71 genes and a dated phylogeny of 1758 gecko species. I also collected body size and biogeographic data for 2,244 described gecko species. With these data, I address 1) which geographic region is the center of origin for geckos? and 2) if insular species display distinct macroevolutionary dynamics for body-size. Preliminary results suggest that geckos likely have an eastern Gondwanan origin in Africa and Australasia, agreeing with previous phylogenetic evidence. In addition, island species tend to have higher evolutionary rate in body size compared to mainland species.

A-0642 (Oral)
Looking at the Whole Picture: Gharial Conservation in the Karnali-Ghaghara River Systems

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River damming has transformed aquatic ecosystems globally by fragmenting and isolating different species. The Gharial, *Gavialis gangeticus* is a Critically Endangered freshwater crocodile facing severe population and habitat loss in India. A wild breeding population of Gharial inhabits the Girwa River in Katerniaghat but faces nesting habitat degradation due to river damming and river flow shift. Assisted with artificial sandbanks and monitoring by the Uttar Pradesh Forest Department, the nesting has been increased to 36 nests with ~93% hatching success. However, the riverine habitat is further degrading forcing novel approaches to the conservation of the gharials. A landscape monitoring program integrating the research and the stakeholders was initiated in 2022. It had three key objectives: a) sustaining gharial nesting in Girwa and increasing recruitment; b) increasing monitoring in the Kaudiyala River (sister branch of Girwa); and c) exploring the unprotected downstream stretches of Ghaghara River. We have maintained the gharial nesting in Girwa by constructing artificial sandbanks.

Further, we held gharial hatchlings in captive pools during the floods and released them back post flood, to retain and increase recruitment in Girwa itself. Monitoring in Kaudiyala revealed a major shift in habitat use by the gharials where over 50–60 gharials were seen basking on sandbanks in Kaudiyala with two cases of trial nesting in 2023. No confirmed nesting has been found yet. In Ghaghara, we found 84 gharials within the first 100 km of the Girwa boundary. Habitat was viable as huge sandbanks were present with continuously flowing water. However, its presence downstream of a dam causes major habitat changes when dam gates are opened for repairs. Evaluating the scenario, the conservation of gharials in the Karnali-Girwa-Ghaghara Rivers is only possible when done as a single contiguous unit, rather than individual isolated systems.

A-0643 (Oral)

The Costs of Living on the Coast: Salinity Alters Energetic Allocation to Growth and Reproduction in Coastal Populations of a Widespread Amphibian

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Body size is an essential element in the biology and fitness of organisms. It is influenced by numerous environmental parameters, among which exposure to salinity has been relatively neglected. Yet osmoregulatory mechanisms are metabolically costly and can influence energy allocation to competing traits such as growth and reproduction. To understand the influence of environmental salinity on these parameters, we examined the morphology and reproductive investment of adult coastal (naturally exposed to salt) and continental (naïve to salt exposure) spined toads (*Bufo spinosus*). We found that coastal toads were smaller than their continental counterparts, and that coastal females invested proportionately less in all components of reproduction (fecundity, egg size). To experimentally test the causality of salinity on these results, we exposed adult individuals of the same species to environmental salinities (0, 2 or 4 g.l-1) for 7 months. In exposed individuals, we found an increase in osmolality and a reduction in growth. These results suggest an alteration of resource allocation to growth and reproduction in coastal amphibians, presumably linked to osmoregulation, for which local adaptation and/or greater salt tolerance have yet to be tested.

A-0644 (Oral)

Behaviour in the Presence of a Pathogen: Juvenile Agile Frogs Spatially Avoid Ranavirus-Infected Conspecifics, but do not Show Generalized Social Distancing or Self-Isolation

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Exposure to contagious pathogens can result in behavioural changes, which can alter the spread of infectious diseases. Healthy individuals can express generalized social distancing or actively avoid the sources of infection, while infected individuals can show passive or active self-isolation. Amphibians are globally threatened by serious contagious diseases, yet their behavioural responses to infections are very scarcely known. We studied behavioural changes in agile frog (*Rana dalmatina*) juveniles upon exposure to a Ranavirus (Rv). We performed classic choice tests in chambers containing a conspecific infected with Rv in one end compartment and a non-infected conspecific in the other end, with an Rv-infected or non-infected focal individual in the central compartment. We found that both non-infected and Rv-infected focal individuals spatially avoided infected conspecifics, while there were no signs of generalized social distancing, nor self-isolation. Spatial avoidance of infected conspecifics may effectively hinder disease transmission. On the other hand, the absence of self-isolation by infected individuals may facilitate it. Our finding that infected individuals spent more time near the non-infected than infected conspecifics suggests that the strong behavioural drive to avoid infected conspecifics may not be silenced by infection, possibly to prevent secondary infections. The observation that infected focal individuals did not spend more time near conspecifics than non-infected focals renders it unlikely that the pathogen manipulated host behaviour to aid disease spread. More research is urgently needed to understand under what circumstances behavioural responses can help amphibians cope with infections, and how that affects disease dynamics in natural populations.

A-0645 (Oral)
Unraveling the Disease Ecology of *Ophidiomyces ophidiicola*: High Genetic Variability and Ecological Basis of Snake Fungal Disease

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The discovery of the fungal pathogen *Ophidiomyces ophidiicola* (Oo), the aetiologic agent of Snake Fungal Disease (SFD), has raised a growing interest in the North American and European scientific communities, in particular toward conservation. This pathogen is known or suspected to be associated with the declines of some snake populations in North America and was detected later in Europe. Its ecology, distribution and phylogeography still remain largely unknown. In this study, we collected skin swabs from 271 free-ranging snakes in Switzerland across eight different species and 13 sites. The overall pathogen prevalence was at least 28% with sequences consistent with both the European and the North American lineages (respectively Clade I and II) of Oo. Semi-aquatic snakes were more likely to be

infected by Oo, and high human disturbance (human frequentation and direct impact on snakes) was associated with a higher Oo prevalence, whereas season, body condition and snake species introduction was not. This study suggests that Switzerland might represent a region characterised by high genetic variability in Oo, and where long-term monitoring might be particularly important to follow the evolution of the disease in free-ranging snakes.

A-0646 (Oral)
Caribbean Anoles are Responding to Climate Warming by Thermoregulatory Behavior or by Heat Tolerance Increases

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Global warming is accelerating extinction of squamates worldwide. Nevertheless, squamates could respond to rising environmental temperatures by behavioral adjustments and/or physiological adaptation. Yet, a temporal comparison of these compensatory mechanisms in wild populations is lacking. Here, we compared historical (2011–2013) and contemporary (2022–2024) thermoregulatory behavior and heat tolerance (critical thermal maximum; CTmax) of Caribbean anoles (from Hispaniola, Jamaica and Puerto Rico) inhabiting contrasting thermal environments (open/edge habitat vs. closed-canopy habitats). We found that open-habitat anoles leveraged thermal heterogeneity to behaviorally maintain a relatively stable field body temperature and a similar heat tolerance across years. By contrast, shaded-habitat anoles continued to be thermoconformers (i.e., their field body temperature tracks microenvironmental temperature) as much as they were ten years ago. These closed-canopy species, however, increased their heat tolerance by 2°C. Our evidence suggests that Caribbean anoles may face rising temperatures by behavior or physiological adjustments, but rarely both.

A-0647 (Oral)
Island Hopping with the World's Least Interesting Lizards: A Multiplocus Phylogeographic Study of *Dibamus* (Dibamidae) with a Focus on Wallacea

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Secretive, fossorial, and rarely encountered, the "blind skinks" of the family Dibamidae are among the world's most poorly-understood reptiles. Yet their phylogenetic position (possibly sister to all other squamates) and highly disjunct geographic distribution (in Southeast Asia, Wallacea, New Guinea and Mexico) make them an intriguing group to study from a phylogeographic perspective, a task rendered very difficult by their scarcity in museum collections. In this study, we attempt to elucidate the phylogenetic and biogeographic history of Dibamids, particularly in Wallacea. Using a target-capture approach, we sequenced 324

genes of 24 museum specimens represinting at least seven species in the genus *Dibamus*. Combining these data with data available on GenBank, we estimate a Maximum-Likelihood phylogenetic hypothesis for Dibamidae and trace the history of the group through Wallacea. Our results indicate several putative new island-endemic species of *Dibamus* in Wallacea and provide insight the age and biogeographic history of the widespread *Dibamus novaeguineae*. The phylogeography of *Dibamus* is indicative of a group quite capable of both overwater dispersal and local endemism, suggesting that, given the paucity of records of *Dibamus*, many species remain unknown to science. Integrating our results with recent work on mainland *Dibamus* species and including historical tissue samples will further elucidate the history of these enigmatic lizards, and may well help resolve their unstable placement in the squamate tree of life.

A-0648 (Oral)
Northern Long-Necked Turtle (*Chelodina rugosa*) Estivation Characteristics and Feral Water Buffalo (*Bubalus bubalis*) Impacts in the Arafura Swamp Region, Northern Territory, Australia

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The culturally significant *Chelodina rugosa* (Northern long-necked turtle) inhabits wetlands in the wet-dry tropics of Northern Australia and Southern New Guinea. In the Northern Territory of Australia on Aboriginal lands, the species' habitat is under increasing threat by growing populations of feral water buffalo (*Bubalus bubalis*). *C. rugosa* has heterogeneous life stages, including facultative estivation during the dry season, when animals bury themselves under mud. To better understand the impacts of feral buffalo on *C. rugosa*, we used an impact-pathway methodology, which takes into account the complexity of the turtle's life cycle in conjunction with its highly seasonal habitat and assesses against the environmental changes resulting from buffalo. Modelling indicated two major areas for further investigation. First, direct crushing or reduced aestivation and nesting success due to modification in soil structure and property. Second, reduced reproduction due to altered food webs, reduced food availability and loss of productivity, during the wet season. We then focused on the characterization of turtle estivation sites and behaviour in varying habitats within the region to better understand the effect of buffalo soil modification on estivation in these habitats. Initial results indicate an increase in soil temperature at estivation depths, due to buffalo denuding sites of vegetation. Additionally, observations made over the seasonal variation in habitats have uncovered more complex animal behaviours transitioning in and out of estivation then previous studies. Our results indicated behaviours may vary within habitats and time of the year. This has highlighted the importance of embedded research in indigenous settings and led to recommendations in researching with First Nations groups.

A-0649 (Oral)
Synthesizing the Impact of Human Activities on Reptiles and Amphibians in Brazil: Insights from BioDivA Lab Research

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The global impacts of human-induced climate change are getting more evident each year, with extreme events of temperature and precipitation knocking at our doors. Current rates of greenhouse gas emissions lead the planet to reach several climatic tipping points (i.e., large-scale system discontinuities), impacting different aspects of biodiversity and ecosystems. Together with habitat loss, climate change is considered a leading cause of the sixth mass extinction, so predicting how natural populations will respond to global and local climate change is paramount for their conservation and management. In the face of such drastic change, species may i) adapt to new environmental conditions (provided there is enough standing genetic variation) or ii) track shifting suitable areas; otherwise, they go extinct. My early research concentrated on Amazonian lizards, investigating their thermal physiology and behavior to perform mechanistic niche models to assess their vulnerability to stressful environments. This initial focus evolved into a macroecological and transdisciplinary approach embracing not only climate change and reptiles but also other human impacts, such as land use changes, deforestation, and roadkill, on other organisms, including amphibians. In this presentation, I'll share the overall results we found when analyzing such impacts, mostly focused on lizards, snakes, and anurans from different Brazilian ecoregions. This talk represents a summary of the research developed in the Laboratory of (Bio)Diversity in the Anthropocene by undergraduate, master's, and PhD students under my supervision.

A-0650 (Poster)

Inter- and Intrapopulation Variation in Homing Behavior of Swinhoe's Tree Lizards: Influences on Mating Opportunities, Intrasexual Competition, and Habitat Structure

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Homing behavior, characterized by repeated navigation to specific spatial areas, is shaped by individual condition and numerous environmental factors varying at both individual and population levels. Homing behavior is often measured by quantifying homing tendency and homing success. Homing tendency reflects an individual's inclination to stay or reuse its previously occupied location (i.e., site fidelity), while homing success assesses the likelihood of an individual returning to its original location after an involuntary translocation. Exploring the effects of ecological and environmental factors on homing behavior across populations

offers valuable insights into the adaptability of homing in diverse and changing environments. Here, we conducted a translocation experiment involving eight populations of Swinhoe's tree lizard (*Diploderma swinhonis*). We examined the effects of resource availability (mates and food), morphological traits, habitat structure, and population density on both site fidelity and homing success. Our results revealed significant variation in both site fidelity and homing success, both within and between populations. Males exhibited higher site fidelity when they had large numbers of female neighbors and low levels of heterogeneity of male neighbors. Regarding homing success, males returned to their territories more rapidly when their territories provided abundant mating opportunities and low levels of intrasexual competition. Additionally, habitat structure influenced homing success, with males showing higher success rates in populations characterized by smaller trees or when they occupied smaller territory trees. Our findings emphasize the necessity of making comparisons within and between populations to better understand the evolutionary and ecological forces shaping animal navigation.

A-0651 (Oral)
Aquatic Habitat Preferences of the Eastern Long-necked Turtle in Australia

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River regulation and urban or agricultural development often reduces the water quality of freshwater systems. Water quality is an important environmental variable to freshwater turtles, and many species have limited tolerances to different abiotic parameters. Despite the potential for large effects of water quality variables on turtle physiology, we still do not understand the extent to which many species identify and select different water quality parameters within their habitats. The Eastern snake-neck turtle (*Chelodina longicollis*) frequently migrates between different habitats throughout east Australia, including rivers, lakes, lagoons, dams, agricultural ponds, and sewage systems. However, their ability to perceive the quality of these environments and whether they select for specific water quality attributes is unknown. Our objective was to identify the preferences of eastern long-necked turtles to different water quality parameters. We aimed to quantify the time spent in varying concentrations of abiotic variables: dissolved oxygen, fertilizer, pH, salinity, and turbidity. Ten turtles were each placed in an enclosure containing a single water quality parameter (e.g., salinity) at four different concentrations; the selected concentration of each turtle was monitored via a time lapse camera over a period of two continuous days for each water quality parameter. Each turtle was rotated through all water quality parameters in a random order. Eastern snake-neck turtles demonstrated a preference for freshwater over treatments with high concentrations of salinity, pH, turbidity, and fertilizer. However, they showed no preference for differing dissolved oxygen concentrations. Here, we show that although the eastern snake-neck turtle occupies a variety of natural and artificial environments, they have the ability to identify and select specific water quality attributes. Maintaining such water quality parameters should be a focus of catchment management and is likely to benefit both turtles and the broader food web.

A-0652 (Oral)
Anthropogenic and Climatic Factors Interact to Influence Reproductive Timing and Effort

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Reproduction, although absolutely essential to a species' persistence, is in itself challenging. As anthropogenic change increasingly affects every landscape on Earth, it is critical to understand how specific pressures impact the reproductive efforts of individuals, which directly contribute to the success or failure of populations. However, organisms rarely encounter a single burden at a time, and the interactions of environmental challenges can have compounding effects. Understanding environmental and physiological pressures is difficult because they are often context-dependent and not generalizable, but long-term monitoring across variable landscapes and weather patterns can improve our understanding of these complex interactions. We tested the effects of urbanization, climate, and individual condition on the reproductive investment of wild Side-blotched lizards (*Uta stansburiana*) by measuring physiological/reproductive metrics from six populations in urban and rural areas over six consecutive years of variable precipitation. We observed that reproductive stage affected body condition, corticosterone concentration, and oxidative stress. We also observed that reproductive patterns differed between urban and rural populations depending on rainfall, with rural animals increasing reproductive investment during rainier years compared to urban conspecifics, and that reproductive decisions appeared to occur early in the reproductive process. These results demonstrate the plastic nature of a generalist species optimizing lifetime fitness under varying conditions.

A-0653 (Oral)
The Crocodile Conundrum of Charotar

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Humans and wild-animals have shared spaces for centuries; however, we are witnessing radical transformations due to increasing encroachment into wild habitats. This study examines the complex relationships between humans and crocodiles in two human-dominated landscapes, Charotar and Vadodara, in western India. Our study investigates factors influencing the evolving dynamics of human-crocodile interactions, and anticipates future transformations. Employing an interdisciplinary approach, we explore crocodile behaviour and human attitudes toward them. Through qualitative methodologies, we analyse the intricate dynamics of human-crocodile relationships depicted in historical wall-paintings, oral histories, and sculptures within our research area. We observe a significant contrast in the frequency and nature of interactions with crocodiles at the two study sites, despite similar densities. In rural and semi-

urban Charotar villages, where people engage regularly with crocodiles, we find cultural ecosystem services being derived from these interactions. The community's awareness of crocodile ecology and keen observational skills highlight the role of wildlife knowledge in shaping attitudes and perceptions. The differences in traditional knowledge about crocodiles and their behaviour in Vadodara and Charotar, suggests that learning is not only structured by cultural or religious influences, but the transmission of traditional knowledge is more important at the community level. Human attitudes, informed by perceptions, play a crucial role in managing everyday interactions with crocodiles. Our study finds that these attitudes, shaped by traditional ecological knowledge, vernacular ethological accounts, and past experiences, contribute to the construction of local cultures that integrate the historical presence of crocodiles alongside humans. Such strong human beliefs in coexistence with crocodiles hold important lessons for the conservation of human–nonhuman lifeworlds in the evolving Anthropocene of the tropics, where we question how to survive with what is left.

A-0655 (Oral)

Evolution of the Kukri Snake Genus *Oligodon* Fitzinger, 1826: Sharpening the Blade of the Second Largest Serpent Radiation (Reptilia: Squamata: Colubridae)

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With over 90 recognized species, Kukri snakes of the genus *Oligodon* Fitzinger, 1826 represent the second largest snake genus in the world and the most speciose snake genus on the Asian continent. While *Oligodon* contains a high level of species richness and a number of unique ecological attributes, the biology and evolutionary history of the genus poorly understood due to a limited number of samples available in earlier studies. In this presentation, we present the largest molecular dataset of *Oligodon* to date, which we use to assess phylogenetic relationships, systematics, and biogeographic patterns. In addition, we use an expanded dataset of over 35 high-resolution computed tomography (CT) scans to explore variation in skull morphology and dentition. Based on a combination of phylogenetic analyses, we recover eight major clades within *Oligodon*, of which only two correspond with species groupings recognized by earlier morphological classifications. We recover dual cases where taxonomic diversity is underestimated and overestimated and identify several species complexes that likely require integrative revisions in the future. Our examination of CT-scans reveal that enlarged 'blade-like' maxillary teeth are found across most *Oligodon*, though considerable variation in other dental and cranial features were noted. Taken together, we provide insights on how osteological features found in *Oligodon* correlate with aspects of feeding and habitat ecology, and discuss the utility of skull morphology in kukri snake systematics. Finally, we discuss the biogeographic history of *Oligodon* and identify future directions that require further investigation once new data becomes available.

A-0656 (Oral)

Lotic Specialization in Modern Asian Newts (Caudata: Salamandridae), Phylogeny, Historical Biogeography and Ancestral Traits based on Combined DNA Data

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Modern Asian Newts, including *Cynops, Laotriton, Pachytriton*, and *Paramesotriton*, are distributed in East Asia and have adapted to various environments, including generalists inhabiting both lotic and lentic habitats, and lotic specializations. Despite recent efforts on biogeographic history, these studies could not explain the causes of emergence of lotic

specialized species. Furthermore, it is unknown how these species have shaped their morphology to adapt to their habitat preferences. In this study, we estimated the divergence time and reconstructed the ancestral traits based on the phylogeny constructed by mitochondrial and nuclear DNA sequences. Both the maximum-likelihood and Bayesian inference approaches significantly grouped the lotic-specialized species and determined the sister position of genera *Laotriton* and *Pachytriton*. Our results suggest the divergence between lotic-specialized species and generalised species occurred during the middle to late Miocene, which can be considered to correlate with the long-lasting arid period and the uplift of Wuyi-Nanling mountains. Furthermore, ancestral traits reconstruction suggested male body size enlarged and epibranchial feature strengthened with the emergence of lotic specialized lineage, suggested these two characters might be vital for adaptation in lotic habitats. On the other hand, evolution of extra flange of epibranchial structure and tongue movability suggested needs of suction feeding efficiency might differ among lotic habitats, while skin texture might suggest different level of aquatic among Modern Asian Newts. Based on these results, this study provides the first attempt to reveal ancestral state evolution among divergent species of Modern Asian Newts.

A-0658 (Poster)
Epigenetic Regulation of Immune Response in the Swedish Sand Lizard (*Lacerta agilis*)

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Sand lizards (*Lacerta agilis*) are found across Europe, even stretching as far north to extremely cold environments such as in Sweden. Being highly adapted to such extreme temperatures makes them highly susceptible to climate change, and the knock-on effects this could have on disease dynamics. Using an experimentally isolated, outbreed, island population in southern Sweden we are investigating immunogenetics and epigenetics in these highly adaptable populations. Using immune challenge experiments, we are characterising the sand lizard immune response using RNA and bisulfite sequencing, and assessing the role of DNA methylation in reptilian immunity. This study will greatly improve our understanding of epigenetic regulation of immunity in reptiles in general but also give us key insights into specific genes under underlying the Swedish sand lizard immune response. Our results are also important for the conservation of the species in Sweden, which are expected to face novel changes in disease dynamics as a result of climate change.

A-0659 (Oral)
Expansion, Contraction, and Diversification Nonclassical MHC-I Gene Lineages in *Xenopus*

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The growing number of nonclassical MHC-I (MHC-Ib) genes and lineages phylogenetically distinct from classical polymorphic MHC-Ia (MHC-Ia) genes in the available sequenced genomes of amphibians, cartilaginous and bony fish afford an opportunity to reevaluate the evolution of MHC-I and adaptive immunity in jawed vertebrates. Interestingly, the genomes

of two divergent amphibian species *Xenopus laevis* and *X. tropicalis* (~ 18 million years ago), exhibit multiple MHC-Ib (mhc1b-uba) lineages unusually conserved in a large cluster containing more than 20 MHC-Ib (mhc1b-uba) genes located outside the MHC locus in the telomeric region of chromosome 8. Some MHC-Ib gene lineages display flexibility with species-specific expansion or contractions, whereas other lineages have remained oligogenic with minimal intra-species sequence variations. Unlike classical MHC-Ia mainly expressed by thymic epithelial cells, six of these oligogenic MHC-Ib genes are expressed preferentially by thymocytes from the onset of thymic organogenesis, which is consistent with a specialized role of MHC-Ib in early development of innate T cells. In addition, a corresponding 6 distinct alpha T cell receptor (TCRa) rearrangements dominate (80%) the tadpoles TCRa repertoire. This implies a preponderant role of some of these MHC-Ib molecules in directing the development and function of distinct iT-cell populations in *Xenopus* tadpoles. The expansion and diversification of class Ib/iT cell immune surveillance systems across jawed vertebrates raises the possibility that this system was the forerunner during evolution of the polymorphic MHC-Ia/conventional T cell system, which is the key component of the adaptive immunity.

A-0660 (Oral)
Phylogenomics in the Sphenomorphini: Australia's Most Diverse Endemic Vertebrate Radiation

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Australian sphenomorph skinks (Subfamily: Lygosominae, Tribe: Sphenomorphini) are the most diverse vertebrate radiation on the continent. Following arrival, rapid evolutionary radiation generated a diverse set of bodyforms and ecological adaptations. This early, explosive radiation means phylogenetic reconstruction has been challenging, likely due to incomplete lineage sorting. As part of my PhD, we present the most complete and high-resolution phylogenomic tree to date, using a squamte sequence capture dataset with both maximum-likelihood and coalescent tree inference. We combine this phylogenetic framework with distribtuion models and environmental data to map phylogenetic diversity and paleoendemism hotspots, ancestral biogeography, and modelling niche-space evolution. Early results are promising, revealing both well-established and some novel systematic arrangements, paleoendemism patterns, as well as some technical challenges. We discuss these in the context of taxonomic changes, niche conservatism versus divergence, and biogeographic history of the group.

A-0661 (Oral)
Increasing Chytrid Resistance in Southern Corroboree Frogs through Selective Breeding

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Functionally extinct in the wild, the Southern Corroboree frog is dependent on captive management and breeding to survive. Their main threat to survival is the deadly amphibian chytrid fungus. With no effective management strategies to control chytrid in wild frogs, this project aims to enhance their resistance through selective breeding. While this method has been successfully achieved in domesticated animals, its application to wildlife remains unexplored. Given that the entire extent of the genetic diversity of Corroboree frogs is held in captivity and a successful breeding program is already established, we are uniquely positioned to evaluate the efficacy of this approach in this species. Traits correlated with chytrid resistance are required for targeted genetic improvements. To identify these, we have conducted a 1,000 animal chytrid exposure experiment to collect chytrid susceptibility data, and designed and manufactured the first custom SNP array for amphibians to genotype the frogs in our experiment. We will use the collected phenotypic and genetic information to conduct a GWAS for chytrid resistance/susceptibility. The overarching goal of our research is to implement a breeding strategy across the captive colonies to increase beneficial alleles, and decrease deleterious alleles, thereby increasing the tolerance of Corroboree frogs to chytrid infection. This study is the first of its kind, on this scale in amphibians. Our findings enhance not only our understanding of chytrid susceptibility in Corroboree frogs, providing targets for selective breeding, but also establishes a platform to build upon in other species.

A-0662 (Oral)

Design and Application of a Custom SNP Array for the Southern Corroboree Frog (*Pseudophryne corroboree*)

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High density single nucleotide polymorphism (SNP) arrays enable high throughput, cost-effective, and accurate genotyping. However, despite being widely used in studies of humans and domesticated plants and animals, SNP arrays are lacking for most wild organisms. Here, we present the development and application of a custom 50K SNP array for the critically endangered Southern Corroboree frog (*Pseudophryne corroboree*), which will be used to advance in genomic research and conservation efforts in this species. For the SNP array design, we conducted SNP discovery using Illumina whole-genome sequencing data obtained from 23 founding frogs. Out of the 48,386 SNPs tiled on the array, 78% successfully converted and were polymorphic in 1,089 corroboree frogs. We also assessed the effectiveness of the array across multiple tissue types, including non-invasive swabs, and evaluated its potential for

genotyping three related myobatrachid frogs. Using the SNP data, we assessed the genetic diversity of the *P. corroboree* captive population, we investigated the population for evidence of bottlenecking, relatedness, and level of inbreeding in this species. The development of a custom genotyping array for *P. corroboree* will facilitate future studies on breeding for genetic management and targeted genetic improvement in the captive population. Additionally, this array has the potential to serve as a wider resource for genomic research in myobatrachids.

A-0664 (Oral)

Comparative Aspects of the Ecology of Four Syntopic Species of Angle-headed Lizards, Genus *Gonocephalus*

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Global studies on reptile coexistence and resource partitioning are well-documented but few studies have been conducted on Borneo and in Southeast Asia. While some ecological generalizations may hold true locally, species interactions can vary significantly based on geographical and environmental factors. This study focuses on the comparative biology of four *Gonocephalus* species (*G. bornensis, G. liogaster, G. doriae* and *G. grandis*) to develop a better insight into the ecological phenomena of resource partitioning, the rationale being their perceived ecological similarity and syntopic occurrence. From June 2018 to December 2019, field work was conducted using radio telemetry to study the home range, habitat preference, and thermal biology, while stomach flushing was employed to analyze the diet of populations in Kubah National Park, Sarawak. These species in the region generally occupy similar microhabitats and had moderate home range sizes that were similar across species and sexes. Nonetheless, species of *Gonocephalus* diverge slightly along the spatial dimension by exhibiting different levels of preference towards aspects of microhabitats utilised, while the lack of interspecific home range overlaps suggests that these species are occupying different parts of the forest. These species were primarily shade-dwellers and had relatively low mean body temperatures. They exploit the thermal niche differently which reflects the spatial niche and are likely influenced by the trophic niche. *G. bornensis* was overall a habitat generalist compared to its congeners, whereas *G. doriae* are relatively specialised. A total of 13 prey types were also identified, consisting mainly of insects and other non-insect arthropod groups (earthworms and snails). However, there was insufficient evidence to conclude unequivocally that trophic resource partitioning contributed to coexistence among these species. This study augments our understanding of these lizard species and contributes to the broader comprehension of resource partitioning dynamics and mechanisms governing coexistence within Borneo's tropical rainforest ecosystem.

A-0665 (Oral)

Uncovering the Ecology and Diversity of Sea Snakes from the Bay of Bengal bordering Bangladesh

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Sea snakes are the least studied marine reptiles, making it difficult to evaluate their conservation status. The waters of the Bay of Bengal, bordering Bangladesh, are home to 16 of the 38 species of sea snakes in the Indian Ocean. Despite being an obvious conservation priority, little is known about the ecology, distribution, phylogenetic relationships, and conservation status of sea snakes in Bangladesh, including some species that have yet to be confirmed. Much of our knowledge of sea snakes in Bangladesh is primarily based on historical data collected during the British colonial period (pre-1947) and Pakistan occupation (pre-1971), which lack empirical data. We surveyed sea snakes in the coastal waters of Bangladesh and sampled fisheries bycatch from 2012-2016. Our sampling yielded eight species of sea snakes from the waters of Bangladesh, half of the (eight of 16) sea snake fauna reported to be found in the coastal waters of Bangladesh. Six of the species (*Hydrophis caerulescens, H. curtus, H. platurus, H. stricticollis, H. obscurus* and *H. nigrocinctus*) we documented were first confirmed reports from Bangladesh, including Data Deficient and a species (*Hydrophis nigrocinctus*), endemic to the Bay of Bengal, had been rediscovered after over a century. In addition, we documented their diet and novel information on the reproductive status of *Hydrophis stricticollis* and *H. nigrocinctus*. Our findings highlight the importance of the unique sea snake species in Bangladesh and the need for a comprehensive study to better understand the diversity and facilitate conservation efforts of these ecologically and medically important marine reptiles.

A-0666 (Oral)
The Effect of Inundation on Frog Communities and Chorusing Behaviour

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Globally, river regulation has degraded wetlands and continues to threaten wetland-dependent biota, including parts of the Murray-Darling Basin (MDB), an environmentally and economically significant drainage basin in Australia. Frogs in floodplain wetlands largely depend on habitats created by river flows, but little is known about how frogs in the northern MDB have been impacted by river regulation. We tested how wetland inundation affected the

frog community in a catchment of the northern MDB. We surveyed frogs between 2015 and 2019 to determine long-term changes in the community composition with floodplain inundation from river flows. Additionally, we recorded nightly soundscapes for four days before and after the arrival of river flows between 2019 and 2020. The abundance and richness of frog species increased during larger inundation events and altered the community composition (beta diversity). Warmer temperatures increased the number of frog species detected (richness), and frog community dominance decreased with decreasing vegetation cover (i.e., the relative abundance became more even across species). The abundance of five frog species (*Limnodynastes tasmaniensis, Limnodynastes fletcheri, Crinia parinsignifera, Litoria peronii*, and *Litoria latopalmata*) was higher in response to greater inundated area in survey sites. The total species richness of chorusing frogs increased after the arrival of river flows; six species chorused over the four nights preceding, and eight species chorused following the flow arrival, but the responses varied among species and sites. After inundation, the choruses of *Limnodynastes tasmaniensis* increased, whereas *Limnodynastes fletcheri* decreased. Our findings indicate that inundation has a positive impact on breeding behaviour for these species and suggest complex overnight chorusing behaviour in response to river flows inundating floodplain wetlands.

A-0667 (Poster)

Chorusing Behaviour of Frog Communities in Response to Environmental Flow in Gwydir River Catchment, Australia

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Globally, river regulation has degraded wetlands, including parts of the Murray-Darling Basin (MDB), an ecologically significant drainage basin in Australia. Frogs in floodplain wetlands largely depend on habitats created by river flows, but little is known about how frog chorusing activities, a measure of potential breeding behaviour, are impacted by river regulation and vary in response to wetting and drying cycles in the northern MDB. Frog chorusing activity is highly variable and is cued, in part, by environmental factors. In floodplain wetlands, river flow drives frog breeding responses for many species. We examined how the overnight long-duration chorusing behaviour of a frog community varied in response to the inundation of wetlands. We also tested the influence of additional environmental variables, such as air temperature and rainfall. We used passive acoustic recorders to record and compare 14 hours of nightly soundscapes for four days before and after the arrival of river flows following environmental water delivery, which inundated the wetland survey sites. Our results indicate that the total

species richness of chorusing frogs significantly increased after the arrival of water, but the responses of frogs to the arrival of water varied among species and sites. After inundation, the choruses of *Limnodynastes tasmaniensis* significantly increased, and the choruses of *Limnodynastes fletcheri* significantly decreased. Most species were detected before and after flow, but one species (*Cyclorana alboguttata*) was only detected before flow, and three species (*Cyclorana verrucosa, Cyclorana cultripes*, and *Limnodynastes salmini*) were only detected after flow. Our study revealed complex overnight chorusing behaviour in wetland-dependent frogs in response to wetland inundation. Based on our findings, we conclude that environmental watering may help initiate the breeding of different frog species.

A-0668 (Oral)
Philippine Herpetology History Current Status and Future Opportunities

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The progress of Philippine herpetological research starting from the 1521 Spanish occupancy is presented to provide an overview on the advancement of herpetology in relation to current conservation efforts. Through the classification and consolidation of nearly 2,000 references, the history of Philippine herpetological studies unfolds. Results show very minimal records during the 14th to the 19th century (1500 to 1800). The birth of taxonomic analysis started in the 1800s by Weigmann, Dumeril, and others. This period is highlighted by the establishment of the Systematic catalog of the Philippine fauna and the establishment of the first Museum of Natural History in the University of Sto. Tomas. The 20th century records from 1901-1950 is highlighted with Taylor's herpetological collections housed at the Bureau of Science Manila and providing the robust baseline, but were sadly were burned during the Japanese war in 1945. Studies were augmented by Boulenger, Griffin, Stejneger, Tubangui, Villadolid, Myers, Herre and others. The latter half of the century (1951-2000) boasts of the collections of D. S. Rabor, A. C. Alcala, and W. C. Brown. Leviton's publications provided the data on snakes, boosted by Inger, Gaulke, Auffenberg, Ota and others. In the 21st century, more Filipino scientists emerge into the Philippine herpetological research scenario. The years 2001 onward are enriched by the publications of A. C. Diesmos and R. M. Brown, and a new generation of young Filipino herpetologists. Almost five hundred publications came out in this period. Local and international collaborative research developed in more areas and new species were discovered. Herps were also used as a thematic group to mark conservation priority areas. More recently, gaps on conservation and opportunities for research priorities based on key biodiversity areas are recognized and presented in this paper.

A-0669 (Oral)
Environmental Hazards and Conservation Challenges for Sea Snakes in the Arabian Peninsula

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Ten species of sea snakes are known from the Arabian Gulf and Gulf of Oman, with research on their ecology in the coastal waters of the Arabian Peninsula being notably limited. This

scarcity of research extends to the effects of environmental hazards, such as oil spills, on these marine reptiles. Our comprehensive study over a decade not only sheds light on the ecological aspects of several species but also reports on advancements in veterinary care and husbandry, particularly for *Hydrophis lapemoides*, post-recovery from mass stranding events linked to oil spills. We detail an oil spill incident off the coast of Kalba, Sharjah, UAE, which resulted in the mass mortality of 39 sea snakes from four different species, with the majority exhibiting severe oil coverage over their bodies, including sensitive areas such as the snout and eyes. Furthermore, this study presents novel findings on the concentration of organochlorine pesticides (OCPs) and polycyclic aromatic hydrocarbons (PAHs) in the tissues of stranded sea snakes, revealing significant bioaccumulation and correlations with environmental exposure. Our analyses utilized GC/MS for quantifying contaminants in muscle, liver, and fat tissues, highlighting that OCP concentrations were notably higher than those previously recorded for marine reptiles in the region. Additionally, we report on the elevated levels of heavy metals in sea snakes affected by the spill compared to non-oiled counterparts, indicating significant pollution impact. This study underscores the urgent need for environmental protection measures for sea snakes in the Arabian Gulf and Gulf of Oman, highlighting the detrimental effects of pollution on these understudied marine species.

A-0670 (Oral)
Applying Ensemble Distribution Models To Predicting *Ranavirus* Risk In Turtles

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Ranaviruses infect amphibians, reptiles, and fishes, causing mass mortality events and posing threats to wildlife. While many studies have examined amphibian infections, few have explored Ranaviruses in turtles. In this study, we gathered turtle outbreak coordinates from published literature sources. We employed an ensemble species distribution modelling (ESDM) approach to predict geographic risk of *Ranavirus* infections in turtles across North America and we cross-validated results for infections worldwide. Our ensemble models included MaxEnt, GLM, and GAM algorithms, and predicted *Ranavirus* occurrences using bioclimatic variables, elevation, and amphibian richness as predictors. Our best model discriminated probable high-risk infection areas from background pseudoabsences in North America with high accuracy (AUC: 0.876, sensitivity: 0.879, specificity: 0.873). Predicted high-risk regions from our model overlapped known infections worldwide. Our findings provide insights into which regions require targeted surveillance to mitigate turtle population declines from viral ranavirus pathogens.

A-0671 (Oral)
The Amphibian Survival Alliance: A Model Vehicle for Fostering Genetic Resource Management and Biobanking Networks

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The Amphibian Survival Alliance (ASA) is an international partnership currently comprised of 69 organizations, from more than 30 countries, which execute and multiply amphibian

conservation collaborations and actions. The ASA collaborates with international bodies, scientists, governments, and local communities to address amphibian conservation globally, working in amphibian biodiversity hotspots like Asia, Africa, and Latin America, among others. The main objective of the partnership is to coordinate and connect the different organizations working on amphibian conservation in different parts of the world by focusing primarily on four pillars: (i) coordination, leading global conservation initiatives; (ii) collaboration, catalyzing alliances and cooperation among partner organizations; (iii) communication, educating and raising awareness in the population; and (iv) financing, offering financial support to implement conservation projects or initiatives. Amphibians are the most endangered vertebrates on the planet, with at least 41% of their species classified under some category of risk and lagging behind other taxa in genetic and genomic resources that could aid in their conservation management. This class faces numerous threats, some of which can be mitigated at the local level, however, most require efforts at the global level. The ASA is dedicated to aligning with the priorities set by the Amphibian Conservation Action Plan (ACAP), including the urgent development and implementation of Assisted Reproductive Technologies and Biobanking. Many ASA partners have identified the need to utilize these tools, while others have already begun implementation. Leveraging its wide network, ASA coordinates training initiatives, understands partner needs, and focuses attention on these critical matters. By fostering the establishment of amphibian biobanks and genetic management, ASA aims to enhance conservation efforts and safeguard amphibian species worldwide. This presentation aims to highlight the crucial role that ASA plays at the global level, emphasizing the main lines of action, partner organizations and initiatives led both regionally and globally.

A-0672 (Oral)

Paleoecology of the Pleistocene Fossil Amphibians from La Brea Tar Pits, Los Angeles, USA

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Amphibians are the most dispersal-limited vertebrate group and exhibit extreme sensitivity to climate change, and thus have great potential as paleoecological proxies. However, paleontological studies about amphibians are scarce due the fragile bones of the anuran skeleton that are rarely preserved in the fossil record. One North American locality that does preserve a robust fossil record of amphibians is Rancho La Brea (RLB) in Los Angeles, California, owing to naturally-occurring seeps of viscous asphalt that have trapped and preserved hundreds of species over the past 60,000 years. However, to-date, only three publications on RLB amphibians have been published, documenting just five species of anurans (*Bufo nestor, Anaxyrus boreas, A. microscaphus, Rana aurora*, Hylidae) and one salamander (*Aneides lugubris*) throughout the Pleistocene and Holocene records. In this study, we analyzed the RLB fossil collection from the La Brea Tar Pits and Museum (LBTPM) and the University of California Museum of Paleontology (UCPM) to develop a complete amphibian taxonomic list for this site. We also conducted morphological, paleobiogeographical, stable isotopic, and radiocarbon dating analyses for the first time on Quaternary anurans. This research has added two new taxa to the amphibian diversity of

Rancho La Brea: the Mexican burrowing toad, which is not currently distributed in the RLB area, and a potentially new extinct species of spadefoot toad. Dates obtained so-far on bones of *A. boreas* range from 630 ± 20 to 5965 ± 20 14C years Before Present. Nitrogen and Carbon isotopes obtained on the dated fossils are higher than in modern amphibians. We identified morphological characteristics in the *A. boreas* humerus to separate males and females, and found measurements in different bones to infer body size in *A. boreas*. This information is being used to help understand the impact of the Late Quaternary climate changes in southern California.

A-0673 (Poster)
Costs and Benefits of Polyandrous Mating to the Female Emerald Treefrog (*Zhangixalus prasinatus*), a Lek-Chorusing Anuran

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Polyandrous mating, where females mate with multiple males, can be caused by male manipulation, primarily benefiting males. Females, conversely, may suffer costs without direct benefits. In lek-breeding species, females choose superior males at the lek to pass on good genes to their offspring. However, when females are compelled to mate against their preference, which leads to polyandrous mating, indirect genetic costs arise, with lower-quality males fathering some offspring. Despite these costs, polyandrous mating may benefit females through fertilization insurance and increased genetic diversity. This study investigated the costs and benefits of polyandrous mating in the lek-chorusing treefrog (*Zhangixalus prasinatus*) by comparing offspring performance (embryo viability, survival, growth, development - linked to fitness), fertilization success, and allelic diversity between the clutches after monandrous and polyandrous mating. Our results showed that polyandrous mating (1) did not affect embryo viability, offspring survival, growth, or development, (2) did not increase fertilization success, but (3) increased genetic diversity. Additionally, we found that primary males (chosen by females) sired more offspring than peripheral males (not chosen by females). The small proportion of the clutch sired by peripheral males suggests that polyandrous mating in Z. prasinatus may be driven by males to pursue reproductive success, and may, as a by-product, potentially benefit females by increasing their offspring's genetic diversity. Therefore, peripheral males achieve higher reproductive success, while females tolerate a few costs, which is likely a primary reason for polyandrous mating in this species.

A-0674 (Oral)
Role of Citizen Science in Amphibian Conservation in India

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India harbours a rich diversity of amphibians, with over 465 species known to date. New species are added to the growing list in the last two decades at a rate of 11 species per year. Global Amphibian Assessment 2020 carried out after almost two decades, has revealed a shift

in the ecological status of Indian amphibians. A citizen science initiative called India Biodiversity Portal (IBP) was started in 2012 under Creative Commons licensing. In two years, there were about 289 observations of amphibians. We started Frog Watch (India) within IBP in 2014 and then the Mapping Malabar Tree Toad programme in 2015. As of today, Frog Watch has over 4,900 observations coming from 743 contributors spanning across India. The data platform is now merged with GBIF. Initial observations posted on Frog Watch were close to the date of observation in the field, later we encouraged citizen scientists to post their observations even from the past. This positively impacted the number of uploads during the Covid-19 lockdown. At present, anyone can upload an observation as a photo, a video or an audio. In this presentation, we showcase the pattern of observations on spatial and temporal scales across India, along with key insights on species data. We highlight the case of the Malabar Tree Toad (*Pedostibes tuberculosus*), once considered Endangered B1ab(iii) with a decreasing population and how focusing on a species helped garner interest among citizen scientists, which eventually helped in re-assessing the species. We will discuss the challenges faced and the way forward.

A-0676 (Oral)
Influence of River Basins on the Genetic Diversity of Endemic Amphibians from Western Ghats India

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Amphibians are one of the highly diverse as well threatened group of vertebrates on earth with 41% of species facing extinction. One of the measures of amphibian conservation include estimating genetic diversity and identifying barriers for their dispersal. Most of the amphibians are relatively poor dispersers and can show high genetic structure at small scale. For freshwater dependent amphibians, the genetic diversity is often partitioned according to river basins but is poorly documented especially from tropical regions of the Western Ghats, India. In this study we analyse the influence of river basins on the genetic diversities of widespread amphibian, Kempholey Night Frog and range restricted Jog Night frog from India. Using molecular methods, we show that genetic variation in those frogs is influenced by geographic distance rather than the dendritic structure of river basins. The results provide a baseline data for conservation of fresh water dependent amphibians of the Western Ghats.

A-0677 (Oral)
What's Eating You? Coinfection by Fungal and Helminth Parasites in a Common Australian Amphibian

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The devastating impacts of *Batrachochytrium dendrobatidis* on frog populations are well documented, however after more than 40 years of the Bd pandemic, little is known about how

coinfections can impact amphibian health and reproduction. Sublethal effects of disease can cause influence host vigour and reproductive output, which can have significant consequences for the survival of a population in the wild. Here, we explored the sublethal effects of coinfection with Bd and helminth parasites on multiple aspects of individual size and reproductive fitness in wild populations of the common and widespread Australian frog species – the Stony Creek frog (*Litoria lesueuri*). We also identified the helminth parasite using Sanger sequencing and the NCBI GenBank database. There were no perfect percentage identity matches on the database, therefore our helminth sample is likely to be an unclassified species from the *Oesophagostomum* genus. Our investigation of naturally acquired Bd and helminth infection in *L. lesueuri* concluded that there was no correlation between infection of the two parasites. We found a significant correlation between helminth infection and increased body condition, indicating that helminth infection affects host health. This result is surprising, given the expectation that a gut parasite should negatively impact growth and host health. With this research, we will have a better understanding of the role *L. lesueuri* plays in disease dynamics in the field, and how capable these hosts are at maintaining Bd and helminth infections in their environment – potentially act as a source of infection for other amphibian populations. It is valuable to evaluate how non-declining species respond to disease, as this could illuminate the mechanisms enabling non-declining species to persist in the environment with disease and might reveal declining population trends in otherwise common species that would have gone unnoticed.

A-0678 (Oral)
Captive Propagation of Blunt-Nosed Leopard Lizards at Fresno Chaffee Zoo

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The Blunt-nosed leopard lizard (*Gambelia sila*) is an endangered and charismatic lizard species endemic to California's Central Valley where it occurs in harsh, desert environments. The Fresno Chaffee Zoo (FCZ) has maintained a captive assurance colony of *G. sila* since the summer of 2020. The spring and summer of 2024 marks the fourth breeding season for the colony. We founded the colony with seven lizards captured from Panoche Plateau and the colony has since produced 107 animals and we released 17 back to Panoche Plateau in 2023 and will release 25 in 2024. Our rapidly growing colony is now housed in a newly constructed Conservation Action Center building on zoo grounds. In addition to housing the colony, this building provides literal windows into the conservation science happening at FCZ as we study *G. sila*. The colony has already taught us a great deal about the reproduction and life history of this elusive species emphasizing the important role captive propagation can play for understanding rare and hard-to-observe species or life-stages. We will continue producing, releasing, and monitoring *G. sila* annually until > 50 natural born females successfully reproduce on the Panoche Plateau and the population can grow without further captive propagation.

A-0679 (Oral)
Assessing Vulnerability of Herptiles to Global Change Factors in Europe

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A main goal of the United Nations 2030 Agenda is to halt biodiversity loss due to anthropogenic global change factors (climate change, land conversion, etc.). Amphibians and reptiles are among the most vulnerable species to impacts from components of global change. The influence of climate factors shaping the geographic distributions of amphibians and reptiles is stronger, and their protection crucial for ecosystem functioning as they are in intermediate positions in the food chain. It is thus urgent to detect those hotspots of the herpetofauna where global change impacts are being more acute, and disentangle which species are crucial for ecosystem functioning. The project SPOTIMPACT pursues detecting hotspots of herpetofauna at different scales (Europe and the Iberian Peninsula) that are being threatened by global change factors. The potential threats to each hotspot will be assessed by exploring the temporal evolution of variables related to direct (climatic, land uses) and indirect (primary productivity) effects of global change. Also, we are testing the interrelationships among the time-series of the above-mentioned environmental variables within each relevant hotspot. In general, while we found widespread monotonic increments of regional temperature in herptile hotspots at two different scales (Iberian Peninsula and Europe), this was not the case for precipitation. In the Iberian Peninsula (at a resolution of 10 km) and Europe (at a resolution of 50 km) we observed that temperature significantly increased in 43% and 99.5% of the herptile hotspots, respectively. In the Iberian Peninsula, temporal increments in primary productivity were related to temperature increments and also to changes in shrub and forest cover. Besides, the Natura 2000 network offers moderate protection to reptiles under global change. At a broader scale, the mismatch between recent past and predicted future temperature increments has a geographic structure within herptile hotspots, which is explained by biogeographical regions in Europe.

A-0680 (Oral)
The Role of ASG ART's and Biobanking in Coordinating Global Genetic Management, ART's and Biobanking Efforts

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In response to the global amphibian extinction crisis, the IUCN SSC Amphibian Specialist Group (ASG) was established, alongside thematic working groups representing diverse disciplines aiming to tackle global amphibian extinction crisis. In 2007, this collaborative effort led to the publication of the Amphibian Conservation Action Plan (ACAP), a seminal document shaping worldwide amphibian conservation efforts. Nearly two decades since its inception, conservationists have witnessed persistent species extinctions and declines amidst growing resource limitations. While conservation breeding expands to meet *in situ* strategies, challenges persist, highlighting the importance of integrating Assisted Reproductive Technologies (ARTs) and genome resource banking for optimal management of genetic diversity. Consequently, the original Genome Resource thematic group underwent reorganization, giving rise to the ARTS and Biobanking Working Group as the newest thematic group in 2017. Since its establishment, the Working Group's main goal has been to lead integration of ARTs, and biobanking as genetic management tools into amphibian conservation strategies. By conducting an awareness campaign, the group has highlighted the importance of creating and using these tools in both *ex-situ* and *in-situ* amphibian conservation programs. Additionally, the group successfully advocated for the inclusion of a dedicated chapter on ARTs and biobanking within the 2023 Amphibian Conservation Action Plan (ACAP),

enhancing the visibility of these critical tools within the amphibian conservation community. By identifying key stakeholders with expertise, as well as those in need of training, the working group facilitates connections and collaborations among its members, cultivate a supportive network for sharing knowledge and resources and continue planning future initiatives that further integrate ARTs and biobanking into amphibian conservation strategies. By promoting the importance of ARTs and biobanking and fostering collaboration among stakeholders, the group aims to make tangible progress in safeguarding amphibians and their genetic diversity.

A-0681 (Oral)

Advancements in Amphibian Reproductive Technologies: Characterizing Sperm Quality Metrics Using Flow Cytometry for the Development of an Index for Pre and Post Cryopreserved *Xenopus* Sperm Analysis

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Artificial manipulation of reproduction for genetic management requires that the best quality gametes are obtained to ensure increased fertilization and offspring quality as well as the probability of post cryopreservation gamete recovery. As we navigate the challenges of incorporating assisted reproduction into amphibian conservation, a nuanced understanding of sperm quality becomes indispensable. Updated assessment protocols, including rapid multi-parametric analysis of single cells and viability metrics indices, are emerging as transformative technologies in safeguarding these vital species. The presentation compares the efficiency of flow cytometry (FL) versus fluorescent microscopy (FM) and a weighted measure-based sperm indexing system as time- and cost-effective tools that combine relevant metrics into an accessible database. Verification of the sperm indexing efficacy involves simultaneous evaluation of multiple sperm parameters using both FM assessments and FL. Efficacy of these tools was tested using *Xenopus* sperm, collected from testes macerates and stained with SYBR-14 and Propidium iodide (PI) to determine live/dead viability. Subsequently, cells were analyzed using both methods to validate the accuracy of one over the other for assessing viability. The results of this study indicated that FL overestimated sperm concentration and viability by approximately 15.1% compared to FM counts and 3.4% difference in live cells compared to FM. Despite the observed differences, flow cytometry remains a reliable tool for simultaneously assessing multiple fluorescent markers compared to microscopic methods. This capability is particularly crucial in situations where sample volumes are limited, which is common when working with vulnerable amphibians. To further develop a comprehensive viability assessment methodology, we created a sperm indexing system that utilizes weighted averages to combine various sperm quality metrics into a single scoring system. Our results indicate that the sperm index is an applicable scoring framework for assessing the overall quality of a sample.

A-0682 (Oral)

Modelling the Past, Present, and Future Distributions of Leiopelma Frogs

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Aotearoa New Zealand is home to the endemic, archaic Leiopelmatid frogs. Since human arrival, these frogs have undergone severe range contractions, due to habitat degradation and the introduction of mammalian predators. Extant *Leiopelma* species now persist only in fragmented, remnant populations, with the subfossil record preserving their more expansive past distributions. Fortunately, the subfossil record is relatively extensive for the three recently extinct species (*L. auroraensis, L. markhami*, and *L. waitomoensis*). The IUCN lists *L. archeyi, L. hamiltoni*, and *L. hochstetteri* as 'Critically Endangered', 'Vulnerable', and "Least Concern", respectively, while the New Zealand Threat Classification is more severe listing *L. archeyi* and *L. hochstetteri* as 'At Risk – Declining" and L. hamiltoni as 'Nationally Vulnerable'. Understanding how climate change may alter distributions of environmentally suitable habitat is challenging with remnant populations often occupying suboptimal habitat that may not reflect prehuman habitat preferences. Our research was inspired by the Māori (New Zealand indigenous culture) whakataukī (proverb), kia whakatōmuri te haere whakamua [I walked backwards into the future with my eyes fixed on my past]. We modelled and compared past, present, and potential future distributions of *Leiopelma* using species distribution models (SDMs). SDMs predict the likelihood of species occurrence at a given locality, combining environmental variables (e.g. precipitation/temperature), with presence and pseudo-absence data. Our research compared two sets of SDMs; 1) based off contemporary populations only, and 2) inclusion of subfossils, including recently extinct species. Comparison of SDMs allows us to demonstrate how the inclusion of subfossils can increase our understanding of environmentally suitable habitat. This improves the applicability of SDM's under different future climate change scenarios. Our methodology followed a limited number of studies incorporating fossil records to better predict future distributions. This research is a valuable resource to inform future translocations and strategic evidence-based conservation management of the remaining *Leiopelma* species.

A-0683 (Oral)
Segmentation: Using Geometric Morphometrics to Study Regionalisation in Elapid Snakes

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Utilising a method of shape analysis, 3D Geometric Morphometrics, the vertebral columns of snakes can be explored in much more detail than ever before. This thesis aims to expand on established data and further the study of regionalisation within the vertebral column of snakes. The study focuses on elapid snakes, a prominent family occurring in all continents save for Antarctica, and explores regionalisation within them and correlate their morphological forms to functional adaptations within their environment.

A-0685 (Oral)
Between Forest and Plantations: Movement and Habitat of Bushmasters (*Lachesis muta*) in the Brazilian Atlantic Forest

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Bushmasters (*Lachesis* spp.) are the largest pitvipers, inhabiting "primary" forest from Central to South America, a continuously declining habitat. In particular the populations of the South American Bushmaster (*Lachesis muta*) from the Atlantic Forest need to cope with remaining small and scattered forest patches within a mosaic of plantations, pastures, and suburban areas throughout their historic 2000 km range in northeastern Brazil. Burdened with a historic reputation of problems considering manual handling, captivity, and applying telemetric field methods, we were advised to take particular care with these pitvipers. Up to six individuals, native and translocated ones, were fitted with internal radio transmitters for one season to compare their home range, movements and habitat selection within forest fragments and modified rubber plantations at the Reserva Ecologica Michelin, Bahia, Brazil. The average home range HR was 9.47 ha (MCP 95%) and 44.11 (Kernel 95%) for Bushmasters tracked for > 6 mos. They usually moved within their HR of ca. 500–800 m max. extent, and often changed location between two consecutive tracking events of 2–3 days. Macrohabitats consisted of disturbed primary (partially logged) and secondary (originally cleared) forests, but also of rubber tree plantations with a dense understory vegetation, while microhabitats (*in situ* physical properties) primarily consisted of a complex vegetation structure. During the day Bushmasters were mostly found "resting" on the forest floor, whereas they were ambushing at night in a more open understory space close to a mammal trail. We found no lasting evidence of negative effects of individuals translocated by > 20 km from outside the study site, as all tracked pitvipers grew impressively, and continued an apparently normal life by establishing a home range like a native Bushmaster. Although the database is restricted considering study duration and individuals involved, the results show the feasibility of such a field study.

A-0686 (Oral)
Multi-Level Data Acquisition and Networking for Rapid Distribution Assessment of Vipers

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Accurate distribution data are important for a meaningful interpretation of a species' geographic limits and habitats, which are relevant constituents of their biology and conservation related threat assessments. With the last IUCN-threat assessments of West Asian vipers from 2008 (IUCN 2009) we realized that their portrayed distribution appears highly sketchy and unrealistic regarding basic biological principles' (e.g., postglacial expansion, carrying capacity), and rather reflect the lack of field data. To counter this hiatus of information, the author/colleagues begun to compile data of West Asia vipers (between eastern Mediterranean and the Caspian Sea) from all available sources, including > 15 expeditions since 2013–2023, interviewing locals, colleagues, evaluating literature and social media, and often contacting respective authors to obtain more precise distribution coordinates. Unpublished and imprecise localities, including social media and other online records, were categorized as "New", when author-provided coordinates revealed a locality being separated by at least 1 km from the nearest conspecific locality (multiple records within 1 km were combined). Published Records were categorized as "Refined" bearing more detailed information and occasional adjustments. We generated an Xcel-entry for each new record/group with: 1) a viper´s field ID, 2) locality name/designation (based on online maps), 3) coordinates, 4) elevation (based on Google Earth), 5) date, 6) source and name of person/mobile, 7) voucher ID/photo of animal or GE-landscape. While data sampling is

straight-forward, contacting/interviewing authors and organizing/maintaining a reliable database requires substantial efforts. However, this is greatly compensated by reducing time and costs needed for field teams/expeditions, particular in light of difficulties finding new locality records in the frequent unsuitable weather conditions today. Yet, our all-inclusive method has resulted in massive distribution gains from 400 to > 1,000%, new habitats and ´perplexing´ contact zones (parapatry without environmental demarcation/density blocking, transition zones) impacting threat assessments, taxonomy, and biological knowledge.

A-0687 (Oral)
At a Younger and More Vulnerable Stage - Climate Change Impact on the Embryonic Survival of Oviparous Reptiles

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Embryos of egg-laying reptiles develop within immobile eggs, which are directly exposed to nest temperature variation. Being at a relatively vulnerable life-history stage, how these embryos will be threatened by climate change are largely unknown. We collected embryonic developmental rate and success at various incubation temperatures from open datasets and the literature, and established embryonic development models for 43 reptile species. Using these models, we predicted climate change impact on the embryonic survival of oviparous reptiles on a global scale. We found significant phylogenetic signal in the embryonic development rate. Among all studied reptile families, embryos of Viperidae develop fastest, while embryos of Scincidae show the widest range of temperature tolerance. Under a warming scenario that assumes global mean temperature becomes 2°C above preindustrial level, the mean soil temperature at species' nesting depth will increases by -0.19°C to 3.53°C, while the warming magnitude increases with depth, absolute latitude and elevation. Embryos of Colubridae will experience the largest increase in nest temperature. As a result, under the warming scenario, egg-laying opportunity that allows successful embryonic development was predicted to decline at parts of distribution range for 18 species, while Trionychidae will loss egg-laying opportunity at the largest proportion (49%) of distribution range. It is noteworthy that, species of Colubridae cannot compensate the loss of egg-laying opportunity in over 50% of their distribution range even if females lay eggs at a 30% deeper depth. Our study highlights the inter-species variation in the embryonic vulnerability of oviparous reptiles to climate change.

A-0688 (Oral)
A Multi-Disciplinary Approach to Assessing the Conservation Status of Australian Sea Snakes

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Sea snakes are among the most unique yet poorly understood components of Australia's biological heritage. Many populations are susceptible to local extinctions and rely on coastal habitats that also support fisheries and industrial developments. The north-west coast of

Australia harbours five endemic species of sea snake, including two critically endangered species. Unexplained extinctions of these species on offshore reefs, and their subsequent re-discovery in coastal habitats, has highlighted the lack of scientific framework for understanding the role of protected areas in protecting and connecting sea snake populations. Furthermore, the impact of bottom trawling on sea snakes are unknown. Using a combination of acoustic telemetry and molecular analyses, we quantify movements of individuals between marine parks and unprotected habitats; generate critical data on their ecology and fine-scale habitat use; and assess the impact of commercial fishing on their behaviour and survival. Seventy sea snakes across three commonly trawled species were tagged and released in Exmouth Gulf, Western Australia for passive acoustic telemetry between July 2022 and October 2023 (expected battery life is one year), thirty of which were sourced from by-catch in local commercial trawl fisheries. A further eight individuals were continuously tracked for 9-18 hours. Results indicate two species are capable of greater movements than previously recorded, whereas one is highly philopatric. The same two species also spend most of their time either travelling in the water column or resting on the seafloor. Furthermore, one species prefers deep sandy bottom habitats used by bottom trawlers and spends most of their time travelling in the water column or resting on the seafloor, whereas the others prefer shallow reef habitats with more structure. Exposure to trawl fishing will therefore be greater for this species, and different species of sea snakes will require tailored management based on their habitat preference and dispersal abilities.

A-0689 (Oral)
Gods and Monsters: The Global Cultural Significance of Crocodylians

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Crocodylians – dangerous, awe-inspiring, terrifying – have long held high cultural significance to peoples worldwide, across diverse worldviews and knowledge systems. In many societies who have coexisted with crocodylians for millennia, crocodiles play prominent roles in belief systems, including sacred roles in fertility, the coming of rain and waters, connecting this life with the next, and in placing judgement. More broadly, crocodylians and their parts have contributed to foodways, healing systems, artistic expression, histories, folklore and religious practice. Historically, such beliefs and knowledges between people and crocodylians led to tolerant, or even reverent or fraternal, relationships. The fall from grace of many crocodylians species – from god to monster – has invariably been associated with colonialism, and as such the cultural role of crocodylians in European and European colonial societies. Using examples from the published literature, and collaborations with researchers working on crocodylians, we have collated representative examples of 5000 years of human-crocodile relationships – from the gharial seals of the ancient Indus Valley Civilisation, Cipactli of Aztec cosmology, the black caiman as the 'queen of the marshes' to indigenous peoples of French Guiana, and the saltwater crocodile as the 'spirit of the water' to indigenous Mentawaians on Siberut Island, to the crocodile as a contemporary popular figure in children's media, a classic 'creature feature' movie villain, or as a character in satirical news coverage. In this presentation, I will discuss the remarkably consistent patterns of cultural significance of crocodylians across pre- and post-

colonial societies, and consider the implications of these types of significance for conservation of crocodylians, the complex biocultural relationships of crocs and people, and the socio-ecological systems humans share with them. In particular, we will consider the applied contexts in which the cultural role of crocs is essential for ethical and appropriate conservation and conflict management.

A-0690 (Oral)
The Once and Future Gharial: Retrospective and Future Projections to Improve Headstarting Success in Nepal

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Headstarting is a commonly used conservation intervention for gharial, with at least fourteen programmes of rear-and-release used throughout their range in India and Nepal. The theoretical underpinning of headstarting is to rear small life stages in captivity, thus avoiding high predation mortality in the wild and improving rates of recruitment into the adult population. Despite the widespread use of the technique in gharial, there is limited evidence that headstarting contributes to population recovery. For evidence-based gharial conservation, it is necessary to improve understanding of the past and potential contribution of headstarting as a conservation tool. Our understanding of a population into which headstarts are released can be outlined by a model of that system, representing our current theoretical understanding to create predictions of past dynamics, which can be tested against historical population data. This retrospective model can then be used to develop predictive models on which to base management decisions. To investigate the use of models as part of an adaptive management approach to gharial conservation, we present a case study of the Chitwan population in Nepal. I will discuss work that uses management, population, mortality and behavioural data to parameterize two models. The first model retrospectively considers how past changes in the management programme have led to changing success in the headstarting programme in Chitwan. The second model predicts future scenarios under different potential management interventions, identifying changes that should lead to improved population recovery. Taken together, the models show that headstarting alone is insufficient for population recovery in gharial in Chitwan, but with improved post-release survival it can be an essential tool to restore the adult population to a self-sustaining level. Our models can be used as a key component of a future adaptive management approach, informing management decisions, and identifying areas of uncertainty as key research priorities.

A-0691 (Oral)
Toxic Toads on the Silk Road: Speciation and Historical Invasions in a "Most-Wanted" Amphibian

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Past and present animal translocations make compelling examples of the human impact on biodiversity. Through continental-wide genomic and DNA-barcoding analyses, we retraced the evolutionary history of the Asian black-spined toad (*Duttaphrynus melanostictus*), a poisonous, globally invasive amphibian that currently threatens several biodiversity hotspots. We discovered a convoluted diversification complexified by hybridization and consisting of two ~7 Myo lineages, one in the Indian subcontinent (invasive in Wallacea), the other in Southeast Asia, which represents a new species (invasive in Madagascar). Remarkably, the Indonesian population originates from India, suggesting historical human-assisted dispersal, perhaps via the maritime silk road, which corroborates archeological evidence for millennia-long anthropogenic connections across the Gulf of Bengal. Our study calls to re-assess D. melanostictus under a two-species framework in invasion research and conservation, emphasizes the inaccuracy of standard molecular methods for species discovery, and illustrates how these commensal toads potentially became worldwide invaders long before modern times.

A-0692 (Oral)
Management of Snakebite Without Available Antivenom: Experience from Thailand

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Snakebite envenoming poses a serious and significant public health problem worldwide. In 2017, the World Health Organization (WHO) categorized snakebite envenomation as Category A in Neglected Tropical Diseases. Snakebite envenomation often requires hospitalization and can lead to substantial morbidity and mortality. While the majority of snakebite victims reside in Africa, Asia, and South America, the true extent of the problem remains unclear. Antivenom serves as the specific antidote for snakebite envenoming. However, it is not universally produced and available for all types of snakebite envenoming. In such instances, patients may receive conservative treatment and aggressive supportive care. This topic explores the clinical data and management of snakebite envenomation caused by snake species for which antivenoms are not available in Thailand, such as *Ovophis monticola, Ovophis convictus, Protobothrops mucrosquamatus* and *Protobothrops kelomohy*. The experiences from Thailand will be presented and discussed further to guide proper management strategies.

A-0694 (Poster)
A Multi-Omics Approach to the Toxin Evolution of True Vipers

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True vipers, belonging to the subfamily Viperinae, constitute a clade of approximately 100 species of venomous snakes spread across the Old World. Despite their significant medical relevance, with certain species as the saw-scaled viper causing around 30,000 human deaths per year, research on this group has been mainly carried out from a proteomic approach. Genomic data is almost absent in this clade, being essential to identify orthologous genes and to untangle the contribution of gene content and regulation to venom evolution. In fact, only two reference genomes (although highly fragmented) have been publicly released for this group, leaving some of the most perilous genera, such as *Echis* or *Bitis*, devoid of any close high-quality genomic resources. Here, we combined long- (either PacBio HiFi or ONT) and short-read sequencing data (Illumina), coupled with linkage data (Hi-C or Omni-C) to assemble a total of six high-quality chromosome-level reference genomes for three Western European (*Vipera latastei, Vipera aspis* and *Vipera seoanei*), and three Arabian vipers (*Cerastes gasperettii, Echis omanensis* and *Echis carinatus*). We also annotated their genomes with a combination of extrinsic evidence (RNA-seq, Iso-seq and protein databases) and previously published reference genomes, placing special focus on the identification of venom toxins. We report the quality metrics for these highly contiguous chromosome-level reference genomes (minimum contig N50 of 35 Mbp, maximum of 75 Mbp). Our results show that the chromosomal architecture is highly conserved within the Viperinae subfamily. Finally, we also

focus on the evolution of the main toxin-encoding gene clusters for these species (i.e., SVMPs, SVSPs and PLA2), using both phylogenetic and microsynteny approaches.

A-0695 (Poster)
The Niche Partition of two Sympatric Homalopsid Snakes, *Hypsiscopus murphyi* and *Myrrophis chinensis*, in a Small and Enclosed Eco-Friendly Paddy Field with Dense Density in North Taiwan

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Two or more species that coexist in the same habitat may compete exclusively with each other if they have similar preferences and requirements. Water snakes tend to gather in large numbers in suitable wetlands. The current composition of snake species is just like a trace due to ecological competition and exclusion. A field study has been ongoing to investigate the ecological characteristics of two homalopsid snakes that coexist in a closed, eco-friendly paddy field in north Taiwan. The entire study area is 3,708.7 m^2, divided into 28 mosaic patches with varying sizes and uses, separated by ridges. We conducted the visual encounter survey (VES) twice a month from April 2019 to May 2023 to document the presence of water snakes. However, the modified funnel trap technique has been used instead since then. Three water snake species co-occur in these paddies: *Hypsiscopus murphyi, Myrrophis chinensis,* and *Trimeredytes percarinata*. The first two species are permanent residents living in dense conditions, primarily in paddy fields and a nearby pond. The Jaccard coefficient estimated the annual time-patch similarity between *H. murphyi* and *M. chinensis* as 0.043-0.077 (mean ± SD = 0.063 ± 0.015; n = 5). The former activity is from the end of April to October and sometimes extends to December in warmer years. The latter can be recorded for almost all years. The previous VES stage data was collected on crops, ground vegetation cover, water and mud depth, and water temperature at sites where snakes were found to study the coexistence of the two species. The initial active temperature threshold for *M. chinensis* is 13.7°C, while *for H. murphyi*, it is 18.3°C. The former exhibits better thermal adaptation to cooler temperatures than the latter. When the two coexist in the same habitat, their primary differences are based on temporal occurrence, thermal adaptation, and prey preferences.

A-0696 (Oral)
First Evidence of Food Calls in Reptiles: Vocalizations of a New Zealand Gecko is Associated with Food

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Food calls are sounds produced in the foraging context. Animals may use food calls to convey ecological information about food, such as food quality or quantity. Food calls typically have a social function; either advertising food findings to attract conspecifics, or negotiating food ownership with conspecifics. The use of food calls has been demonstrated in primates, bats, dolphins, whales, and birds, but has not been reported in reptiles before. Our focal species, the kōrero gecko (Woodworthia "Otago/Southland large") is an endemic and crevice-dwelling species in New Zealand. We observed the acoustic behavior in ten captive male-female pairs in the social foraging context. Each gecko pair lived in an independent space, and their partner was the only individual they interacted socially with on a day-to-day basis and during foraging.

We recorded vocal activity for 20 minutes in total, providing food after the first five minutes of recording. The number of calls was significantly higher after food was provided, and the call rate was highest during the 10–15 min period after some food had already been consumed and food items were less available. Geckos did not respond in the same way to a neutral stimulus, suggesting that calling behavior is triggered specifically by food provision. Our study provides the first evidence of food-associated calls in reptiles, and suggests that food calls could have a social function in the foraging context. The acoustic behavior of our focal gecko species may contribute to the understanding of social information, acoustic communication and their interplays in reptiles.

A-0697 (Oral)
Global Status and Threats to Rock Dependent Reptiles

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Rocky areas are ubiquitous across many biomes globally and provide critical habitat for a diverse range of plants and animals. One group commonly associated with rocky areas are reptiles, with many species adapted to exploit the unique structural and microclimatic characteristics of these areas. However, to what extent reptile species depend on rocky habitats remains poorly documented globally. Using International Union for Conservation of Nature habitat association data, we determined that 25.5% of terrestrial squamates are associated with, and 10.5% are completely dependent on, rock habitats. Of these species, 20.6% of rock associated, and 21.7% of rock dependent species, are classified as threatened. Notably, rock dependent species were 51% more likely to be Critically Endangered, compared to non-rock associated species. Additionally, both rock dependent and rock associated species had significantly smaller range sizes compared to non-rock dependent species, suggesting these species could be particularly vulnerable to the effects of habitat loss and degradation. Concerningly, despite rocky habitats being important for over a quarter of the world's squamate species, there is limited protection of these habitats globally.

A-0698 (Oral)
Host Specificity of Blood Parasites in Amphibians

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Understanding the host specificity of parasites is essential to elucidate the dynamics of parasite transmission and the factors influencing host-parasite interactions and disease outcomes. Such knowledge is crucial for threatened taxa such as amphibians, which have experienced a threefold increase in biodiversity loss over the last 40 years. In this study, we investigated for the first time the specificity of blood parasites among amphibian species in two geographically distinct regions: Spain and Poland. Our study involved the examination of over 1000 individuals of 24 amphibian species inhabiting the same pond environments. The results reveal a striking pattern of host specificity, with blood parasites mostly detected in water frogs of the genus *Pelophylax*. Blood parasites from the phylum Apicomplexa (e.g., the genera *Lankesterella* and *Dactylosoma*) as well as microfilariae and trypanosomatids, were found even in the same individual pointing out that tolerance mechanisms may play a role in this pattern. Interestingly, despite cohabiting in the same environment, *Pelophylax* frogs do not seem to share blood parasites with other amphibian species, suggesting a high level of specificity in parasite-host interactions. These findings shed light on the complex dynamics of blood parasite transmission in amphibian communities and highlight the importance of considering host specificity in understanding disease ecology and conservation strategies.

A-0699 (Oral)
Are *Speleomantes* Social Species? A Test with *S. italicus*

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The genus *Speleomantes* is the only representative of the family Plethodontidae in Europe and is composed of eight species which are endemic or sub-endemic to Italy. During the recent years, different aspects of this genus, such as trophic niche, reproduction, and habitat selection, have been the main subject of multiple studied. On the other hand, very little is known about the social behavior of these species. Two studies attempted to provide some information on their social behavior based on the distribution of different age classes. Although both identified some sort of separation between adults and juveniles, their interpretation of such distribution was antithetical. The first study suggested that the segregation between adults and juveniles was due to intraspecific competition, while the second stated that the two groups simply selected for different environmental conditions. By analyzing multiple subterranean populations of *Speleomantes italicus*, here we tested the support of the role of intraspecific interactions vs. niche segregation on the spatial segregation of these salamanders. We analyzed abundance data collected over a year using Structural Equation Modeling, a method allowing

to test the effect of each predicting variable included into the model, independently from their covariation. The model included both abiotic (i.e., microclimatic features) and biotic (i.e., predators and prey) predictors, while the abundance of males, females and juveniles *Speleomantes* were used as dependent variables. Our result showed that the abundance of each *Speleomantes* group was the main driver of the abundance of the others, with consistent positive relationships between life history stages. This suggests the occurrence of some sort of aggregative behavior, in contrast to what is known for some American plethodontid species. We hypothesize that the colonization of subterranean environments might be facilitated by the lack of antagonistic behavior and might promote positive interactions that remain to be properly understood.

A-0700 (Poster)
Habitat-Specific Allometric Trends Shaped Ecomorphological Evolution in *Pristurus* Geckos

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Island colonization often spurs phenotypic diversification, yet exceptions abound. We examined this phenomenon in *Pristurus* geckos across continental Arabia, Africa, and the Socotra Archipelago, analyzing phylogenetic and morphological data and estimating ancestral habitat occupancy. Overall, the degree of morphological diversification was similar between Socotran and continental taxa. Habitat specialization, and specifically the colonization of ground habitats, was found to have a primary role in morphological disparity and evolutionary rates in the genus. Furthermore, allometric trends significantly influenced the patterns of morphological differentiation. Analysis of phylomorphospace revealed an intriguing interplay between size and shape across habitats, with ground-dwelling and rock-dwelling species exhibiting opposite patterns due to differential allometric trajectories. These findings underscore the complexity of the relationship between ecological processes (e.g., habitat specialization) and morphological dynamics (e.g., allometric patterns and evolutionary rates) that results in the ecomorphological diversity observed across the tree of life.

A-0701 (Oral)
Phylogenomics of the *Gekko* group Based on Long Exon Data

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Sequence capture data were obtained for 217 loci and 675000 bp of long exons from 72 representatives of the genera *Gekko, Lepidodactylus, Luperosaurus*, and *Pseudogekko*, along with representative taxa from other gekkotan lineages. Sequences for eight of these species were generated from archival formalin-fixed museum specimens. Phylogenetic analyses were

performed using long exon data alone and combined with existing sequence sets to identify the relationships of these taxa. Our results support some novel relationships between known subgenera or lineages. *Japonigekko* is recovered as more closely related to the clade that includes parachuting geckos (*Ptychozoon*) than they are to the subgenus *Gekko*, previously thought to be their closest relatives. *Luperosaurus palawanensis* is recovered as yet another independently evolved lineage of "*Luperosaurus*". The phylogeny was used to reconstruct ancestral states of external and osteological morphological characteristics. Results of these analyses suggest that the common ancestor of the *Gekko* group had a generalized morphology, and traits associated with parachuting, including digital webbing, limb folds, lateral patagia, and osteological features, have evolved independently of one another.

A-0702 (Poster)
Evolutionary Relationships, Diversity, and Biogeography of Angolan Geckos

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We evaluated patterns of geographic distribution, divergence times, and biogeographic boundaries across genera of geckos in Angola. We hypothesized that lizards with more similar habitat requirements would show the most similar historical biogeographic patterns. The project uses both newly synthesized sequence data and preexisting sequence data from Genbank that covers all genera of Gekkonidae known to occur in Angola, including the diverse genera *Afroedura, Hemidactylus, Lygodactylus*, and *Pachydactylus* as well as the endemic genera *Bauerius* and *Kolekanos*. Phylogenies were used in combination with fossil calibrations to estimate times of divergence within each group. Results from the timing analysis were compared to see if Angolan geckos had common patterns of diversification, with the data suggesting that diversification patterns are lineage-specific and not generalizable across gekkonids. The Great Escarpment is the most significant geographic feature separating lowland lineages with affinities to taxa further south in Namibia from more northern species.

A-0703 (Oral)
Distribution of Snakes Along the Elevational Gradient of Eastern Himalaya

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Large scale biodiversity pattern especially of vertebrates have been driven by combined temperature and water availability while reptiles are largely driven by temperature alone. Considering the ectothermic nature, close relationship between temperature and reptile richness is obvious. To see if temperature is truly pervasive, numerous replicates along the diverse environmental gradients across the world can lead to better understanding of mechanism underlying the trend. Mountain region possesses high biodiversity than lowlands due to physical heterogeneity. Eastern Himalaya, representing a part of four global biodiversity hotspots, harbours exceptionally rich biodiversity much of which remains poorly explored. Among the two common patterns, snakes followed both patterns showing monotonic decline as well as unimodal patterns with low elevation peak. Snakes in Sikkim Himalaya, India showed maximum diversity at 500–1,000 m while it peaked at 1,000–1,500 m in Hengduan Mountain, China. Overall snake diversity in the Eastern Himalaya also peaked at 1,000–1,500 m elevation. Climatic variables might limit the distribution of snakes in the Himalayan elevation gradient. Potential evapotranspiration (PET) was the key driver of elevational

distribution of species in the Himalaya (Fern – Bhattarai et al., 20024; reptiles - Fu et al., 2006; Chettri et al., 2010; birds - Acharya et al., 2011; amphibians - Chettri and Acharya, 2020). The range size of snakes increased with increasing elevation thus supporting Rapoport's rule. Mean elevation range size showed significant relationship with temperature seasonality, mean annual temperature range, potential evapotranspiration along the elevation gradient. The elevational zones between 500–1,500 m in the Eastern Himalaya seems to be very important for snakes. However, this elevation zone are densely populated by humans and hence any conservation initiatives should be planned with the participation of local community.

A-0704 (Poster)
Shifts in Prioritization of Immune Components in Freshwater Turtles

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Organisms are resource-limited and allocation toward physiological processes may shift under different contexts, like reproductive investment and stress. One costly physiological process is maintaining and activating the immune response. Reptiles heavily rely on innate immune components such as leukocytes, the complement cascade, antimicrobial peptides, and natural antibodies. The costs of these innate immune components are likely not uniform due to differences in roles and composition, and it may be beneficial to prioritize specific components through within-immune system tradeoffs. We investigated the differential contribution of innate immune components in wild adult male and female Red-eared sliders (*Trachemys scripta elegans*) during the beginning of the nesting season in Arkansas, USA in 2022 and 2023. To assess the influence of an acute stressor on the immune response, we collected blood samples at three time points during a standardized stressor: at baseline, at the peak of the stress response (120 min), and during recovery (240 min). Plasma was subjected to three treatments to systematically remove immune components and used in microbial killing assays against Escherichia coli, a Gram-negative bacterium. Our findings suggest that complement and heat-labile natural antibodies are upregulated during the acute stress response. However, the duration of upregulation differs by sex. Females may be limited in resources during the height of the nesting season and cannot upregulate immune proteins for as long as males following a stressor. This work provides evidence of tradeoffs within the innate immune system and enhances understanding of immunity in reptiles.

A-0705 (Oral)
Phonotactic Responses by Native Frogs to Non-native Frogs

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An unexplored dimension of biological invasions is how invading and native species interact in novel soundscapes. In anuran assemblages invaded by invasive anurans, novel vocalizations

may result in attraction by heterospecifics if there are acoustic similarities to their conspecific signals. To understand this potential interaction, we conducted field experiments in playback arenas that focused on the acoustical overlap between calls of invasive American Bullfrogs (*Rana catesbeiana*) and native Chiricahua Leopard Frogs (*Rana chiricahuensis*). Results indicate female *R. chiricahuensis* exhibit positive movements towards *R. catesbeiana* playbacks more frequently than male *R. chiricahuensis*. However, this frequency of movement depends on other playbacks present, indicating attraction but not necessarily preference. On the other hand, regardless of sex, *R. catesbeiana* has strong positive movement towards *R. chiricahuensis* vocalizations.

A-0706 (Oral)
Heterospecific Oophagy of Anuran Eggs by American Bullfrog (*Rana catesbeiana*) Tadpoles

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There is much we do not know about vulnerability to predation for anuran eggs and how predation on anuran eggs may structure anuran communities. Predation by conspecific and heterospecific tadpoles may be one of the greatest threats to anuran egg survival. Tadpoles of introduced species like the American Bullfrog (*Rana catesbeiana*) could thus reshape anuran communities through this predator-prey interaction. Though there are historical records of heterospecific oophagy of anuran eggs by American Bullfrog tadpoles, it remains unclear what this behavior's extent is and whether it may be a threat to native anurans in the introduced range of American Bullfrogs. To further understand this threat's potential and gain insight into implications for conservation, we sought to determine if American Bullfrog tadpoles in later development stages consume more heterospecific anuran eggs than American Bullfrog tadpoles of earlier developmental stages. We also assessed whether there are differences in predatory pressure exerted by American Bullfrog tadpoles on heterospecific anuran eggs between different anuran species and taxonomic groups. We conducted experimental trials in which R. catesbeiana tadpoles were exposed to 10 heterospecific anuran eggs. For each heterospecific anuran in the experiment, we included two treatments of predatory tadpole development (tadpoles of Gosner stages 28-32 and tadpoles of Gosner stages 33-37) and replicated these treatments 10 times. Our preliminary results indicate development is a key factor for American Bullfrog tadpoles to consume heterospecific anuran eggs. In addition, some anuran eggs are not threatened by predatory bullfrog tadpoles, but Ranid eggs are frequently consumed.

A-0707 (Poster)
Spread like Weeds: Global Trends of Red-eared Sliders (*Trachemys scripta elegans*)

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In a world of globalization, the socially constructed lines of division between natural ecosystems are constantly shifting. Hybrid zones are critical study systems to address these issues, as these novel interactions can negatively impact native species. Red-eared sliders (*Trachemys scripta elegans*) are a readily growing species, having expanded their native range of the southern United States and northern Mexico to every continent except Antarctica. They are famed as one of the world's top 100 worst invaders. Overexploitation and misinformation in the pet trade are the primary leaders in their introductions to new ranges. I have conducted a literature review to investigate the breadth of red eared slider invasion. In this review, I assemble evidence of the drivers and impacts of their invasions across the globe. Preliminary results suggest that hybrids can be produced across multiple genera, but their impact is consistently seen in resource and habitat competition at all life stages. My talk will describe the current span of research and identify gaps for regions and topics in need of more investigation. I will follow with future research goals that have sparked from this investigation. With an understanding of the impact and establishment of these red eared sliders, proper management of invading populations can mitigate the potential for native population decline and genetic pollution.

A-0708 (Oral)
Ten Years of Frog Monitoring in a Bornean Rainforest: What have we Learnt?

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Monitoring is an essential component of all biodiversity conservation programs, yet it is rarely implemented effectively. When awareness of global amphibian declines emerged in the late 1980's and 1990's, the absence of robust population monitoring for nearly all species was a significant impediment to detecting and evaluating the significance of declines, which in turn delayed mobilisation of responses and resources by the scientific and conservation communities. Throughout Southeast Asia amphibians, like other organisms, are subject to extensive habitat loss and a host of other threats. However, with few exceptions, most research on amphibian biodiversity in this regional is still foundational - focussed upon systematics. Amphibian monitoring programs are few in the region and their effectiveness for evaluation, reporting and management purposes is uncertain. After conducting extensive amphibian baseline surveys between 2008 and 2012 in the Lower Kinabatangan Wildlife Sanctuary, Sabah, Borneo, we established a frog monitoring program to track changes in species and assemblage composition as part of on-going conservation and management programs in the reserve. Nineteen 400m transects have been surveyed in lowland forest most years since 2015, acquiring data on 40 frog taxa. We report on the findings of this program, evaluate its effectiveness for trend detection, and identify insights for optimization.

A-0709 (Oral)
Genomic Data Reveal Multiple Drivers of Diversification in Southeast Asian Mud Snakes

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Advances in molecular methods have led to phylogenomic efforts at broad and narrow scales, especially to study broader evolutionary dynamics. In Southeast Asia, fluctuating sea-levels and historical, cyclic connection and separation of landmasses are known to have generated diverse groups. However, recent research has shown that geological shifts of the mainland, dispersal events, and environmental influences may be better explanations of biodiversity drivers for some faunal groups in this region. We investigate these processes using the poorly-studied and geographically widespread Mud Snakes (Serpentes: Homalopsidae) using genomic data from fresh tissues and mitochondrial data from formalin tissues from museum specimens. Our phylogeny identifies their biogeographic origins, and we test hypotheses regarding the roles of sea-level change and habitat selection on diversification. Divergence dating and ancestral range estimation supports an Oligocene origin and diversification from mainland Southeast Asia and Sundaland in the rear-fanged group ~20 million years ago, followed by eastward and westward dispersal. GeoHiSSE models indicate that niche expansion of ancestral rear-fanged lineages into aquatic environments did not impact their diversification rates, but niche model and quantification analyses suggest both geological and environmental drivers of diversification in more recent lineages, like *Hypsiscopus* (rice paddy snakes). Our results highlight that Pleistocene sea-level changes and habitat specificity did not primarily lead to the extant species richness of Homalopsidae. Alternatively, geological shifts in paleorivers in mainland Southeast Asia, tectonic uplift events in Thailand, the formation of islands, and environmental niche shifts acted as a mosaic of diversity drivers over the course of homalopsid evolution. We emphasize the importance of using fresh and degraded tissues, and both nuclear and mitochondrial DNA, for filling in knowledge gaps in poorly known, but highly diverse and conceptually important groups, constituting a non-traditional model study system for understanding transitions between terrestrial, marine, and freshwater environments.

A-0710 (Poster)

Precocious Maturation and Semi-Multivoltine Lifecycle in a Subtropical Grass Lizard, *Takydromus toyamai*

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There are many short-lived animals, but a lifecycle with more than one generation per year (multivoltine lifecycle) is rare in terrestrial vertebrates. The multivoltine lifecycle requires rapid growth and maturation, and a long active season. Thus, small lizards in humid tropical or subtropical areas are candidates for multivoltine lifecycles. To test this prediction, we conducted a capture-mark-recapture study of a subtropical grass lizard, *Takydromus toyamai*, endemic to Miyako Islands, Japan. Juveniles grew very quickly, averaging 0.3 mm/day in the warm season, and attained sexual maturity at 2.5 months post-hatching. The breeding season was very long, and hatchlings emerged from May–November. The prolonged breeding season and rapid growth to maturity allowed some individuals to produce a second generation within a year. Estimates of hatching date from growth rates indicated that many females that hatched in May–June became gravid 76–120 days after hatching and 122–165 days after oviposition of the eggs from which they hatched. Analyses of juvenile survivorship and month of hatching suggest that nearly half of breeding adults were members of multivoltine generations, although the two generations were not discrete. The species is short-lived, with only 16% of individuals surviving beyond 12 months, and few individuals reproduced in a second year. We refer to this

condition as a "semi-multivoltine lifecycle." Comparison with congeneric species suggests that the long warm season on Miyako Island facilitates rapid growth and an extended breeding season, permitting this lifecycle. Adult mortality is especially high in the breeding season and the first generations seldom survived until the next spring. Individuals that hatch late in the season defer reproduction until the following year, and their lower mortality rate allows them to become founders of the next season's cohort. This putative advantage of late-hatching individuals may have driven the evolution of the semi-multivoltine lifecycle.

A-0711 (Poster)
Analyses on the Origin and Distribution Modelling of the Invasive Mourning Gecko (*Lepidodactylus lugubris*) in Taiwan

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With the rapid development of global trade, the spread of invasive species has been recognized as a significant threat to biodiversity, particularly in island ecosystems. In order to effectively mitigate the invasion of alien species, it is crucial to study the phylogeography of these species, recognizing their origin and invasion pathways. Species distribution modelling (SDM) can also monitor the ecological niche of invasive species in newly colonized areas and predict potential invasion ranges. Recent studies have confirmed the widespread dispersion of geckos through human transportation activities. With the advantages of parthenogenesis, *Lepidodactylus lugubris* has become one of the most successful species, with a distribution extending from the Pacific Ocean to Southeast Asia and the Indian Ocean. In recent years, it has even been recorded in South America and the Caribbean. Nevertheless, there is currently a lack of research on *L. lugubris* in Taiwan. Therefore, in the first part of this study involved analysis of the genetic structure of the Taiwanese population using mitochondrial gene (ND2) sequences. We integrated sequences from previous international studies and the geographic locations of sampling sites to reconstruct the phylogenetic tree and evaluate the possible origin of the Taiwanese population through the haplotype network. The analysis revealed two closely related haplotypes in the Taiwanese population. However, due to the closest haplotype being shared across multiple regions, its origin could not be accurately determined. In the second part, we employed species distribution modelling to compare the differences between the native and invasive habitats of *L. lugubris*, analyzing whether there were any expansions or shifts in the ecological niche. The results indicated that no significant differences or changes were observed. Finally, we used distribution modelling to assess the potential habitat of *L. lugubris* in Taiwan, aiming to monitor whether the invasion range will expand in the future.

A-0712 (Oral)
Podcast Engagement Reflects a Vibrant Herpetological Community

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We have been producing a herpetological podcast for six years, highlighting and translating scientific papers for a broad audience. While we started with the intention of making scientific research accessible and providing information for our listeners, we have found it to be a two-

way exchange of knowledge. We have a vibrant and engaged community of listeners who share their experiences with us, demonstrating that support for herpetofauna is out there if you can find it. During this mini live podcast, we will share some of the stories that our community has told us, and hopefully demonstrate that if you reach out and you are present, you are not alone in changing perceptions – you can find many people with similar intentions and interests.

A-0714 (Oral)
How Do We Know What We Know About Where Snakes Go?

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Possibly the best way to determine a snake's needs is to follow their movements. Once we have learnt of the snake's movements we can infer habitat requirements, behaviour, and potential threats. Combined, the movement data and inferences can inform decisions on snake conservation and human snake conflict. However, extracting useful information from snake movement requires many steps, from sampling to analysis. Other studies have shown that a single dataset can result in many different answers in the hands of different researchers, so how can we be confident the results from snake movement are leading to the correct decisions in snake conservation? We used a multiverse approach to explore thousands of ways of extracting the habitat preference estimates from the movement of simulated snakes with a pre-defined preference. We found that despite different sampling approaches, and completely different analysis methods, the vast majority of results agree and correctly identify habitat preference. The agreement between different habitat preference estimates tended to be better with more data, and when using more modern analysis methods. Now we apply this multiverse of analyses to re-examine several previous studies of snake habitat preference from Thailand. We examine how the published results compare to the thousands of other ways a researcher could have examined the snake movement data. Would certain analysis choices have led to a different conclusion and therefore a different conservation recommendation? We hope the answers to these questions will inform how confident we can be in the findings from snake movement studies and direct us towards more robust studies in the future.

A-0715 (Oral)
Taste Aversion Training Buffers the Impact of Toxic Invaders on Monitors and Crocodiles

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Can we train wild reptiles not to eat toxic invasive species? Aversion training is well suited to conservation challenges because behavioural changes are fast, strategies can be readily adapted to different scenarios, and methods can be more ethical than traditional alternatives (e.g. culling). In tropical Australia, invasive cane toads (*Rhinella marina*) fatally poison many frog-eating predators. We've trialled taste aversion training with large monitor lizards and freshwater crocodiles by exposing populations to small doses of cane toad toxin or unpalatable cane toad baits prior to meeting the cane toad invasion. We present results for multi-year, landscape level studies on both predator groups (with disparate ecology). We deployed > 200,000 eggs, tadpoles or metamorph toads into home ranges of large monitor lizards, eliciting aversions to cane toads and buffering the short-term invasion impact on populations by 30–

100%. We deployed > 2,300 custom taste aversion baits around dry season crocodile refuges, eliciting aversion to cane toads and either halting or completely preventing the mass mortality events that are common for crocodiles once cane toads arrive. We show that taste aversion learning is possible in large reptilian predators, and can be deployed as a landscape conservation strategy, targeting populations ahead of invasions of toxic prey. We discuss the nuances of this technique, considerations for management plans, and exciting avenues of future research.

A-0717 (Oral)
1 Million Turtles: A Community Conservation Program Helping to Protect Freshwater Turtles in Australia

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1 Million Turtles is a conservation initiative that provides a mechanism for community members and citizen scientists to develop and lead their own approaches for conservation of endangered species. The problem addressed is that government-led conservation initiatives are inadequate due to funding constraints and/or initiative, and communities see the loss of native species in their regions as failure to act. With a community that is eager to help, but often lacks specific knowledge, expertise support from researchers is essential to ensure that their activities and resources are applied effectively. The program provides training and resources for all ages and skill levels. Citizens can be involved in conducting standardised nest predation surveys, actively protect turtle nests, reporting turtle and nest sightings through the TurtleSat app anywhere in Australia, helping turtles to cross roads, and promote turtle art activities. It also offers lesson plans and school activities for Year 5- students, aligned with Australian state curricula, and a variety of other turtle-related activities. With a thriving community of over 5,000 engaged turtle champions across Australia, who have saved over 1,500 turtles from car strikes, and protected over 860 turtle nests from invasive predators since 1 January 2023, the project's success is recognised nationally, winning the 2023 Eureka Prize for Innovation in Citizen Science. Data recorded by citizens in TurtleSat has helped researchers to map hotspots for nesting sites and dangerous road crossings, identifying potential priority areas for conservation and management actions, as well as provided data for the Australian list of threatened species. The challenges we have faced, will be discussed in our presentation, including IT support, how to keep citizens engaged, and how to measure behavioural change and impact.

A-0718 (Poster)
Can we Simplify ENZO's Affinity for Two Viper Dynamics in the Secondary Forest of Northeast Taiwan using Present and Absent Data?

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The El Niño-Southern Oscillation (ENSO) is a widely recognized driver of global climate variability that significantly impacts the surrounding ecosystem of the Pacific Rim. Unusual sea temperature fluctuations during specific periods in the East Pacific can cause heat waves, droughts, floods, and tropical storms, significantly affecting the great extent region. However,

determining the ENSO impacts on species or ecosystem level is a long-term ecological monitoring process. In addition, previous literature suggests a correlation between the El Niño of ENSO event and venomous snake bites in humans, which is probably attributed to the activity of ectotherms driven by higher temperatures. A weekly long-term snake ecological monitoring has been conducted since June 2010 in a 650-meter forest trail at the Dajioushi-Yenwen Experimental Forest of National Ilan University. The visual encounter survey (VES) was conducted every Tuesday night from ca. 20:00–23:00 h along the study trail. We classified each sampling occasion of ENSO type into three phases based on the Oceanic Niño Index (ONI): regular, La Niña, and El Niño. On each survey, two nocturnal medically significant vipers of Taiwan, *Trimeresurus stejnegeri* and *Protobothrops mucrosquamatus*, were counted and compared. Regular study occasions accounted for 41.05% (n = 296) of the total, while La Niña and El Niño accounted for 36.75% (n = 265) and 22.2% (n = 160), respectively. From June 2010 to March 2024, *Trimeresurus stejnegeri* was present in 61.44% of all recorded occasions, whereas in only 11.79% of the cases involving *P. mucrosquamatus*. The former species is positively associated with La Niña, whereas the latter demonstrates the opposite tendency. During the La Niña phase in northeast Taiwan, forest-dweller viper *T. stejnegeri* would benefit from increased frog prey supplements and reduced predation pressure from *Bungarus multicinctus* and *Lycodon rufozonatus* due to cooler temperatures and higher humidity when drought and hot weather cause non-typical habitat exploitation *P. mucrosquamatus* shows up.

A-0719 (Oral)

A Small Frog in Big Trouble: Population Size and Possible Extirpation of the Endangered Malagasy Poison Frog *Mantella cowanii*

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Madagascar is home to 400+ endemic frog species. Alarmingly, over 46% of the island's frog species assessed by the IUCN Red List are at risk of extinction. Assessed as Endangered, *Mantella cowanii* occurs in only four isolated areas of the central highlands. To address the threats facing *M. cowanii*, a national conservation strategy was recently enacted for the species. Here, we present collaborative work to fill the research needs in the conservation strategy. Working with local communities, we established the geographic distribution, population trends, and demographic traits of populations. Using photographic capture-recapture and occupancy modeling, we show several historic localities may be extirpated and the remaining

populations consist of precariously few adult frogs. Habitat destruction and illegal collection for the international pet trade are ongoing threats. Results are being used to reassess the IUCN Red List status of *M. cowanii* and inform conservation efforts.

A-0720 (Poster)
Slow and Steady Decline: Revealing Demographic Patterns in Two Isolated Ornate Box Turtle (*Terrapene ornata*) Populations

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Turtle life history is characterized by delayed sexual maturity and a long lifespan, making populations susceptible to decline following perturbations. Indeed, over half of the world's turtles and tortoises are assessed as threatened with extinction by the IUCN Red List. Despite the need, we lack crucial demographic data for many species and most populations. We are studying two isolated Ornate Box Turtle (*Terrapene ornata*) populations in Illinois to estimate annual survival, fecundity, and population sizes. Using over three decades of capture-mark-recapture data and stage-based matrix modeling, we found both populations are declining under mean estimated vital rates. Sensitivity analyses showed adult survival has the greatest impact on population growth and fecundity the least. Our results highlight the importance of long-term monitoring for informing turtle conservation.

A-0721 (Oral)
Developing Metrics for Evaluating the Welfare of Snakes, A Progressive Approach

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Evidence-based husbandry and standardized welfare metrics are underprovided for reptiles and amphibians maintained in captivity, thwarting zoologists, researchers and other animal care professionals from adequately assessing and improving animal care. This deficit is likely due to failure to recognize or the misinterpretation of behaviors, and the common perception that reptiles are highly adaptable to artificial captive environments. Often housed in large numbers by hobbyists, zoological parks and academic institutions, snakes represent an ideal model group to investigate the impacts of artificial environmental factors on behavior and physiology. Providing the appropriate environment to captive snakes is an important aspect of maintaining these species, especially when research or conservation-breeding outcomes are desired. This presentation will review some previous and ongoing studies that illuminate the importance of developing evidence-based metrics to evaluate ophidian care and welfare with the goal of standardizing methods for broad use within the herpetological community. A preliminary study using ethograms and fecal glucocorticoid (FGM) concentrations showed that changing the substrate in Wagner's viper (*Montivipera wagneri*) enclosures resulted in increased glucocorticoid metabolite concentrations, but did not result in increased behaviors associated with arousal (tongue flick, exposure, locomotion) when the frequency of substrate changes

were increased. A current study is evaluating the survival, growth, blood chemistry parameters and behavior of juvenile False water cobras (*Hydrodynastes gigas*) under different offerings of infrared light for thermoregulation. Preliminary results show significant differences in behavior between treatments. These studies, in addition to an expanding body published literature on snake welfare, have begun to unravel the impacts of the environmental conditions provided to captive snakes. As common study subjects, providing care that aligns with the biology of a species and maximizes welfare should be prioritized to ensure accurate and impactful results.

A-0723 (Oral)
Global Patterns of Climate Change Impacts on Desert Lizard Communities

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Desert fauna are threatened by ongoing climate change as they live close to their physiological limits. Interspecific variation in functional traits hinders the species-specific vulnerability assessment at a global scale. Taking advantage of comprehensive trait databases and phylogenetic trees published in recent years, we established a complete set of parameter dataset for building biophysical models for 235 desert lizards. We then predicted climate change impacts on desert lizards globally using models parameterised with species-specific data. Our analysis revealed significant variations in thermal tolerances and field body temperature between taxonomy groups and desert realms. Among all studied desert lizards, species in Sphaerodactylidae family and Neotropical desert realm were predicted to be threatened most by climate change. Heterogeneity also exists within desert realms in terms of climate change impacts. Desert lizards with lower critical thermal maximum and field body temperature were predicted to suffer greater climate change impact due to a greater loss of activity time. Our study highlights the importance of considering interspecific variation in functional traits when evaluating species vulnerability under climate change.

A-0724 (Oral)
Updating the Japanese Distribution of *Batrachochytrium salamandrivorans* from a Massive Screening from Wild and Captive Collections in Japan

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The chytrid fungus *Batrachochytrium salamandrivorans* [Bsal] is causing declines in the amphibian populations. After a decade of mapping the pathogen in Europe, where it is causing dramatic outbreaks, and North America, where its arrival would affect to the salamander's biodiversity hotspot, little is known about its current status in Asia, from presumably is native. Japan has several species considered as potential carriers, but no regulation is implemented against Bsal spreading. Previous Bsal known presence detected high incidence on the Okinawa Island, southwestern Japan. There, other studies on its sister species, *B. dendrobatidis* presented a high genomic variation in this area and particularly on *Cynops ensicauda*. Here, we present the results of a large monitoring of more than 1300 samples in Japan, focusing on Okinawa Island and updating its distribution and providing more information to unravel the still unknown origin of Bsal. Interestingly, we provide revealing facts about different detectability depending on the used molecular techniques and changes in its Japanese distribution. We detected Bsal in 13 samples in nature, 10 of them are from different localities. Bd was detected in 32 samples. One locality showed 55% of prevalence. We also confirmed the presence of Bsal in 4 captive collections in Japan. Furthermore, 2 individuals were positive for both chytrids. Here, we have shown how under the current legal framework *Batrachochytrium salamandrivorans* is moving within the Japanese pet trade. Ongoing conditions where imported and native amphibians were Bsal positive, could lead into a strain recombination with undesirable effects for the amphibian conservation. All in all, the current knowledge of Bd together with the Bsal presence in Japan and its low variability, plus the apparent lack of mortalities, may indicate that this part of Asia has a high diversity of chytrids.

A-0725 (Oral)
Stopping Skinks: Evaluating Fencing Options for Invasive Reptile Control

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Preventing the spread of small cryptic invasive species presents significant challenges for conservationists. The Australian skink *Lampropholis delicata* was accidentally introduced to New Zealand in the 1960s and rapidly spread, becoming highly abundant in some areas. While the impact of the species on New Zealand's ecosystems is not fully understood, limiting the spread of the species will almost certainly benefit the native ecosystems. Fencing has widely been used to exclude invasive species around the world. However, most of New Zealand's existing fencing was designed to exclude mammals and cannot limit the spread of species as small as *L. delicata*. This study tested the effectiveness of materials that could be used in the field or other sensitive sites to exclude the species. We conducted captive experiments to test four feasible fencing materials: spun polypropylene fabric, woven polypropylene, polythene sheet, and acrylic sheet. Skinks (n = 27 adults) were placed individually into an empty 30 cm high plastic box with one side consisting of the test material. Skinks successfully climbed the spun polypropylene fabric in 60% of the trials and the woven polypropylene in 38% of the trials. Of the four materials, only the polythene and acrylic proved 100% effective at preventing

skinks from escaping. We also tested the effect of moisture or heavy wear of polythene and acrylic on the skinks' climbing ability. Both materials were effective when in worn condition; however, when wet, skinks escaped in 5% of trials for both materials. While polythene and acrylic are promising as exclusion materials, further investigation is needed to ensure 100% success under all conditions for limiting the spread of *L. delicata* into sensitive areas.

A-0726 (Oral)

Smarter Lizards in the City? Urban and Non-urban Syntopic Species Perform Similarly in a Cognitive Task

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Urbanization occurs at a global scale, imposing dramatic and abrupt changes in the environment that lead to biodiversity loss. Yet, some species can handle these changes, and thrive in this artificial environment. One possible explanation is that urban individuals are equipped with better cognitive abilities, but most studies focus on birds and mammals and yield varied results. Reptiles have received much less attention despite some lizard species being common city dwellers. *Podarcis siculus* and *P. muralis* are two of the most successful lizards in anthropogenic habitats, being able to thrive in urban locations and also become invasive. We investigated lizards' inhibitory control through a detour task in 249 wild lizards across their native range, in syntopic populations living in urban and semi-natural habitats. Inhibitory control is a general cognitive domain and one of the basic processes that are essential for behavioural flexibility and higher-level cognitive skills. In this task, we confronted lizards with a transparent barrier, separating them from a desired shelter with a heat source which they could only reach by controlling their impulse of going straight and instead detour the barrier. Contrary to expectations, we found no differences between lizards from urban and semi-natural habitats, nor between species, but we found females overall to perform more correct trials. This study is among the first addressing lizard cognition in cities and challenges the assumption that urban animals have enhanced cognition, highlighting the need for further research across diverse taxa and environmental contexts.

A-0727 (Oral)

Towards the Conservation of the Threatened Tandilean Lizard of the Pampas Highland Grassland: First Steps of Habitat Restoration

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The Tandilean Lizard (*Liolaemus tandiliensis*) is an endemic and threatened species inhabiting the Tandilia Mountains within the Argentinean Pampas. This lizard lives in highland grasslands

associated with rocky outcrops, and its habitat has undergone significant fragmentation due to several threats such as unplanned urbanization, agriculture, quarry expansion, and invasive exotic plants. Spanish Broom (*Spartium junceum*) is an invasive woody species introduced in Argentina for ornamental purposes. This plant covers the rocks and competes with native grasslands, reducing the available microhabitat for the Tandilean Lizard. To secure the long-term viability of this species, we started a project aiming to enhance its habitat through restoration efforts in Sierra del Tigre Natural Reserve (Tandil, Buenos Aires, Argentina). This reserve spans 120 ha, with Spanish Broom covering 11% of its area. Our initial objective is to restore a patch of 2.4 ha of habitat by removing Spanish Broom during one year (i.e., 18.6%). Employing GIS mapping and field surveys, including transects and aerial drone photography, we identified areas for habitat restoration. Field trials involving four individuals over eight hours during two days were conducted to gauge the time required to reach our objective. We used chainsaws and the herbicide, Tocon, to remove the invasive exotic plant. With this work plan, we were only able to remove 0.063 ha (3.15%) of our goal. Therefore, 37 days will be necessary to complete our goal. The removal activity of exotic plants includes clearing the area of debris, which added more work time. These results suggest increasing the number of people involved in the removal activity for upcoming campaigns to reduce the time required to accomplish the objective. By executing these strategic interventions, we aim to mitigate the adverse impacts of habitat fragmentation and degradation, ultimately fostering the conservation of the Tandilean Lizard and its associated ecosystem.

A-0728 (Oral)

Genome-scale Chytrid Data without Culturing: Using Sequence Capture to Genotype Fastidious Strains

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The chytrid fungus *Batrachochytrium dendrobatidis* (Bd) was discovered in 1998 as the cause of the amphibian disease chytridiomycosis. Since then multiple genetically distinct and regional lineages of Bd have been sequenced, but to date, most Bd research has been restricted to the limited number of samples that could be isolated using culturing techniques. This causes a selection bias for strains that can grow on media and may miss other unculturable or fastidious strains that are also present on amphibians. We used sequence capture technology on DNA extracted directly from host samples to characterize these uncultured Bd lineages. We successfully enriched for and sequenced thousands of fungal genes from multiple hosts, providing data for both strain identification, phylogenetic reconstruction and crucial new information on the spatiotemporal and evolutionary history of Bd. We also discuss the application of this technique to samples of the related pathogen, *Batrachochytrium*

salamandrivorans (Bsal), which to date has only been sequenced in its invasive range in Europe. Sequence information from its presumed native range in Asia are crucial to understanding the invasion route and evolutionary history and genetic diversity of this pathogen. Our work demonstrates the power of sequence capture to uncover cryptic pathogen diversity, offering new insights into the complex dynamics of these emerging amphibian diseases.

A-0729 (Oral)
Reviewing 20 Years of Herpetofauna Mitigation Translocations in Aotearoa New Zealand

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New Zealand's speciose lizard fauna uses diverse habitats in a wide range of terrestrial environments, and several species are frequently impacted by land development. The most common approach for mitigating development impacts upon the taxa is translocation, despite a concerning lack of evidence for current mitigation translocation practices achieving no net loss of populations. However, whether lizards are managed during development is variable, depending on planning rules and what herpetological knowledge is available in different regions of the country. We reviewed trends in translocation permits (Wildlife Act Authorities) issued for the purpose of lizard and frog mitigation in New Zealand to examine variation over time, administrative boundaries, and development activity types. We compared issuing rates of translocation permits required for residential development with residential building permits for the 66 districts of New Zealand, and examined planning regulations that might account for this variation. We found a dramatic increase in permits issued for mitigation translocation over the last 10 years across many but not all administrative areas. Notably, in 5 of the 16 regions, and 26 of the 66 districts, no mitigation translocations had taken place despite many of these areas having similar lizard distributions and rates of development to those where mitigation translocations occurred. Indeed, the 15 districts that made up 100% of the mitigations due to residential development accounted for only 50% of the number of residential building permits issued nationally. We recommend that upcoming reform of wildlife protection legislation considers the practicalities of enforcing wildlife protection during land development through improved integration with resource management legislation. In the meantime, changes to practice such as increasing awareness of the protected status of lizards and frogs among developers and those who advise them, and requiring more comprehensive impact assessments during consent applications may increase consideration of this often-overlooked taxonomic group.

A-0730 (Oral)
Shifting Shades: Assessing Lizard Camouflage in Post-Fire Landscapes

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Significant alterations to interspecific interactions can pose a threat to the viability of reptile populations post-fire. Vulnerability to predation in particular is heightened post-fire; with a loss of vegetation and a reduction in viable refuge availability, prey species are left more exposed. Predation risk may also be heightened by the drastic alteration in the visual environment of a burnt landscape. Colour plays an important role for reptiles, with a complex interplay between communication, thermoregulation and camouflage, and the occurrence of fire may change this balance. Here, we aimed to assess the visual conspicuousness of lizards in a post-fire environment, providing greater depth to our understanding of post-fire predation vulnerability. To do this we photographed lizards in burnt and unburnt habitat in a fire-prone region of southern Australia, focussing on the common species, Morethia obscura. We did find significant changes in lizard colouration, with individuals exhibiting significantly higher chroma and luminance in burnt habitat. This shift may be driven by an interplay between heightened predation pressure, and greater thermal stress in burnt habitat.

A-0731 (Oral)

Exploring Genetic Evidence for Post-Epidemic Recovery and Selection at Major Histocompatibility Complex in Fleay's Barred Frog (*Mixophyes fleayi*)

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The amphibian skin disease chytridiomycosis, caused by the fungal pathogen *Batrachochytrium dendrobatidis* (Bd), has been a driver of unprecedented amphibian extinctions and mass mortalities around the world. Many affected species continue to decline after initial epidemics, but the endangered Fleay's barred frog (*Mixophyes fleayi*) has demonstrated strong resurgence in a few localities despite persistence of Bd in the environment. Long-term infection monitoring data at these *M. fleayi* sites show reduced susceptibility to Bd, suggesting that pathogen-mediated evolution of the amphibian immune response may be contributing to recoveries. However, potential mechanisms behind such adaptations – and the extent to which these recoveries are occurring across the *M. fleayi* range – have not been evaluated. Here, we conducted an extensive range-wide population genetic investigation of *M. fleayi* to (1) infer recent demographic trends (i.e., Bd-associated bottlenecks, subsequent recoveries) across dozens of poorly studied *M. fleayi* populations and (2) identify signals of selection acting upon the antigen binding pocket of Major Histocompatibility Complex 2β (MHC2β), an immune locus implicated across many amphibian species in the evolutionary response to Bd. Using genome-wide RADSeq data, we detected strong signals of Bd-associated genetic bottleneck and moderate signals of recent recovery or stabilisation occurring in most (but not all) *M. fleayi* populations. Using amplicon sequencing of all four MHC2β gene copies across hundreds of *M. fleayi* individuals, we identified 43 unique translated alleles of exon two,

with most polymorphism (and potential for evolutionary response) occurring in the first gene copy. Beyond merely informing conservation of *M. fleayi*, understanding the true extent and potential mechanisms of these post-epidemic recoveries can provide insight into management strategies for other species which are still threatened by Bd.

A-0733 (Oral)
Amphibian Chytrid and Ranavirus: Partners in Crime or Chaotic Co-stars?

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Despite the increasing pathogen-driven biodiversity loss, coinfection dynamics remain understudied in disease ecology. Overlapping both within hosts and geographically, chytrid fungus (*Batrachochytrium dendrobatidis*, Bd) and ranaviruses (Rv) have impacted amphibian populations globally. Over a decade of research on the co-occurrence of these pathogens in Iberia has uncovered some patterns and prompted new questions, reflecting evolving perspectives on this complex topic. While initial studies suggested that infection by one pathogen could enhance the susceptibility of the host to the other, field observations increasingly challenge assumptions about synergistic effects. Co-infections are rare except in highly susceptible life stages, with single infections of either Bd or Rv more prevalent. This pattern is likely influenced by host specificity, where the presence of one pathogen does not reliably predict the occurrence of the other. Bd impacts are concentrated at high altitudes and among specific host species, whereas Rv outbreaks are more widespread across multiple hosts, life stages, and altitudinal ranges. Additionally, the asynchronous emergence of these pathogens, with lethal ranavirosis often following chytridiomycosis, may explain the low detectability of coinfections. Yet, limitations in field observations hinder our understanding of host-level interactions and the detection of cumulative or amplified effects. We have addressed these limitations experimentally, showing that subsequent Rv exposure impairs the host's ability to resolve Bd infections. Moreover, prior exposure to Bd enhances the host's ability to cope with Rv exposure. Overall, longitudinal studies reveal context-dependent outcomes in multi-pathogen interactions, emphasising the need for an individual host-level approach to better understand disease severity and population responses.

A-0734 (Oral)
From the Species to Ecosystem Levels: Integrating Ecological Complexity into our Understanding of NaCl Tolerance in Amphibians

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Secondary salinization threatens freshwater ecosystems throughout the globe. We explore how NaCl influences amphibians across multiple organizational levels (i.e., species, population,

community, and ecosystem-levels). At the individual and population levels, we evaluate species- and population level variation in NaCl tolerance across four common co-existing North American amphibians and across 15 wood frog populations. At the community level, we investigate the effect of sublethal concentrations of NaCl on a common ecological interaction (host-parasite). At the ecosystem-level, we ask how leaf litter input from native vs. invasive plants influence native and non-native amphibian susceptibility to NaCl. At the species and population level, NaCl tolerance in the most to the least susceptible amphibian species and populations varied by 54% and 61%, respectively. This wide variation in tolerance underscores the importance of considering model species or populations when evaluating the effects of NaCl. At the community level, sublethal concentrations of NaCl increased amphibian susceptibility to a common parasite highlighting that low environmentally relevant concentrations of NaCl may have negative cryptic effects on amphibians by modifying how amphibians interact with other members of the community. Lastly, we found that native amphibian tadpoles reared in invasive leaf litter were more susceptible to NaCl compared to when reared in native leaf litter, but non-native amphibian tadpoles reared in invasive leaf litter leachates were more tolerant to NaCl compared to when reared in native leaf litter. Thus, considering ecosystem level variation in abiotic conditions may be important in understanding NaCl toxicity to amphibians. Collectively, this work offers a framework for integrating an ecological perspective across multiple organizational levels to facilitate our understanding of the complex effects of NaCl on amphibians.

A-0735 (Oral)

Spatiotemporal Variation in Skin Microbiome and Chytrid Infection of a Neotropical Torrent Frog

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The consortium of symbiotic microorganisms recruited by vertebrate hosts and their metabolic products (the microbiome) is known to aid in host health. The amphibian skin microbiome serves as a crucial defense against various pathogens, including the waterborne fungal pathogen that causes chytridiomycosis, *Batrachochytrium dendrobatidis* (Bd). However, there is limited understanding of the basic ecology of the microbiome associated with neotropical amphibians. We used high-throughput 16S rRNA gene sequencing to explore the spatiotemporal skin microbiome of a Neotropical torrent frog (*Hylodes phyllodes*) and its relationship with Bd infection across the host's distribution in the Brazilian Atlantic Forest. Our findings reveal significant variation in the diversity and composition of skin microbiome across sampled populations and over time. The observed variation is predicted by elevation, temperature and precipitation of each site. We identified a high proportion of Bd-inhibitory bacterial sequence reads in our samples, indicating that skin microbial communities of *H. phyllodes* may play a protective role by enhancing resistance to pathogen infection in this species. However, the relatively high prevalence of Bd in all sampled populations, coupled with low infection loads, could indicate that the torrent frog hosts serve as a reservoir for the pathogen, sustaining and disseminating zoospores in the environment. This may potentially heighten the exposure risk for sympatric species that are less tolerant to Bd. Therefore,

understanding the mechanisms of host-microbiome interactions, particularly in terms of disease resistance across time and space, may aid in the conservation of Neotropical amphibians.

A-0736 (Oral)
Testing Habitat Management Strategies while Rewilding Endangered Blunt-nosed Leopard Lizards (*Gambelia sila*) to California's San Joaquin Desert

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Although Blunt-nosed Leopard Lizards (*Gambelia sila*) are inaugural members of the US Endangered Species List and have been protected since 1967, their populations continue to decline and disappear. In 2020, a unique population in central California's San Joaquin Desert declined to less than 10 individuals as a result of drought-induced reproductive failure followed by demographic collapse. We received emergency permission to collect five animals in 2020 and two animals in 2021 to found an assurance colony at Fresno Chaffee Zoo. We successfully bred these animals, producing > 100 offspring in three years, and released 17 ~10-month old animals back to their site of origin in 2023. Each animal was radio-collared and regularly monitored throughout the 2023 active season along with 4 wild lizards at the site. Because 2023 was an exceptionally high rain year, invasive grasses inundated the site, so we experimentally mowed eight 25 x 25 m plots, half connected by cleared corridors and half not connected. We then released captive-reared animals into two of the plots. We designed the cleared patches to test the effects of uncontrolled grass on habitat use and colonization. Although released lizards displayed high survival (41% confirmed survival, and 47% slipped collars with no sign of predation), they moved and grew little compared to wild animals, and they did not reproduce. Additionally, wild animals did not utilize the experimentally cleared areas but instead used a gravel roadway for movement and foraging. In June 2024, we will release a second cohort of captive-reared animals, this time to the gravel roadway utilized by wild lizards in 2023. We will continue releasing lizards until ≥ 50 wild-born females successfully reproduce. Our work illustrates the utility of well-planned captive propagation and release programs for testing the efficacy of habitat management strategies while simultaneously increasing the density of at-risk-species.

A-0737 (Oral)
Trialling Novel Methods to Protect Turtle Nests

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In the Murray-Darling Basin (MDB), Australia, two of the three local freshwater turtle species have declined by 69-90% since the 1970s. Nest destruction by introduced foxes is considered the primary driver of these declines, as comprehensive nest destruction inhibits the influx of juveniles that would otherwise replace aging adults. Traditional lethal control methods (e.g., baiting and shooting) have proved to be ineffective in preventing nest predation, and new methods are needed to promote juvenile recruitment and curb declines. Objective: We tested

the effectiveness of three different *in situ* nest protection methods (fenced nesting beaches, artificial floating islands and individual nest protection via a mesh cover) in reducing fox predation. We also tested whether different nest protection methods are more likely to attract certain types of native predators once foxes are excluded. We created plots of artificial turtle nests under each protection method, as well as corresponding unprotected control plots at each site. We placed remote cameras overlooking nests and used this imagery to determine the number of nests destroyed and associated predators at each plot. At the end of the study period, all nests were excavated to determine their status as destroyed or intact. The amount of nest predation was significantly lower in protected nests of all treatments compared to unprotected nests. Artificial islands were the most effective at protecting nests, followed by fences and lastly mesh. Unprotected nests were almost exclusively predated by foxes, while protected nests saw higher predation from native animals. The types of native predators were not significantly different between protection methods. While mesh protection has been used for many years to protect turtle nests, the efficacy of fenced nesting beaches and floating islands are still under evaluation. Our study provides support for these methods as valuable conservation tools deserving further study.

A-0739 (Oral)

What, if Anything, is a Hard Egg: Mechanical Properties of Non-avian Reptile Eggshells

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Non-avian reptile eggshells show great phenotypical diversity, ranging from thin and paper-like to leathery or calcareous and everything in between. This results from adaptations against different selective pressures such as collision damage, abrasion from small particles, or puncture. We currently have a basic understanding of the mechanical properties, mostly focused on highly calcified eggs and one weakly calcified egg, where they are viewed as either rigid or highly flexible, even though recent literature agrees that these eggshells cannot be dichotomized. While the most obvious difference between the eggshell of species is this outermost calcareous layer that forms a thick layer in crocodiles, most turtles, and some squamates, which is generally less thick or sometimes absent in most squamates, and some turtles, there is also a lot of variation in the fibre structure composing these eggshells. Therefore, in this project, we aim to get a more detailed understanding on the mechanical properties and determine how the orientation and proportion of fibres influence this by performing a phylogenetic comparative analysis on 17 species (6 snakes, 10 lizards, and 1 turtle) combining microscopy and tensile strength tests. We found that not only can these eggshells be viewed as bio-composites, consisting of interwoven fibres with various amount of minerals embedded. They also behave as such. More specifically we found that the eggshells' stiffness, strength, and toughness vary gradually depending on both the proportion and orientation of the fibres as well as the amount of calcium within the eggshell. These findings highlight that the mechanical properties of non-avian reptile eggshells consist of a gradient rather than two groups and they are not solely determined by the presence of a thick calcified

outer layer. They can also serve as inspirations for innovative, sustainable biomimetic designs for producing bio-composites across different fields.

A-0741 (Oral)
Hybridisation within the *Ptyodactylus hasselquistii* Complex: Morphology, Bioacoustics and DNA Barcoding

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In recent decades, animal biocommunication, in particular acoustics, has received special attention as one of the mechanisms of reproductive isolation and an evolutionary driver. However, data on reptilian bioacoustics remain scarce. The subjects of this study were geckos of the genus *Ptyodactylus*. This genus comprises 12 species distributed in North Africa, the Arabian Peninsula and the Middle East. The majority of species exhibit species-specific acoustic communication, with some groups being able to hybridise with each other. Particular attention was paid to the hasselquistii complex, which comprises several morphologically distinct groups that are able to hybridise with each other. The acoustic signals were recorded using a remote microphone. A spectral analysis was conducted using Raven Pro software for the five measured parameters. In total, more than 2,000 sound signals were subjected to analysis. A sample of 130 specimens was subjected to morphological analysis with respect to 29 parameters. The molecular analysis included the examination of more than 100 specimens for the presence of mitochondrial and nuclear markers. Consequently, we devised a quantitative system for evaluating male-to-female sexual response based on acoustic cues. In the context of pairing experiments, the acoustic response of hybrid males to hybrid females was almost absent, whereas all males exhibited a significantly more intense response to females of both parental forms. A variety of fertile hybrids (F1, F2 and F3) between hybrid and parental forms were generated under experimental conditions. Hybrid individuals are also capable of hybridising with more phylogenetically distant species, such as *P. ananjevae*, but rarely hybridise with one another. The acoustic repertoire of hybrid males was found to be the most unstable of all the forms examined. This may facilitate the formation of reproductive barriers within the hasselquistii complex and the emergence of discrete morphotypes.

A-0742 (Oral)
Verreaux in Australia (1842–1846)

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Jules Pierre Verreaux (1807–1873), of the Paris natural history and taxidermy company Maison Verreaux, visited Australia between 1842–1846 to collect on behalf of the Museum d'Histoire Naturelle in Paris. During his 47 months there, he collected over 11,000 specimens. Although reptiles and amphibians were only a small component of these collections, he still sent nearly 200 herpetological specimens home. These specimens constituted the largest collection of Australian herpetology to reach museum collections in the first half of the 19th century. Unfortunately, they arrived too late for most to be examined for Duméril & Bibron's

monumental Erpétology Générale. However, the snakes were available for the seventh volume (1854), and several other species were described in Duméril & Duméril's Catalogue Méthodique (1851), and in later papers by Auguste Duméril. Unlike the botanical specimens on herbarium sheets, the herpetological collection suffers from incorrect or imprecise localities, including types of two Western Australia snakes purportedly from Tasmania. Verreaux's manuscript diaries in Paris, recently digitised, provide a wealth of information on his localities and specimens and his interactions with other local natural history collectors. Except for three months (31 July–30 Oct 1844) after his marriage, and three weeks (28 Nov–19 Dec 1844) when ill, they cover his daily activities throughout his Australian sojourn. Verreaux himself collected only in Tasmania (27 Dec 1842–18 Apr 1844), mainly around Hobart, and in Sydney (21 April 1844–7 Nov 1846), mainly in the eastern suburbs. His herpetological specimens were mostly obtained by his paid servants, especially one named Emile (possible Emile Adolphe), who was sent on several collecting trips to the north coast of NSW (Camden Haven, Port Macquarie, Clarence River and New England) and to Moreton Bay (Queensland). Diary entries indicate that the Western Australian part of his collection was purchased by him from a Mr Cox in Hobart.

A-0743 (Oral)
Snake Education: Connecting Science and Society

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Human-snake conflict is an increasingly common problem around the world, stemming from a lack of education about snakes and this conflict can often cause incidences of snakebite. As human encroachment increases, the likelihood of human-snake conflict also increases. The Hoedspruit area in South Africa is predominantly rural with increasingly more development taking place and a large diversity of venomous and non-venomous snakes is found in the area which are often encountered and killed. To create a better relationship between snakes and humans in the area, we aim to mitigate human-snake conflict through effective education tools and mentorship, particularly in schools and through community outreach. Snake Education and Community Awareness Program (SECAP) was born from a partnership between Save The Snakes, a non-profit organisation working to mitigate human-snake conflict and Hoedspruit Reptile Centre, an education and conservation focused snake park. Over the last few years, we have visited schools in the area, conducted presentations focused on the biology of snakes and demonstration with snakes. To monitor and evaluate the impact of our efforts, we have conducted pre and post workshop surveys. The survey results indicated that learners had a range of different attitudes towards snakes, from loving snakes (28%) and fearing snakes (44%) to hating snakes (9%) and killing snakes (23%). The post workshop survey results showed an improved perception of snakes and two times less likelihood of killing snakes A core part of our work focuses on scientific research and bringing the science of snakes to the community and school curriculums. Through our continuing engagement with learners and community members in and around Hoedspruit, we believe that we have been able to reduce the fear of snakes and encourage people to view snakes in a positive light.

A-0744 (Oral)
Changing the Way We Do Snake Conservation

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Snakes are one of the most ecologically diverse groups of animals that occupy many different niches around the world. However, most efforts to conserve snake species are often included within the conservation plans that dominantly focus on other organisms. Due to their Least Concern status, snakes are often not considered for priority conservation despite their long-standing persecution from humans. Recently, as snakebite has become a cause for concern in the human health sector, the status of snake conservation is being revisited. The fear of snakes is the primary reason for human-snake conflict and the result of this conflict can result in a bite to the human and/or a killed snake. When the bites occur from venomous snakes, it can lead to severe consequences for humans and the best way to prevent this is to change mindsets regarding the fear of snakes. Education is becoming an intricate part of biodiversity conservation, particularly at the local community level. Save The Snakes, a non-profit organisation that focuses on promoting human-snake coexistence has established a unique snake conservation model in South Africa. The programme focuses on bringing the science of snakes to rural communities and using local knowledge to change the current fear-based mindset that exists about snakes. In the last 3 years, building valuable relationships with people living in these communities has enabled a new way of conserving snakes including building partnerships with other locally based conservation organisations. By paving a pathway for snake conservation, many additional species would reap the benefits and promote a holistic approach to many conservation efforts that currently exist around the world

A-0745 (Oral)
To Defend or not to Defend: Causes and Fitness Consequences of Alternative Social Ontogenies in Male Collared Lizards

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We combined behavioral and genetic parentage data recorded over a decade to test the effects of delayed versus accelerated territory acquisition and the length of time that individuals held territories on lifetime fitness in male collared lizards displaying alternative social ontogenies. The most successful males acquired territories in Year-1 and maintained them for more than one season. Surprisingly however, average lifetime fitness of males postponing territory acquisition until Year-2 was not statistically lower than first-year territorial males, indicating that both ontogenetic trajectories can be successful. In structurally complex rock patches having a network of sub-surface crawlspaces, males that delayed territory acquisition achieved higher reproductive success because they could travel without being detected, whereas territory owners more effectively inhibited mating by non-territorial males on structurally simpler habitat patches. Moreover, relative stability of the proportion of males that delayed territory acquisition over our ten-season study suggests that this trajectory is successful enough for selection to maintain it. Monitoring first-year males from spring emergence onward indicated that individuals hatching from first clutches and larger at the beginning of Year-1 — both traits that may be heritable — were more likely to accelerate territory acquisition. Our results

demonstrate the power of combining genetic parentage and behavioral data recorded over the lifespan of individuals to address key questions about the evolution of individual behavior, social systems, and the role of ecological variation in shaping these attributes.

A-0746 (Oral)
MUSEOMICS: New Solutions to Old Problems

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Museomics has made DNA from archival material housed in natural history collections available for sequencing, allowing us to answer long-standing questions that would previously have defeated us. Interventions required to make museomics work occur at all steps of the process, from sampling to the lab to bioinformatics. Our team have developed and applied a variety of methods to various groups of frogs from Madagascar, with major impacts for the taxonomy and evolutionary understanding of endemic Malagasy radiations. We present a general overview of these methods, compare and contrast their relative pros, cons, and costs, and give some recommendations for others exploring this exciting emerging field.

A-0747 (Oral)
Fossils and Embryos on the Origin of the Tympanic Ear in Crown-Reptiles

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The evolutionary success of reptiles on land is linked to a series of morphological and physiological transformations. Among these, the evolution of a tympanic middle ear helped to mitigate the problem of impedance mismatch between the air and the fluid of the inner ear, enhancing sound detection in the terrestrial environment. The origin of tympanic ear is a classic example of a long-standing debate in evolutionary biology. The current consensus is that it appeared independently in turtles, birds, lizards, and, crocodylians. Evidence for this hypothesis comes mainly from information from the fossil record. We addressed the origin of the tympanic ear in reptiles from the perspective of modern integrative biology, combining data from two distant but complementary research areas: palaeontology and evolutionary

developmental biology. We carried out *in-situ* hybridizations to compare the embryonic evolution of the middle ear in two species phylogenetically bracketing all extant reptiles, the lizard Tropidurus catalanensis and the crocodylian *Caiman yacare*. Based on HoxA2 expression during embryonic development, our results reveal that the tympanic membrane is formed within the second pharyngeal arch in these animals. This condition is similar to that of birds and differ from that of mammals, in which the membrane arises from the first pharyngeal arch. We reassessed the reptilian fossil record in order to conduct phylogenetically-inferred analyses to estimate the ancestral morphology of the otic region. Based on a comprehensive sample of the earliest known reptiles, our results indicate that a tympanic membrane was present in the earliest members of the group and that it corresponds to the ancestral condition of reptiles. Thus, our analyses show consistency between data from the fossil record and the developmental biology of reptiles and support the hypothesis of a single origin of the tympanic ear in crown reptiles.

A-0748 (Oral)

Save the Galaxy Frog: Status, Distribution, Threats and Conservation of *Melanobatrachus indicus*

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Evidence based conservation decisions are important for species conservation. This becomes difficult with poorly known species. Often, a deeper understanding of their ecology and threats are necessary. The Galaxy Frog (*Melanobatrachus indicus*) is considered one of the rarest frogs in India. This Western Ghats endemic is extremely cryptic and has only been recorded by scientists eight times since its scientific description in 1878. It is an Evolutionarily Distinct and Globally Endangered (EDGE) species and was listed as EDGE's top 25 robust priority vertebrates in the world in 2024. We lack information on their distribution, ecology, and their threats. We began the first ever ongoing study on this species in 2019 with the support from EDGE of Existence Programme. We undertook visual encounter surveys, targeted searches and collected data on the species' natural history, habitat and local ecological knowledge. We recorded 53 individual *M. indicus* from seven locations, of which four were new distribution records. To garner further local support for its conservation, we popularised it through articles, blogs, newspaper articles and various social media platforms. As a result, it became the flagship species of Mathikettan Shola National Park, and the first frog flagship species in India. After 145 years of its description, we have identified their breeding and are working to describe it. Rotting logs were their identified microhabitats and habitat modification, firewood collection the major threats. Furthermore, unethical wildlife photography is a newly documented threat and with the help of local communities and Forest Department officials we could protect the location and population by imposing stronger regulations. Our study results underpinned the recent GAA2 IUCN Red List Assessment of the species, with it being down-listed to Vulnerable from Endangered. Similar continuous research on poorly known species are required to make informed decisions and protect them.

A-0749 (Oral)

First Insights into Reptile Biodiversity in the King AbdulAziz Royal Reserve: Baseline Surveys and Conservation Perspectives

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The distribution of herpetofauna on the Arabian Peninsula is generally poorly known, particularly in Saudi Arabia. The King Abdul Aziz Royal Reserve (KARR) in east-central Saudi Arabia is in an area predicted to have high reptile species richness, yet no baseline reptile checklists exist for this reserve. Understanding what species occur within a protected area is vital for ensuring that conservation strategies and long-term monitoring are effective. To fill this gap, we conducted a multi-season baseline survey on the reptile fauna of the reserve. This study recorded a total of 31 species from 1,551 observations, composed of 25 lizards and six snakes. Two of the species found are of conservation concern: the large bodied and charismatic *Uromastyx aegyptia* (VU); and the range restricted *Tropiocolotes wolfgangboehmei* (DD)). Through species accumulation curves we were able to evaluate that the sampling methods implemented during the survey were adequate and we predicted that the species richness of the reserve is likely as high as 38 species. Prior to this study, only 82 reptile records (30 species) were known from the study area and thus we add a significant number of new records to the reserve and an additional four species that were previously unknown from the region.

A-0750 (Oral)
The Novel Type of Nuchal Glands in *Rhabdophis* from Sulawesi

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Several species of *Rhabdophis* can sequester bufadienolides from toads, store them in their nuchal glands and reutilize them for their defensive mechanisms. There is no information regarding the occurrence of nuchal glands in Sulawesian *Rhadophis*. This study aimed to examine the presence and the morphological features of nuchal glands in *Rhabdophis* from Sulawesi island of Indonesia. Morphological examination of the glands was conducted by observing the presence or absence of structures, the type of glands, the size of glands, and the number of gland pairs. The glandular fluid of the snake was extracted and analyzed by liquid chromatography/mass spectrometry (LC/MS). Two symmetrical pairs of unusual structures resembling glands were found on the head and neck region of preserved or freshly dead specimens of the snakes. The first pair is attached to the underside of the temporal skin, while

the second pair resides under the anteriormost skin of the neck. The type of glands differed from the sacculated and unsacculated types described by Smith (1938). LC/MS analyses confirmed that the glandular fluid of the snake was composed of bufadienolides. The present study documented the novel form of glands and their bufadienolides composition of Sulawesian *Rhabdophis* for the first time and thus confirmed that it is comparable to the nuchal glands.

A-0751 (Oral)

Measuring Interspecific Admixture in Endangered Houston toads (*Bufo* [= *Anaxyrus*] *houstonensis*) with Sympatric Gulf Coast Toads (*Bufo* [= *Incilius*] *nebulifer*) and the Limitations of Phenotype to Identify Hybrid Individuals

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Evaluating introgression rates between two sympatric species is crucial when one of the species is threatened with extinction. We measured interspecific admixture in Endangered Houston toads (*Bufo* [= *Anaxyrus*] *houstonensis*) with the sympatric Gulf Coast toads (*Bufo* [= *Incilius*] *nebulifer*). From multilocus genotypes and mitochondrial sequence data, we evaluated the level and direction of admixture for contemporary populations (2020–2021) of both species. Prior assessments (2000–2008) detected higher genetic admixture in Houston toads than was indicated by phenotypic assessments. From 2000–2008, asymmetric backcrossing was observed with F1 hybrids backcrossing more frequently with Houston toads. During that previous assessment, Houston toads had been at critically low numbers (i.e., 30-171 annually) relative to more abundant Gulf Coast toads (i.e., 100 annually). An increase in Houston toad abundance and therein larger breeding aggregations was considered a potential means to alleviate hybridization for this endangered species. Hypothetically, under decreased rarity, fewer opportunities for hybridization would occur. Although we observed an increase in the size of Houston toad breeding aggregates (i.e., 114–422), potentially from population supplementation efforts; we observed no change in levels of interspecific admixture in Houston toads. We did confirm the discrepancy in identifying hybrid individuals based on distinguishing morphological characteristics associated with each of the focal species. Historically, the breeding seasons were non-overlapping between the rare and common taxa here; however, in a changing climate, it may be that prezygotic isolating mechanisms are weaker than previously reported. Ultimately, our results suggest that phenotypic identification of hybrids is unreliable, whereas genotypic identification is effective. Interestingly, there may be prezygotic isolating mechanisms at play that differ from those reported previously between these two species, which potentially enable the maintenance of stable hybridization rates.

A-0752 (Oral)

Phylogenomics of Lesser Sunda Emerald Tree Skinks (*Lamprolepis smaragdina*) Uncovers a Broad Range Expansion Followed by Low Gene Flow

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The Emerald Tree Skink, *Lamprolepis smaragdina*, is an arboreal lizard that is well adapted to over-water dispersal and is found throughout Wallacea and the western Pacific islands. These lizards are found on every major island in the Lesser Sundas where they exhibit one or more of three distinct color patterns: a green morph, a brown morph, and a half-green half-brown morph. Given this species' propensity to successfully disperse from island to island, we expected to find moderate levels of gene flow and low genetic divergence between Lesser Sunda island populations. We used both mitochondrial (1426 bp for 174 lizards) and exon-capture (1411 sequence loci for 104 lizards) datasets to reconstruct phylogenetic relationships and estimate divergence times and levels of migration for *L. smaragdina* populations across 12 Lesser Sunda islands. The results support a scenario where the Lesser Sundas assemblage diverged from the Peleng Island (off eastern Sulawesi) population ~1.5 Ma with subsequent dispersal events within the Lesser Sundas occurring between 1–0.4 Ma. Biogeographical model testing supports a scenario where many dispersal events occur parallel to or against major long-term oceanic currents of the "Indonesian Throughflow". While some of the mito-nuclear discordances indicate secondary dispersal events have occurred between established populations, genomic estimates of migration show near total genetic isolation of all populations. This implies that either population sizes are too large to detect the genes of more recent migration events, or that recent migrants are unable to successfully reproduce with the established population.

A-0753 (Oral)
Assessing the Toxicity of Curcumin, a Plant-Derived Fungicide that Reduces *Batrachochytrium salamandrivorans* Infection Burdens

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Batrachochytrium salamandrivorans (Bsal), a fungal pathogen and one of the causative agents of chytridiomycosis in amphibians, was first identified in the Netherlands in 2013. Since its discovery, Bsal has been documented in six European countries and has been associated with substantial population declines in several salamander species. Bsal is hypothesized to originate from Asia and has the potential to spread through the international trade of amphibians. Previous experiments in our laboratory indicate that curcumin, a plant-derived compound found in turmeric, has inhibitory and fungicidal effects on Bsal growth. Additionally, adult

newts (*Notophthalmus viridescens*) exposed to a simultaneous dose of curcumin (7 µg/mL) and Bsal (5 x 103 zoospores/mL) had lower infection burdens and greater survival than those exposed to curcumin 3 days after Bsal exposure. To determine the safety of curcumin for environmental application at high-risk Bsal sites, we are estimating the lethal concentration of curcumin (LC-50) across a panel of aquatic invertebrate (*Girardia tigrina, Daphnia pulex, Lampsilis fasciola*) and vertebrate (*N. viridescens, Lithobates catesbeianus, Oncorhynchus mykiss, Lepomis macrochirus*) species. Following the American Society for Testing and Materials protocols, animals were acclimated to recommended testing temperatures and exposed to a range of curcumin doses, a dilution agent (methanol) control, or water. Survival was recorded at regular intervals during the exposure period (48 hours for invertebrates, 96 hours for vertebrates). The acute toxicity tests with curcumin completed to date indicate that the LC-50 estimates of curcumin for *N. viridescens, L. catesbeianus*, and *G. tigrine* far exceed recommended concentrations for environmental applications (7 µg/mL). Our results suggest that curcumin is safe to be applied to aquatic environments according to U.S. Environmental Protection Agency standards and should be considered for use in Bsal management strategies.

A-0754 (Poster)
Identifying the Tātahi Skink Colour Pattern Range and Morphological Differentiation between the Shore Skink

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The Tātahi skink sits within the Shore skink (*Oligosoma smithi*) species complex, separated by deep phylogeographic divergence between the east and west coast of their geographic distribution. The Tātahi skink is found around beaches, sand dunes, coastal vegetation, and rocky habitats on the west coast of the northern part of North Island, New Zealand. This taxon is currently not formally described, and how they differ morphologically from *O. smithi* has not yet been determined. We propose to record the range of colour patterns of the Tātahi skink across its geographic distribution. We will also focus on the differentiation (colour pattern, morphology, and genetics) between the Tātahi and shore skinks where their distributions overlap in the upper North Island. We will select existing populations on the west coast to collect images and morphometrics. In the area where the two taxa overlap, tissue samples will be collected to conduct mitochondrial sequencing to confirm species identification, images and morphometrics will be examined for these individuals and compared to museum specimens. This study will contribute to the formal description of the taxon and also help in identifying morphological characteristics and better identification in the field.

A-0755 (Poster)
Methylene Blue Colorimetry is More Reliable than Optical Density, Microscopy, and BacTiter-Glo Assays for Measuring *in-vitro* Growth of *Batrachochytrium dendrobatidis*

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Batrachochytrium dendrobatidis (Bd) is one of the most destructive fungal pathogens, contributing significantly to the global decline and extinction of numerous amphibian species.

Development of robust methodologies to measure fungal growth accurately is imperative when conducting *in-vitro* experiments aimed at understanding the physiology and pathogenicity of this fungus. This study describes and compares four methods to quantify Bd growth in-vitro: Optical density (OD), BacTiter-Glo® microbial cell viability assay (GLO), Methylene blue colorimetry (MB), and microscopic image analysis using ImageJ program (IMG). We cultivated zoospores at low and high concentrations, alongside incremental levels of a stressor, creating a gradient of Bd growth. Four primary experiments were conducted, each involving the application of two known stressors (Hygromycin and Cadmium) on two isolates of Bd. Our findings revealed that MB consistently yields precise results across a spectrum of cell concentrations regardless of the stressor or Bd isolate. OD was effective for high-concentration Bd, yet lacked accuracy for low concentrations, while GLO assays performed well with low concentrations but was less reliable with high concentrations. IMG results closely aligned with those of MB but showed more variability. While OD is commonly used for growth studies, our study highlights its potential for inaccuracy with low cell concentrations. However, despite the drawbacks, OD and IMG are the preferred methods for non-destructive or repeated measures of Bd growth, as both MB and GLO assays involve cell death during the process. Of the four methods, GLO assay is the costliest, yet it only demonstrates reliability for low-concentration Bd. Despite its lower precision, IMG emerges as a cost-effective method suitable for less-equipped laboratories, as it only requires a digital microscope and a computer. In conclusion, we recommend MB as the most reliable and relatively cost-effective approach for measuring Bd growth *in-vitro.*

A-0756 (Oral)

Saving The Canberra Grassland Earless Dragon: A Government Perspective

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The Canberra Grassland Earless Dragon (CGED) is one of the most imperilled reptile species in Australia. This species is a habitat specialist restricted to Native Temperate Grasslands, of which less than 1% of its original distribution remains. Restricted to only two valleys in the Australian Capital Territory (ACT) region, this species has a small and increasingly fragmented range due to threats accompanying widespread urban and agricultural development. As a result, only a few satellite populations of CGED remain that are now almost undetectable. An intensive monitoring program, coordinated by the ACT Government, has revealed ongoing CGED population decline following the severe droughts of 2007 and 2019. Remaining CGED populations exhibit high levels of inbreeding and extremely low effective population sizes, characteristic of an extinction vortex. In response, the ACT Government has invested significant funding into driving a wholistic conservation approach to save the species. In my talk, I will provide unique insight from the perspective of land managers and conservation practitioners on the development of this multi-faceted conservation program that has overseen the development of captive insurance colonies, intensive habitat research arenas, wild reintroduction trials, climate and distribution modelling, and novel genetic management tools. I will highlight attributes critical to the program's success, and lessons leared, in the hope our experience can support and enhance other programs dedicated to the recovery of critically endangered fauna.

A-0757 (Oral)

Australian Freshwater Turtle Ecology and Conservation

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Australian wetlands are characterised by highly dynamic hydrological cycles that support booms in productivity. These same characteristics have created sought after human resources with agronomically rich alluvial soils and high demand for agricultural irrigation. Of the 25 species of native Australian freshwater turtle, eight species are listed as threatened by Australia's federal government. With increasing need to understand the ecology and conservation requirements of Australian freshwater turtles, many new projects are emerging. We summarize research from freshwater systems around Australia including farm dams and upland streams of the New England Tablelands, the highly regulated Murray-Darling Basin, and desert river systems of the unregulated Lake Eyre Basin to explore impacts of disturbance on the ecology and physiology of reptile and amphibian communities, and to discuss prospects for conservation. Physical and chemical changes driven by river regulation provide challenges to freshwater turtles in a changing climate through salinization, barriers to dispersal, and habitat alteration. Feral species such as foxes, weeds and pathogens, pose ongoing challenges to the conservation success of turtle populations. Yet there are logistical obstacles to undertaking research in unregulated rivers. Using the Lake Eyre Basin as an example, the practical challenges of studying unpredictable Australian rivers during flood quickly becomes evident. Successful conservation efforts driven by private landowners and citizen scientists are both improving ecological knowledge, and conservation efforts for freshwater systems in Australia.

A-0758 (Oral)
Assessing the Impacts of Nest Inundation on Western Saw-Shelled Turtles

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Globally, climate change and extreme weather conditions are impacting biological systems at multiple scales, ranging from individuals to entire ecosystems. Intense storms can cause damage to many ecosystems and can alter habitats, especially riverine habitats that flood during these intense storms. Flash flooding exposes threatened freshwater turtle nests to inundation, which can negatively impact embryonic development and hatchling survival. We aimed to identify the lethal and non-lethal effects of nest inundation on a riverine specialist (*Myuchelys*

bellii) endangered freshwater turtles from the Northern Tablelands of New South Wales, Australia. We artificially incubated 475 eggs and exposed them to one inundation treatment (0 hrs [control], 12 hrs, 24 hrs, 48 hrs, or 96 hrs underwater) at one of two developmental stages (21 days through development [early-stage development] or 42 days through development [late-stage development]). We found that increased inundation duration increased embryo mortality and decreased hatching success compared to the control group embryos. However, eggs from this riverine specialist showed substantially higher survival from longer periods underwater than previous studies. We found high hatching success (over 95%) from 12 and 24 hrs underwater during both the early- and late-stage developmental inundation groups. Surprisingly, a few hatchlings survived an early-stage inundation at 96 hrs underwater. The late-stage inundation period showed higher mortality of eggs, likely due to higher oxygen demands from more developed embryos. Thus, no hatchlings survived late-stage inundation in the 48 hrs inundation group. While these results suggest high inundation tolerance for this riverine specialist, extended flooding during the nesting season may decrease hatchling survival. These results provide support and prioritization for management and conservation actions during flooding events, to help prevent potential population decline of freshwater turtles and their ecological functions in riverine habitats.

A-0759 (Oral)
Do Functional and Phylogenetic Nestedness Follow the Same Mechanisms as Taxonomic Nestedness?

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The nested subset pattern has been raised to explain the distribution of species on islands and habitat fragments for over 60 years. However, previous studies on nestedness focused mainly on species richness and composition and overlooked the roles of species traits and phylogeny in generating and explaining the nestedness. To address this gap, we sampled amphibians on 37 land-bridge islands in the Zhoushan Archipelago to explore nestedness as well as the underlying causal processes through three facets of diversity, i.e., taxonomic, functional, and phylogenetic diversity. The taxonomic nestedness was measured by organizing the species incidence matrix to achieve a maximum value, while the functional and phylogenetic nestedness were quantified by incorporating how similar species were in terms of their ecological traits and phylogeny. We also obtained six island characteristics and seven species traits as predictors of nestedness. We found that amphibians were significantly nested in these three facets of diversity. When relating different predictors to nestedness, island area, habitat diversity, and species traits were highly correlated with taxonomic nestedness. Moreover, island area and habitat diversity significantly influenced functional and phylogenetic nested patterns. Therefore, the results support the selective extinction and habitat nestedness hypotheses. Interestingly, although we did not observe significant influences of isolation on taxonomic nestedness, functional and phylogenetic diversities were significantly higher than expected when matrices were ordered by increasing distance to the mainland. The result suggests that there are more functionally and phylogenetically diverse species on less-isolated islands, reflecting an overlooked selective colonization process by the traditional analysis of taxonomic nestedness. Our results showed largely congruent nested patterns and underlying processes across three facets of diversity, and distance-related functional and phylogenetic nestedness for amphibian assemblages. Hence, we highlight that a framework that simultaneously considers taxonomic, functional, and phylogenetic nestedness contributes to a complementary understanding of nestedness processes.

A-0760 (Poster)
First Insights of Activity Patterns and Enclosure Use in Captive Mountain Chicken Frogs *Leptodactylus fallax* (Müller, 1926)

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The Mountain chicken frog *Leptodactylus fallax* is a Critically Endangered species restricted to Montserrat and Dominica, in the Caribbean. Chytridiomycosis caused a population decline of over 85% on both islands and, as consequence, the mountain chicken frog is part of a long-term conservation programme that includes *in-* and *ex-situ* research, and extensive captive breeding efforts. Here we investigate activity patterns and enclosure use of captive *L. fallax* at the exhibit enclosure in Jersey Zoo, UK Channel Islands. We installed two camera traps in two different enclosure zones overlooking the pond and leaf litter areas of the enclosure. Time-lapse cameras were used to capture one image/minute for four days. Activity patterns were estimated for both enclosure zones using R statistical software and 'activity' package. We quantified use by mean abundance and total number of records at each enclosure zone, and differences were compared with a t-test. Number of records in the pond were slightly higher during the night when compared to daytime. Considering only the night records, individuals were recorded most often in the pond (84.5%), and the average number of individuals occupying the pond in any given period of night-time (2.12 ± 0.99) was statistically higher than the leaf litter (1.02 ± 0.13). Nonetheless, a larger proportion of frogs were active during the night in the leaf litter when compared to the pond habitat. Activity patterns were similar and overlapped by 78% in both enclosure zones. Our results can assist the design of exhibit enclosures in the future such as increasing pond accessibility and size, and further support husbandry activities for captive-bred mountain chicken frogs.

A-0761 (Poster)
Earlier Maturation or Egg Retention in Tree Lizards Responding to Predation Risks in Different Age Stages

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Predation risk is a significant selective force in the evolution of reproductive characteristics of prey. Prey confront multiple predators, leading to varied predation risks and triggering defensive responses in traits and behavior. However, rare studies have examined whether

different reproductive strategies in response to different predation risks, such as predators of adults versus offspring in lizards. Most studies often focused on a single risk type, neglecting mixed risk scenarios. Here, we utilized the reburied lizard clutches and clay lizard model experiments, each conveying different predation risks. We also examined how females respond to their reproductive strategy and age of maturity under the influence of predation risk. We reared the pregnant *Diploderma swinhonis* females captured from eight populations of Taiwan and outlying islands to assess how differences in predation risk associated with the morphological traits and reproductive strategies. The results showed that females' reproductive strategies are associated with predation risk. We found that in Kenting, females with highest avian predators reproduce earlier but lay more eggs with higher hatching rates per clutch. This suggests that females may invest more energy into reproduction by maturing earlier. Females from Orchid Island's population with the highest density of egg-eating snakes exhibit larger body sizes and later reproductive ages. Furthermore, 20% of these females tend to lay an additional clutch in a different location on the same day, and the eggs from this clutch represent relatively long periods of egg retention and relatively short periods of hatching. This implies that female lizards may reduce egg predation risk by not only increasing clutch number but also reduced the hatching period. This research helps to understand how lizards employ flexible strategies to cope with different predation risks. These adaptations balance reproductive costs and benefits according to perceived risks.

A-0762 (Oral)

Patterns, Drivers, and Consequences of Chemical Signal Variation in an Australian Gecko Radiation

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Chemical signals are important for many animals, influencing behaviours such as mate choice that mediate reproductive isolation and speciation. For several genera of Australian geckos, we now know that the secretions (chemical signals) produced from epidermal pores of males vary between otherwise cryptic lineages, and that chemical signals vary across the geographic ranges of some lineages. This suggests these signals are under both sexual and natural selection associated with environmental variation. How chemical signals play a role in reproductive isolation among reptile species is poorly understood, as is how environmental factors shape these signals. My research explores these knowledge gaps using Australia's most speciose gecko genus: *Gehyra*. I sampled male epidermal pore secretions from 900 individuals across more than 50 species and intraspecific lineages, covering diverse climatic environments across Australia's monsoonal tropics and arid zone. I characterised these secretions using gas chromatography, and then used large-scale multivariate phylogenetic comparative methods to assess environmental correlates of chemical signal variation and to assess whether chemical signals have evolved more quickly than other traits (e.g., morphology). This study will increase our understanding of how biotic and abiotic factors have shaped the evolution of chemical signals within and among lizard species to generate the tremendous 'cryptic' diversity we see today.

A-0763 (Oral)

Leaky Breathing: Assessing the Trade-off between Gas Exchange and Water Loss, Methodology, and Thermal and Hydric Sensitivity

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Amphibians are unique due to their ability, and sometimes need, to breathe through their skin. This poses a unique physiological constraint because the same mechanisms that enable skin breathing also require wet skin, which leads to high cutaneous water loss rates. Differences in water loss, gas exchange, and the extent of their trade-off should vary among species, and those patterns will deepen our understanding of eco-physiological form and function. We assess the tradeoff between water loss and gas exchange, and measure the relative contribution of lungs versus skin to these rates among anurans. We also quantify differences among water loss measurement methods. Quantitatively accounting for methodological differences will be critical for future meta-analyses. To measure gas exchange and water loss, we use flow-through respirometry to quantify both whole-animal and tissue-specific values. Tissue-specific rates are measured with a mini-chamber that seals against the nares or skin surface. We compare our respirometry water loss measurements to rates measured gravimetrically or with an AquaFlux evaporimeter. Finally, we test the thermal and hydric sensitivity of metabolic rate and water loss rate of the whole organism, for the lungs versus the skin, and for animals at rest versus during exertion. Our methodological developments and comparisons will inform the decisions of future studies. As climate change makes many habitats hotter and drier, all organisms are at increased risk of fatal desiccation. Taking effective measurements of and understanding the thermal and hydric effects on gas exchange and water loss rates will deepen our understanding of ecology and evolution in a way that enables better predictions of climate vulnerability.

A-0764 (Oral)
Comparative RNA-seq Analysis of Limb Blastema of Tadpole and Froglets Decodes the Limb Regeneration Mechanism in Frogs

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Anuran amphibians regenerate hind limbs during tadpole stages but lose this ability post-metamorphosis making them unique models for comparative regeneration studies. *De novo* transcriptome of limb blastema and homeostatic limbs of tadpoles and froglets of the Indian tree frog, *Polypedates maculatus* were generated and differential gene expression analysis was done in between homeostatic hind limbs of froglets and tadpoles; homeostatic hind limbs of froglets and 3 days post-amputation (3dpa) froglet blastemas; homeostatic hind limbs of tadpoles and 3 dpa tadpoles blastemas; 3 dpa blastemas of froglets and tadpoles. Differential gene expression analysis between early tadpole and froglet limb blastemas discovered species-specific novel regulators of limb regeneration. There was upregulation of proteoglycans, such as epiphycan, chondroadherin, hyaluronan and proteoglycan link protein 1, collagens 2,5,6, 9 and 11, several tumour suppressors and methyltransferases in the *P. maculatus* tadpole blastemas. Differential gene expression analysis between tadpole and froglet limbs revealed the molecular repertoire supportive of regeneration such as the upregulation of cysteine and serine protease inhibitors and downregulation of serine proteases, antioxidants, collagenases and inflammatory genes in the tadpole limbs. Dermal myeloid cells were GAG+, EPYC+, INMT+, LEF1+ and SALL4+ and contributed to the tadpole blastema. On the other hand, the

myeloid cells of the froglet limb blastemas were few and probably contributed to sustained inflammation resulting in healing. Thus, comparative studies help unravel the regeneration mechanisms and can provide valuable insights into regenerative medicine and engineering.

A-0766 (Oral)
Reactive Nitrogen Species via S-Nitrosylation Mediates Cell Proliferation during Tail Regeneration in Geckos

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Geckos exhibit outstanding powers of appendage regeneration and are the only amniotes closest to mammals capable of composite tissue regeneration. Geckos regenerate structurally incomplete but functionally equivalent replacement of the original tail. The study investigated the role of reactive nitrogen species (RNS) during tail regeneration in a gecko, *Hemidactylus murrayi*. Tail autotomy triggered nitrosative stress demonstrated by high expression of iNOS and elevated concentrations of reactive nitrogen species. Higher concentrations of reactive nitrogen species triggered protein S-nitrosylation that probably restricted the acute inflammatory response caused by wounding and facilitated regeneration. Increased nitrosative stress was associated with the proliferation of the wound epithelium and the tail blastema as nitric oxide synthase inhibitor (L-NAME) caused retarded growth and structural anomalies in the regenerating tail while peroxynitrite inhibitor (FeTmPyp) arrested tail regeneration. Spermine NONOate and retinoic acid, used as NO donors generated small outgrowths post-amputation of limbs with an increased number of proliferating cells and s-nitrosylation indicating the role of nitric oxide signalling in cell proliferation during regeneration. Additionally, retinoic acid treatment caused regeneration of nerve, muscle and adipose tissue in the regenerated limb structure 105 days post-amputation suggesting it to be a putative modulator of tissue regeneration in the non-regenerating limbs. Proteomic analysis of 5 days post-amputation tail blastema showed nitrosylation of proteins associated with cell proliferation such as CMOS, NGFβ, CHRM4, matrix remodelling protein, MXRA-5, mitochondrial protein, CYTB and immune system related, RAG1 and RAG2.

A-0768 (Oral)
Shifting Color Morph Frequency in Polymorphic *Plethodon* Salamanders in Response to Climate Change

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Animals with discrete color polymorphisms offer a unique opportunity to examine the effects of climate change on intra- and inter-specific morphological variation. Color morphs have correlated trait complexes, and, therefore, morphs may exhibit divergent adaptative responses to changing environmental conditions. Here, we examine spatiotemporal shifts in color morph frequency in *Plethodon* salamanders, which has a widespread striped/unstriped color polymorphism. Recently, we demonstrated that a single, commonly studied species has experienced rapid shifts in color morph frequency in less than 50 years. In total, there are at least ten species within the genus *Plethodon* that display a striped/unstriped color polymorphism, and non-polymorphic closely related species are typically fixed for either phenotype. We know little about these other polymorphic *Plethodon* species and whether they

also show similar, divergent changes in color morph frequency in response to shifting climate. Using historical museum collections, we categorized color morphology of *Plethodon* salamanders. We use a phylogenetic generalized linear modeling framework that includes information about spatial population structure to examine how body size varies with climate, elevation, and over time. With use of historical biological collections, this work provides essential data for understanding the evolution of color morphs and whether species or morphs respond concordantly to changing environmental conditions.

A-0769 (Oral)
Habitat Associations of the Upland Herpetofauna of Florida, USA

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Although the state of Florida in the United States is known for its high rainfall, hot temperatures, and wetlands, Florida also has a series of upland habitats, defined by well-draining sandy soils and sparse trees, being more a savanna than subtropical forest. These "upland" habitats, though only a few meters above sea level, are vastly different from the oak hammocks, marshes, and swamps of the rest of the state. The herpetofauna of upland Florida scrub has been studied relatively well due to its uniqueness. However, the reptiles and amphibians in other upland habitats, pine flatwoods and dry prairie, have received less attention. I installed 60 triad drift fence arrays in Florida scrub, pine flatwoods, dry prairie, and the ecotones between them in the protected lands of Avon Park Air Force Range in south-central Florida. Amphibians and reptiles were recorded through pitfall traps, funnel traps, and camera traps associated with the arrays. After seven months of sampling, I recorded 30 species and 1,154 individuals. The highest overall species richness and abundance were in the scrub whereas the lowest were in dry prairie. Reptile species richness was highest in the prairie/flatwoods ecotone. Eight species occurred only in a single habitat type, whereas seven species were found in all five habitats. *Sceloporus woodi*, Scrub Lizards, were endemic to scrub and scrubby flatwoods. A species previously believed to be a scrub endemic, *Plestiodon egregius*, Mole Skinks, occurred in three habitats. The two invasive species encountered (*Anolis sagrei*, Brown Anoles, and *Eleutherodactylus planirostris*, Greenhouse Frogs) were widespread but most abundant in pine flatwoods. Most of the native species appear to be generalists, with a few notable exceptions. The herpetofauna of the understudied upland habitats of Florida deserves more scientific attention because even the basic ecology of some of the species is still unknown.

A-0770 (Oral)
Including Physiological Variation in a Mechanistic Niche Model Reveals Species Differences in Climate Vulnerability across the *Plethodon* Phylogeny

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Physiological variation between species can result in different levels of climate vulnerability across closely related species. Incorporating species-specific physiology in biophysical models could allow us to tease apart these differences and determine how vulnerability is phylogenetically structured. Here we developed a biophysical model to predict climate vulnerability across three *Plethodon* clades – *Plethodon glutinosus, cinereus*, and *welleri*. We

included lab-based measurements of mass, metabolic rate, and resistance to water loss to parameterize our model. We also allowed individuals to adjust their behavior depending on thermal or hydric stress. Specifically, salamanders were able to move above-ground if conditions were favorable or into below-ground burrows to escape these stressors. To measure climate vulnerability, we calculated the change in energetic cost, activity, and water loss values between current (1970–2000) and future (2081–2100) climates for each species. We then plotted these values on the *Plethodon* phylogeny to determine how climate vulnerability is structured across the three clades. We found that *Plethodon welleri* experienced the lowest change in energetic cost, and average metabolic rate explained 17% of the variation in cost between species. *Plethodon glutinosus* had the largest decline in activity, with some species losing up to 400 hours of yearly activity. Lastly, *Plethodon welleri* and *Plethodon cinereus* had the highest increase in evaporative water loss, likely because they maintained higher activity levels in the future climate. These results indicate that the *Plethodon glutinosus* group will likely be most sensitive to climate change, since decreased activity and increased energetic cost could result in unsustainable conditions for organismal performance. Additional analyses will investigate the role of morphology, average physiological trait values, and habitat on explaining this variation in vulnerability, providing more insight into the reasons behind climate sensitivity in *Plethodon*.

A-0771 (Oral)

One Leap Forward, Two Hops Back! Uncovering Southeast Asian Cryptic Frog Species

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Southeast-Asian frog diversity is underestimated and taxonomically perplexing (see Brown et al., 2009; Chan and Grismer 2019; Chan et al. 2019; Dufrenses, 2022). Although molecular markers have significantly improved proper species identification and the elucidation of evolutionary history, they often increase confusion by uncovering cryptic species (nearly morphologically indistinguishable species). Moreover, no set standard for species delimitation exists (Hillis, 2019). Revealing putative species by phylogenetic analyses is the first step but proper identification requires the meticulous examination of preserved specimens-even though frogs have few morphological characteristics to examine. An integrated approach, and patience, are essential in the pursuit of understanding frog biodiversity. To illustrate how challenging cryptic species can be, and how revealing cryptic diversity can make taxonomy less clear initially I will present research on frogs within the *Nyctixalus, Occidozyga*, and *Theloderma* genera.

A-0772 (Oral)

Evaluating Translocation Success of a Vulnerable K-Selected Skink Species to a New Zealand Predator-Fenced Sanctuary

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Some reptiles have characteristics that put them at particular risk when attempting translocations aiming to establish new populations. These characteristics include low annual

reproductive output, cryptic behaviours that make them difficult to sample, and long life spans that can take more than a decade of monitoring to determine success. Species-tailored outcome evaluations performed periodically during long-term monitoring can reveal the level of success of reptile translocations. Otago green skinks (*Oligosoma* aff. *chloronoton* "eastern Otago") are an understudied, taxonomically cryptic species that are listed as At Risk-Declining in New Zealand. We used a growing knowledge of this species' life history to assess translocation outcomes of Otago green skinks translocated from the wild to Orokonui Ecosanctuary, a 307 ha fenced sanctuary which protects native species from most invasive mammals. Forty skinks were translocated to the sanctuary in 2016, the first translocation of this species. Fifteen photo-resight surveys using artificial cover objects (ACOs) were completed the first year following release. Twenty-two photo-resight surveys using ACOs were conducted from December 2023 to May 2024, resulting in 227 skink encounters and identification of 55 individuals. Life-history stage was recorded for all skink encounters, and morphological characteristics and ID photographs were recorded for each hand-captured skink. Founders and other individuals were identified using a photographic ID library to make comparisons with observations from earlier surveys. Our analysis shows that Otago green skinks in Orokonui Ecosanctuary have achieved a viable population in eight years, i.e., (1) ≥ 40 are observed (2) ≥ 20% of animals each year were juveniles or subadults; (3) founder animals comprised ≤ 50% of the individuals encountered. We demonstrate that Otago green skinks thrive when protected from most mammals, paving the way for using translocation as a conservation tool for the three highly endangered members of the green skink complex.

A-0773 (Oral)
Detecting the Elusive Archey's Frog using Holly, New Zealand's first Frog Dog

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First described in 1942, the archaic Archey's frog (*Leiopelma archeyi*), is one of the rarest and most endangered amphibians, known as the world's most Evolutionarily Distinct and Globally Endangered (EDGE) amphibian species. This terrestrial species is the smallest of the three endemic frogs occurring on the North Island of New Zealand. It inhabits damp forested areas mostly at higher altitudes, and is known for its incredibly cryptic nature, being nocturnal masters of camouflage. With its varying shades of green and brown, each with unique patterning, combined with their lack of vocalisation, locating the species in the wild is no small task! In 2018, Debbie Bishop and Dr. Phil Bishop decided to test the efficacy of canine detection methods for presence/absence during day-time surveys with Holly, a Nova Scotia Duck Tolling Retriever, in conjunction with Tegan Murrell as part of her MSc thesis. The idea was to provide presence detection that could narrow areas of searching for night time monitoring, by harnessing the natural ability of dogs to detect scent and using this as a non-invasive wildlife monitoring method in the natural environment. This presentation will draw upon experiences in the training, both *in-situ* and *ex-situ*, and certification of this dog team by New Zealand's Department of Conservation (DOC), Conservation Dogs Programme, the challenges encountered, and key highlights. The aim is to show how this can be a promising herpetological tool for future research, surveys and conservation strategies.

A-0774 (Poster)
A Study on Thermoregulation in Five Lizards Related to Foraging Types in Okinawa, Japan

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Some reptiles are known to maintain a constant body temperature during activity by thermoregulatory behavior, while others do not thermoregulate and synchronize their body temperature with the environmental temperature. We investigated body temperatures of five species of *Diploderma polygonatum* (P), *Anolis carolinensis* (C), *Plestiodon marginatum* (M), *Takydromus smaragdinus* (S), and *Ateuchosaurus okinavensis* (A) in the wild in Okinawa Prefecture to clarify the relationship between their body temperature and environmental temperature. These five species are tentatively classified into two sit-and-wait types (P and C) and three active foraging types (M, S, and A) with respect to foraging behavior based on literature and observations. Our data revealed a significant positive correlation between body temperature and substrate temperature in all species, and both the slope and y-intercept of the regression line were significantly different from the line y = x (y: body temperature, x: substrate temperature) in which body temperature and substrate temperature were completely synchronized. This suggested that all species are thermo-regulated to some degree. In the regression line of body temperature and substrate temperature in each species, we regarded a slope of 0 indicates complete thermoregulation, while a slope of 1 indicates complete synchronized body temperature according to literature (Huey and Slatkin, 1976; Lee, 1980). The comparisons of slopes among the five species showed that, in order of increasing slope, P(a=0.85) > A(a=0.72) > C(a=0.69) > S(a=0.56) > M(a=0.21). Although this study does not clearly explain the differences in thermoregulation by foraging behavior, the degree of thermoregulation tended to be lower in the sit-and-wait types and higher in the active foraging types. It is necessary to further investigate the validity of the classification of foraging behavior in the next study.

A-0775 (Oral)
Rediscovery of Paedomorphic Ezo Salamander after almost 90 Years

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Although paedomorphosis is widespread across salamander families, only two species have ever been documented to exhibit paedomorphosis in Hynobiidae. One of these two exceptional species is *Hynobius retardatus* in which paedomorphosis was first reported in 1924, in specimens from Lake Kuttara in Hokkaido. This population became extinct after the last observation in 1932; since then, no paedomorphs of this species have been reported anywhere. Here, we report the rediscovery of paedomorphs of this species. Three paedomorph-like male salamanders were collected from a pond in the south Hokkaido in December 2020 and April 2021; in size, these specimens were similar to metamorphosed adults but they still displayed larval features such as external gills and a well-developed caudal fin. An artificial fertilization experiment demonstrated that they were sexually compatible with metamorphic females, thus, confirming them to be paedomorphs. Future efforts to find additional paedomorphs in this and

other populations are required to assess the prevalence of paedomorphosis in *H. retardatus* and to improve understanding of the ecology and evolution of paedomorphisis in Urodela.

A-0776 (Poster)
Contrasting Effects of Deer Wallowing on Survival and Growth in Two Amphibian Species

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Ecosystem engineer is an organism that creates habitats for other species. Engineered habitats can significantly affect the fitness of the species utilizing them. Understanding the ecological role of ecosystem engineering requires accurately assessing the benefits of these habitats throughout the life history of the species that utilizing them. In this study, we compared the survivorship and growth from the egg stage to metamorphosis in two amphibian species, *Rana pirica* frogs and *Hynobius retardatus* salamanders, between engineered ponds by deer wallowing and natural ponds. We found that the suitability of wallows as habitats varied between the two species in terms of survival. *R. pirica* showed higher survival rates in wallows compared to ponds, whereas *H. retardatus* showed lower survival rates in wallows. However, *R. pirica* in wallows showed smaller sizes at metamorphosis compared to those in natural ponds, suggesting potential limitations for growth. These results indicate that the suitability of engineered habitats can vary depending on the species utilizing them and their life history traits focused on.

A-0777 (Poster)
Gene Flow Through Multiple Hybrid Zones Complicating the Population Genetic Structure in Fire-Bellied Newts *Cynops pyrrhogaster*

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The Japanese fire-bellied newt, *Cynops pyrrhogaster*, includes five mtDNA lineages which are mostly parapatrically distributed. Hybrid zones are formed at the contact zone among lineages, and various degrees of premating isolation are observed in captive conditions. Thus, this species is an excellent research target for considering the diversification process of species. In this study, genetic backgrounds of 130 individuals from 28 sites covering the entire distributional range of this species were investigated by ddRAD-seq to elucidate the detailed population genetic structure and hybridization status. We used 124 individuals with 16,273 SNPs for population genomic analyses. Principal component analysis and admixture analysis showed that the species was divided into three major groups (Northern, Central, and Western groups). Each major group contained several genetically distinct subgroups. We newly identified two hybrid populations: Kawazu (Shizuoka) and Awaji (Hyogo). Wakayama populations showed the mito-nuclear discordance. We estimated the detailed gene flows using the four-population test (f4 test). Compared with other populations of the Central group, the populations from western and eastern side of the range of Central group have been relatively more strongly affected by the gene flows from the Western and the Northern group, respectively. We estimated the admixed genome proportions in each population of the Central group from the Western group or the Northern group using the f4 ratio test. The admixed proportions of Western genome in the populations from western side of the Central group decreased along with the distance from the hybrid zone. In contrast, regardless of the distance from the hybrid zone, the admixed proportions of the Northern genome in the populations from eastern side of the Central group were comparable. These results suggest that geographic isolation and the subsequent gene flow through multiple hybrid zones formed the different characteristics in each population of Japanese fire-bellied newt.

A-0779 (Oral)

Survival Strategies of Toads Against Urbanization: Possibility of Complementary Growth between Aquatic and Terrestrial Life-Stages

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Amphibians have been considered susceptible to habitat manipulation, such as urbanization, because they use multiple ecosystems through their complex life history. However, they may be able to flexibly cope with the manipulation through complementary growth between life stages. We aimed to investigate whether Japanese toad, *Bufo japonicus*, inhabiting urbanized areas show growth patterns that are complementary between the larval and adult stages. We conducted field surveys in the vicinity of Tokyo for two years. Measurements included size at metamorphosis as the outcome of aquatic growth, and the snout-vent length of breeding adults that reflects both aquatic and terrestrial growth outcomes. As an indicator of urbanization, we calculated Normalized Difference Vegetation Index (NDVI) within a 1,000 m buffer around the survey site. We investigated the correlation between NDVI and both the size at metamorphosis and adult size. The size at metamorphosis exhibited large variation both within and among survey sites, with differences exceeding tenfold. There was a negative relationship between NDVI and size at metamorphosis, whereas no significant relationship was observed between NDVI and adult size. These results support our idea that toads exhibit complementary growth between life stages: toads in less vegetated (urban) areas tend to grow more during the aquatic stage to achieve comparable adult size as those in more vegetated areas. High variation in size at metamorphosis suggested that not all urban populations experience benefits from this

complementary growth. Further studies to verify the effect of size at metamorphosis on the post-metamorphic growth rate will be needed.

A-0780 (Oral)
The Global Conservation Status of *Varanus* Merrem, 1820 - Overview of Threats and Uncertainties in the Assessment of Their Protection Status

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In 2003, 58 *Varanus* species were known to science, today ca. 89 species are known. More than 10 subspecies now have full species rank and new species have been discovered. Currently 74 species have been evaluated in the IUCN Red List, of which ca. three species require an update due to taxonomic changes, and others likely including new taxa. Among the 74 species, 12 have been assessed in threat categories (CR, EN, VU), two species as Near Threatened (NT), 10 species as Data Deficient (DD), and 50 species evaluated Least Concern (LC). Information on population trends does not necessarily match with Red List categories, e.g., species evaluated LC may have a decreasing population trend. Importantly, in 30 species the population trend is unknown, of which several have been evaluated LC. Year of assessment is crucial to evaluate a species' current conservation status, in 10 species the year of assessment dates back ≥ 10 years. Analysis of threats indicated in the Red List clearly reveal numerous uncertainties. For almost no species it is possible to indicate the various combinations of threats and the contribution they make to overall declines; accordingly, further research and monitoring is recommended. Various species are utilized for consumption, traditional medicines, hides for the fashion leather industry and the pet trade, with the latter often not indicated in the Red List. Gradually, more space is being given to use and trade as a potential/actual threat, but its assessment as a possible cause of population declines often remains unconsidered. For many Hapturosaurus spp. for example there is a perpetual international demand; information on potential fragmentations of geographically wide-ranging species remain unmentioned, especially when these are well-established lucrative resources. More research is required to eliminate existing uncertainties to establish measures for improved conservation of the Varanidae in the short term.

A-0781 (Oral)
Amphibian Translocations in Belgium (Europe)

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Belgium is one of the most densely populated countries in Europe. The critical state of many amphibian populations, and the highly fragmented remaining habitats have rendered natural dispersal and colonization impossible for several species. As a consequence, conservation of amphibian populations shifts towards translocations to achieve (inter)national species-specific goals. Animals are moved as a mitigation measure, to supplement genetically impoverished populations, or to create novel populations. We present translocation projects of four native amphibian species: Common spadefoot toad (*Pelobates fuscus*), Common midwife toad (*Alytes obstetricans*), Natterjack toad (*Epidalea calamita*), and Great crested newt (*Triturus cristatus*). Considerable effort and funding are invested for the conservation of these species. First, natural

habitats are created and/or optimized. Next, *ex-situ* headstarting or breeding of captive populations is conducted. Subsequently, larval and juvenile life stages are released for a number of consecutive years, after which the populations are monitored. Despite these efforts, the outcomes vary substantially due to the complex nature of translocations and the interplay with the receiving habitats. We discuss the actions and results and provide an overview of the key elements for successful translocations in this context.

A-0782 (Oral)
A New Spin on Field ID: An Identification Guide for Snakes of Zenadth Kes (Torres Strait)

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Species identification guides help people to understand and connect with nature. Australia is a large and ecologically diverse country with >1,000 recognised species of reptiles and more being described annually. Over time, identification support has shifted from a focus on nation-wide field guides that combine both reptiles and frogs to a focus on reptile-specific guides at the state and region level. These more localised guides not only inform people about reptiles in their area but also support emerging ecologists and naturalists to rapidly identify some of our most cryptic reptiles. While working for the Australian Wildlife Conservancy in the remote Kimberley, I developed a series of eight clear and easily updateable reptile guides for the region. These in-house guides support ecologists, volunteers, and partner organisations working across this diverse region where new species continue to be described in most years. Using this concept, I later developed in-house guides to support biocultural survey programs across the Torres Strait. The Torres Strait is an area where scientific information is scarce, emerging, and sometimes contradictory. With support from the Torres Strait Regional Authority, First Nations Rangers, Elders, and fellow reptile experts and photographers, I converted one of these preliminary internal guides into an external and free PDF that has a community focus and a citizen scientist element. During my presentation, I'll discuss this guide in detail, focusing on features that support community engagement and knowledge sharing. The latest version can be previewed, download and shared from my Google Drive account at https://drive.google.com/drive/folders/1lpId0ZFYj92lw4iYs55FNbXXN77QL8nR.

A-0783 (Poster)
Home Ranges of Sand Lizards (*Lacerta agilis*) along Railway Tracks

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Railways are important novel habitats for sand lizards, where they often occur in high densities. Nevertheless, railways are subject to regular interventions, which might threaten local sand lizard populations. To assess possible threads of construction activities, detailed knowledge of how sand lizards use their habitat along railways is essential. Therefore, we used VHF telemetry transmitters to track Sand lizards from spring to late summer in their habitat along a railway track in Brandenburg, Germany. Our aim was to find out how large home ranges of sand lizards are and if home range sizes differ between seasons and sexes. Furthermore, we

wanted to know which microhabitat structures are present in the core areas of the home ranges. We also tried to locate the sleeping sites. We found that home ranges are smallest in spring and largest in summer. Differences in home range size between males and females were detected for June, when females were gravid. Home range size was best predicted by calendar week, most likely due to changes in air temperature. The core areas of tagged Sand lizards were located directly along the railway track, comprising of the track itself, the adjacent sideway and the following embankment. Sleeping sites were found mostly in the embankment and in the railway track. The latter was the main sleeping habitat in summer, while in spring and late summer embankment and forest edge were found to provide suitable sleeping sites. Our study shows that habitat use of Sand lizards varies during different seasons and – as a novelty – provides valuable insights into the use of different microhabitats as hiding and sleeping sites. Furthermore, we showed that the railway track and the adjacent embankment with high structural diversity provide all crucial elements for the occurrence of Sand lizards throughout the year.

A-0785 (Oral)
Alternatives To Animal Experimentation In Herpetological Research

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Amphibians are widely used as model organisms and increasingly as focal research subjects. Global amphibian declines have sparked an increase in amphibian experimentation. To account for biological variation, proper replication and the desired number of treatments, such experimentation often results in the use of high numbers of amphibians in lethal experiments. We will present an overview of currently available or future alternatives for large scale *in vivo* trials with amphibians that improve welfare despite coming at a cost. We will discuss possibilities to significantly reduce the number of animals needed and the use of captive bred versus wild individuals. While the use of other vertebrates as alternatives for amphibians is not commonplace, invertebrates offer some opportunities. In specific cases, the use of live animals can be avoided or strongly reduced using tissue or cell cultures or by collecting body secretions, microbiomes and mucosomes. Finally, the use of abiotic models is gaining importance and developments in organs-on-a-chip and *in silico* predictions yield promising tools that someday may make the use of amphibians redundant.

A-0786 (Oral)
Responses to Habitat Change in Knysna Dwarf Chameleons (*Bradypodion damaranum*)

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Environmental change is a fundamental evolutionary driver, but the magnitude, rate and direction of evolutionary change depends on the strength of natural selection and the genetic cohesion between populations. In addition, behavioural compensation might be a factor, and if operative, traits may remain conserved. In contrast, if selection is intense and behavioural compensation weak, trait states can diverge rapidly. With the rapid pace of anthropogenic induced environmental change due to urbanization, some populations of various species appear be undergoing rapid evolution of traits, but the tempo of change may vary due to behavioural compensation. African dwarf chameleons (*Bradypodion*) have populations in both natural habitat and in towns urbanised over the last century. This system allows for examination of trait shifts in the urban populations, and whether behavioural compensation may be allowing those populations to persist, or whether rapid adaptation has occurred. We examined multiple populations of *B. damaranum* from Afrotemperate forest and nearby urban areas for trait shifts associated with the less dense vegetation of the urban setting. Urban populations appear to be under directional selection toward robust bodies, but with under-developed ornamentation, possibly conferring an advantage for remaining cryptic to predators in the sparse vegetation of the urban environment. Furthermore, urban chameleons are significantly more scarred by conspecifics. This suggests that their reduced ornamentation compromises their ability for signalling to reduce conflict, and instead their encounters escalate to physical contests. In contrast, we found that selected body temperature is conserved, with no significant difference between populations, even for populations that are subjected to significantly different ranges of environmental temperatures. The complexity of responses to urbanisation, from labile to conserved traits, suggests that population responses to habitat transformation are highly contingent on the system and its history.

A-0787 (Oral)
Translocation Efforts for the Critically Endangered Northern Corroboree Frog (*Pseudophryne pengilleyi*) in South-Eastern Australia

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Australia has experienced severe amphibian population declines in recent decades, with close to one quarter of native species currently threatened with extinction. Six species are thought to have become extinct during that time with a further seven species regarded perilously close to disappearing, including the Northern Corroboree Frog (*Pseudophryne pengilleyi*). This small myobatrachid frog is restricted to the Brindabella and Fiery Ranges of south-eastern Australia. It has rapidly declined in recent decades largely due to disease, caused by infection with amphibian chytrid fungus (*Batrachochytrium dendrobatidis*). Population numbers are critically low, with two of the three Evolutionary Significant Units (ESU) within the species consisting of less than 200 mature adults. Immediate management objectives for this species include establishing robust insurance colonies, maintaining populations in the wild via translocation, and developing efficient offspring production and translocation methods. Conservation breeding programs for all three ESUs have been established in Australian zoos, with the most recent insurance population created as an emergency response to the impact of the devastating

2019/20 bushfires on its remaining breeding populations. Translocations for this species have focused on maintaining viable populations of the species despite the ongoing presence of chytrid fungus. Experimental translocations currently include the release of eggs and frogs into artificial and natural pools at wild sites, investigating factors such as the effect of seasonal timing and the age of released frogs on post-release survival and reproductive success. Additionally, research is being undertaken on artificial reproductive technologies to increase the output of offspring for release and husbandry techniques to maximise the health and viability of offspring being translocated.

A-0788 (Oral)

Salamanders in a New-found-land: How Dietary Changes and Preexisting Invasive Prey may have Promoted the Invasion Success A Novel Amphibian

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Biological invasions provide research opportunities to study how organisms react to ecological change, as well as how human activity can influence invasion outcomes. Such studies can be particularly relevant for taxa that are suffering declines in their native range, but also often represent significant ecological threats as invaders (e.g., amphibians). The island of Newfoundland, Canada, has no native amphibians, however, five species have established populations – the most recent being the Eastern Red-backed Salamander (*Plethodon cinereus*). Our description of this invasive population represents the first established urodelan to the island, as well as the first account of this species establishing a population outside of its own native range. This species has a broad invertebrate diet and is able to form high density populations in their native range. We posit that their successful colonisation of Newfoundland may have been mediated by dietary shifts that allowed them to capitalize on an even wider variety of prey (i.e., the Niche Breadth Invasion Success hypothesis), as well as by exploiting pre-existing invasive prey communities (i.e., the Invasional Meltdown hypothesis). To test this, we identified prey items from the stomach contents of Newfoundland salamanders and compared the composition of the invasive diet to that of their native range, as well as categorised prey as either native or invasive. As expected, the invasive salamander population's diet became (1) more generalised diversified and (2) invasive invertebrates comprised a substantial proportion of prey eaten. Our research provides insight into how prior invasions of invertebrate prey types – that may often be viewed inconsequential – can bolster the invasive potential of a more concerning predatory species, especially when the predator posses the capacity for dietary flexibility and high population density.

A-0789 (Oral)

Influence of Climatic Factors on Morphological Traits of *Kalophrynus palmatissimus*

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This study explores the influence of climatic factors on morphological traits of *Kalophrynus palmatissimus*, commonly known as the Lowland Grainy Frog, within Ayer Hitam Forest Reserve (AHFR) in Selangor and Pasoh Forest Reserve (PFR) in Negeri Sembilan, Malaysia. Data collected over a period from November 12, 2016, to September 13, 2017, included morphometric measurements of 15 traits using vernier callipers and sampling was done using 15 and 18 nocturnal 400 m transect lines with an interval distance of 20 m at AHFR and PFR, respectively to assess frog populations. The precise geographic locations were recorded along with five climatic variables. Results revealed positive correlations among most morphometric traits within forest reserves, AHFR ($n = 34$) and PFR ($n = 31$). Soil pH exhibited a significant positive influence on most traits ($p < .01$), while temperature showed a significant negative impact on all traits ($p < .01$). General Linear Model (GLM) analysis identified snout-vent length as a key factor influencing morphometric traits (SVL) ($F \leq 80.86$, $p < .01$). Additionally, *K. palmatissimus* at AHFR exhibited slightly larger SVL compared to PFR (AHFR: $\mu = 37.00$ mm, SE = 1.16 c.f. PFR: $\mu = 30.29$ mm, SE = 1.07). Principal Component Analysis (PCA) highlighted distinct trait groupings for AHFR and PFR, suggesting simultaneous growth patterns within each reserve. Insufficient data exists regarding the distribution and morphometric characteristics of *K. palmatissimus* in Malaysia, particularly within AHFR and PFR. This study revealed disparities in 15 morphometric traits of *K. palmatissimus* between AHFR and PFR, indicating that individuals from AHFR tend to be slightly larger than those from PFR. This research contributes valuable insights into the morphometric variations of *K. palmatissimus* between AHFR and PFR, emphasising the importance of climatic factors in shaping frog morphology.

A-0790 (Oral)

Fitness Consequences of Maternal Nest Sight Choice in a Widespread Invasive Lizard

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Environmental heterogeneity imposes numerous challenges to individuals in ways that could reduce their Darwinian fitness. Consequently, natural selection has favored several routes that enable organisms to overcome these challenges. For example, individuals can reduce exposure to environmental variation by behaviorally choosing habitat with optimal conditions. This can be critical during early life stages (e.g., embryonic stages) that are sensitive to environmental variation. Indeed, parental reproductive behaviors (e.g., nesting behavior) can buffer developing offspring from a wide range of environments, thereby exposing offspring to good developmental environments that have life-long positive effects; this is the crux of the Silver Spoon Hypothesis (SSH), which posits that individuals that experience 'good' early-life environments maintain a fitness advantage throughout life. We address the SSH with respect to maternal nesting behavior in the Brown anole lizard (*Anolis sagrei*) and predict that nest-site choice shields embryos from suboptimal environments and facilitates offspring phenotypes and survival. Eggs were experimentally "planted" in maternally chosen and randomly chosen nest locations in the field, and we measured egg hatching success, hatchling phenotypes and survival. Preliminary analyses indicate that egg hatching success was high regardless of the location where eggs were located. Future analyses will examine the impacts of maternal nest-site choice on abiotic conditions of the nest and on hatchling survival. Overall, this work provides insight into how maternal behaviors can influence offspring fitness in heterogenous environments and how they may deal with environmental change.

A-0791 (Oral)

A Vision for a Healthier Herpetofaunal Trade

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Wildlife trade has been linked to the global dissemination of various pathogens. Considerable evidence exists that chytrid fungi and ranaviruses exist in amphibian trade, which can spillover to wild populations and contributed to declines. In the USA, chytrid fungi and ranaviruses cause an estimated 140 million US dollars in annual revenue losses to businesses. Previous surveys indicate that U.S. businesses and pet owners are in support of an industry-led healthy trade certification program that facilitates the sale of pathogen-free amphibians. In June 2022, we began discussions with over 20 industry stakeholders and experts to develop a voluntary program that would certify U.S. businesses as healthy trade partners. Member businesses are required to participate in online training; incorporate biosecurity practices that promote healthy animals; test a subset resident, for-sale, and newly acquired amphibians for target pathogens (chytrid fungi, ranavirus); and quarantine animals if a positive detection occurs. As market incentive, testing amphibians in shipments between certified businesses is not required. Testing is done using nonlethal swab samples and performed by approved laboratories that demonstrate proficiency in diagnostic assays for the target pathogens. In 2024, we created the Healthy Trade Institute, Inc. (HTI) – a U.S. 501(c)(3) nonprofit organization that will launch and coordinate this program. The HTI is currently recruiting diagnostic laboratories to lead pathogen testing and is opening membership to U.S. businesses that sell pet amphibians. Membership fees are tiered based on annual sale revenues. Member businesses are authorized to use the HTI certification logo to increase market value of their sellable amphibians. The HTI certification program is an innovative partnership among industry, academia, and a non-profit organization that empowers businesses to champion healthy trade practices that enhance the wellbeing of pets and wildlife.

A-0792 (Oral)
Socioeconomic Evidence for an Industry-led Healthy Trade Certification Program in the USA

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Wildlife trade can contribute to the global dissemination of pathogens that are harmful to pets and biodiversity. International and domestic movement of chytrid fungi (Bd, Bsal) and ranaviruses have been documented in amphibian trade and contribute annually to millions of dollars loss in revenues to US businesses. Spillover of pathogens from captivity to the wild also can have negative impacts on native species. In 2021, we performed a socioeconomic survey of US pet amphibian businesses and consumers to assess their awareness of pathogen threats to amphibians and gauge interest in purchasing pathogen-free amphibians. Most US businesses and consumers were aware of the threats that Bd, Bsal and ranaviruses pose to industry and biodiversity, and they were very interested in a program that could facilitate healthy (clean) trade. US consumers were willing to pay 77% more for an amphibian that was negative for Bd, Bsal and ranavirus. Using an average price per amphibian of $50 reported by US consumers, US businesses could increase profit margins by at least 26% if they incorporate pathogen testing and other biosecurity practices into their operations. Our results provide evidence that a market-driven healthy trade certification program is feasible for pet amphibians in the US.

A-0793 (Oral)
Fitness Consequences of Natural Incubation Environments: A Test of the Environmental Matching Hypothesis in the Brown Anole

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Environmental heterogeneity can present a challenge for many organisms. Overcoming this challenge can be difficult, especially for embryos of oviparous species without parental care who are subject to the stochasticity of the environment without the ability to behavioral change their circumstance. Adaptive developmental plasticity is one route by which embryos can cope with environmental heterogeneity. The environmental matching hypothesis (EMH) predicts that organisms will develop phenotypes that are suited to their environment when the developmental environment matches the post-developmental environment. We collected eggs (n = 2,296) from a wild-caught breeding colony of Brown anoles (*Anolis sagrei*) and subjected them to incubation profiles that mimicked the shaded and open environments in the field. After hatching, we measured the hatchling body size, critical-thermal maximum, desiccation rate, and behavioral reactions to a predator. Hatchlings (n = 1,535) were then released on one of two islands that corresponded with the incubation conditions in the lab: an open island with very little structure and a shaded island mostly covered with trees. Our reciprocal transplant design ensured that the developmental environment either matched or mismatched the post-hatching environment on the island. We recaptured hatchlings over a 5-month period to access growth and survival. In accordance with the EMH, we predict that survival will be relatively high when the incubation environment is matched to the island's environment compared to when there is a mismatch. Preliminary results show that hatchlings from the open incubation treatment have increased survival on the open island compared to those from the shaded incubation environment. However, hatchling survival did not differ between incubation treatments on the shaded island. These results partially support the EMH and provide evidence that the fitness consequences of the developmental environment may depend on the post-hatching environment.

A-0794 (Poster)
Drones as a Reptile Survey Tool on Offshore Islands in New Zealand

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New Zealand comprises many different habitat types and terrain, ranging from the alpine region to sub-tropical offshore islands. These habitats often have rugged, isolated terrains, the last strongholds for many native lizards. Additionally, some of these sites are inaccessible due to their cultural significance to the local indigenous communities. Traditional methods of field surveying for lizards can be challenging within these difficult-to-access areas. Drones present a potential alternative approach to surveying lizards. To date, drones used for surveying lizards in New Zealand have focused on alpine habitats but have not been conducted on offshore islands. We propose to investigate the effectiveness of drones in surveying the only known surviving population of a gecko species (*Hoplodactylus duvaucelii*) in the Bay of Plenty and other reptile species (e.g., *Sphenodon punctatus* and *Woodworthia maculata*) on two islands off the coast of Bay of Plenty on the North Island, New Zealand. These islands have rocky cliffs where the geckos reside, and some parts of one island are tapu and, therefore, inaccessible to humans due to their cultural significance to Māori residents on the island. Drones have the potential advantage of surveying lizards in these tapu sites and rocky cliffs and could reduce the likelihood of accidentally introducing pests/invasive species or damaging habitat.

A-0795 (Oral)
Stomach Content of Adult Crocodiles in Sarawak

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Sarawak is home of the Estuarine crocodile (*Crocodylus porosus*), where the size of its population is showing an upward trend. Consequently, human crocodile conflict (HCC) is unavoidable. When HCC occurs, relevant agencies respond immediately which include trapping and culling the crocodiles. Limited information is available on stomach content of adult wild crocodile in Sarawak, therefore this study was carried out to assess the type and abundance of non-organic and organic items found in crocodile stomachs, particularly those involved in HCC. Five stomachs of adult crocodiles were examined following the standard gut content analysis procedure. A total of 44 pieces of non-organic items were found in the stomachs, with plastic debris was the most common, followed by metal, fabric and glass. Additionally, 80% of the stomach samples contained skeletal remains such as skull, bones, and other remnants of prey items. The findings in this study serve as baseline data on stomach content of adult crocodile in Sarawak. In future, more samples should be examined to provide a better insight on crocodile feeding behaviour, consequently data could be useful in future sustainable management of the resource.

A-0796 (Poster)
A Latitudinal Gradient in a Sexually Dimorphic Trait: Evolutionary Change of Snout-Vent Length in Males due to Male–Male Competition in *Hynobius nigrescens*

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The latitudinal pattern in temperature causes various latitudinal patterns of morphological traits in living organisms. Although such latitudinal patterns have been generally viewed as the result of natural selection, sexual selection may also lead to these latitudinal patterns. Although a recent study has shown the latitudinal pattern in the strength of male–male competition in medaka fish, such a latitudinal pattern related with sexual selection is rarely known in other organisms. Here, we show the latitudinal pattern of a sexual dimorphism of snout-vent length (SVL) driven by sexual selection in *Hynobius nigrescens*. We collected 661 individuals at 111 sites and conducted phylogenetic analyses to examine the phylogenetic pattern along latitude. From the constructed phylogenetic tree, this species was split into five lineages. Next, we examined whether the operational sex ratio (OSR) has been biased toward males in lineages distributed at lower latitudes by field survey. We found that the OSR was more biased toward males in a lineage distributed at lower latitudes due to its longer breeding period. To examine the differences in the degree of sexual dimorphism among lineages, we collected 617 males and 158 females and compared for differences in SVL between sexes for each lineage. We found that SVL was longer in females in all the lineages. To examine the relationship between sexual dimorphism and OSR, we conducted PGLS analysis. The degree of sexual dimorphism was lower at the sites where the OSR was biased toward males. These results suggest that the SVLs of females were originally longer than those of males in the ancestors of *H. nigrescens* due to the production of egg sacs in females, whereas at the low latitude, the male SVLs might have evolved to be longer due to sexual selection, leading to the disappearance of the difference between sexes.

A-0797 (Poster)

Has Predation Pressure by Newts Driven Evolution of Egg Sacs from Clear to White in Japanese Black Salamander?

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Predation pressure often leads to diverse evolutionary outcomes in the prey. Eggs themselves are unable to escape from their predators, though, in most animals, parents don't protect their eggs. Therefore the defensive traits of eggs themselves are the important factors. However, few studies have compared the effect of the defensive traits of eggs themselves against predators within species. Egg sacs of Japanese black salamander (*Hynobius nigrescens*) show geographic color variation from clear to white. Considering that all related species spawn clear egg sacs, the color has evolved from clear to white in this species. We found that white egg sacs are harder than clear ones, and that white egg sacs can be physically more defensive against predator than clear ones. We also found that the main predator was newts (*Cynops pyrrhogaster*). Here, we show that white egg sacs have evolved from clear ones in areas with strong predation pressure by newts in this species. We surveyed predation pressure by newts against egg sacs in the field. We found that predation pressure by newts was strong at the sites where white egg sacs were spawned. we provided any one of color egg sacs to newts, and counted the number of eggs preyed in a day. The eggs in white egg sacs were less preyed than

those in clear ones, indicating that white egg sacs are physically more defensive against the predation by newts than clear ones. Lastly, egg sacs were exposed to UV, and compared mortality rate among egg sac colors to verify the hypothesis in a previous study that clear ones are more vulnerable to UV than white ones. Our result showed that mortality rates were not different between them. These results suggest that hard egg sacs with white color have evolved in areas with strong predation pressure by newts.

A-0798 (Oral)
Sea Turtles in Similajau National Park, Bintulu, Sarawak, Malaysia

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The most commonly found sea turtle in Sarawak is the green sea turtle, *Chelonia mydas*. This turtle is an endangered species based on IUCN Redlist and is listed as Totally Protected Animal in the Wildlife Act 2010. Due to its long-distance migrating behaviour, turtles are at risk of being involved in fatal accidents in fisheries, shipping, and other maritime activities. Research on turtles in Sarawak was mostly done at Talang-Satang National Park. Up to-date, there is limited scientific studies on turtles of Bintulu Sarawak, therefore more data is required to support conservation effort of the species. This paper decribes the ecology of sea turtles in Similajau National Park, Bintulu Sarawak besides brief analysis on the historical data on turtle nesting and local knowledge on sea turtles. It is hoped that findings of this study could aid in sustainable management of sea turtles.

A-0799 (Oral)
Maternal Sex Reversal Provides Early Benefits for Offspring Fitness-Related Phenotypes

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Sex in vertebrates is generally determined by genetics or the environment but, in some species, sex determining genes interact with developmental temperatures to produce sex-reversed individuals. This phenomenon provides an opportunity to observe how fitness-related traits could influence transitions between modes of sex determination. The Central Bearded Dragon (*Pogona vitticeps*) typically has genotypic sex determination. However, sex-reversed females are produced when incubated at hot temperatures in the laboratory and occur at low to moderate frequency in some wild populations. The presence of sex reversal in this species could lead to an evolutionary transition between modes of sex determination but this is likely to require a positive relationship between sex reversal and fitness – a relationship that has not yet been explored. Here, we quantify the effects of maternal sex reversal on morphology, growth,

locomotor performance, and critical thermal limits of captive bred juvenile *P. vitticeps* to evaluate how these fitness-related traits may influence the persistence or spread of sex reversal. We show that sex-reversed mothers produce larger offspring with better body condition at hatching. Although this size difference dissipates quickly, it does not affect offspring locomotor performance or critical limits. The maternal effects are complicated by the influence of developmental temperatures on locomotor performance as well as the critical thermal minimums of offspring. The larger size at hatching exhibited by the offspring of sex-reversed mothers may allow sex-reversed offspring to better survive to adulthood and enhance transitions from GSD to TSD modes of sex determination.

A-0800 (Poster)
Predicting Risk of Temperature-driven Sex Reversal through Microhabitat Modelling

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Nest site selection by oviparous reptiles can affect environmental characteristics experienced by incubating eggs and can alter phenotypes, including sex, in ways that persist into adulthood. Maternal nesting behaviour may be essential to mitigating the risks posed by a heating climate through the choice of cooler nest sites or shifts in reproductive phenology. The central bearded dragon lizard (*Pogona vitticeps*) has thermally labile sex determination, with ZZ male/ZW female genetic sex determination and a high temperature override that produces sex-reversed (ZZ) females. This phenomenon has been observed in natural populations, yet little is known of their nesting behaviours and if these behaviours may mitigate or perpetuate sex reversal in free-ranging populations. We quantified microclimate variables from five nest sites chosen by free-ranging females and potential nest sites across eight geographic locations within the species' range. We used these data to inform microclimate models using NicheMapR Shiny app web interface to predict the risk of sex reversal at these points. Our observed nesting data shows that females preferentially chose relatively open habitats that provide warmer incubation temperatures across the reproductive season, which may explain the presence of sex reversal in some populations. We show that the NicheMapR Shiny app models frequently under-predicted soil temperatures likely due to our relatively minimal parameter entries. We offer a general correction that improves the predictions and can be utilised by future studies without relying on intensive microhabitat sampling. Adjusted predictions and observed soil temperature data show that canopy cover and early nesting in some of the hottest regions of the species' range may offer thermal refuge to buffer sex reversal. This study informs on the relative risk of reversal at point locations and highlights the necessity of nesting behaviour studies across the range of this species.

A-0801 (Oral)
High Levels of Micronutrients on Freshwater Turtles Meat: Implications for Remote Communities' Conservation and Health Programs

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Freshwater turtles over millennia have been a key resource to human societies worldwide, although they are amongst the most endangered groups of vertebrates. The role of bushmeat as a source of protein for remote indigenous communities is widely recognised. However, the lack of awareness of its importance as a micronutrient source might lead to the labelling of animals captured and consumed sporadically as a delicacy and nonessential for the community's dietary needs. During our various studies on metal concentrations in freshwater turtles in Amazon (*Peltocephalus dumerilianus, Podocnemis expansa, Podocnemis unifilis*) and Northern Australia (*Chelodina rugosa, Carettochelys insculpta, Elseya dentata*) we observed that all freshwater turtle species analysed accumulated high concentrations of iron and zinc in both muscle and liver. All turtle samples reported iron concentrations (ppm) at least twice higher cattle muscle (Australian beef), with *C. rugosa* having a seven-fold higher iron concentration when compared to cattle. There was a significant relationship between species average size and species average iron concentrations in raw muscle (Spearman's Rho = 0.5, $n = 5$, $p < 0.05$). In average, smaller species had significantly higher concentrations of iron (ppm) in their muscles. Animals used as flagship species, such as turtles, are particularly susceptible to being categorized as a nonessential meat resource. Iron deficiency is the most predominant micronutrient deficiency, affecting an estimated 30% of the global population, particularly those living in remote communities, such as the Gulf Province of Papua New Guinea and the Northern Territory. Conservation programs expecting communities with high levels of anaemia to cease consuming turtles, without introducing alternative sources of micronutrients, might aggravate local health issues. Both wildlife conservation and health programs in such locations must consider the potential importance of freshwater turtles and other bush meats as sources of micronutrients.

A-0802 (Oral)
Friend or Foe? Opportunities and Challenges in Generative Artificial Intelligence for Wildlife Conservation. A Case Study with Turtles

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Generative Artificial Intelligence (GenAI) programs (e.g. ChatGPT, Gemini) create content derived from its training on extensive datasets, including scientific literature, books, and websites. In wildlife conservation, GenAI has the potential to be a tool for equality and inclusion. For example, it could be a game changer for grassroots organizations, boosting their content creation, and addressing bureaucratic tasks efficiently and timely. However, GenAI can also amplify already existing bias and harmful stereotypes. There is also the potential for jeopardizing public perception on the value and scale of biodiversity. Our results on GenAI output analyses and training data tests indicate a clear bias on conservation actions and perception between charismatic and feared species (e.g., turtles vs. snakes). There is also a high degree of bias between the number of sea and freshwater turtles' outputs, which is derived from the GenAI training dataset. A low level of species diversity on image generator programs outputs was observed, with only a limited number of generic turtle species images been created.

Furthermore, although most outputs mentioned sustainable traditional harvest of turtles as an acceptable practice, its overall tokenistic tone could lead to an increase in the stigma and consequently the alienation of traditional communities, who are practicing sustainable use. In a case study, we introduced GenAI programs to a small, local NGO in Papua New Guinea, the Piku Biodiversity Network (PBN; Piku = Pig-nosed Turtle). GenAI tools were quickly incorporated to complete previously time-consuming content creation tasks, allowing PBN to boost outreach productivity. However, as a research tool, GenAI outputs were generic and unsatisfactory for its local and specific contexts of freshwater turtles in the Pacific. GenAI is only as good as the information it is trained on. In wildlife conservation, we should acknowledge GenAI limitations and advocate for new tools that incorporate those ethical frameworks.

A-0803 (Poster)
Modelling Vehicle Impact on Flatback Turtle Eggs: A Mechanical Engineering Perspective

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Flatback turtle nests are located above the high tide mark of Cable Beach, Broome, Western Australia. Similar to many touristic beaches around the world, Cable Beach is a popular path for recreational vehicles, which can potentially damage incubating eggs. Currently there are no empirical studies to validate this assumption, nor data pertaining to the strength of the Flatback turtle egg against such forces. Our study aimed to determine the forces imparted onto eggs and model the potential effect of vehicles driving over Flatback turtle nests. We tested the mechanical properties of the eggshell and modelled it in 3D CAD software. Finite element analysis (FEA) software was used to simulate stresses involved in the vehicle-sand-egg interaction. The resulting stresses and deformation can be compared to the strength of the egg to infer whether eggs risk being damaged. Such analyses give an indication of the level threat that vehicles pose to nests of the Flatback turtle and provide evidence to guide future conservation and management efforts. The novel data acquired from testing Flatback turtle egg properties, and the unique vehicle-sand-egg simulation model also provide a basis for further studies merging mechanical engineering and turtle ecology and conservation.

A-0804 (Poster)
A Review of Sea Turtle Awareness Programs in Malaysia Through the Eyes of the Public

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Malaysia is blessed with important sea turtle nesting rookeries along its coasts. As the population of sea turtles declines in the country, conservation efforts in the form of outreach are important to obtain support and civic engagement in this sector. To understand the sea turtle outreach efforts in Malaysia, the outreach programs, program types and strategies by Malaysian non-governmental organisations (NGOs) and government agencies are reviewed in this paper, by tracking their social media and websites between January 2023 and mid-April 2024. Out of the 15 agencies analysed, approximately 50 per cent conduct only two types of outreach programs out of four types, with ecotourism (80%) and community outreach (73%) being the

most common. Knowledge dissemination and hands-on activities are strategies employed by all organisations, while only 20 per cent of the organisations were found to employ knowledge application on top of the former two. This review is highly dependent on the activeness of each organisation in their website and social media updates, which is the communication channel to the public.

A-0805 (Oral)
How do Fisheries Impact Sea Snake Assemblages in India? Insights from the Konkan Coast

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Interactions with fisheries have contributed to the decline in sea snake populations worldwide. In Asia, fisheries affect the resource and habitat use of sea snakes in addition to being harvested for consumption. There have been fewer studies on the impacts of fisheries on sea snake ecology and species assemblages along the Indian coast. To address this knowledge gap, a study was conducted in Malvan by the Dakshin Foundation, Bengaluru, and the Maharashtra Forest Department to determine trends in sea snake bycatch in coastal fisheries. Sea snake bycatch from trawl and gill nets were sampled from January 2016 to December 2018 at landing centres and through onboard surveys. Findings indicate that highly concentrated fisheries are driving changes in sea snake assemblages. High mortality rates of *Hydrophis curtus* in bycatch may have caused its population decline in less than two decades. Furthermore, the vulnerability of gravid females of *H. schistosus* to fishing mortality might trigger a population decline in this species if it continues unchecked. Additionally, mechanized fishing has increased in Maharashtra and Goa from 2005 to 2019 with operational vessels growing by 25% and over 100%, respectively. The way forward will be to examine how varying fisheries pressures impact population demographics, abundance, species assemblages, habitat use, and diet of sea snakes in multiple sites along the Konkan coast over time using museum and live specimens. This will help understand the impact of fisheries on sea snake populations from a perspective beyond rates of bycatch and associated mortality.

A-0806 (Poster)
Can Wet Museum Specimens be used to Understand Trophic Changes in Sea Snake Populations over Time?

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In Asia, sea snakes compete for resources (prey and habitat) with fisheries and are harvested for consumption. The outcome of these interactions potentially includes shifts in trophic ecology, species assemblages, and population demographics and size. However, assessing the long-term impact of fisheries on sea snakes is challenging without historical data collected using robust methods. Isotopic ecology has been widely applied to comprehend spatial

connectivity and trophic interactions in marine systems, with some studies using historical and contemporary museum specimens to assess historic trophic shifts in fish, cetaceans and sea turtles. Few studies have employed stable isotopes to explore the spatial and trophic ecology of sea snakes and their relationship with the surrounding environment, and none have used museum samples to understand trophic changes. This research will examine specimens at the Bombay Natural History Society (Mumbai, India) and Indian Institute of Science (Bengaluru, India) to assess changes in the trophic ecology of sea snakes over time. Ten specimens of three species (such as *Hydrophis schistosus, Hydrophis curtus*, and *Hydrophis cyanocinctus*) will be selected from two time periods, categorised as historic (collected between 1900–1960) and contemporary (collected between 1960-present), collected from locations on the west coast of India. Since preservation media of wet specimens may affect isotopic signatures in different types of tissues, multiple samples (muscle and bone) from specimens will be analysed to determine the extent of variation in C and N ratios using mass spectrometry. Isotopic profiles of prey species will also be created. The results will define sea snake trophic position, inform understanding of spatial and temporal variation in sea snake trophic ecology, and inform future protocols for stable isotope analysis of tissue from museum specimens preserved in fixative media. In a broad context, the findings will also further research on the biology and conservation of sea snakes.

A-0807 (Oral)
Finding Rearrangements in Organellar Gene Order (FROGO)

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Hybrid-enrichment has gained popularity as a third-generation sequencing approach targeting potentially thousands of markers. Off-target reads, dominantly comprising mitochondrial DNA due to its large copy number, have the potential to yield valuable additional data. We performed successful *de novo* assemblies of structurally unique mitochondrial genomes using off-target reads generated by hybrid-enrichment target capture performed on 165 frog specimens. As *de novo* genome assembly algorithms are designed with whole genome sequencing data in mind, the gaps inherent to reduced representation sequencing methods like target capture can hinder the effectiveness of *de novo* methods. To address this, we developed a seed exploration method to optimize seed selection for seed-based *de novo* assembly. Our methods produced circularized mitochondrial genome assemblies covering the generic-level diversity of the Microhylid frog subfamily Cophylinae. Cophyline frogs are found exclusively on Madagascar and exhibit great taxonomic diversity, with 115 currently described species in 9 genera. Our mitochondrial genome assemblies have facilitated the creation of a new, well-resolved phylogeny that lends support to the generic relationships previously reported in the literature. Over 50 *de novo* mitochondrial genome assemblies, not hampered by methodological constraints of reference based methods, revealed the existence of derived reorganization of mitochondrial structure that arose in the ancestor of three genera: *Stumpffia, Anilany*, and

Rhombophryne, while independently confirming the novel mitochondrial genome structure previously reported for Anilany based on whole genome sequencing data. However, the complicated pattern for gene rearrangements observed in these genera can not be explained by simple models like tandem duplication and random loss. Our results indicate off-target reads from target capture data can be used to reconstruct mitochondrial genomes with variable structure, and provide a framework for optimizing seed-based *de novo* assembly methods.

A-0808 (Oral)
Molecular Phylogenetics and Systematics of Sulawesi Reedsnakes (Calamariinae)

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The Sulawesi calamarine snake assemblage is currently composed of 16 species across four genera, including: *Calamaria, Calamorhabdium, Rabdion*, and *Pseudorabdion*. Of the 16 recognized species, nine are known from very few specimens, likely due to their localized, often high-elevation distributions, as well as their fossorial life histories. A corresponding lack of specimens with associated tissue samples has hindered the estimation of phylogenetic relationships from genetic data, thus limiting the ability to investigate diversification processes within this assemblage. Herein, we present results from targeted elevational transect surveys on eight Sulawesi mountains. We improved historically sparse sampling gaps and collected 74 additional specimens – representing all four Sulawesi calamarine genera. By combining the molecular data from the newly acquired samples with data from our existing repository of samples collected over the past 25 years, we are now able to provide a baseline for more comprehensive phylogenetic estimates within this group. The resulting phylogenetic analyses have greatly enhanced our knowledge of the distributions and diversification histories of these snakes, revealing new species and species complexes on the island. Our analyses suggest that calamarines are polyphyletic, not monophyletic. We also coupled our molecular efforts with in-depth morphological investigations of available specimens, thereby expanding the known morphological variation within this group, and revealing previously unrecognized diagnostic characters that serve to differentiate both currently recognized and undescribed species.

A-0809 (Oral)
Here and Now: A Novel System for the Global Assessment of Ongoing Climatic Threats for Endangered Herpetofauna

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The evaluation of climatic vulnerability for herpetofaunal species has largely focused on contrasting thermal tolerance with predictions of the thermal environment. However, the

multifaceted nature of climatic vulnerability makes it challenging to guide funding and responsibility allocation toward herpetofauna's climate adaptation. This complexity has led to the widespread use of incorrect thermal indices in vulnerability models or predictions that look too far into the future to press authorities to implement adaptation actions. In this talk, I present a simple and novel system, rooted in sound ecological concepts and publicly available distribution and climatic data, to find sites where to promote climatic adaptation actions against biodiversity erosion, starting now. New geographic and geopolitical patterns in climatic threats for the world's endangered squamates and turtles are presented.

A-0810 (Oral)

Taxonomic and Functional Diversity of Anura Across Lowland Forest and Agroforest Ecosystems of the Makiling Forest Reserve

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Agricultural expansion is one of the primary drivers of biodiversity loss in the tropics, leading to homogenization of the landscape and increased habitat fragmentation. Considering this ecological crisis, agroforestry is increasingly recognized as a promising strategy that balances diversified production while maximizing ecosystem services and reducing environmental impacts. Despite an increasing number of studies showing that agroforestry systems can contribute to the conservation of tropical biodiversity, there are still few studies in the Philippines that tackle the biodiversity values of agroforestry systems compared to those of intact forests in multiple biodiversity dimensions (taxonomic and functional). This study aims to assess the taxonomic and functional diversity of frogs as bioindicator taxa across the lowlands of the Mt. Makiling Forest Reserve. Frogs were sampled using a visual encounter survey. Species richness, abundance, and Shannon diversity were used for analyzing taxonomic diversity, while functional richness, functional divergence, and beta diversity were used for functional diversity analysis. Results showed that the agroforest ecosystem holds a comparable species richness of frogs with that of the forest. Species composition and abundance do vary between the two ecosystems.The two most abundant species in forests are *Kaloula conjuncta* and *Limnonectes woodworthi*, which are forest-associated species, while the most abundant species in agroforestry are *Fejervarya vittigera* and *Rhinella marina*, which are disturbance-tolerant species, with the latter being invasive. Agroforestry contains comparable functional diversity with that of the forest, although variation in ecological traits can be observed; and the functional beta diversity of frogs between the two ecosystems is overlapping. The main findings of this study highlight the ecological importance of the agroforestry system in harboring a taxonomic and functional diversity of frogs comparable to that of forests. This implies that agroforestry can be used to conserve frog diversity in fragmented landscapes.

A-0812 (Poster)

Home Range and Habitat Preferences of Reintroduced Juvenile Yellow-margined Box Turtle in Taiwan

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The Yellow-margined box turtle (*Cuora flavomarginata*) is one of the most endangered freshwater turtles, threatened by the massive illegal turtle trade in Asia. Therefore, it has received increased attention for reintroduction programs as a flagship conservation species in Taiwan. However, like most turtle species, knowledge gaps regarding juvenile ecology hinder effective management strategies. This study employed radio-tracking to investigate the behavior and habitat use of 23 juvenile turtles (carapace length 9-12.5 cm) over two years. We assessed factors influencing post-release adaptation and identified suitable release sizes. Results show that these juveniles have an average home range of 5.36 hectares; males exhibited larger home ranges compared to females. Interestingly, a negative correlation emerged between home range and pre-release condition index (CI), suggesting that healthier turtles dispersed less after reintroduction. Habitat preference leaned towards forest edges bordering betel nut plantations or grasslands, likely due to the lower canopy cover facilitating thermoregulation. Overall, we observed an improvement in CI over time, indicating that turtles exceeding 9 cm might be strong candidates for reintroduction. Furthermore, Ensuring the good health of these juveniles before release may be crucial for maintaining their presence in the chosen location and increasing the efficacy of reintroduction programs of this endangered species.

A-0813 (Oral)
Hear that Lonesome Whistle Blow: The Impact of Railroad Tracks on Turtles

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Roads and railroad tracks are the largest terrestrial transportation infrastructure systems; however, unlike roads, few studies have addressed the potential influence of railroad tracks on vertebrate movement, migration, gene flow, and mortality. Although most previous research has focused on large mammals, turtles' small size and life history patterns, such as seasonal movements between habitats for overwintering or nesting, may make them especially vulnerable to the effects of railroad tracks. Our study examined how railroad tracks impact turtles and how different species are affected. We assessed the number of turtles potentially affected by two 1.6-km sections of railroad tracks in Prince George County, Virginia, USA, over a four-month active season in two years, 2005 and 2006. Species, sex, plastron size, and location were recorded for each turtle. We encountered 33 turtles, representing seven of nine species known for the County. Approximately equal numbers of turtles were found between the tracks or against an outer rail. Mortality was 83% for turtles found between the tracks. To frame the maximum potential effect, assuming movement locations across tracks are not associated with unstudied environmental or population characteristics, we estimated that approximately 65,750 turtles would suffer mortality or interference with movement along Virginia's 7,450 km of railroad tracks during a similar period to our study. The number of turtles, potential species impacted, and the high mortality rate of those found between the tracks in this research suggest an important under-researched threat that could be affecting turtle populations and hence would be important for conservation actions.

A-0814 (Oral)
Studying the Spectrum of Maternal Care in Cordylid Lizards

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Animal sociality describes the association between conspecifics and the nature of those interactions, including parental care. In recent decades, reptiles have emerged as a model for the study of social behaviour. In particular, the Australian *Egernia*-group skinks exemplify the wide range of social systems in reptiles. Notable field observations of parental care in Egernia-group skinks include the defence of young from predators and conspecifics, as well as providing access to resources. Yet, our understanding of sociality in squamates is largely based on this clade. So, to fully understand the extent of sociality and parental care exhibited by lizards, we must expand our scope to other taxonomic groups. We studied four species within the African lizard clade, Cordylidae, to investigate the diversity of their sociality. In the field, these cordylids ranged in their tendency to aggregate and the size of their groups (listed from least to most aggregative): *Karusasaurus polyzonus, Namazonurus peersi, Cordylus macropholis*, and *Ourobourus cataphractus*. Also, all species' groups included aggregations of juveniles and adults. Thus, we asked the question: do females from more aggregative species exhibit greater social tolerance of their young? To answer it, we observed associations between females and offspring post-birth in the lab. We then quantified offspring tendency to associate with their mother using two behavioural assays: a y-maze choice test and a predator simulation assay. Findings from these examinations will be presented and compared among the four cordylid species. We relate these findings to each species' social organisation and habitat use (rock- or plant-dwelling), as well as discuss the suitability of lab-based behavioural assays for quantifying lizard parental care. Overall, this research underscores the importance of studying sociality, and the factors that influence it, within new taxa. Broadening our scope will expand our understanding of the diversity and evolution of social behaviour in reptiles.

A-0815 (Oral)
Assessing Predation Pressures and Management Strategies for the Critically Endangered Hungarian Meadow Viper (*Vipera ursinii rakosiensis*) in the Kiskunság National Park

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The Hungarian meadow viper (*Vipera ursinii rakosiensis*), classified as Critically Endangered by the IUCN, faces population decline due to habitat loss, fragmentation, and predation pressure. This study investigates the role of predation in Kiskunság National Park, where the subspecies exclusively resides within protected areas. We hypothesize that predator abundance significantly impacts viper population dynamics. Our objectives were: (i) to document predators of *V. u. rakosiensis*, (ii) to assess predator population trends near viper habitats, and (iii) to evaluate the effectiveness of ongoing predator management within the LIFE18 NAT/HU/000799 project. Fourteen avian and mammalian predators were identified, with observed increases in their abundance. Targeted predator control (badger, fox, jackal, corvids; n = 2,289) implemented by the park rangers under the LIFE project resulted in a 34% reduction in hunted predator numbers. Additionally, wild boar exclusion fencing (2,615 ha) minimized habitat disturbance. We employed stratified random sampling with control and intervention areas, conducting surveys (n = 167, 50 x 50 m squares) in spring and autumn (n = 8) across 2020–2023. Viper detections (n = 523) were recorded in each square at least 10 times (n = 13,360) per season. Multi-season occupancy models were used for data analysis. Predation

control efforts showed a positive trend in viper occupancy over time, suggesting their effectiveness. Raptor exclusion also yielded positive results. This multifaceted approach provides valuable insights into the predator-prey dynamics impacting *V. u. rakosiensis* populations. The study demonstrates the efficacy of targeted conservation measures in mitigating predation pressure and promoting viper population recovery.

A-0816 (Oral)
Quantifying the Sensitivity of Targeted eDNA Surveys: A Case Study using the Invasive Cane Toad (*Rhinella marina*)

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Targeted environmental DNA (eDNA) surveys are increasingly used to monitor biodiversity because they are often more sensitive (have higher detection probability) than conventional monitoring methods. The sensitivity of a survey method is a fundamental consideration in designing monitoring programs because it determines such things as the sample sizes required to achieve a given likelihood of detecting a target species. However, relatively few studies have quantified survey sensitivity and examined the factors influencing this. Here we compare the sensitivity of eDNA and conventional methods (visual surveys) for detecting the invasive cane toad (*Rhinella marina*) at its invasion front in northern Australia. Cane toads are advancing westward and pose a major threat to native biodiversity when they colonise new areas. Early detection of cane toads at the invasion front could assist in managing this threat in sensitive areas. We sampled water bodies across the invasion front and show that both a targeted eDNA approach using a species specific assay and conventional methods have high sensitivity to detect cane toads. However, eDNA sensitivity was affected by several factors, being higher at sites with higher toad densities, in smaller waterbodies, when a greater volume of water was sampled, and when cane toad tadpoles were present. We show how these results enable cane toad eDNA surveys to be tailored to specific conditions, for example by scaling the number of samples as a function of water body size to achieve a desired level of confidence in detection. Our study highlights the value of quantitatively assessing the sensitivity of eDNA survey methods and understanding the factors influencing this to achieve monitoring objectives.

A-0817 (Oral)
The Scale of Unregulated International Trade in Australian Reptiles and Amphibians

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Reptiles and amphibians are becoming increasingly popular in the global exotic pet trade, where species are valued for their rarity and uniqueness. Due to high rates of endemism and unique morphologies, Australian herpetofauna are particularly prized in international markets.

While some species may be sustainably sourced in trade via captive breeding, others are taken directly from the wild. To prevent unsustainable harvesting, Australia regulates wild-harvest and bans commercial export for all native fauna. Despite this, smuggling and subsequent international trade of Australian herpetofauna frequently occurs in an unregulated and unmonitored manner. To gain international cooperation in monitoring and regulating this trade, Australia has added several squamate species to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), making use of CITES Appendix III which is historically underutilised. As the majority of international trade in Australian herpetofauna was undocumented prior to this Appendix III listing, it has been unclear whether the newly-listed species represent the majority of trade or whether there are other Australian species that would benefit from similar listings. We investigated current trade and assessed the value of this Australian CITES listing using web-scraping methods to monitor the international online pet trade in endemic Australian herpetofauna, with additional data from published papers, official trade databases, and government seizure records. We identified 170 Australian species in international trade, 33 of which were not recorded previously in the international market. While newly CITES-protected species were prevalent in trade, at least 78 traded species remained unregulated. We also identified hotspots of trade in Australian herpetofauna, namely the USA and Central Europe, and laid the groundwork for our subsequent research exploring the dynamics and drivers of trade, with the ultimate aim of creating a framework to predict the risk and potential impacts of poaching for each species.

A-0818 (Oral)
Fine-scale Movements and Diving Patterns of Threatened Sea Snakes in Northern Australia

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Sea snakes (Serpentes: Elapidae) are fully-aquatic, air-breathing snakes that live an energy-intensive lifestyle. They must dive through the water column to forage along the seafloor and return to the surface to breathe. However, our knowledge of the diving behaviours of sea snakes is limited due to the challenges of studying them in their spatially complex, three-dimensional environments. As a result, there are many knowledge gaps around their daily activity patterns and movements. To overcome this, advances in acoustic tracking technology provide new opportunities to quantify dive durations, dive depths and behaviours. This talk will report novel findings on diel, fine-scale movements and activity patterns of free-ranging individuals of two ecologically distinct sea snakes, *Hydrophis elegans* and *Hydrophis curtus*. Continuous tracking data was used to 1) visualise fine-scale habitat associations and movement patterns over a day-night cycle; and 2) characterize differences in diving behaviour by comparing dive durations, dive depths and dive shapes. The results from this study will aid ecological impact assessments by identifying species traits (i.e., nocturnality and dive limits) that increase their susceptibility to threats like incidental fisheries bycatch.

A-0819 (Oral)
Subclinical Impacts of Enzootic Chytridiomycosis on Movement of Stream Anurans

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Chytridiomycosis, a fungal infection caused by *Batrachochytrium dendrobatids* (Bd), is one of the primary drivers of global anuran decline. While Bd is known to cause anuran mortality, the intensity of infection varies with geographic regions, species, and populations. The regions where Chytridiomycosis is characterised by the absence of clinical symptoms are considered "coldspots" of infection and might have subclinical Chytridiomycosis. Subclinical infections are known to cause changes to anuran physiology and behaviour. India is a Chytridiomycosis "coldspot", where despite high Bd prevalence, clinical signs associated with Chytridiomycosis, and anuran mass mortality are absent. The objective was to test the effect of Bd infection load on daily movement of stream anurans in the Western Ghats of India We used Capture Mark Recapture to record fine-scale location data of anurans from five streams of Tillari Conservation Reserve, Maharashtra, India and calculated their daily movement. Based on the snout-vent length and body mass of the captured frogs, we calculated a Scaled Mass Index and used it as a proxy for body condition. We then performed quantitative Polymerase Chain Reactions (qPCR) to quantify Bd infection load. Finally, we ran a generalized linear mixed model factoring in infection load, weather variables, body condition and species as fixed effects with tag ID as the random effect. Our best model showed that movement decreased with increasing infection load, suggesting the likely role of subclinical Chytridiomycosis on stream anuran movement. Additionally, movement was positively associated with maximum air temperature. Movement being integral to anurans has strong consequences for gene flow, adaptation, and population persistence. Lastly, we underscore the importance of understanding subclinical Chytridiomycosis to optimise conservation strategies in "coldspots". Our results add to the existing knowledge on subclinical Bd infection from Chytridiomycosis coldspots.

A-0820 (Oral)
We are all Scientists: How Community Science Reshapes Herpetology

R. Kannan
Herpetological Society of Singapore, 12J Sime Road, Singapore 288296

Community science, or citizen science, is more than just a trend. It's a transformative force in the field of herpetology. Engaging the public in scientific research and conservation efforts reshapes how we understand and protect amphibians and reptiles. This talk explores the profound impact of community science on herpetology, highlighting its role in data collection, public engagement, and conservation, instilling a sense of hope and optimism for the future of our herpetofauna. Community science allows people from all walks of life to contribute to scientific research. This involvement can range from simple tasks like data entry to more complex activities like field surveys. Regardless of the level of participation, each contribution is valuable and helps to build a comprehensive understanding of the subject. By involving the public in scientific research, community science projects expand the reach of data collection and foster a sense of stewardship and connection to nature. Through case studies and examples, this talk will demonstrate how community science has reshaped our understanding of herpetofauna. It will showcase how projects like the Herpetological Society of Singapore's Project Runover have successfully engaged the public in recording and analysing wildlife-vehicle collision data involving herpetofauna, leading to improved conservation strategies. Additionally, the talk will discuss the challenges and opportunities of community science in

herpetology, including data quality, participant engagement, and project sustainability. By empowering communities to become involved in scientific research, community science is revolutionising herpetology and paving the way for a more inclusive and impactful approach to conservation, where every contribution is valued and makes a difference.

A-0821 (Poster)
Project Runover: Herp-vehicle Collision Community Science Project by the Herpetological Society of Singapore

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Project Runover, a collaborative citizen science initiative, collects and analyses data on wildlife-vehicle collisions (WVCs) involving herpetofauna in Singapore. By understanding the patterns and impacts of WVCs on local herpetofauna populations, the project aims to contribute to conservation efforts by identifying WVC hotspots and effective mitigation measures. Through citizen participation, Project Runover collects data on WVCs, including the species involved, location, date, and other relevant information. This data is then analysed to identify hotspots of WVCs and assess the effectiveness of existing mitigation measures or propose new ones. Project Runover's findings have far-reaching implications for wildlife conservation. The project has identified hotspots with high incidences of WVCs, often areas where roads intersect with natural habitats. These findings underscore the urgent need for targeted mitigation measures such as wildlife crossings or speed reduction zones. Furthermore, the project's documentation of the species most affected by WVCs provides tangible insights into the impact of roads on local herpetofauna diversity, highlighting the immediate action required to protect these populations. In addition to data collection, Project Runover contributes to outreach and education activities to raise awareness about the issue of WVCs and promote coexistence between humans and wildlife. Through its comprehensive approach, Project Runover underscores the value of citizen science in addressing conservation challenges. Its findings highlight the importance of considering wildlife conservation in road planning and development and contribute valuable information to herpetological conservation. This knowledge forms a solid basis for informed decision-making to mitigate the impacts of roads on local herpetofauna populations.

A-0822 (Oral)
Growth Rate and Survival in the Genus *Speleomantes*

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Among the intrinsic biological features characterizing the species, a proper knowledge of the growth rate and survival of individuals are highly important to properly comprehend species-specific dynamics. Survival ang growth are key biological parameters driving life histories and population dynamics. Because of their direct impact on population viability, these parameters are of critical importance for conservation strategies. The European cave salamanders, genus *Speleomantes*, are the only plethodontid species present in Europe. Due to their peculiar physiology and strict habitat requirements, *Speleomantes* are highly susceptible to

anthropogenic disturbances (e.g., climate change, change in land use), and are therefore strictly protected by both National and Community laws. To date, Information on growth and survival is available for one cave salamander species, *Speleomantes italicus*, thus strongly limiting our knowledge of the demographics of these salamanders. To fill this gap, we studied survival and growth rates in all species of Speleomantes genus. Over a period of 12 years, we repeatedly monitored 37 populations belonging to the eight *Speleomantes* species, including hybrids, producing a dataset that includes capture-mark-recapture data of 494 individuals. This study identified a moderate survival of juveniles (about 50%) and a high survival rate in adult *Speleomantes* (about 80%). Sexual maturity is reached between 5 and 7 years. The average seasonal growth rate of juvenile *Speleomantes* (SVL < 50 mm) is much faster than that of adults (≥ 50 mm) (1.18 vs. 0.21 mm); this is probably a strategy that individuals use to become unsuitable to predators and therefore reach a higher survival rate. These results are in line with those observed for *S. italicus* and support the hypothesis that the whole genus is characterized by a relatively high longevity of individuals.

A-0823 (Oral)

Out of the Himalayas: Phylogeny and Biogeography of Ablepharine Skinks (Reptilia: Scincidae) of Eurasia

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Ablepharine skinks are an assemblage of small semi-burrowing lizards currently encompassing 23 species assigned to the two genera *Ablepharus* and *Protoblepharus*. They inhabit a wide range of natural habitats, from the Mediterranean to the Himalayas, and are frequently the most common reptiles in these regions. Despite their abundance, the diversity and evolutionary history of ablepharine skinks remain poorly understood, largely due to the limited number of samples examined in earlier studies, which mostly focused on the western members of the group. We present the largest molecular dataset of ablepharine skinks to date, including 306 specimens representing approximately 20 nominal taxa, which we use to assess diversity, phylogeny, and a biogeographic scenario for this group. Molecular data included a 4244-bp alignment of four mtDNA and three nuDNA genes. Within several ablepharine species complexes, we apply genetic and morphological data, as well as species distribution modeling, and report on ca. 10 putative new species and several lineages of unclear status. Our data show a close relationship between ablepharine skinks and the sphenomorphine skinks of Southeast Asia and suggest the group's origin in the Himalayan Region in the mid-Oligocene. The uplift of the Himalayas and the progressing aridification of Asia during the Miocene likely facilitated group diversification and dispersal from east to west, colonizing Central Asia, the Middle East, and the Mediterranean. Several unique features of snake-eyed skinks, such as a partial and then complete fusion of eyelids with a transparent window in the lower eyelid, an elongated body,

shortened limbs, and oviparity, likely evolved as an adaptation to more arid and hot environments. Our study identified several ablepharine species complexes in need of integrative taxonomic revisions in future studies. The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0824 (Oral)
Alien vs. Frog: New Data on Vietnamese Amphibians' Endoparasitic and Ectoparasitic Leeches (Amphibia: Anura)

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Leeches (Hirudinea), which are well-known as ectoparasites feeding on vertebrate blood, often choose amphibians as prey. Feeding on amphibians has been reported for the members of various families of freshwater and land leeches in South and North America, Australia, Madagascar, and East and Southeast Asia. There have also been documented cases of predatory leeches consuming eggs, tadpoles, and juvenile amphibians. However, records of endoparasitic leeches in amphibians are rare. Only two studies report on finding usually free-living ectoparasitic leeches of the families Glossiphoniidae and Haemadipsidae inside the dorsal lymph cavities of *Lithobates catesbeianus* (Ranidae) in Canada in 1949 and of *Litoria becki* (Hylidae) in Papua New Guinea in 1963, respectively. Since then, no similar observations have been made. However, 60 years later, we describe four cases of large-sized endoparasitic leeches of the family Praobdellidae on the three species of anuran amphibians from Vietnam: Amolops daorum and *Amolops tonkinensis* (Ranidae) and *Bufo luchunnicus* (Bufonidae). Most notably, in all four cases, the leeches were found inside the body cavity attached to the liver of a frog. Our observation represents the third documented case of facultative endoparasitism in leeches on amphibians. The taxonomic status of endoparasitic leeches, the prevalence of this phenomenon among Asian leeches, and how and when the parasitic invasion occurs remain unclear. Further studies should investigate whether the host choice is random or species-specific, how the presence of the parasite affects the hosts' reproductive success and mortality, and how the leeches adjust to the lack of sexual partners. Also, for the first time in Vietnam, we present a description of three cases of ectoparasitic leeches of the families Glossiphoniidae and Haemadipsidae on amphibians *Boulenophrys rubrimera* and *Boulenophrys palpebralespinosa* (Megophryidae), and *Kurixalus* sp. (Rhacophoridae). The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0825 (Poster)
Hidden on the Roof of the World: New Data on Diversity of Himalayan Ablepharine Skinks (Reptilia: Scincidae)

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Snake-eyed, or ablepharine skinks, are common residents of the highest mountain ranges on Earth, including the Himalayas, Tibet, Karakoram, Pamir, and Tian Shan, colloquially known as the Roof of the World. Previously, these skinks were assigned to the genera *Scincella, Ablepharus, Asymblepharus*, and *Himalblepharus*. Recently, a new genus, *Protoblepharus*, was established for the taxa from the Eastern Himalayas, while all the remaining snake-eyed skinks were assigned to the genus *Ablepharus*. However, the taxonomy of this group remains in a state of flux, while the recent phylogenies included very limited materials from the Himalayan region. At the same time, limited sampling, discrepancies in morphological characters examined by various authors, and a lack of information on name-bearing types, coupled with a high degree of endemism in this group, hint at serious problems in the ablepharine taxonomy. We assessed the diversity and phylogenetic relationships of the Himalayan snake-eyed skinks using 62 tissue samples from approximately 34 populations in Pakistan, India, Nepal, and China, representing nine out of ten nominal species of ablepharine skinks inhabiting the Himalayan region. We assessed the phylogenetic relationships based on a 4244-bp alignment of four mtDNA and three nuDNA genes. Our analysis revealed a remarkably high cryptic diversity within Himalayan ablepharine skinks. We identify from 14 to 16 species-level lineages within the Himalayan *Ablepharus* and four lineages within *Protoblepharus*, contrary to the previously recognized seven and three species within the respective genera in this region. This hidden diversity highlights the Himalayas as a key area, housing over half of the species-level diversity of ablepharine skinks. Our results highlight the role of the geological and climatic factors influenced by the uplift of the Himalayas, which played a crucial role in shaping the diversity of ablepharine skinks. The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0826 (Oral)
Imperiled Arks and Biodiversity Labs: New Discoveries of Limestone Karst-Specialized Herpetofauna in Indochina

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Karstic landscapes are widely known as both the 'imperiled arks'—refugia cradling numerous relic lineages—and the 'biodiversity labs'—platforms of speciation and generators of biodiversity in herpetofauna. In Indochina, limestone karsts cover over 12% of the total land area and are most extensive in Vietnam, Laos, and Thailand. At least 149 species of Indochinese amphibians and reptiles are specialized limestone karst endemics, including 14 species of frogs, 118 species of lizards, and 17 species of snakes; a large portion of this diversity was discovered only recently. I will review some significant new discoveries on limestone-specialized amphibians and reptiles made by our team during the last decade. In amphibians, examples include the discovery of the first troglophilous frog genus and species *Siamophryne troglodytes* (Microhylidae) from Thailand, as well as observations on other limestone-specialized frogs in the families Microhylidae, Rhacophoridae, Bufonidae, and Ranidae. In reptiles, I will review the discovery of the first karst-specialized agamid lizard, *Laodracon carsticola*, present new data on the diversity of limestone-associated pitvipers of the genera *Trimeresurus* and *Protobothrops* from Vietnam, Laos, and Thailand, and make observations

on limestone-associated colubrid snakes of the genera *Oligodon* and *Lycodon*. Overall, in Indochina, there is a strong correlation between the area of a territory occupied by karsts and the level of reptilian endemism. At the same time, the limestone karstic habitats in Indochina are perhaps among the most endangered in the world, as most of them are actively exploited for mineral extraction and have almost no legal protection. There is an urgent need to intensify systematic and thorough herpetological surveys in the karst areas across Indochina. Such surveys are critical for an adequate assessment of karst biodiversity in light of the urgent need for appropriate management and conservation. The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0827 (Oral)
Island Hopping Anurans: Evolutionary History of Ceratobatrachid Frogs

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Ceratobatrachid frogs are a widely distributed, largely insular, lineage occurring from Indo-Burma to Fiji. There are ca. 103 recognised species described from the family and multiple undescribed lineages from the Philippines. We used published molecular data to re-build phylogenies to include Liurana, and we compiled personal observations and literature reports of natural-history data. The concatenated molecular dataset included 120 tips from two mitochondrial (12S and 16S) and two nuclear (Tyrosine and POMC) genes. We used a concatenated dataset partitioned by gene; secondary calibrations were used to date the phylogeny in BEAST, and BioGeoBEARS was used to estimate biogeographic patterns. Among the four genera, *Cornufer* (58 species) is found east of Wallace's Line to Fiji, Platymantis (32 species) is endemic to the Philippines, *Liurana* (seven species) is restricted to high elevations (> 2,200 m/asl) in the Himalayas, and *Alcalus* (six species) has a disjunct distribution across Indo-Burma, Borneo and Palawan. We estimate that *Liurana* split from the other genera earliest (ca. 60 mya) followed by *Alcalus*, which split from the other three genera ca. 58 mya. The two specious genera, *Cornufer* and *Platymantis* diverged from each other around 35 mya. Lineage-through-time and Bayesian Analysis of Macroevolutionary Mixtures (BAMM) suggest that there has been a constant rate of speciation in ceratobatrachids, with no rapid changes in diversification rates through time. Ancestral-state estimates suggest that the ancestral habit of these direct-developing frogs was most likely terrestrial/semi-aquatic, with arboreal and scansorial ecomorphs evolving multiple times within *Cornufer* (n = 4) and *Platymantis* (n = 5). Given that most diversification within *Cornufer* took place in the past 32 my, most current geographic distributions can only be explained by island hopping of ancestral lineages across the complex chain of archipelagos in Western Melanesia.

A-0828 (Oral)
Brain and Sensory Trade-offs in Caecilians (Gymnophiona)

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Caecilians (Gymnophiona) are elusive amphibians, most species beings subterranean. Compared to other amphibians, caecilians have poorly developed vision, with variations within the group. The brain and olfactory apparatus of caecilians are among the least studied in tetrapods, and it is hypothesized that caecilians heavily rely on olfaction for foraging and mating. In this study, we stained and CT-scan the heads of 33 species of caecilians, encompassing all families and most ecologies, to investigate their olfactory apparatus and test potential sensory trade-offs between vision and olfaction. Our results challenge the common hypothesis regarding tetrapod olfaction.

A-0829 (Oral)
From Water to Land, a Study of the Olfactory Apparatus of the Tiger Salamander (*Ambystoma tigrinum*) Along Ontogeny

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The transition from water-to-land represents a major change of the physical conditions that affect both animal locomotion and senses. Such transitions occurred independently in several tetrapod lineages but, what are the impact of these transitions on the animal's sensory system and how can animals adapt to it remains poorly understood. Here, we investigate the impact of water-to-land transitions and development of the olfactory system of one species of salamander using synchrron radiation and x-ray microtomography. We additionally investigated some variation among other species of salamanders.

A-0830 (Oral)
Optimizing Responsible Translocation of Displaced Organisms

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The IUCN/SSC Conservation Translocation Specialist Group (CTSG) has drafted guidelines for optimizing responsible translocations of displaced organisms. These guidelines were developed as a need on how displaced organisms can contribute to species conservation management projects or *ex situ* species conservation management. Humans displace and irresponsibly release a large number of organisms due to conflicts, legal and illegal trade, perceived need for rescue, infrastructure development, agriculture, natural resource extraction and other human activities. Organisms are also displaced by climate change and disasters both natural and human-generated. Irresponsible translocations pose significant health, genetic, behavioral, and well-being risks to wild organisms, domesticated animals, ecosystems, and humans, as well as risks to the well-being of released individuals. Displaced organisms are a potential source of candidates for responsible releases to benefit species and ecosystem conservation. Beyond conservation potential, additional opportunities exist to encourage and improve responsible translocations of displaced organisms that maximize their well-being while preventing significant risks to wild organisms, ecosystems, domesticated animals, and humans. When conducting responsible translocations the following should be ensured where possible: 1. Identification of Species and/or /subspecies; 2. Individuals are suitable for release programs; 3. Suitable release site(s) identified; 4. Optimal methods of rescue, rehabilitation, and translocation are used; 5. Translocation follows precautionary principle; 6. Post-release monitoring of released individuals; and 7. Translocations are part of a conservation program wherever possible.

A-0831 (Oral)
Infection After Snakebite Envenoming – Experience in Laos and a Review of the Literature

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Estimates put the number of snakebites at 5 million per year, with 1.8 to 2.7 million envenoming, 81,000 to 138,000 deaths and more than 400,000 people left with permanent disabilities. Death after snakebite is predominantly caused by acute neurotoxic, hemotoxic, nephrotoxic, and myotoxic venom effects. The majority of physical disabilities such as amputation and a loss or limitation of extremity function are caused by local cytotoxicity with subsequent necrosis and infection. In Laos, bites of Malayan pit viper (*Calloselasma rhodostoma*) and cobras (*Naja* species) pose the greatest risk for infection. Risk factors for infection after snakebite are the cytotoxic activity of snake venom, the extent and severity of local envenoming, the bacterial flora in the snake's mouth, the socio-economic and nutritional status of the snakebite victim and preexisting diseases, such as *Diabetes mellitus*. Studies from Taiwan and Vietnam showed that *Morganella morganii* and *Enterococcus faecalis* are the most frequent bacteria found in wounds after bites of *Naja* species. Very little is known about the bacterial spectrum that cause severe deep tissue infections after Malayan pit viper bites. Infections after Green pit viper bites, and particularly after bites of kraits and non-venomous snakes seem to be rare in Laos. Prophylactic treatment with antibiotics after snakebite is not indicated. In case of extensive swelling, blister and necrosis, microbiological examination and

broad-spectrum antibiotics are indicated, particularly after Malayan pit viper and cobra bites. Necrotizing fasciitis, a life-threatening complication with a poor prognosis may occur in rare cases. The hallmark is severe local pain that is disproportional to the degree of inflammation together with clinical and laboratory signs of sepsis. Broad spectrum antibiotic treatment and prompt surgical removal of necrotic tissue are essential to save the patient's life.

A-0832 (Oral)

Four in One: An Integrative Taxonomic Revision of the *Microhyla berdmorei* Complex (Amphibia: Anura: Microhylidae) Illustrates the Tremendous Amphibian Diversity of Southeast Asia

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The largest member of the genus *Microhyla*, Berdmore's Narrow-mouthed Frog, *Microhyla berdmorei* (Blyth, 1856), is distributed all over Southeast Asia, from northeast India and southern China to Sumatra and Borneo in Indonesia. We present an integrative revision of *M. berdmorei* across its range, demonstrating that it represents a complex of four species that are morphologically and genetically distinct from each other. Phylogenomic analyses of 2,700 ddRAD-seq loci (387,270 bp) corroborate phylogenetic analyses of three mitochondrial DNA (mtDNA, including COI, 12S, and 16S rRNA; 3119 bp) and one nuclear (BDNF; 716 bp) gene sequences. Overall, we analyzed genetic data for 135 specimens from 53 localities. All phylogenetic analyses support that the *M. berdmorei* complex, which originates from the early Miocene (ca. 19.7 MYA), consists of two clades that we date to the late Miocene (ca. 7.5 MYA). The first clade, which regroups populations of large-sized individuals, is distributed in Indo-Burma and includes a lineage from Northeast India, Bangladesh, and Myanmar (corresponding to *M. berdmorei* s. str.) and a lineage from West Malaysia, Thailand, Laos, Cambodia, and Vietnam (for which the name *M. malcolmi* Cochran, 1927 is available). The second clade, which consists of small-sized populations, occurs in Sundaland and also includes two lineages that likely represent new species. The first lineage is widely distributed from Peninsular Malaysia to the islands of Borneo and Sumatra, while the second one is restricted to the Malay Peninsula and occurs in extreme southern Thailand and adjacent Malaysia. We argue that the *M. berdmorei* species complex originated on the Thai-Malay Peninsula, where it exhibits its maximum diversity today. Our study illustrates the high diversity of Southeast

Asian amphibians, especially in the genus *Microhyla*. The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0833 (Oral)
Beyond Disturbance: Effects of Forest Regeneration on Leaf-Litter Frog Assemblages in the Chocó Forest of Ecuador

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Amidst the alarming disappearance of primary tropical forests and the effects on biodiversity, over recent years, several studies have emphasized the role of secondary forests in supporting amphibian communities. Yet, understanding local-scale processes is crucial for implementing effective conservation measures, particularly in areas facing preeminent threats such as the Chocó Forest in South America. In Ecuador, for instance, less than 10% of the original forest remains due to conversion to agriculture and impacts from the timber industry. Using a chronosequence approach, we aimed to understand how the taxonomic and functional diversity of leaf-litter frogs in the Chocó Forest in northwestern Ecuador change along a forest regeneration gradient. Thirty-eight plots were placed in active cacao plantations, pastures, secondary forests undergoing a natural regeneration process following agriculture (ranging from 1 to 37 years), and old-growth forests. We investigated whether forest age, historical land use effects, and forest percentage around the plot had an impact on taxonomic and functional richness, as well as diversity of leaf-litter frogs. We likewise examined whether there was a change in community composition between forests at different stages of recovery. We found that forest age influenced species richness and diversity, with both metrics increasing along the regeneration gradient. Functional richness and diversity remained relatively stable throughout the chronosequence. Additionally, we observed a shift in leaf-litter frog community between agricultural areas and old-growth forests. Our study underscores the role of secondary forests in supporting the recovery of leaf-litter frog communities in the Chocó Forest. Heterogeneous landscapes, comprising fragments of old-growth forest and agricultural crops, connected by secondary forest, might have the potential to promote the recovery of taxonomic diversity and the preservation of functional diversity of leaf-litter frogs.

A-0834 (Oral)
Southern African Python (*Python natalensis*) Diet, using Information Gathered from Social Media and Historical Data

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Although they are arguably the largest snakes in Africa, surprisingly little is known about the details of the diet of southern African pythons (*Python natalensis*), presumably because of the

difficulty of establishing a predation list of a generalist species. We used historical literature and citizen science, in the form of social media, to establish a baseline list of species that pythons eat and are eaten by, including birds, mammals, reptiles and fish. The social media data increased the list of species preyed on significantly compared with historical data. We also established a progression from more avian prey to more mammalian prey species and a noticeable increase in human-animal conflict as the snakes got larger. We also recognised hunting behaviours and documented caudal luring for the first time in this species. Social media proved to be a useful data source that, when used correctly, can provide a rich source of raw data that can be fruitfully analysed, and combined with other sources to answer, enrich and validate several questions about cryptic and difficult to research species.

A-0835 (Oral)

Reproductive Behaviour of the Long-toed Tree Frog, *Leptopelis xenodactylus*

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While little is known about the reproductive behaviour of the *Leptopelis* genus, this study, focussing on the endangered *L. xenodactylus*, sheds light on this species and offers insights into the genus as a whole. The position from which the males call changes during the progression of the season; possibly in relation to the females becoming more conspicuous in the wetlands as time passes. These frogs use axillary amplexus with evidence of a glue substance being secreted where the male's forearms grip the female to assist with maintaining grip. Approximately 176 eggs are laid in a shallow burrow on the top of a hummock, which the female digs. The eggs take approximately one month to develop; with the tadpoles able to wait for suitable conditions before hatching. Tadpoles take approximately three months to metamorphose, when conditions are suitable, but show evidence of being able to overwinter. The insights gathered about this species could guide conservation management and shed light on other members of the genus.

A-0836 (Oral)

Exploring the Diversity of Haemoparasites in *Smaug depressus* (Flat Dragon Lizard), an Endemic from the Soutpansberg Mountain Range in South Africa

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The Soutpansberg mountain range is a component of the Vhembe Biosphere Reserve and is renowned for its abundant biodiversity, encompassing more than 30 species of lizards. Despite

this, our understanding of the blood parasite diversity within these reptiles, particularly in the case of *Smaug depressus*, a species endemic to the Soutpansberg and surrounding regions in the Limpopo province of South Africa, remains limited. Thus, our study set out to explore the spectrum of blood parasites found specifically in *S. depressus* within the eastern reaches of the mountain range. Blood samples were collected, and a combination of morphological and molecular analyses was employed for parasite identification. Our investigation revealed a spectrum of blood parasites inhabiting *S. depressus*, including trypanosomatids, haemosporidians, haemogregarines, haemococcidians, and filarial nematodes. By providing crucial foundational data on blood parasite diversity in *S. depressus*, our research enriches our understanding of reptilian behaviour and ecology in the Soutpansberg mountain range.

A-0837 (Oral)
Environmental Drivers of Body Size Variation in Hatchling and Juvenile Lizards (*Anolis sagrei*)

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Environmental factors shape phenotypic variation of organisms in a variety of ways and exert their effects at different life stages. For example, embryonic environments influence the development of offspring in ways that affect phenotypic variation. In addition, post-embryonic environments influence the distribution of phenotypes through ecological processes such as natural selection. We integrate information from our laboratory and field studies of the brown anole (*Anolis sagrei*) to understand how environmental factors shape body size variation from the perspectives of developmental plasticity and natural selection. We performed laboratory experiments to determine how natural nest environments shape variation in offspring phenotypes and show that eggs exposed to shaded environments produce larger offspring than those exposed to open environments. A subsequent laboratory study that decoupled the effects of nest temperature, moisture, and substrate demonstrates that moisture conditions during egg incubation generates most of the variation in hatchling body size; these results are corroborated by data from natural nests. We also demonstrate that large body size is favored by natural selection during the juvenile stage. Our data from a five-year study across six island populations show that natural selection consistently favors large body size in juvenile lizards, but not in adults. Moreover, the strength of selection for large body size of juveniles increases with the density of adults in the population. Hatchlings and small juveniles are likely under strong pressure given the suite of predators and territorial/cannibalistic interactions with adults. Overall, our studies show that the environment contributes to variation in body size by influencing development (i.e., plasticity) and acts as an agent of natural selection that operates on existing variation. Studies that consider multiple factors that are experienced during early-life stages will provide a more comprehensive understanding of the complex ecological drivers of phenotypic variation.

A-0838 (Oral)
Salt in the Wounds: Can We Create Refuges from Amphibian Chytrid Pathogens?

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In response to emerging pathogens, one management strategy is to identify host refuges to prevent extinctions. Batrachochytrium fungal pathogens are decimating amphibian populations around the world, thus creating habitats where amphibian hosts are safe from the fungal disease chytridiomycosis could support species recovery. Researchers have discovered chytridiomycosis refuges in several coastal regions where amphibians can tolerate salinity levels that are not ideal for *Batrachochytrium* fungi. This has led to the recommendation that managers should create chytridiomycosis refuges for amphibians by adding salt to water bodies. While some populations of coastal amphibians have evolved increased salt tolerance, only about 2% of > 7,300 amphibian species are thought to display local adaptations to elevated salinity. Research on freshwater amphibian populations overwhelmingly suggests that even small changes in salt concentrations can cause harmful sublethal effects and increased mortality from ranavirus infection. Thus, evidence suggests that the relatively high concentrations of salt needed to kill *Batrachochytrium* would cause widespread direct and indirect harm on amphibians and would kill most other aquatic taxa. Altogether, intentionally salinizing freshwater habitats is a well-intentioned management strategy, but it is not a well-advised strategy.

A-0839 (Poster)
Preliminary Findings on the Systematics and Biogeography of the Western Melanesian Microhylid Frog Genus *Mantophryne*

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Western Melanesia—comprising New Guinea, the Admiralty and Bismarck archipelagos, Solomon Islands, and smaller outlying islands—is one of the Earth's five High-Biodiversity Wilderness Areas, yet it is also one of the most understudied regions. Lying at the junction of five tectonic plates with many regional microplates has resulted in high tectonic activity, giving rise to modern Western Melanesia relatively recently geologically. This has led to extreme topographic heterogeneity and complex evolutionary histories for the region's biota. Western Melanesia supports exceptional frog diversity, including > 400 New Guinean species representing > 8% of global diversity on < 0.6% of global land cover. However, evolutionary relationships and diversity of many frogs of this region are poorly understood, and some species within widely distributed genera, such as *Mantophryne*, are being unveiled as cryptic species complexes. The genus *Mantophryne* currently consists of five described species (*M. axanthogaster, M. insignis, M. louisiadensis, M. menziesi and M. lateralis*) distributed on mainland New Guinea and islands to the east. Previous work has suggested that *M. lateralis* is a species complex with at least nine independent lineages, many of which are immediately distinctive in the field as well. In this poster, we present new data, building upon previously published findings for the genus, using three mitochondrial (16S, 12S and cytb) and three protein-coding nuclear genes (cmycex2, cmycex3 and tyr1). We strengthen biogeographic hypotheses by identifying areas and times of origin for clades and tracing their dispersal patterns. Whilst analyses are ongoing at the time of writing, we expect to find evidence of tectonic events driving dispersal, vicariance, colonisation and speciation events.

A-0840 (Oral)
Prohibitions and Legal Compliance in Totally Protected Areas in Sarawak

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Sarawak, on the island of Borneo in Malaysia, is one of the biodiversity hotspots, exhibiting rich biodiversity which is safeguarded through a robust legal framework designed to conserve its biological resources. Notable law which regulates this are the Wild Life Protection Ordinance, 1998 and the National Parks and Nature Reserves Ordinance, 1998. These laws play a pivotal role in conservation of biodiversity in Sarawak. The Wild Life Protection Ordinance regulates the hunting, collection, use and trade of wild species especially the protected wildlife, effectively curbing illegal activities that threaten wildlife. This Ordinance establishes legal protections for a wide range of flora and fauna. Complementing this, the National Parks and Nature Reserves Ordinance, 1998 facilitates the creation and management of Protected Areas within Sarawak. This Ordinance is essential in establishing Protected Area which serves as sanctuaries for many species of wildlife. Together, both these Ordinances complement each other to establish protocols and conditions for the collection of wildlife samples for research purposes, requiring researches to obtain specific permits before engaging in any such activities. This ensures that scientific research does not threaten the survival and well-being of the species. This paper is to highlight the prohibitions and legal requirements needed for certain activities in Totally Protected Areas in Sarawak.

A-0841 (Oral)
Uncovering Biogeographic Origins of Geckos in the West Indian Ocean Islands with a Focus on Madagascar and the Andaman and Nicobar Archipelago

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Geckos in the Indian Ocean islands show high levels of endemicity and diversity, as well as disparate colonisation and diversification histories. The Andaman day gecko (*Phelsuma andamanensis*), for example, is an outlier endemic in the Andaman Islands, as it is currently ~6,000 km from Madagascar, the centre of diversification of the genus *Phelsuma*. Deep phylogenetic splits within the genus Phelsuma remain poorly resolved, a likely result of rapid diversification and/or a lack of sufficient sampling of nuclear markers. Utilising genomic markers and near-complete taxon sampling of day geckos, we obtained a well-supported dichotomous time tree using which putative ancestral biogeographic ranges were estimated. With additional lines of investigation of drivers of species diversification, such as ecological adaptation and geographical opportunities, we provide a strong hypothesis for the biogeographic history and species diversification processes that gave rise to the day gecko radiation. Other gekkonids in the Andaman and Nicobar Islands are considered to have Indo-Burma and Indo-Sumatran biogeographic origins owing to species' resemblances as well as the geographical location of these continental islands. Yet, the phylogenetic relationships and colonisation histories of the geckos of the Andaman and Nicobar Islands remain to be discovered owing to the lack of extensive spatial sampling and genetic data from the islands. With extensive spatial sampling and sequencing of key phylogenetic markers from geckos in the A&N islands and available data from closely related South Asian and South-East Asian geckos, we uncover the putative colonisation routes and biogeographic origins of endemic

gekkonids of the Andaman and Nicobar Islands. Our studies uncover that the colonisation histories of different gekkotan lineages to the Andaman and Nicabar Islands are not homogeneous; rather, each genus has a unique history of colonisation and phylogenetic affinities in South and Southeast Asia.

A-0842 (Oral)
Applications of Immunological Techniques to Reptile Models

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In the face of emerging diseases and changing environments, mounting robust immune responses is a key factor for individual survival as well as population persistence. New attention has been given to a long-understudied area of immune research—reptile immunology. With many emerging diseases and a greater examination of potential endemic diseases in reptiles, it has become clear that understanding how reptiles fight pathogens is of utmost importance. Unfortunately, there are many basic gaps in our knowledge of reptilian immunology and especially how individual variation influences responses. To effectively gauge immune responses, we must validate and optimize assays developed for other taxa. Our work has focused on the broad application of ecoimmunology to reptilian models in the field to make the use of key tools more accessible and repeatable across institutions and laboratories. The combination of microbial killing assays, differential white blood cell counts, flow cytometry, comet assays, endocrine analyses, energy markers, oxidative stress indicators, lysis-agglutination assays, swelling responses, parasite counts, and more can be applied widely and customized to the specific question, interests, and logistical constraints of any given research project. We demonstrate that by judiciously selecting immunological approaches, more targeted and informative data can be collected to further our understanding of reptile immunity and their responses to pathogenic and environmental challenges.

A-0843 (Oral)
Immune Responses to an Antigenic Challenge in Watersnakes (*Nerodia rhombifer*)

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The innate immune response is complex and highly context dependent. In reptiles, relatively little information is available regarding how individual innate immune components interact and change over the course of an immune response. We characterized innate immune responses of Diamond-backed Watersnakes (*Nerodia rhombifer*) over a 72-hour period after stimulation by a nonpathogenic antigen, lipopolysaccharide (LPS). Blood samples taken at predetermined time points throughout the duration of the experiment were used to determine bacterial killing ability and concentrations of circulating leukocytes. We performed a series of bacterial killing assays using fresh versus frozen-thawed plasma and different microbes (*Escherichia coli* and

Staphylococcus aureus) to explore the contribution of unique immune components. LPS-treated snakes exhibited elevated bacterial killing abilities and levels of circulating heterophils and azurophils compared to vehicle-treated snakes. As components of the innate immune system were removed with each of the different bacterial killing assay treatments, bacterial killing ability took more time to reach its peak. Concentrations of circulating azurophils, a unique leukocyte in snakes, were elevated at all time points but appeared to peak at 12-hours post treatment in LPS-treated snakes. This study describes the response of multiple metrics of innate immunity to an immune challenge over a 72-hour period, which provides novel insight into the immune response of a poorly understood squamate.

A-0844 (Oral)
Multi-Criteria Assessment of Control Methods for the Invasive *Trachemys scripta*

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Invasive alien species (IAS) are a major cause of biodiversity loss, impacting endemic species via predation, competition for resources, habitat alteration and hybridization. There are numerous approaches to control IAS, but their success can vary widely depending on the target species and management context. A formal evaluation of different methods is helpful when dealing with limited resources and complex ethical implications of lethal and non-lethal control methods. This study focuses on control methods for the Pond slider, *Trachemys scripta*, one of the 100 most invasive species according to the IUCN. The presence of *T. scripta* can have negative ecological impacts to native pond habitats, particularly through competition with endemic freshwater turtles. While the trade of *T. scripta* has been banned in most countries, their presence and potential proliferation often requires active removal measures to minimize their pressure on local ecosystems. During our project, we collaborate with multiple management projects in Europe to assesses commonly used control methods for *T. scripta*. The selected control methods, consisting of basking or fyke traps, dog-assisted nest removal and shooting, were assessed in terms of their biological effectiveness, costs and animal welfare. For effectiveness, we have built a size-based population model to project *T. scripta* population dynamics under different control methods. Trapping probabilities of each trap type were estimated from management data using a removal model, while nest removal and shooting accuracy required experimental approaches. Based on these modelling results, we then estimated the total management costs for each method. During my talk, I present these results, and propose further questions which I aim to answer during my PhD on the same topic (such as animal welfare and dispersal). Through this assessment, we aim to facilitate rational planning, balancing ethical and financial constraints against biological evidence, allowing optimal protection of native species.

A-0845 (Poster)
Microgeographic Variation in Wood Frog Hormonal Response across Suburban and Rural Landscapes

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Globally, amphibians are experiencing population declines related to disease, habitat changes, and shifting global temperatures. These drivers can lead to mortality but also change patterns of development, leading to sub-lethal health and reproductive implications. The adult wood frog (*Rana sylvaticus*) exhibits extreme adaptations in overwintering; however, larval stages are sensitive to disruption, desiccation, and disease. Tadpoles must undergo an intense process of development to complete metamorphosis. Hormones signaling metamorphic shifts drive this process, but environmental signals can also influence hormone levels. This study assessed microgeographic variation in baseline corticosterone (CORT) and thyroid hormone (TH) levels in wood frog tadpoles across suburban and rural landscapes in Connecticut. CORT and TH work synergistically to promote development and metamorphosis, but CORT concentrations can shift when individuals are under acute stress. Sampled ponds ranged over various temperatures, drying conditions, canopy covers, distances to roads, and water quality parameters. Analysis showed no significant difference in average CORT response across larger landscapes (suburban vs. rural). However, variation in CORT response was evident across individual pond habitats, suggesting that microgeographic drivers may influence CORT production and TH response. Mixed-effects regression modeling indicated significant pond-level factors for predicting tadpole-level CORT response within the rural habitat. However, these same factors were not significant in predicting CORT levels in suburban habitats, further suggesting that populations living in rural, forested areas may be more sensitive to slight changes in environmental factors. These findings directly coincided with an analysis of the predictive relationship between CORT and TH, showing that CORT concentrations in rural areas are more predictive of TH response. This evidence suggests that microgeographic factors may be as crucial as landscape-level changes for determining amphibian hormone concentrations and developmental responses.

A-0846 (Oral)

New Insights Into the Phylogeny of Pitvipers of the Subfamily Crotalinae (Serpentes: Viperidae) based on Multilocus Data

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Crotalinae is a subfamily of highly venomous snakes from the family Viperidae, which includes about 300 species and represents one of the most successful radiations among snakes. In the Old World, pitvipers inhabit a wide area from Central to Eastern Asia, while in the New World, they extend from southern Canada to South America. Crotalinae taxonomy remains essentially unresolved, largely due to a lack of multilocus studies with wide taxon sampling. We present an updated Crotalinae phylogeny, including sequences of 22 loci (21,702 bp) from 66 Crotalinae species, with a primary focus on Oriental taxa. Our phylogeny is well-resolved at most key nodes and strongly supports the Asian origin of Crotalinae, with the Asian genera *Calloselasma, Hypnale, Garthius, Deinagkistrodon*, and *Tropidolaemus* representing the basal

radiation of the subfamily. However, the position of the New World pitvipers is different compared to the previous studies, as they form a sister clade to all the remaining Old World pitvipers. *Trimeresurus gracilis* and *Ovophis okinavensis* form a sister clade to *Trimeresurus*, *Craspedocephalus, Protobothrops, Ovophis*, and *Gloydius*, and our phylogeny strongly supports their distant phylogenetic position, warranting recognition as a separate genus. Our study suggests that the invasion of pitvipers into the New World most likely happened in the mid-Oligocene, way before the majority of other Asian genera diversified; this estimate is also essentially older than those proposed earlier. During that time, a continuous belt of boreotropic forests stretched across the entire Northern Hemisphere from Asia to North America, facilitating the dispersal of subtropical fauna across the Beringian land bridge. Furthermore, we discuss the status of lineages within the genera *Trimeresurus, Craspedocephalus*, and *Protobothrops* and propose a new genus-level taxonomy for these groups. The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0848 (Oral)
It's Better When it's Wetter: Precipitation Moderates Activity Restriction Associated with High Temperatures in an Endangered Desert Lizard

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Water governs animal activity, reproduction, survival, and population persistence, yet the focus remains on temperature. Thermal drivers of animal activity are well established, but the same patterns could be related to water. Water availability might also determine the effect of temperature. We aimed to disentangle the effects of temperature and precipitation on activity restriction in an endangered desert lizard. Blunt-nosed Leopard Lizards (*Gambelia sila*) were radio-tracked for four consecutive years to observe microhabitat use throughout their active season. Within an active season, their desert habitat gets progressively hotter and drier, and lizards spend increasing time in burrows, until they retreat underground to estivate for the remainder of the summer. Among the four study years, two were wet years with above-average rainfall and two were dry years with below-average rainfall. The amount of time lizards spent belowground in burrows increased as air temperature and vapor pressure deficit (the drying power of the air) increased throughout the active season. The rate of increase in burrow usage differed based on relative rainfall, with greater increases in burrow use in dry years. In wet years, lizards maintained surface activity despite the increasing temperatures. Thus, lizard activity is restricted by additive effects of high temperatures and inadequate precipitation. Dry years could directly lead to lizard dehydration, or indirectly reduce shade resources or prey items. At our study site, vegetation growth directly follows precipitation, and arthropod abundance booms in wet, green years. Unsurprisingly, these lizards are known to fail to reproduce in dry years. Consecutive years of drought could be detrimental to the persistence of the last wild population of these endangered lizards. Effective climate vulnerability assessments and conservation management decisions will rely on our understanding of the complex ecological effects of precipitation and its interaction with temperature.

A-0849 (Oral)
New Insights into the Phylogeny and Biogeography of Helmeted Toads of the Genus *Ingerophrynus* (Anura: Bufonidae)

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Helmeted toads of the genus *Ingerophrynus* are a group of terrestrial toads that currently includes 12 species endemic to Southeast Asia. Until now, no phylogenetic hypotheses have been proposed for the genus *Ingerophrynus*. We present a comprehensive assessment of the diversity and phylogenetic relationships of this genus based on the analysis of three mitochondrial (16S rRNA, 12S rRNA, and ND1) and three nuclear (POMC, BDNF, and RAG1; up to 7159 bp in total) genes for 175 specimens, covering all currently recognized species of *Ingerophrynus*. Our study suggests that the genus *Ingerophrynus*, which likely originates from the early Miocene (ca. 16 MYA), consists of two clades that we date to the mid-Miocene (ca. 13 MYA). The northern clade is distributed on the mainland of Southeast Asia (Indo-Burma and Indochina) and includes *I. galeatus, I. ledongensis*, and *I. macrotis*. The southern clade occurs in Sundaland and includes all the remaining species of the genus. Our research confirms the monophyly of *Ingerophrynus* and indicates a significant underestimation of its diversity. Overall, we report on up to 10 deeply divergent lineages (p = 4.5–8.4% in the 16S rRNA gene) within *I. galeatus, I. macrotis, I. parvus, I. claviger*, and *I. celebensis*, suggesting that these represent species complexes. The taxonomic status of *I. ledongensis* and *I. gollum* requires further study, as these taxa are deeply nested within the radiations of *I. galeatus* and *I. divergens*, respectively. We argue that the genus Ingerophrynus likely originated in Sundaland, from where these toads repeatedly dispersed to Indochina, and the northern clade later spread to East Asia, while the southern clade has colonized the Wallacea (Sulawesi) and the Philippines (Palawan). Further integrative studies are required to fully stabilize the *Ingerophrynus* taxonomy. The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0850 (Oral)

Multiple Transitions between Karst- and Forest-Associated Lifestyles in the Evolution of Pitvipers of the Subgenus *Trimeresurus* (Serpentes: Crotalinae)

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The Asian pitviper genus *Trimeresurus* is a complex group of venomous snakes, currently comprising more than 50 nominal species widely distributed across South and Southeast Asia. The genus is known to contain numerous cryptic species; the *T. macrops* species group is one of the most taxonomically challenging groups of pitvipers and comprises two species complexes. The *T. kanburiensis* species complex includes mostly karst-dwelling snakes with blotched dorsal pattern, such as *T. kanburiensis, T. kuiburi, T. venustus*, and recently described *T. ciliaris* and *T. kraensis*. The *T. macrops* species complex includes mostly forest-associated pitvipers with uniformly green dorsum like *T. macrops, T. cardamomensis*, and *T. rubeus*. Finally, *T. honsonensis* inhabits large granite boulders and riparian vegetation and has dark bands on its back. The phylogenetic relationships between these two species complexes have long remained unclear. We have analyzed the sequences of three mitochondrial genes with a total length of up to 2406 bp for all currently recognized members of this group of pitvipers. According to our data, both the forest-dwelling *T. macrops* and the karst-dwelling *T. kanburiensis* species complexes are not monophyletic, with T. ciliaris forming a sister clade to all other species, implying that the karst-associated lifestyle is likely an ancestral state for this group of pitvipers. Among the remaining taxa, at least three pairs of sister species demonstrate striking differences in habitat specialization and body coloration between rupicolous (RU) and forest-associated (FA) lifestyles. Examples include: *T. kuiburi* (RU) + *T.* cf. *macrops* from northern Thailand (FA); *T. macrops* (FA) + *T. honsonensis* (RU); and *T. cardamomensis* (FA) + *T. venustus* (RU). Our results emphasize that the transition between the forest-dwelling and karst-dwelling lifestyles likely occurred multiple times within the subgenus *Trimeresurus,* often resulting in strikingly similar morphologies. The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0851 (Oral)
Parallel Evolution of Ecological Adaptations in Asian Microhylids (Amphibia: Microhylidae: Microhylinae)

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Microhylid frogs represent a morphologically and ecologically diverse clade that includes terrestrial, arboreal, and fossorial morphotypes. Microhylids exhibit extensive variation in adult external morphology and osteology, and in many cases, parallel lifestyle specializations may have led to remarkable morphological convergences. We studied the morphological diversity of Asian radiation in microhylid frogs (the subfamily Microhylinae) using cleared-and-stained specimens and 3D models of skeletons obtained by micro-CT. In total, we studied 72 species, representing all major lineages within the group. To estimate phylogeny, we used a combined mtDNA and nuDNA dataset comprising 448 sequences of 102 species of the subfamily. The phylogenetic relationships of Microhylinae suggest that many lineages have repeatedly transitioned to semi-arboreal and burrowing lifestyles, presumably from a more generalized terrestrial lifestyle. Semi-arboreal forms evolved at least four times: the genus *Chaperina*, the *Kaloula-Uperodon-Phrynella-Metaphrynella* assemblage, *Microhyla nepenthicola,* and *Nanohyla arboricola*. At least five burrowing forms emerged: a number of *Kaloula* and *Uperodon* species, *Microhyla picta, M. fodiens*, and *M. rubra*. Evidently, several lineages reversed to the terrestrial lifestyle, notably, *Kaloula rigida*. Comparative analysis shows that in Microhylinae, the transition to a certain lifestyle is associated with a specific morphology. Semi-arboreal frogs have well-developed forelimbs with large finger disks and

poorly developed prehallux in their hindlimbs. We report general vertebra shortening and even vertebra fusion in several independent lineages of phytotelm-breeding frogs. Burrowing morphotypes consist of species with simple terminal phalanges, no developed disks, but well-developed hind limbs bearing large shovel-like prehallux. Terrestrial forms are the most diverse in their morphological composition. Individual ecological niches occupied by species, rather than a general trend, may determine the diversity of morphological states in terrestrial forms. The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0852 (Poster)
Relict Leopard Frog (*Rana onca*) Breeding Biology: Informing Management and Conservation of a Species once thought Extinct

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The Relict Leopard Frog (*Rana onca*) was thought to be extinct until it was rediscovered in Lake Mead National Recreation Area, Mojave Desert, Nevada, USA in the 1990s. Since then, collaborative multi-agency efforts have increased populations throughout what is believed to have been its historic range in the Colorado River area downstream of the Grand Canyon, AZ. We present breeding biology data on this species, collected 2003-2021 via long-term headstarting, translocation, and monitoring efforts, and their value in informing continued management actions and conservation efforts to ensure the future of this once-thought-lost desert Ranid species.

A-0853 (Oral)
Drones as a Detection and Monitoring Tool for Reptiles in Terrain Inaccessible to Human Observers

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Many reptile species occupy difficult to survey habitats, thus distribution and abundance can be poorly understood, making conservation management problematic. This is particularly true for species inhabiting forest canopies, cliffs, or dense vegetation. In such habitats, drone surveys may potentially assist in detection or monitoring. Our objective was to evaluate the utility of drones as a tool for surveying lizard populations in both accessible and inaccessible habitats. Drone surveys for lizards are in their infancy worldwide and the species-rich lizard fauna of New Zealand (125 species) provides an ideal testing ground. We used three drone models to approach, photograph, and assess responses of nine different lizard species in accessible habitats. We then used a DJI Mavic 3 pro drone to attempt to locate two lizard species, Jewelled geckos (*Naultinus gemmeus*) and Canterbury Spotted skinks (*Oligosoma lineocellatum*), in inaccessible habitats. We found that drones can reliably approach, identify, and photograph lizards in accessible habitats. With the DJI Mavic 3 pro drone we were able to detect and identify lizards from a distance of 12–30 metres using the x 28 hybrid zoom function. Only Canterbury Spotted skinks reacted strongly to drone approach (fled), usually at a distance of 10–12 metres, and well after they had already been photographed and identified from further away. Our drone proved efficient at locating lizards in two inaccessible habitats that are unable to be surveyed using traditional lizard survey techniques: Jewelled geckos in forest canopies and Canterbury Spotted skinks on steep-sided islands or sea-stacks. We were thrilled to

discover a new population of the highly threatened Canterbury Spotted skinks on an offshore island with the drone from the adjacent mainland. We conclude that drone surveys have huge potential for discovering new populations of herpetofauna and increasing our knowledge of species worldwide, thus aiding conservation management.

A-0854 (Oral)
Understanding Patterns of Herpetofaunal Diversity and Endemism on New Guinea - The World's Largest and Highest Tropical Island

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Melanesia, centred on the vast island of New Guinea, has a diverse biota and an exceptionally complex geological history. Here we review some recent insights into the diversity and history of the Melanesian herpetofauna, with a specific focus on the following key questions: 1) what are current best estimates of true species richness in this region; 2) is the biota of Melanesia best characterised as a derived subset of that on the vast continent of Australia to the south, or the legacy of discrete insular radiations with long histories of isolation in the south-west Pacific; and 3) to what extent is species-richness within Melanesia explained by mountain uplift versus divergence across formerly more discrete islands in the proto-Papuan region?

A-0855 (Oral)
Karst Endemism and Specialisation in the New Guinea Herpetofauna

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Areas of karst across tropical Asia, Madagascar and Australia are characterised by herpetofaunal endemism. However, New Guinea has some of the largest areas of karst in the world, our understanding of herpetofaunal endemism and diversity in karst landforms there is in its infancy. Here we present a summary of insights from over 20 years of research in and around the South-Fold Mountains of Papua New Guinea, an extensive region of uplifted karst that extends for hundreds of kilometres along the southern edge of New Guinea's central Cordillera, and in places rises to nearly 3,000 metres above sea level. Ecological and morphological data for some recently described frogs and lizards in the region suggests that at least some are karst-specialist taxa, providing the first evidence for this in the New Guinea herpetofauna. There is also a larger suite of recently discovered species that are only known only from karst areas, but for which inadequate knowledge of their distributions precludes strong statements as to whether they are karst endemics or specialists.

A-0856 (Oral)
An Olfactory Receptor Gene which may be Responsible for the Tongue-Flicking Behavior among Squamates

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Most squamates have two neuroanatomical distinctive olfactory epithelia, the main olfactory epithelium (MOE) located in the nasal cavity and the vomeronasal epithelium (VNE) located in the vomeronasal organ (VNO). The olfactory receptors (ORs) are used in the MOE, whereas the type-2 vomeronasal receptors (V2Rs) are employed in the VNE. Squamates perform tongue-flicking to deliver odor molecules to the VNE, but there are no taste buds on the tongue of squamates and it remains unknown whether the squamate tongue itself functions as a chemosensory organ or not. Here, I report an OR gene that is expressed in the tongue among broad taxa of squamates. Unlike in the case of other OR genes, the tongue-expressed OR gene has evolved among squamates without gene duplication or pseudogenization events. The tongue-expressed OR may have an important function in the tongue-flicking behavior of squamates.

A-0857 (Oral)

Integrated Biomarker-Based Ecological Risks Assessment of Tadpole Responses to Tris(2-Chloroethyl) Phosphate, Tris(1-Chloro-2-Propyl) Phosphate, and their Combined Environmental Exposure

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Tris(2-chloroethyl) phosphate (TCEP) and tris(1-chloro-2-propyl) phosphate (TCPP) are chlorinated organophosphorus flame retardants (OPFRs) commonly utilized in industrial applications. They have been frequently detected together in natural aquatic environments and associated with various hazardous effects. However, the ecological risks linked to prolonged exposure of non-model aquatic organisms to these two OPFRs at environmentally relevant concentrations remain unassessed. This study examined the effects of long-term exposure to TCEP and TCPP on metamorphosis, hepatic antioxidants, and endocrine function of *Polypedates megacephalus* tadpoles at environmentally relevant concentrations (3, 30, and 90 μg/L per substance), both individually and in equal-concentration mixtures, with a control for comparison. Furthermore, the integrated biomarker response (IBR) method was used to develop an optimal model for predicting ecological risks. This approach enabled an assessment of the potential overall ecological risks that tadpoles may face due to exposure to TCEP and TCPP concentrations in their potential distribution areas. Our results showed that: (1) Exposure to TCEP and TCPP elicited varying adverse effects on tadpole metamorphosis, hepatic antioxidant, and endocrine, with their combined exposure exacerbating these effects. (2) The ecological risk posed by TCEP to tadpoles was higher than that of TCPP at equivalent environmentally relevant concentrations, with an additive effect observed under their combined exposure. (3) Significant differences were observed in the overall ecological risks to tadpoles associated with the presence of TCEP and TCPP presence in water across their potential distribution locations. In summary, prolonged exposure to environmentally relevant concentrations of TCEP and TCPP presents potential ecological risks to amphibian tadpoles, providing insights for the development of policies and strategies to control TCEP and TCPP pollution in aquatic ecosystems. Furthermore, the methodology employed in establishing the IBR prediction model provides a methodological framework for assessing the overall ecological risks of mutiple OPFRs.

A-0858 (Oral)

Genetic Structure of the Parthenogenetic Mourning Gecko *Lepidodactylus lugubris* (Dumeril & Bibron, 1836) in the Daito Islands of Japan based on Mitochondrial DNA and SNPs Data

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The Mourning gecko, *Lepidodactylus lugubris*, is an obligatorily parthenogenetic species widely distributed in tropical and subtropical Indo-Pacific islands. This species consists of several diploid and triploid clones discriminated by dorsal patterns. One diploid clone (Clone A) is considered to have emerged through hybridization between two parental species, *L. moestus* as the mateal and *L. pantai* as the pateal, and the diverse triploid clones are thought to have emerged through subsequent multiple hybridizations between Clone A and males of bisexual species. On the Daito Islands (a group of oceanic islets of southwestern Japan), one diploid and several triploid clones supposedly endemic to the islets are known. Because there are no bisexual congeners in the Daito Islands, origins of these clones are quite enigmatic. In this study, we conducted genetic analysis for the diploid and triploid clones from the Daito Islands, alien Clone A from the Ogasawara Islands, Japan, and Clone A and *L. moestus* from Palau to clarify the genetic characteristics of the Mourning gecko assemblage on the Daito Islands. Mitochondrial DNA analyses revealed that all samples examined are close to *L. moestus* with minor variations. However, analyses using 17,196 genome-wide single nucleotide polymorphisms (SNPs) showed that the Daito diploid clone forms a cluster that is distinct from Clone A. Furthermore, genetic distance between the Daito diploid clone and Clone A was very large (Nei's D = 0.224). These results strongly suggest that the mateal ancestor in the Daito clones is *L. moestus* as in Clone A, but the paternal ancestor is different from *L. pantai*. The Daito triploid clones shared the same mtDNA haplotypes with the sympatric diploid clone, but they substantially differed from the latter in the SNPs data. We thus conclude that the Daito triploid clones have arisen through hybridization between the Daito diploid clone and related bisexual species.

A-0859 (Oral)
Frogs Providing More Complex Parental Care are at a Greater Risk of Extinction

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Amphibians are the most threatened vertebrate group. Anurans are also known for their diversity of parental care forms, which helped them conquer terrestrial habitats. Alarmingly, many species with complex care have already disappeared or are on the verge of extinction. I investigate if frog species with more complex parental care are more threatened. I collected the IUCN threat status and population trends for ca 1000 frog species with thoroughly quantified parental care behaviour. Parental care and IUCN categories were transformed into ordinal or binary scores, and I inspected their relation using phylogenetically informed methods. My results show that frogs performing longer duration of care and providing more complex

protection for their progeny by guarding, internal brooding and viviparity are more threatened. I discuss that specialized and less resistant habitats and less favourable demographic characteristics may have contributed to the observed patterns which put a risk on conserving behavioural diversity.

A-0860 (Oral)
Herpetological Peekaboo - The Unspoken Surprises Faced by a Young Herpetologist

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In this presentation, I will share some stories from a decade of working in herpetology, shedding light on the lesser-explored realms of amphibian and reptile conservation. While early career herpetologists often anticipate species-related, methodological, and analytical hurdles, the reality often presents a complex tapestry of non-scientific challenges. From the dynamics of interpersonal relationships and negotiating political landscapes to mastering the art of fundraising and management, all while struggling with mental health, the terrain of herpetological conservation proves to be multifaceted and unpredictable. Drawing from personal experiences, I offer insights into overcoming these obstacles, transcending the traditional scope of herpetological discourse, with the hope that this can be valuable to the audience, to prepare them for the challenges they may face in herpetofauna conservation.

A-0861 (Oral)
New Data on Phylogeny and Biogeography of Blind Skinks of the Family Dibamidae (Reptilia: Squamata)

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Blind skinks of the family Dibamidae represent an ancient group of essentially limbless squamates characterized by a burrowing lifestyle, worm-like appearance, and rudimentary eyes. The family Dibamidae includes two genera: the monotypic genus Anelytropsis, which occurs in Mexico, and the genus *Dibamus*, which currently includes 26 species inhabiting the Oriental region. A previous study suggested that the genus *Dibamus* is paraphyletic with respect to Anelytropsis and consists of two clades corresponding to the mainland and insular parts of Southeast Asia. The life history of dibamids remains essentially unknown, while the scarcity of available collection materials hinders the taxonomic and phylogenetic assessment of these lizards. Here we present an updated phylogeny of Dibamidae, which includes 18 species and is based on sequences of three mitochondrial and six nuclear DNA genes (7920 bp). Our analysis strongly confirms the monophyly of the genus *Dibamus*, further subdividing it into two clades: the northern *Dibamus* from China and northern Vietnam (D. bourreti-D. greeri group), and the southern *Dibamus*, which encompasses all the remaining species from

Indochina and Sundaland. These two clades demonstrate profound morphological differences and likely represent independent genera. The diversity of Dibamidae appears largely underestimated; we report on at least five lineages warranting recognition as full species. Dibamidae likely originate from Indochina, where the group still exhibits its maximum diversity today. From Indochina, dibamids colonized Sundaland and East Asia and further dispersed to North America. The basal radiation of Dibamidae dates back to the Early Cretaceous; the mid-Cretaceous thermal optimum could have facilitated dibamid dispersal from Asia to North America across the Beringian land bridge. Increased sampling efforts on Sundaland taxa and the application of additional nuDNA markers are required to achieve a better understanding of the phylogeny and biogeographic history of dibamids. The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0862 (Oral)
Osteological Characters in the Taxonomy of Dibamidae (Reptilia: Squamata)

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The family Dibamidae is one of the most ancient living groups of squamates and currently includes two genera: the genus *Dibamus*, comprising 26 species from Southeast Asia, and the monotypic genus *Anelytropsis*, inhabiting Mexico. Because of their burrowing lifestyle, all dibamids are characterized by morphological conservatism, which hinders the classification of Dibamidae based on external morphology characters alone. Here we explore variation in the skeletal morphology of the main Dibamidae lineages based on the largest molecular dataset for the family available and the morphological data from 3D models of skeletons obtained by micro-CT scanning. The Dibamidae include three main clades: *Anelytropsis*, northern *Dibamus* from China and northern Vietnam, and southern *Dibamus* from Indochina and Sundaland. We were able to reveal significant differences in the cranial and postcranial morphology among these three clades, which can be used as diagnostic characters for the Dibamidae lineages, providing further evidence for their recognition as three independent genera. In this study, we report for the first time the presence of metatarsal bones in dibamid hindlimbs, which are characteristic of the northern *Dibamus* clade. Moreover, our analysis revealed considerable variation in cranial features in Dibamidae, including the shape of the dermatocranium and the number of maxillary and dentary foramina. Although previous studies stated that the prefrontal bone is only found in Anelytropsis, we also document the presence of this bone in the northern *Dibamus* clade. Furthermore, although most dibamids are characterized by the presence of well-developed coronoid bone, we report on independent cases of complete reduction in several lineages of the southern *Dibamus* clade. In summary, our study demonstrates that the combination of osteological and molecular characters is an important step for further progress in the taxonomic studies of Dibamidae. The Russian Science Foundation (Grant No. 22-14-00037) supported this work.

A-0863 (Oral)
Chasing Ghosts: Spatial Ecology and Home Range Usage of the Central American Bushmaster (*Lachesis stenophrys* Cope 1875)

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Considered by many to be the most enigmatic snake taxon of the Western Hemisphere, the genus *Lachesis* has seen surprisingly little attention in the scientific field. Rarely encountered, the Central American Bushmaster's (*Lachesis stenophrys*) ecology is severely understudied. This species has an increased vulnerability to anthropogenic pressure due to its large body size and low population density, but also due to it being an animal displaying parental care. In this study Very High Frequency (VHF) radio telemetry is used to study the habitat usage and spatial dynamics of *L. stenophrys* in the Kéköldi Indigenous Reserve, located on the Caribbean slope of Costa Rica. Home range estimators Kernel Density Estimation (KDE) and Dynamic Brownian Bridge Movement Model (dBBMM) proved the specimens to inhabit small home ranges ranging from 3.44 ha to 8.82 ha with multiple core areas. Within these areas, the specimens covered an average daily distance of 12.17 m, which is considered short displacement compared to other pit vipers. Additionally, we determined macro- and microhabitat selection and the environmental drivers behind bushmaster activity. The data shows they prefer to reside in primary rainforest habitats and remain in close proximity to fruit-bearing plants. Furthermore, no significant evidence was found that movement is influenced by gender or season, but lunar phase and humidity did seem to trigger displacements. This study offers the very first insights towards the ecology of *Lachesis stenophrys* and is an effort of a newly founded conservation program, the Bushmaster Conservation Project.

A-0864 (Oral)
MUSEOMICS: Using Specimens from the Past to Solve Present Problems in Amphibian Taxonomy

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Over the last centuries, natural history collections have come a long way, from mostly displaying unknown creatures from remote places to the public towards being scientifically valued as unparalleled repositories of biodiversity over space and time. Recent advances in extraction protocols and next-generation sequencing methods have further allowed us to obtain DNA from archival specimens, which has been long-time restricted especially for wet-preserved specimens like amphibians due to unknown preservation histories and chemically induced DNA damage. Gaining access to genetic information on the biodiversity of the past has yielded new insights into the evolutionary history of organisms and revolutionized taxonomic research by complementing common tools used in biodiversity research with museomic data. We generated first molecular data for name-bearing types of several anuran genera to overcome typical impediments hindering taxonomic progress, such as

morphologically cryptic species and the uncertain allocation of historical species names. This museomic approach allowed us to include data from rare or even extinct populations for a sound assessment of the genetic diversity and distribution of western African *Werneria* toads, to decipher the relationship between coloration and species distinction in members of the *Platypelis mavomavo* complex and to confidently disentangle the *Anodonthyla boulengerii* species complex. A focus on type specimens for museomics research has unparalleled value, and should be a priority for museum digitisation projects globally.

A-0865 (Oral)
Diversity of Tadpoles in the Family Megophryidae Along Thanon Thongchai Mountain Range, Northern Thailand

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The Family Megophryidae is one of the diverse group of frog that can be found throughout southern and southeastern Asia. The wide distribution of these family has resulted in a high degree of variation within and between species. However, most identification data for this family is based on adult specimens, while information on tadpoles is limited. In this study, we present the morphological characters of Megophryid tadpoles found in streams of Thanon Thongchai mountain range, Northern Thailand. Tadpoles were collected during day and night time, at developmental stages between Gosner's stage 25 to 29. Identification of tadpoles was based on external morphology and confirmed with mitochondrial genes 16S. Our findings reveal the existence of nine tadpole species, out of which four species reported their larval description for the first time. The main characters that separate known tadpole species are discussed to facilitate fieldwork identification.

A-0866 (Oral)
Intraspecific Variations in the Venom Proteomics of *Trimeresurus gracilis*, an Endemic Protected Pit Viper of Taiwan

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Kikuchi habu (*Trimeresurus gracilis*) is a protected pit viper species endemic to the mid-to-high-altitude mountainous areas of Taiwan. Further investigations are necessary to clarify its conservation status, as well as to explore venom composition variation and pathophysiology. In this study, we collected venoms of *T. gracilis* from northwestern (n = 4 and 8 for adults and neonates/juveniles, respectively), northeastern (n = 3 and 9), southwestern (n = 6 and 14), and southern/southeastern (n = 11 and 26) Taiwan. Proteomic analyses of venoms from the four geographical regions were conducted using polyacrylamide gel electrophoresis (SDS-PAGE), high performance liquid chromatography (HPLC), and liquid chromatography-tandem mass spectrometry (LC-MS/MS), as well as searching the sequences of trypsin-digested peptides of the separated HPLC fractions against the NCBI database. In total, we identified 154, 287, 177, and 145 toxin proteoforms for the adult venom samples from northwestern, northeastern,

southwestern, and southern/southeastern Taiwan, respectively. The venom was found to contain metalloproteases (SVMPs), serine proteases (SVSPs), phospholipases A_2, L-amino acid oxidase, Cys-rich secretory proteins, disintegrins, vascular endothelial growth factors, C-type lectin-like proteins, as well as minor toxins, nontoxins, and unidentified peptides or compounds. While geographical differences in snake venom samples were less pronounced on SDS-PAGE, ontogenetic variations existed. The results of principal composition analysis and anlysis of similarities on HPLC profiles indicated significant variations in venom compositions between adult and neonate/juvenile snakes, as well as among the adults from different regions. Adult snakes exhibited higher levels of SVMPs, while neonate/juvenile snakes showed richer contents of SVSPs and PLA2. Samples from southwestern Taiwan exhibited higher levels of SVMPs, accounting for 69.8% of the total venom proteins, while those from southern/southeastern Taiwan exhibited lower levels of SVMPs, accounting for 41.4% of the total venom proteins. The geographical variation of *T. gracilis* venom partly corresponds to its molecular phylogeography.

A-0867 (Oral)

Factors Influencing the Optical Properties of Scales in *Trimeresurus stejnegeri* and *Ptyas major*

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Animal body coloration serves various biological functions and is often viewed as a trade-off between predation and sexual selection. The correlation between the optical properties of scales and the ontogenetic and reproductive biology in snakes remains insufficiently explored. To investigate whether the optical properties of scales in Taiwan's green arboreal snakes exhibit sexual dimorphism and ontogenetic change, and their correlation with candidate factors, *Trimeresurus stejnegeri* (n = 434; including adults and juveniles) and *Ptyas major* (n = 61) were collected in southern Taiwan from January 2021 to January 2024. While under anesthesia, the reflectance of their dorsal and ventral scales was measured using a spectrometer, and brightness, UV chroma, green-yellow chroma, and hue were calculated from the reflectivity spectrum. Additionally, the spectrum was compared with principal composition analysis. Blood levels of reproductive hormones, including testosterone and progesterone, were also analyzed. The results indicated both species appear to display cyclical changes in reproductive hormones. Sexual dichromatism on the (dorso)lateral scales of *T. stejnegeri* was evident, while *P. major* did not exhibit this trait. The optical characteristics of scales varied among months but did not show cyclic changes. No optical characteristics of scales showed a linear relationship with the concentration of reproductive hormones, except for that between testosterone levels and the brightness of the second row of dorsal scales in male *T. stejnegeri*. For *T. stejnegeri*, the brightness of adult male scales was lower than those in juveniles, while the hue wavelength of adult female scales was longer than those in juveniles. Although the brightness of body coloration was similar between *T. stejnegeri* and *P. major*, they differed in chroma and hue. These findings offer significant insights into the reproductive and evolutionary biology of *T. stejnegeri* and *P. major*, and provide a comparative foundation for similar studies on congeneric or other snakes.

A-0868 (Oral)

Lessons Learned in Modelling the Abundance of African Savanna Reptiles

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Ecological surveys rarely achieve perfect detection rates of the target species, and failure to account for imperfect detection can produce erroneous estimates of abundance and distribution. N-mixture models account for variation in detectability by separating the observation process from the ecological process determining true site-level abundance, making them theoretically well suited to studies of inconspicuous species, such as reptiles. Multiple N-mixture model variants have been published, but little is known about their ability to provide ecologically realistic abundance estimates. Given their novelty and potential for wider use, literature that helps users decide which variant to use in their case would be valuable. If different, yet data-appropriate, N-mixture model variants provide substantially incongruent abundance estimates for the same dataset, then their uncritical use in ecology is problematic. Using a dataset of reptile observations from south-eastern Zimbabwe, we compare the estimates of five N-mixture model variants, assessing congruence and performance. We find that model variant pairs were rarely congruent in their abundance estimates, and that model performance varies significantly according to species detectability. We provide a framework for the application of multiple N-mixture model variants in faunal ecology to guide analytical decision-making.

A-0869 (Poster)
Preparation and Evaluation of a Rabbit Antiserum Against the Venom from Point-Scaled Pitviper, *Protobothrops mucrosquamatus*

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It is well recognized that antivenom is the most effective drug in the treatment of snakebites, and homologous/species-specific antivenom is recommended to the preferred drug for the treatment. In mainland China, victims envenomed by *Protobothrops mucrosquamatus* can only be treated with heterologous antivenoms. It is imperative to design a homologous monovalent antivenom to improve the therapeutic safety and effectiveness on the victims envenomed by P. mucrosquamatus. In this study, we prepared a monovalent antiserum against P. mucrosquamatus venom in rabbit, and assessed the titer of IgG isolated from the antiserum in immunorecognizing the venoms from six *Protobothrops* snakes. It is revealed the immunological response can be observed in the fifth week, and then increased with the OD450 values in seventh week range from 0.36 to 0.45 after the third immunization injection. Regardless of whether the injection dose of venom increases (from 1.0 to 4.0 μg/g), the immunological response was no longer to increase dramatically in most weeks. The stability of immunological response between two immunization cycles was different among three rabbits. As expected, apparent cross-reactions between IgG and venoms from six *Protobothrops* snakes could be detected by western blot, but cross-reactivities were not positively correlated with the relative abundance of the venom components. Along with the diluting of the IgG concentration, the strength of cross-reaction between IgG and these venoms gradually decreased in the ELISA. Among these snake venoms, *P. cornutus* venom expressed the weakest cross-reactivity with the separated IgG, whereas *P. mucrosquamatus* venom

expressed the strongest. Collectively, we obtained a rabbit antiserum and the relevant IgG against *P. mucrosquamatus* venom, which can effectively immunorecognize venoms from six *Protobothrops* snakes.

A-0870 (Oral)
Community Science for Tracking Impacts of Development and Roads on Amphibians: A Case Study

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Community science, the process of utilizing large scale volunteer participation to gather community-sourced datasets, is an effective tool for gathering geographically widespread data over long periods of time. In the northeastern United States, many species of frogs and salamanders exhibit explosive seasonal breeding that coincides with the arrival of spring (known colloquially as 'big nights'). During this relatively brief period of mass migration, amphibians are often fatally struck by vehicles when moving to and from upland overwintering sites to aquatic breeding and foraging areas. Due to the scale at which roadkill occurs, impacts of vehicles have long been suspected of causing population declines and extirpations. To assess this issue, we began a community science project, known as Maine Big Night (MBN): Amphibian Migration Monitoring. Since its inception in 2018, MBN has recorded data on 357 sites around the state, representing over 20,000 amphibian observations and over 3,800 hours of survey time. Multiyear comparisons are yielding interesting and significant patterns, such as the effects of changing traffic levels during the Covid-19 pandemic-related lockdowns. We also modeled occupancy, colonization, and extirpation probabilities around the state to infer impacts of urbanization on six species of varying rarity. While occupancy was highly variable depending on species, extirpation rates were almost always larger than colonization rates, indicating declining occupancy. Developed area was the most frequently associated variable with top occupancy and extirpation probability models, where it generally increased extirpation probability and decreased occupancy probability. We conclude with a discussion on future analyses and potential adaptations of this model of community science to other large-scale conservation projects.

A-0871 (Oral)
Detection Dogs, a Viable Method to Locate Great Crested Newts *Triturus cristatus* on Land

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Like most amphibians, Great crested newt (*Triturus cristatus*) numbers are dwindling across Europe. In the UK, *T. cristatus* are afforded the highest protection under national (Section 9 of

the Wildlife and Countryside Act 1981) and European (Regulation 41 of the Conservation of Habitats and Species Regulations 2010) legislation. It is an offence under these acts to kill and injure individual *T. cristatus* as well as damage and destroy their habitats. As a result, those wanting to develop land within close proximity to breeding ponds are required by law to undertake mitigation measures which are constrained by costs and time. Wildlife detection dogs are being acknowledged globally as a pivotal method to detect cryptic species. For the present study, controlled field trials were undertaken with two highly trained *T. cristatus* detection dogs in the UK, to investigate the dog's ability to discriminate between *T. cristatus* and three other common British amphibian species, and the distance at which dogs can detect *T. cristatus*. Further experiments revealed whether dogs can detect *T. cristatus* through soil, and how different soil types influence performance. A comparative assessment between an experienced human hand-searcher and the detection dog team in varying grass lengths (15 cm and 5 cm lengths) was also conducted. The detection dogs were able to accurately discriminate between different amphibian species and detected individual *T. cristatus* at channelled distances of up to a minimum of 2 m with no substrate interference. Individual *T. cristatus* located under sandy-soil substrate were harder to detect in comparison to clay soil. The detection dogs were also significantly more effective at locating great crested newts than the hand-searcher. The study highlights the potential of detection dogs for great crested conservation newt management, and how abiotic factors influence the operational success of dogs.

A-0872 (Oral)

First Investigation of Ectoparasitic Fly Larvae Causing Myiasis in Australian Frogs

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Myiasis, or the infestation of living animals by dipteran larvae that feed on living or necrotic tissues, occurs in a range of vertebrates including frogs. Globally, flies in four families (Calliphoridae, Chloropidae, Phoridae, and Sarcophagidae) are known to infest amphibians. Until recently, only 11 fly species in the obligate frog-feeding chloropid genus *Batrachomyia* (subfamily Oscinellinae) had been thought to cause myiasis in Australian frogs. This talk introduces several instances of external parasitism of frogs by fly larvae in Australia being investigated for the first time. These involve flies in genera other than *Batrachomyia* infesting frogs in the families Pelodryadidae and Limnodynastidae in Victoria, New South Wales and Queensland. Unlike *Batrachomyia* larvae which feed subcutaneously, those of the flies being investigated attach themselves externally, including on the trunk and hind limbs of frogs. The rate of parasitism in an area surveyed in south-eastern Australia appears to be low, with a total of 15 larvae found among eight Southern Brown Tree Frogs (*Litoria ewingii*) out of 739 frogs sampled. Although infested frogs appeared to be mostly unaffected, infestation of Victorian Tree Frogs (*L. paraewingi*) likely resulted in very low red blood cell counts and the presence of eosinophils in their blood smears. Further study is needed to inform the identification and determine the life cycles and ecology of these parasites, as well as the impacts on their hosts. The findings so far indicate the incidence of myiasis and diversity of flies causing the condition in Australian frogs is greater than currently realised.

A-0873 (Oral)

Amphibian Declines and Conservation in Great Britain – An Update

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In the 10 years that have elapsed since Wilkinson and Griffiths (2013) provided an overview in the Amphibian Biology series, there have been some significant developments in amphibian conservation in Great Britain. The three countries that comprise Great Britain – Scotland, England and Wales – contain just seven species (four frogs and three newts). However, the Channel Island of Jersey contributes two further frog species by virtue of its comparatively recent connection to continental Europe. On mainland Britain three species of frog are of conservation concern. The Natterjack toad (*Epidalea calamita*) is confined to heathland and coastal sand dune and saltmarsh habitats and is known from about 60 sites and was classified as 'Endangered' in a national Red Listing exercise in 2021. Although widespread, the Common toad (*Bufo bufo*) has suffered from some alarming declines over the past ten years and was classified as 'Near Threatened' nationally. The Pool frog (*Pelophylax lessonae*) was subject to a reintroduction starting in 2005 and is found at two sites and is 'Critically Endangered'. With the possible exception of the Common frog (*Rana temporaria*), no species appear to have incurred widespread disease-driven declines. However, all native amphibians are subject to significant pressures from agricultural, commercial and housing development. In particular, the Great crested newt (*Triturus cristatus*) frequently comes into conflict with development and has been subject to a pioneering landscape-level conservation initiative that has used compensation payments from development to create or restore over 2000 ponds in England. The long-term maintenance of habitat in appropriate condition remains a problem for all species, especially *E. calamita*. Although there are several national NGOs engaged in amphibian conservation, an active network of citizen scientists and multiple recording and monitoring schemes, integrating data management so that it provides an effective evidence base for informing conservation remains a challenge.

A-0874 (Oral)
Ex-situ Approaches to Address Disease-driven Amphibian Declines: How Far have We Come and Where are We Going?

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Over the past four decades the rise of Emerging Infectious Diseases (EIDs) have fundamentally changed approaches to amphibian conservation. Indeed, EIDs rejuvenated the role of *ex-situ* populations as 'Arks' at a time when this philosophy was losing traction within zoo biology. Although the number of species in *ex-situ* programs increased following the launch of the first Amphibian Conservation Action Plan (ACAP) in 2007, this resulted in relatively few new reintroductions. Nevertheless, there was an increased focus on Critically Endangered species and those threatened by disease. This was accompanied by an increased emphasis on captive assurance populations. Research has always been the main role for captive populations both before and after the ACAP, and this has included highly significant contributions to understanding the drivers and mitigation of disease. Collectively, such research has informed and refined protocols for carrying out field research and conservation programs for amphibians. However, rigorous application of new protocols can take time and prove challenging for cash-

strapped conservation projects. A lack of understanding of risks coupled with impatience over progress and bureaucratic policies is leading to a rise in releases into the wild that fail to adhere to IUCN protocols. Fortunately, well-designed *ex-situ* projects now embrace multidisciplinary teams with complementary expertise. Going forward, the different stakeholders that contribute to the delivery of interventions need to embrace the overall risks that emerging challenges pose to projects as well as the risks that relate to their own specialisms.

A-0875 (Oral)

Initial Demographic Estimates for Two Species of Narrowly Endemic Toads in Central Nevada: *Anaxyrus monfontanus* and *Anaxyrus nevadensis*

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Hot Creek toads (*Anaxyrus monfontanus*) and Railroad Valley toads (*A. nevadensis*) are recently recognized species that arose from the Western toad (*A. boreas*) species complex in central Nevada, USA. Both of these species are narrow endemics that depend on isolated, spring-driven habitat and are subject to various conservation concerns. Little is known about these species, and we used Capture-Mark-Recapture methods to derive initial demographic estimates for discrete populations of each species (Hot Creek toads 2021–2023; Railroad Valley toads 2022–2023). We found that both species had relatively high monthly apparent survival (0.853 for Hot Creek toad and 0.893 for Railroad Valley toad) and that the estimated abundances increased throughout the study period. Capture probabilities varied by season but were highest in the spring for both species. These demographic estimates are a starting point for asking more questions about these unique toads of the Great Basin of Nevada.

A-0876 (Poster)

Does the Spitting Cobra have Better Visual Performance than the Non-spitting Species?

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Certain species of cobra belonging to the *Naja* genus, found in Asia and Africa, have a unique defense mechanism of spitting venom at their predators. However, not all cobras possess this ability. This mechanism relies on various skills, including sensory, cognitive, and control abilities. Good vision is necessary for detecting and tracking the target well, while solid muscle contraction in the venom gland is required to spray venom towards the predator's face or eyes. The venom is only effective if it comes into contact with the coea or mucous membrane. This raises the question: Do spitting cobras have better visual acuity than non-spitting cobras? If they do, it would mean that spitting cobras can identify their target's eyes more accurately, allowing them to hit their targets with less venom waste. Therefore, we are conducting a test hypothesis to compare the visual acuity of two species belonging to the Asiatic *Naja* lineage of Elapidae: *Naja sputatrix* (n = 3) and *N. atra* (n = 4). *N. sputatrix* is a typical spitting cobra, while *N. atra* is usually considered a non-spitting species, although a minority display spitting behavior. Unlike *N. sputatrix*, most *N. atra* lack specially modified spitting fangs. Differences

in specific venomous compositions (i.e., PLA2) regarding the reaction to the objects' eyes between spitting and non-spitting species exist. Two cobras were tested to compare their visual performance based on fundamental eye measurements. These measurements included the diameter of their eyes and pupils and their field of view for binocular vision. The refractive state of the cobra's eye was measured using infrared retinoscopy, which determined the diopter. Optomotor experiments were conducted to measure the visual acuity of the cobras. The preliminary results indicate that both species have mild hyperopia in terms of diopter. A more detailed comparison of visual acuity will be presented on the poster.

A-0877 (Oral)

The Herpetological Results of Alexandre Rodrigues Ferreira's "Philosophical Voyage" to Brazil (1783–1792)

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Between 1783 and 1792, the Portuguese-Brazilian naturalist Alexandre Rodrigues Ferreira conducted a "Philosophical Voyage" to Brazil to catalog the colony's natural resources for the Portuguese Crown. Embodying the ideals and methods of the Enlightenment, Ferreira's expedition traversed 25,000 miles through the Amazon, Madeira and Paraguay river basins amassing unparalleled biological and ethnographic collections, producing thousands of illustrations and generating hundreds of pages recording every aspect of Brazil's natural history in what was one of the most extensive natural history expeditions of the eighteenth century. After returning to Portugal, a series of circumstances prevented Ferreira from publishing the expedition results but his collections became known in European scientific circles. In 1808, accompanying the Napoleonic military column that invaded Portugal, commissioners from the Paris Muséum travelled to Lisbon with a mandate to "request" any specimens deemed scientifically relevant. Part of Ferreira's collections were shipped to France, including specimens of dozens of still undescribed South American plants and animals. These specimens were studied by famous European herpetologists, such as Cuvier and Schweigger, who used them to describe some of South America's most iconic species. While Ferreira failed to publish his "Natural History of Brazil", the data and collections amassed during the "Philosophical Voyage" made a major contribution to enriching the developing scientific knowledge base about South American biodiversity. This talk will revisit the history and herpetological outcomes of this expedition, with a strong focus on the surviving herpetological specimens.

A-0878 (Poster)

The Kururu Pytã Project: Conserving the Santa Fe Frog (*Leptodactylus laticeps*) in the South American Dry Chaco

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Leptodactylus laticeps, also known as Santa Fe Frog or Kururu Pytã (Guaraní language), is an endemic amphibian from the South American Dry Chaco (SADC), extending to Argentina, Bolivia, and Paraguay. The global conservation status is Near Threatened with declining population trends, while the national assessment assigned the status of Vulnerable in Argentina. The threats proposed for *L. laticeps* are related to the complex socio-cultural matrix of several coexisting ethnicities. Habitat loss due to the high rates of deforestation in the region, primarily driven by the expansion of the agricultural frontier, has been related to the reduction of the species' potential distribution area by 20%. Furthermore, *L. laticeps* exhibits a distinctive defensive behavior and a striking coloration pattern, suggesting potential danger and evoking aversion feelings. On the other hand, *L. laticeps* stands out as one of the most traded species in the Paraguayan Chaco, often illegally collected by local communities for the international pet trade. Despite various threats, crucial aspects such as its current distribution and population status are unknown. The Kururu Pytã Project, founded in 2021, aims to create a grassroots movement in the Argentinean Great Chaco involving biologists, educators, farmers, conservationists, and indigenous leaders to perform community-based conservation solutions for *L. laticeps* through extensive fieldwork, interviews, capacity building and a public engagement campaign. This proposal lays the foundation for the first amphibian conservation initiative in the SADC, planned to expand efforts to Paraguay and Bolivia to cover the species' global distribution. Here we inform the most significant advances of the project in relation to the natural history of the species and the analysis of the extent and severity of threats.

A-0879 (Poster)
Integrative Taxonomic Review of *Elachistocleis*: Implications for Species Diversity Estimation

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Elachistocleis comprises about two dozen species distributed throughout Central and South America. The genus has a confusing taxonomic history, with most species proposed based on subtle differences and some species with uncertain type localities or lost type specimens. Some authors have suggested classifying the species into two phenetic groups based on ventral coloration: one group with immaculate bellies and another with spotted bellies. However, the monophyly of these groups has never been tested. We conducted a phylogenetic analysis and taxonomic review of the genus *Elachistocleis*. Firstly, we inferred a phylogeny based on

mitochondrial and nuclear DNA sequences with extensive geographic sampling of almost all recognized species. We used molecular species delimitation tools to propose candidate species and conducted an integrative taxonomic review focusing on one group of species defined in this analysis, which includes *Elachistocleis cesarii, E. magna*, and *E. piauiensis*, along with some candidate species. Several morphological traits traditionally used in species diagnoses showed wide variation within and between populations, questioning the validity of some species. Particularly in the *E. cesarii* group, there is no evidence to support the validity of its candidate species. The only variable that could be considered diagnostic for one of the clades, the SVL, is not only extremely variable but also influenced by environmental variables. Thus, species proposals based on few morphological characteristics of few specimens from few localities may have led to an overestimation of diversity in the genus *Elachistocleis*.

A-0880 (Poster)
Non-lethal Skin Biopsy Sampling as a Method for Studying Highly Endangered Amphibians

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Harlequin frogs (*Atelopus*, Bufonidae) stand as one of the most critically endangered lineages of vertebrates. Currently, the IUCN Red List of species classifies 67% of *Atelopus* as Critically Endangered and considers 38% of its species as Possibly Extinct. Recent rediscoveries of more than 30 species provide an opportunity to investigate the consequences of population declines, the mechanisms, traits, and conditions that enabled them to persist. Understanding the genetics of adaptation in persisting populations, mechanisms of chemical defenses deterring predators and reducing infections, the composition of skin microbial communities, and transcriptomic responses to disease are among the questions that could empower scientists and conservationists to develop strategies for maintaining wild populations, informing laboratory breeding efforts, reintroduction trials, and mitigating further species loss. However, sacrificing whole individuals to carry out these studies is not viable as population sizes are extremely small. Herein, we propose the use of a non-lethal sampling methodology employing a small (1–2 mm) skin biopsy tool to collect tissue from the dorsum of *Atelopus*. We sampled 25 individuals corresponding to three species of *Atelopus* and one *Gastrotheca* maintained in laboratory conditions were sampled to evaluate their recovery and possible impacts on the individuals. We photographed and monitored each individual through a veterinary assessment of health condition, body composition, and wound recovery every three days to document the progress of wound healing. Although we identified some normal responses to the presence of wounds such as skin secretions and hematomas during the first days after the sample was taken, animals fully recovered after a couple of weeks. Additionally, we include the results of an enclosure carried out *in situ* for another species of *Atelopus*. Overall, our results suggest that this methodology is safe and constitutes a feasible alternative for obtaining samples that allow researchers to study Critically Endangered amphibian species.

A-0881 (Poster)
Effects of Larval Interactions on the Growth of Salamander Larvae

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Various biotic and abiotic factors influence survivorship, growth, development (e.g., timing of metamorphosis), and other morphological and behavioral traits of larval amphibians. One such biotic factor is the density of conspecific larvae. Under high densities, larval body size and timing of metamorphosis change through competition for limited resources or physical interactions among larval salamanders. In particular, intraspecific aggression and cannibalism among larvae are known to negatively affect body size and delay the timing of metamorphosis when larval density becomes high. Many previous researches have shown that such phenotypic plasticity occurs as a passive response to the negative effects of competition and physical interactions among larvae that occur under high density. However, we think it is adaptive for salamander larvae to change their traits in advance to avoid these negative effects that occur at high densities. In this study, we conducted a rearing experiment to test whether salamander larvae would alter traits in response to the chemical cues from conspecific larvae without limiting food or physical interactions. In the experiment, we divided larvae of Tokyo Salamander (*Hynobius tokyoensis*) hatched from the same egg sacs into two groups, one reared individually without any interactions and the other reared individually with chemical interactions with other larvae. We fed them adlib throughout the experiment and examined whether there were differences in body size, time to metamorphosis, and other morphological traits between the two groups. We found that larvae reared with chemical interactions metamorphosed more quickly than those reared without, and that their growth rate and body size at metamorphosis tended to be smaller. These results suggest that conspecific chemical cues alone can affect the growth and development of larval salamanders and these trait changes may be adaptive.

A-0883 (Poster)

Too Young to Understand: Status and Updates of Tadpole Research in Taiwan and the Philippines with Emphasis on the Ecomorphology of the Mindanao Horned Frog (*Pelobatrachus stejnegeri*)

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Studies on anurans have steadily increased in recent years, primarily focusing on diversity, ecology, and phylogeny of different species. However, publish accounts mainly focused on adult stages and notably only few studies have been conducted regarding their tadpoles. This paper presents a thematic review on the status and updates of tadpole research in Taiwan and the Philippines spanning from 1970 to 2024. A total of 59 tadpole studies have been systematically collated, 51 of which are from Taiwan and only eight publications are from the Philippines. The first tadpole research was dated from the year 1970 in Taiwan and year 1977

in the Philippines. In Taiwan, most of the papers discussed tadpole ecology (69.49%) with emphasis on breeding ecology (39.02%) whereas in the Philippines both ecology and morphology (44.44%) were discussed more. *Kurixalus eiffingeri* was the most studied tadpole species from Taiwan (n = 20) and Nantou County was the most studied area with at least 22 papers published. In addition, developmental studies in the Philippines are few, especially on the aspects of the ecomorphology of ontogenic series. To contribute on addressing this gap, we first examined the tadpole ontogenic series of the Mindanao horned frog (*Pelobatrachus stejengeri*) and found that the tadpoles experiences atrophy at stage 39 following its maximum length at stage 38. The total length of various stages also contributed significantly to other morphometric variables ($p < 0.05$). Different environmental variables also reveal that many parameters might appear to induce an increase in tail length and body length which influences the total length. With these findings, we highly encourage researchers to dwell on the underexplored field of tadpole biology. Furthermore, we highly recommend the increase on emphasis in ontegenic research in Taiwanese tadpoles and in-depth morphological research on Philippine tadpoles as most of these remain understudied and undescribed.

A-0884 (Poster)
Spitting Behavior of a 'Non-spitting' Cobra (*Naja atra*) in Taiwan

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Cobras comprise more than 30 species worldwide, with numerous documented medical cases of venom-spit ophthalmia attributed to the Chinese cobra (*Naja atra*). Despite its significance, the spitting behavior of this species, previously known as a non-spitting cobra, has not yet been investigated in detail. Therefore, in this study, we recorded the spitting behavior of 161 *N. atra* (consisting of 52 male adults, 52 female adults, and 57 juveniles) from Kaohsiung, Taiwan, using high-speed cameras. Upon removing the shelter of a snake within the test box, a laminated photo featuring the pattern of a human face generated by artificial intelligence was waved before the snake several times to trigger spitting. Afterward, dye was sprayed onto the laminated photo to visualize the traces of spitted venom. Among the observed cobras, 40.4% of male and 40.4% of female adults exhibited venom-spitting behavior, while none of the juveniles did. Unlike typical spitting cobras, *N. atra* rotated their heads in the sagittal plane to align their fangs parallel to the ground, facilitating the discharge of venom forward (or upward), while simultaneously everting their supralabial scales. Among the total 42 spitting individuals captured intact on video, 38.1% rotated their heads before directly spitting venom, while the others executed a substantially forward lunge followed by head rotation and spitting. Logistic regression analysis revealed that the probability of displaying spitting behavior was positively related to the snout-vent length of snakes, but not related to the banding patterns on the dorsal body. The lack of spitting behavior in *N. atra* may be attributed to their inability, possibly due to less muscle strength, or it could be a deliberate choice to conserve venom. Hissing sounds were occasionally recorded and may not be essential for spitting venom.

A-0885 (Oral)
Sarawak's Totally Protected Areas and Amphibian Conservation

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Sarawak has one of most extensive totally protected areas networks in Malaysia. The State's totally protected area network includes 67 national parks, wildlife sanctuaries and nature reserves. These areas cover a total area 874,524.53 ha of land area and 1,230,000 ha of water bodies. Currently, there are 37 totally protected areas that are opened to the public which includes national parks and nature reserves. Wildlife sanctuaries, however, are not open to visitors and exist to preserve and conserve vulnerable ecosystems or endangered wildlife. Each has its own crucial role to play in protecting the natural environment and Sarawak's biodiversity. These nature reserves and parks, which are governed by National Parks and Nature Reserves Ordinance, 1998 (NPNRO, 1998) normally exhibit significant geomorphic or physiographic features with significant natural habitats for *in-situ* conservation of wildlife and natural ecosystems. These areas provide legal protection to heavily hunted animals that are not listed in Sarawak's Wild Life Protection Ordinance, 1998 (SWLPO, 1998) and an essential element of conservation because they limit human disturbance on the landscape, which protects biodiversity and ecosystem function. The fact that more than 80% of Sarawak amphibians are found in Sarawak's national parks proves that these areas are a major refuge of the fauna and these numbers represent an important component of the State's biodiversity. Although Sarawak has an extensive protected area network, the documentation of amphibian's diversity in these areas appears to be far from complete. Substantial research on their ecological functions, inventories of species, including the presence of endemics and of rare/endangered species is urgently required, especially to convince conservation planners and managers of natural resources of the importance area for conservation.

A-0887 (Oral)
The Geographical Patterns and Origins of the Genus *Scutiger* in Megophryidae

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Uncovering the relationship between genetics and external drivers in species or even different populations is the key for understanding the pattern of diversity and distribution. We generated two fossil-calibrated phylogenies, using multiple state-dependent speciation and extinction rates, and historical biogeography inference methods to test the relative timing of colonization, rates of speciation, extinction and dispersal among regions. We also tested the ideal macroevolutionary routes and intrinsic mechanisms that could better explain the uneven

distribution of Megophryidae around Qinghai-Tibet Plateau (QTP). Our results indicated that the current species diversity and distribution of megophryids can be explained by two shift phases. In the first phase (KPB, around 66 Ma), the speciation rate of megophryids began to increase after Mass extinctions, whereas in the second shift phase (around 10 Ma), the shift position near the divergence node between clades in Hengduan Mountains (Mts.) and Himalayas and QTP within *Scutiger boulengeri*, might be correlated with niche expansion northward under the effect of the third uplift of QTP. Our study supported the diversification rate hypothesis by balancing speciation and extinction rates, and indicated QTP with higher speciation and extinct rates than Hengduan Mts., leading to lower net speciation rates in QTP. The jump dispersal (founder-event speciation) as major model in S. boulengeri complex diversity, with subsequent range expansion into Himalayas, QTP, Hengduan and Min Mts. The Hengduan Mts. acted as both biogeographic source and sink to connect other regions. The uneven distribution of S. boulengeri among regions was likely caused by different emigration rate between Himalayas and QTP and Hengduan and Min Mts. clades. The patterns of species diversification through time contribute to understanding how and why speciation rates might have varied among clades.

A-0888 (Oral)

Komodo Dragon Breeding Management: Success Report of Natural Hatching at Taman Safari Bali

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The Komodo dragon (*Varanus komodoensis*), holds the distinction of being the largest extant lizard species on Earth. Endemically confined to Indonesia's East Nusa Tenggara province. Its population declines annually due to factors like prey depletion from overhunting and habitat fragmentation. Anthropogenic activity also plays a role in the threat of the Komodo dragon population due to the large number of Komodo dragons. Recent IUCN data classifies Komodo dragons as endangered, emphasizing the need for both *in situ* and *ex situ* conservation efforts to increase their numbers. *Ex-situ* facilities play a crucial role in this endeavor. In 2022, Taman Safari Bali become the first *ex situ* facility that succeeded in breeding Komodo dragons naturally. Preparation of the breeding area was carried out from January to May 2021 to ensure that the temperature and humidity in the breeding area ranged from 30–35°C around basking area with 75–80% humidity and loose soil texture with high aeration. In June 2021, an ultrasonography was conducted to confirm the follicles status. Confirming the reproductive health status, preparations for grouping the female with the selected male were started. The selection of males is done by observing the morphology of the males, choosing the fittest males with larger size. In July the pair of Komodo dragons were observed mating. In August 2021, female initiates nest construction. On 1 March 2022, young Komodo dragons began to emerge from their nests. The 16 hatchlings consist 8 males and 8 females that came out were immediately rescued to get intensive care. After making sure that all the hatchlings have come out of the nest, a nest excavation made by the brood is carried out to ensure the rest of the eggs. Currently, the condition of the Komodo dragons that have hatched naturally is observed to be healthy and active.

A-0890 (Poster)

Skull Morphology of Male Crocodile Newts Genus *Tylototriton* (Urodela: Salamandridae) Distributed in Thailand

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A skull serves as a pivotal anatomical structure for discerning the distinctiveness of species within various vertebrate groups. However, in the case of the crocodile newts genus *Tylototriton*, which are distributed in Thailand, comprehensive studies on their skull morphology are notably lacking. Hence, the objective of this study was to examine and compare the skull morphology of six species of male newts belonging to the genus *Tylototriton* found in Thailand. We analyzed a total of eighteen specimens, with three specimens from each of the six species, utilizing micro X-ray computerized tomography scans. The study aimed to investigate the following aspects: 1) Descriptive characters: This entailed identifying the unique characteristics of each species as well as differences between species, and 2) Linear morphometry: A total of 40 measurements were taken to analyze the dimensional aspects of skull morphology. The results of the study revealed several significant findings. Each species exhibited distinct characteristics. For instance, *Tylototriton phukhaensis* displayed the lowest density of secondary bony ridges distributed across most parts of the skull, whereas *T. umphangensis* showed the highest density of secondary bony ridges. Furthermore, significant differences were observed in the skull morphology among the six species, particularly evident in the angle of the dorsolateral bony crests and the midsagittal ridge. The overall findings of the study underscore the distinctiveness of skull morphology in male crocodile newts. These results provide valuable baseline data for understanding the unique skull characteristics within the six studied species of male newts found in Thailand. Moreover, these findings are pivotal in taxonomy and other areas of biology related to the species.

A-0891 (Oral)
Multifunction Colouration and the Evolution of Imperfect Mimicry in Poison Frogs

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Animal colouration fulfils many different functions and consequently evolves under the influence of a complex mix of selection pressures. For chemically defended species, colour often evolves as a trade-off between the seemingly incompatible benefits of conspicuous warning colours (i.e., aposematism) and of a low predator encounter rate (i.e., camouflage). The nature of this interaction will be defined by defence strength, the physical environment, and the community context, all of which may vary spatially and temporally. By comparing Batesian mimics, which display aposematic signals but lack secondary defences, to their defended models we examined these trade-offs in a system where convergence in morphology has arisen via distinct evolutionary trajectories. We examined the trade-off between camouflage and salient signalling in Ecuadorian poison frogs: the chemically defended *Ameerega bilinguis* and the non-toxic, Batesian mimic, *Allobates zaparo*. We asked whether the balance between camouflage and signalling differed throughout ontogeny and between the two species, as well as how this may affect mimic efficacy in the eyes of predators and conspecifics. We first quantified colouration using calibrated photographs and computational visual modelling. We then conducted a series of screen-based detection trials with human participants, to explore how variation in colour affected detectability. We found that both

model and mimic utilise camouflage within their aposematic displays. Curiously, contrary to our prediction that mimics would rely on camouflage to a greater extent than their models, *Am. bilinguis* was generally more cryptic than *Al. zaparo*. Yet, differences in colour development throughout ontogeny meant that mimicry was imperfect and detectability was lowest in juvenile mimics. Taken together our data suggest a trade-off between camouflage and salient signalling that differs between species and varies throughout life. Therefore, rather than necessarily arising due to evolutionary constrains, imperfect mimicry may represent distinct strategies between model and mimic.

A-0892 (Oral)
Hemoparasites in Herpetofauna: Revealing Hidden Components of Southern Africa Biodiversity

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Hemoparasites of African herpetofauna have been known for more than a century, but little is understood of their biology, taxonomy, evolutionary relationships, or geographic distribution. By combining molecular and microscopic tools, we assessed hemoparasite diversity in the herpetofauna from Angola and Namibia regions. Blood smear analysis from 380 specimens showed that 35% were positive for hemoparasites, 15 (13%; n = 108) from Namibia and 116 (42%; n = 272) from Angola. Lizards had the highest prevalence (33%; n = 106/321) and diversity, being infected by six taxa (hemococcidians, hemogregarines, haemosporidians, microfilariae, piroplasms, and trypanosomes). Snakes (n = 6/14) and chelonians (n = 8/9) showed infections by hemogregarines and piroplasms. Anurans (n = 15/36) had trypanosomes and hemogregarines. Preliminary molecular screening for haemosporidians in reptile samples (n = 260) using the cytb gene revealed 26 sequences belonging to the Plasmodiidae group, with at least two potential new species. Our ongoing work will link parasite morphologies to their DNA sequences and evaluate their phylogenetic relationships. This multispecies survey revealed a high hidden parasite biodiversity in Southern Africa, with a significant potential for new species records. In addition, we emphasize that knowledge of parasites can enrich studies of amphibian and reptile biology.

A-0893 (Oral)
Explaining the Decline of the Critically Endangered Aeolian Lizard, *Podarcis raffonei*: Hybridization with Invasive Species or Competition?

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Island endemic species are among the most endangered animals. The introduction of closely related invasive species can determine the decline of island endemics through different processes, including competition and hybridization. Identifying the actual drivers is pivotal for conservation actions, but measuring the relative importance of these factors is difficult to assess. The Critically Endangered Aeolian lizard, *Podarcis raffonei*, has suffered dramatic declines and extinctions throughout its range. Competition and hybridization with invasive Italian lizards, *Podarcis sicul*us, have been proposed as the main drivers responsible for the decimation of Aeolian lizards, but the mechanisms remain poorly resolved. First, we used genomic analyses (RAD-seq) to evaluate the relevance of hybridization with invasive lizards. In the area of sympatry between the two species, hybridization rate was low (3%); the hybrids were either F1 or early generation backcrosses. Subsequently, we combined morphological data and tests of behavioral interactions between males to measure the potential impacts of interference competition. In agonistic encounters between males, Aeolian lizards were less aggressive and showed a poorer performance than invasive lizards, as they received more attacks from opponents and escaped more frequently than invasive males. The performance of Aeolian lizards was particularly poor in interspecific encounters. The strong competitive advantage of invasive males allows the monopolizing of territories, hampering the reproduction of native males and females, thus resulting in a mechanism of sterilizing interference. Reproductive interference competition mediated by spatial exclusion might be an unappreciated process determining the rapid decline of endemic species. Safeguarding areas devoid of *P. siculus* should be a priority strategy to avoid the extinction of Aeolian lizards
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A-0894 (Poster)

A Conservation Plan for the Critically Endangered Aeolian Lizard, *Podarcis raffonei*

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Podarcis raffonei, endemic to the Aeolian archipelago and listed Critically Endangered by IUCN, is among the most endangered European reptiles. Only four populations survive today on three tiny islets and on a small promontory on Vulcano island. It is believed that the Aeolian wall lizard once inhabited other islands of the archipelago and was confined to its current distribution by habitat loss and the introduction of the Italian wall lizard (*P. siculus*) through competition and hybridization. LIFE EOLIZARD aims to tackle the pending extinction of the Aeolian wall lizard through conservation actions directed at existing populations and through the creation of a sanctuary where captive bred *P. raffonei* lizards will be reintroduced, thus

representing an irreplaceable contribution to the long-term viability of the species. The two suitable islets (Lisca Bianca and Bottaro) selected to build the sanctuary are both inhabited by *P. siculus*, and these populations are genetically indistinguishable from the Panarea population with which they share most of the observed genetic diversity; hence, the establishment of the sanctuary will necessarily require the preventive translocation of *P. siculus* from the selected islets to Panarea island. Aeolian wall lizard founders for captive breeding will be collected from two populations (Vulcano and Scoglio Faraglione) and they will be selected on a genetic basis to maximize the breeding success. Furthermore, conservation actions will be directed at the Vulcano population through habitat management and rat eradication to improve its conservation status. The reintroduction of captive bred *P. raffonei* in the sanctuary after the complete removal of *P. siculus* would determine a significant extension of the area of occupancy (320%), an increase in the number of populations (50%), and an increase in the overall number of individuals (300%), thus decreasing *P. raffonei* extinction risk.

A-0895 (Oral)
Patterns and Drivers of Turtle Meat Markets along the India-Bangladesh Border

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India ranks fifth in the world in terms of tortoise and freshwater turtle (TFT) diversity, with 29 species. The Ganges–Brahmaputra floodplains turtle priority area alone is home to 21 of these species, including seven endemics. Despite strong legal protection given to most TFT species in India, illegal collection targeting hardshells for international and domestic pet trade and softshells for meat markets constitutes a major threat to TFTs in India. Over 58,000 individuals belonging to at least 15 TFT species were seized by enforcement agencies during a five-year period -- i.e., 2011 to 2015, and these trends have continued in recent years. Our previous research found the North 24 Parganas District of West Bengal along the India-Bangladesh border to be a major hotspot of illegal softshell trade, including several endangered species. Here, we interviewed key informants to understand the nature and scale of the softshell trade and develop a detailed problem profile. The information collected with regard to the main actors involved, local contexts under which the trade operates, and the details of the various locations and activities that enable it, has helped us identify possible interventions that can help curb the trafficking of softshell turtles across key markets and source locations in India.

A-0896 (Oral)
From Plateau to Clouds - How to Promote Herpetology Research in the Qinghai-Xizang Plateau through Online Science Popularisation

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In today's digital age, science popularization has shifted from traditional media such as television programs and books to online platforms, presenting new challenges and opportunities for science communication in the field of herpetofauna. As one of the most followed teams for herpetofauna knowledge popularization in China, we have produced documentary films featuring multiple species from the Qinghai-Xizang Plateau for the first time. Through online promotion, these works have garnered hundreds of thousands of views,

greatly stimulating public interest in the biodiversity of the region. Additionally, we have raised funds for related research activities, providing crucial support for biodiversity conservation in the Qinghai-Xizang Plateau. Furthermore, we have collaborated with Yibin University in China to launch citizen science projects, attracting thousands of participants to engage in field surveys and data collection, thus forming a closed loop from research to science popularization, and science popularization feeding back into research. Leveraging this series of practical experiences, we have identified key issues in science popularization work and proposed solutions. Through this presentation, we hope to provide valuable insights and inspiration for global science popularization efforts in the field of herpetofauna.

A-0897 (Poster)
Using Non-conventional Samples to Quantify Hormonal Metabolites and Physiological Status in Neotropical Pitvipers

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Hormones are good indicators of an individual's inteal state, influencing them to fulfill goals in their life history. Responses to reproductive and stress events in animals often correlate with variations in gonadal and adrenal steroids, while nutritional status and energy mobilization can be related to changes in thyroid hormones. Therefore, understanding a species' physiological state and its lifecycle variation is ideal for addressing questions about its ecology and conservation. Using non-conventional samples for endocrinological evaluation is becoming an increasingly popular non-invasive tool, but still uncommon for snakes. This study aims to assess the feasibility of feces, shed skin, and urine from two Neotropical pitvipers (*Bothrops jararaca* and *B. jararacussu*) as matrices for detecting testosterone, progesterone, 17β-estradiol, corticosterone, and T3 using immunoassay kits. We collected samples from 23 free-ranging individuals (10 *B. jararaca* and 13 *B. jararacussu*). In total, we tested nine fecal and five urine samples from *B. ja*raraca, and four fecal, five shed skin, and five urine samples from *B. jararacussu*. Linear regression checked the hormone accuracy between the observed dose to the known standard dose, with $R^2 > 0.95$ indicating good accuracy. The F test assessed parallelism between the kit's standard curve and diluted serum pools for all hormones, with $p > 0.05$ indicating good binding affinity. The tested hormones demonstrated good detectability, binding affinity, and mathematical accuracy across at least two matrices. The T3 metabolite and the urine samples exhibited poorer performance for both species. We also investigated metabolites variations between mating and non-mating seasons in *B. jararaca* using fecal extracts. Preliminary findings suggest an increase in hormonal metabolites during the mating season, except T3. Here we demonstrated the potential to monitor endocrinological status for wild individuals and we provide new methods to expand the applicability of non-invasive hormone technique for investigating snake physiology.

A-0898 (Oral)
Movement Ecology of Neotropical Pitvipers in a Mosaic of Atlantic Forest and Plantation Landscape

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Movement patterns and habitat use represent key aspects of an animal's ecology. Spatiotemporal fluctuations in climate and resources shape movement strategies, driving varied outcomes in reproduction, feeding, and survival of individuals. Therefore, movement strategies influence an individual's fitness, representing an important trait in the evolution of populations and species. We investigated the home range characteristics, movement patterns, and macro and microhabitat preferences of two sympatric venomous snakes, *Bothrops jararaca* and B. jararacussu, in a landscape made of a mosaic of Atlantic Forest patches and plantations. The study is being carried out at Fazenda do Etá, in the Vale do Ribeira region, São Paulo state, Brazil. The two studied species, which occur in sympatry along most of their geographic ranges, share several ecological similarities, including diet and timing of reproductive events, and are collectively responsible for most of snakebites in the study region. Since September 2022 until current days, we tracked ten free-ranging snakes (seven *B. jararacussu* and three B. *jararaca*) implanted with radio-transmitters using a hand-held radio-receiver. We estimated metrics of home range size, daily and total distance travelled, and the macro- and micro-habitat preferences of our study subjects. Preliminary results show a general sedentary pattern for most individuals and an increase in activity during summer and spring. Individuals of *B. jararaca* used exclusively Atlantic Forest habitats while individuals of *B. jararacussu* had more than 50% of total relocations in other environments, including grasslands or agricultural fields. Only *B. jararaca* was observed using higher microhabitats, including bromeliads and tree branches over 6 m above ground. Our study provides new insights about the movement patterns and microhabitat preferences of *B. jararaca* and *B. jararacussu*, contributing to better understand ecological aspects of these species. Greater understanding of spatial patterns is helpful to guide better eco-epidemiological studies on snakebite occurrence in the region.

A-0899 (Oral)
So Widespread and Yet So Rare: *Rana pipiens* in Eastern California, USA

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California, USA, harbors up to 28 species of native anurans in four families. Of these, the majority (17 species-61%) have been noted as declining in distribution and abundance and are protected as threatened, endangered, or under other regulatory status designations. Among this multitude of threatened amphibians, the Northern Leopard Frog (*Rana pipiens*), North America's most widespread amphibian, appears almost forgotten from discussion. The Northern Leopard Frog's status in California has historically been confounded by the introduction and establishment of non-native populations, combined with a confusing taxonomic history and a propensity to occur on private land. A presumed native population has not been observed in California since the early 1990's, and seemingly little effort has been made to document the species: however, in 2019 a dead leopard frog was observed on a snowbank in Mono County, within the historical native range of the species. Subsequent surveys in 2020–2024 have documented an extant but sparse population in the Walker River Watershed west of the Nevada border. Here we report on the collection history of Rana

pipiens in California via museum records. we provide survey results from the Walker River site and outline potential steps for habitat enhancement. Lastly, we present ideas for the conservation of this species in the Golden State.

A-0900 (Oral)
Testing the Effectiveness of Stable Isotopic Analysis to Combat Illegal Turtle Trade and Hunting

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The illegal turtle trade and hunting have become rampant in Hong Kong, posing a significant threat to all species due to illegal hunting to meet the insatiable demand in the pet and food markets. Trade regulations vary for wild-caught and captive turtles for some species, with it being illegal for wild-caught individuals only. As such, a major obstacle in enforcement against illegal trade is to differentiate between wild-caught and captive individuals. While various tools have been suggested for this purpose, little validation has been conducted, and successful application in enforcement has been rare. In this study, we evaluated the effectiveness of stable isotopic analysis in distinguishing between wild-caught and captive freshwater turtles. Specifically, we compared bulk isotopic signals, including δ13C, δ15N, δ34S, δ2H, and δ18O, between wild-caught and captive individuals of four native species, including *Cuora trifasciata, Mauremys reevesii, Platysternon megacephalum*, and *Sacalia bealei*, in Hong Kong. Our findings reveal that wild individuals exhibited significantly lower δ13C and δ15N isotopes, without overlapping, compared to captive individuals for all species. δ34S signals differed significantly between wild and captive individuals of *Cuora trifasciata* and *Sacalia bealei*. Our results demonstrate the usefulness of bulk isotope analysis in wildlife forensics for distinguishing between wild-caught and captive turtles. This method aids in validating the sources of turtles and contributes to halting the laundering of wild-caught turtles in the trade.

A-0901 (Oral)
Save The Snakes: Update on Global Conservation Activities and New Funding Opportunities

Eric Stitt
Save The Snakes, Sacramento, California, USA

Snakes are critically important: they maintain a central position in the food web and provide ecological services by controlling pest populations. Yet, global snake populations are at risk from habitat destruction, disease, over-harvesting, invasive species, climate change, and persecution by humans. The conservation needs of most snake species are little understood by researchers, are chronically underfunded, and garner little sympathy from society as a whole. Additionally, as human populations grow, human-snake conflict is becoming increasingly common, with over 2.5 million people annually suffering a serious envenomation. Clearly there is a gap between the conservation needs of snake species and the need for resolving human-snake conflict. Save The Snakes was founded in 2017 to address these two conflicting needs internationally through grants, partnerships, and project support. In this talk I summarize past, current, and future global Save The Snakes conservation activities. To date, the Save The Snakes Support Grant Program has provided funding to more than 30 research and education

projects world-wide. More than 212,000 people have learned about snake conservation from our website, and our conservation partners have removed thousands of snakes from human-snake conflicts and provided innumerable community-based safety trainings. We have staff in Africa and California in addition to our Board of Directors and Advisory Board. We have recently added two new funding mechanisms: in 2023 we introduced the Pacific States Conservation Grant to facilitate study of snakes in western Canada, Mexico, and the U.S. For 2024, Save The Snakes is excited to announce the Vijayan Devan Southeast Asian Snake Conservation Grant Program, intended to support individuals, particularly from under-represented groups, working on snake conservation within Southeast Asia countries. Applications are currently being accepted for 2024 funding.

A-0902 (Oral)

Introducing the Secretive Serpents of Paradise, the Endemic New Guinea Elapid Genus *Toxicocalamus* (Elapidae: Hydrophiinae)

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Toxicocalamus is a genus of rarely seen, vermivorous, oviparous, hydrophiine elapids, endemic to the island of New Guinea and its satellite islands and archipelagos. A century after George Albert Boulenger named the genus in 1896, *Toxicocalamus* contained 10 taxa (nine species and one subspecies). However, since 2009, resurgent interest in the genus has elevated this number to 24 species, of which 13 have been examined using molecular data. *Toxicocalamus* is now the largest, non-marine, alethinophidian snake genus in the Australasian-Melanesian region, and it is set to become even larger as further species will be described in the near future. Yet *Toxicocalamus* also remains a relatively understudied genus, with dietary preferences and reproductive status largely obtained from post-mortem examination. *Toxicocalamus* species are almost unique amongst terrestrial Papuan elapids in lacking a temporolabial scale between the penultimate and ultimate supralabials, along with only *Pseudonaja*. Several members of *Toxicocalamus* are relatively stout-bodied and quite sizeable (up to 1.0 m in total length in two species), there is also a number of extremely slender "bootlace" species with especially short tails, that may be more fossorial or semi-fossorial in habit. The stouter species exhibit typical colubrid-elapid head scutation; 15-15-15 dorsal scale rows; six supralabials; the cloacal covering consisting of two scales; and paired subcaudals, whereas the "bootlaces" display a great deal of variation. Dorsal scales are arranged in 13-13-13, 15-15-15, or 17-17-17 rows; subcaudals can be paired or single; the cloacal covering can be formed from one or two scales; the supralabials can number from 4–6, and the species exhibit a diverse array of head scute fusions including fused inteasal + prefrontal; preocular + prefrontal; inteasal + preocular + prefrontal; frontal + supraoculars; supraocular + postocular; and supralabials + temporals, which provide valuable clues that aid in the identification of a specimen in hand.

A-0903 (Oral)

The Reptiles of the Archbold Expeditions to New Guinea 1933–1964: A Summary of the 1930s Expeditions

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Most of the natural history collectors visiting the island of New Guinea during the 19th and early 20th centuries focussed on the collection of the four "Bs": birds, beetles, butterflies and botanicals, although mammals were also collected with vigor. The "lower vertebrates", reptiles, amphibians, and fish, usually attracted less attention and formed more of a by-catch, with poorly documented metadata (i.e., date and time of collection, collection locality). One major exception were the Archbold Expeditions, a series of seven expeditions that bookended the Second World War: three expeditions during 1933–1939 and four in 1953–1964. They were financed by the heir to the Standard Oil fortune, Richard Archbold (1907–1976), who personally led the first three expeditions, which made substantial collections for the American Museum of Natural History in New York. Although the participants were still primarily interested in mammals, birds, and botany, they also collected many herpetological, ichthyological, entomological, parasitological, geological, and ethnological specimens, most of which were diligently documented. The combined total for the herpetological collections from all seven expeditions, numbered 9084 specimens, comprising 6396 amphibians and 2688 reptiles. The reptiles included 32 turtles in six genera and three families; nine crocodilians in a single genus and family; 2,092 lizards in 31 genera and five families; and 555 snakes in 28 genera across eight families. Today the herpetological collections from the Archbold Expeditions provide an extemely valuable resource for the study of the herpetofauna of the largest tropical island on Earth, especially since they include ten holotypes and 222 paratypes. I summarise the first three expeditions and the 979 reptiles collected during those explorations, of which the latter two were the first tropical expeditions to use flying boats to recce, insert, resupply, and extract.

A-0904 (Poster)
Hidden Diversity and Natural History of the Secretive New Guinean Worm-eating Snakes, Genus *Toxicocalamus* (Elapidae: Hydrophiinae), Revisited

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Toxicocalamus is an elapid genus represented by 526 specimens in thirty collections worldwide. It is a genus of diual but secretive, terrestrial, or fossorial, oviparous, vermivorous snakes, endemic to the island of New Guinea and its satellite islands. These snakes inhabit rainforest, hill and pre-montane forests, or montane grasslands, but one species is especially common in earthworm-rich highland garden systems. Most species are relatively small (< 600 mm in SVL), but two species approach or exceed 1.0 m total length. Many species exhibit distinctive head-scute fusion arrangements that greatly aid in their identification. The genus was erected in 1896 by George Albert Boulenger based on T. longissimus from Muyua

(Woodlark) Island, a satellite of New Guinea off the southeast coast of New Guinea. During the remainder of the 19th Century additional species were described, both in *Toxicocalamus* but also in three other genera (*Apistocalamus, Pseudapistocalamus, Ultrocalamus*) that were later reduced to subgenera within *Toxicocalamus*. By the end of the 1960s, *Toxicocalamus* comprised nine species, and this number remained constant for forty years until a new generation of herpetologists started to investigate the genus. Since 2009 a further twelve species have been described and three have been resurrected from synonymy, bringing the current total to 24 species, making *Toxicocalamus* the most diverse terrestrial alethinophidian snake genus east of the Wallace Line and descriptions of further new species are currently in preparation.

A-0905 (Oral)
Reptiles in Pet Stores and Cafes in Japan

Kay Wakao
WWF Japan, Tokyo, Japan

Japan boasts a thriving exotic pet market, with reptiles as the primary commodity. Every weekend, reptile expos take place across the country and animal cafes offer the chance to interact with rare exotic reptiles. In this presentation, we introduce the recent situation of pet stores and animal cafés in Japan.

A-0906 (Oral)
Development of a User-Friendly Monitoring Tool for Invasive Cane Toads: Insights into Reproductive Behavior and Implications for Conservation

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Invasive species pose a significant threat to global biodiversity and ecosystem health, necessitating effective monitoring tools for early detection and management. This study presents the development and assessment of a user-friendly and transferable monitoring tool for the invasive cane toad (*Rhinella marina*) using passive acoustic monitoring (PAM) and machine learning algorithms. Leveraging a continental-scale PAM dataset (Australian Acoustic Observatory), a cane toad classifier was trained using the BirdNET algorithm, demonstrating high accuracy and applicability across broad spatial and temporal scales in Australia. The classifier was then used to navigate spatio-temporal patterns and geographic variations in cane toad calling activity, enhancing understanding of their reproductive behavior. Providing a cost-effective monitoring solution adaptable to diverse sensor network configurations and research contexts, this study offers comprehensive insights into cane toad distribution and spatio-temporal calling patterns, aiding in the identification of breeding hotspots and restricted dispersal areas. These findings have significant implications for ecological conservation and invasive species management, contributing to the efforts of researchers, consultants, and ecologists striving to safeguard biodiversity and ecosystem integrity.

A-0907 (Oral)

Habitat Suitability and Reintroduction Site Selection for the Northern Leopard Frog (*Lithobates pipiens*) in British Columbia, Canada

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There currently exists only a single extant population of Northern leopard frogs in British Columbia (BC), and past reintroduction attempts have met with limited success. As a result, the BC Northern Leopard Frog Recovery Team initiated a search for a new reintroduction site in 2021 through the development of quantitative assessment tools. This involved establishment of a Habitat Suitability Index (HSI) model and a Site Selection Criteria table based upon the unique habitat requirements of the northern leopard frog in BC. The HSI model spatially filtered for suitable habitat within the historical range based on attributes such as elevation, number of waterbodies, solar exposure, road density, etc. Any potentially suitable locations detected by the HSI were further filtered during a preliminary desktop assessment whereby clearly unsuitable sites (e.g., located in heavily forested areas or with significant barriers between habitat types) were eliminated. Concurrently with the HSI, a Site Selection Criteria table was developed. Use of this table involves scoring each site for numerous habitat attributes important for the Northern leopard frog in the overarching categories of breeding habitat, foraging habitat, overwintering habitat, connectivity, and land use/other. On-the-ground field visits were completed at any suitable sites in spring, summer, and fall in order to collect the relevant data to allow for scoring of each site in the Site Selection Criteria table. We found these methods to be an effective way to quantitatively compare and select a new reintroduction site.

A-0908 (Oral)
Origins and Diversification of the Lizard Fauna of the Continental Island of Sri Lanka

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Understanding the origins of continental island faunas is a primary goal in evolutionary biology and biogeography. Sri Lanka is a continental island at the tip of southern India with an exceptional diversity and endemism (78%) of lizards. Yet, relatively little is known about the origins of this remarkable diversity in the island. Of the 124 species of lizards, the most diverse lineages are skinks (32 spp.) and geckoes (65 spp.). To understand the biogeographic origins and patterns of diversification in Sri Lankan lizards, we reconstructed the phylogenetic relationships of three of the most diverse lizard genera in Sri Lanka; *Eutropis* (9 spp.), *Lankascincus* (9 spp.), and *Cnemaspis* (42 spp.). Our dated molecular phylogenetic analyses with ancestral area reconstructions reveal that members of the genus *Eutropis* have colonized the island at least four times from India independently between 12.5-0.5 million years ago

(MYA) in mid-Miocene. However, the common ancestor of *Lankascincus* and its south Indian sister lineage, *Ristella* colonized the island from India more than 54 MYA triggering an *in-situ* radiation around 30 MYA predominantly within the southern Wet bioclimatic zone (annual rainfall >2,500 ml) of Sri Lanka. Day geckoes of the genus *Cnemaspis* in Sri Lanka originated from two separate colonization events from Southern India in the late Oligo-Miocene leading to two distinct endemic radiations in the island. Several species of *Lankascincus* and *Cnemaspis* diversified in the Miocene as a result of isolation in humid mountaintops due to climate change driven aridification that led to fragmentation of the contiguous habitat. Our findings therefore suggest that a combination of colonization and *in-situ* radiations has played a significant role in shaping the majority of lizard diversity of this continental island.

A-0909 (Poster)

Using Decision Analysis to Assess the Feasibility of Recovery of Northern Leopard Frogs Using Conservation Translocations in Northern Idaho, USA

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Conservation translocations have increased thirty-fold over the last three decades and are projected to increase further as biodiversity loss continues worldwide. The literature abounds with analyses to inform translocations and assess whether they are successful, but the fundamental question of whether they should be initiated at all is rarely addressed formally. We used decision analysis to assess northern leopard frog reintroduction in northern Idaho, USA, with success defined as a population that persists for at least 50 years. Along with other considerations, the Idaho Department of Fish and Game will use this assessment in the future to make a decision regarding reintroduction of northern leopard frogs. Representatives from government, indigenous groups, academia, land management agencies, and conservation organizations participated in this process. We built an age-structured population model to predict how management alternatives would affect probability of success. We accounted for both parametric uncertainty and stochasticity (environmental and demographic) in the model, which allowed us to explicitly represent uncertainty around the probability of success and to assess the sensitivity of predicted outcomes to uncertainty. For the leading alternative, results were bimodal, with most parameter combinations resulting in either very low (< 5%) or relatively high (> 95%) probabilities of success. Overall, the results of this feasibility assessment suggest that a successful reintroduction of northern leopard frogs is possible but far from certain; a major contributor to model outcomes was uncertainty surrounding survival of early life stages. Conservation translocations would benefit greatly from more widespread use of decision analysis to counter the complexity and uncertainty inherent in these decisions.

A-0910 (Oral)
Do Big-headed Turtles Affect the Community and Ecosystem of Hill Streams?

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Freshwater turtles have been found to suppress invasive species or dominant grazer populations, alter macroinvertebrate communities and accelerate carcass decomposition. The ecological roles of Asian freshwater turtles are poorly known because wild populations have been severely depleted. For instance, the critically endangered Big-headed Turtle (*Platysternon megacephalum*) has been widely poached across its native range. However, several remnant populations persist in Hong Kong, providing a valuable opportunity to study their influences on the ecosystem. In this study, we seized the opportunity to examine the effects of the Big-headed Turtle on three aspects: prey behaviour, macroinvertebrate communities, and food web structure. First, we exposed a common prey item, *Sulcospira hainanensis*, of the Big-headed Turtle to four different treated waters, e.g., water carrying the smell of the Big-headed Turtle, in controlled laboratory experiments. We observed that the smell of the turtle triggered the snails to hide under a shelter, which is a common antipredator behaviour in freshwater snails. Second, by sampling macroinvertebrates in streams with and without the Big-headed Turtle, we found that the presence of the turtle was associated with a higher abundance of Chironomidae. Third, we aim to construct food webs using stable isotope signatures to demonstrate how the removal of the turtle may affect predator-prey interactions of other members of stream communities. Findings from this study emphasize how freshwater turtles affect the ecosystem at multiple ecological levels, and fill knowledge gaps in our understanding of Asian turtle ecology. Better protection of the Big-headed Turtle and other chelonian species against poaching and other threats do not only conserve these rare animals, but also reduce disruptions to the function and stability of stream ecosystem.

A-0911 (Oral)
Museum Venomics to Understand the Evolution of Snake Venoms

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Venoms have long been proposed as a key innovation that drives diversification, however this hypothesis remains to be tested using a robust macro-evolutionary framework. This is mostly because quantitative profiling of snake venoms has remained limited to live specimens making it challenging to have a comprehensive sampling across a clade. Here I will present an approach we have developed to profile venom proteomes using mass spectrometry from museum specimens, unlocking a new way to accessing to proteomes of most living species. This data will be the key to understanding the role of venom in the diversification of Austral-Papuan elapid snakes.

A-0912 (Oral)
Predicting Site-Specific Endemism in Limestone Karst-Dwelling Snake Species

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While limestone karsts have lower levels of alpha diversity compared to nearby ecosystems, they possess high levels of endemic species. Several disconnected karst ranges provide new opportunities for reptile taxa to speciate, resulting in predictable patterns of endemism across Southeast Asia. In this presentation, I provide an overview of new reptile discoveries made in Thailand's karst mountain ranges and argue that the patterns of species diversity across these ecosystems correspond with other endemic genera that are harder to find during field expeditions. These include karst endemic pit vipers in the genus *Trimeresurus* and kukri snakes in the genus *Oligodon*, both of which are known to predate on lizards and their eggs. Given that lizards (especially geckos) have a much higher detectability during herpetological field surveys, I suggest that researchers utilize patterns of lizard diversity across Thailand's karsts to make predictions about rarer species that remain undescribed or undiscovered.

A-0913 (Oral)
An Assessment of the Current Status of Southern River Terrapin (*Batagur affinis*) populations in Perak and Kedah, Malaysia

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Population monitoring is a fundamental component of wildlife management that determines the status of a purposeful introduction of a wildlife species into an area. The Southern River Terrapin (*Batagur affini*s) and Painted Terrapin (*Batagur borneoensis*) are two Critically Endangered species with a limited natural distribution. The Malaysian Department of Wildlife and National Parks (PERHILITAN) initiated a *B. affinis* conservation programme in the 1960s to stem the decline of the species. Since the 1980s, more than 37,000 *B. affinis* have been released into the Perak River as a head-started species introduction; and with more than 8,600 *B. affinis* and *B. borneoensis* released into the Kedah River. This study was undertaken to determine the presence of terrapins population after 40 years of conservation intervention efforts and with recent field studies surveyed from 31 August to 8 September 2023, in these rivers. Gill nets deployed and checked every two hours. Casting nets were continually cast throughout the sampling duration. From these employed sampling methods, the presence of Batagur affinis was not sighted in the Perak nor in Muda Rivers. Only one juvenile *B. affinis* and two juvenile *B. borneoensis* were captured in the Kedah River. During this study, discarded or abandoned fishing gear were also found in significant numbers and was recorded as the plausible cause of low number of river terrapins found in these rivers. It is crucial to document the wild population size of *B. affinis* as this provides crucial information and empirical data for conservation efforts and setting new management guidelines for these Critically Endangered species.

A-0914 (Oral)
Female Preference for Size-Matched Males in an Assortative Mating Frog: Evidence from Acoustic Playback Experiments

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Amplexus is a distinctive mating strategy in the reproductive life cycle of amphibians, encompassing both assortative and random mating strategies. Prior to amplexus, male frogs commonly emit acoustic signals to attract females, emphasizing the predominant role of acoustic communication in anuran reproductive process. However, it has remained unclear whether males' acoustic signals significantly affect female' s choice of male size. In this study, we investigated the mating strategy of *Fejervarya multistriata*, a paddy frog, and examined whether females can use acoustic signals to locate matched-sized males. We measured the size of frog amplexus pairs to explore the relationship between female and male body size. We then recorded male frog calls to optimize a linear model for predicting male frog size based on acoustic properties using the stepwise regression, and evaluated the reliability of the model. We also conducted two-choice arena phonotaxis experiments in which females were simultaneously exposed to male calls representing different body sizes. Our findings showed that: (1) *F. multistriata* employs size-assortative mating as a reproductive strategy. (2) The first frequency band (FB1) and the note interval (NI) in male advertisement calls can serve as key indicators of individual male size and have a negative correlation with body size. (3) The linear model incorporating FB1 and NI effectively accounts for the variation in predicting male frog sizes, closely matching the actual sizes during validation. (4) In phonotaxis experiments, female frogs showed a preference for male calls that represented individuals matching the size of those preferred in size-assortative mating. Therefore, we suggested that *F. multistriata* females can use acoustic signals to select size-matched males, thereby achieving assortative mating. In conclusion, this study provides valuable insights into the mechanisms of mate choice in amphibians and contributes to understanding the role of acoustic signals in reproductive processes.

A-0915 (Oral)
How Environmental Context Shapes Amphibian Responses to Chytrid Fungus

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The emergence of chytrid fungus has reconfigured amphibian biotas across the world. A key characteristic of this restructuring has been high variability between amphibian species and populations in their response to chytrid emergence. These variable outcomes are shaped by a diverse range of host, pathogen, and environmental factors. Drawing on a decade of research on chytrid fungus in Australia, this talk will focus on the role of environmental factors in mediating species and population responses to pathogen emergence. I will illustrate overarching patterns of species range and realized niche contraction since chytrid emergence, and then explore some of the underlying demographic mechanisms. I will illustrate how chytrid has reshaped the contemporary distributions of impacted species, with their ranges now characterized by higher temperatures, lower diurnal temperature range, higher precipitation and lower elevations. These directional niche shifts – in situations where chytrid is now ubiquitous across species entire ranges – suggests an important role of environmental conditions in determining whether chytrid presence translates into population declines and local extinctions (and ultimately, species extinction). For example, contraction from upland

areas likely reflects increased disease impact associated with the well-established bioclimatic preferences of the pathogen, but also the often-overlooked demographic vulnerability of high elevation amphibian populations. I will explore several case studies that reveal the role of environmental context in determining pathogen impact through such demographic mechanisms, from upland, range-restricted species to once common and widespread species that formerly occupied hundreds of square kilometers of eastern Australia. I will illustrate the benefit of combining macroecological and population studies to inform the development of innovative conservation programs for species threatened by chytrid fungus. I will close with a discussion of the broader role of environmental context in shaping species responses to emerging threats.

A-0916 (Oral)
Hidden Diversity of *Cyrtodactylus* in the Karst Ecosystem of Thailand

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Limestone karsts in Southeast Asia cover a vast area in the region and are known for their high levels of endemism. Among Southeast Asian countries, Thailand hosts an extensive area of limestone karsts, especially in the western and southern parts. Geckos in the genus *Cyrtodactylus* have been known for their adaptation to karst ecosystems. Over the past decades, *Cyrtodactylus* has undergone a rapid increase in species diversity across its geographic range–including Thailand–due to the integrative approach of current studies. As situated in the biodiversity hotspot, Thailand currently has 112 gekkonid species and of these, 54 species are in the genus *Cyrtodactylus*. In this study, we conducted intensive surveys in karsts and caves in southern and western Thailand, focusing on hidden diversity of karst-associated species in the *Cyrtodactylus pulchellus* and *Cyrtodactylus oldhami* groups based on the combination of morphological and mitochondrial DNA data. The phylogenetic analyses showed several cryptic lineages within Thai populations for both *C. pulchellus* and *C. oldhami* groups. The Thai populations had uncorrected p-distance of 6.6–17.2% with other members in the *C. pulchellus* group. For the *C. oldhami* groups, the uncorrected p-distances among the Thai populations and other members are relatively moderate to high, 5.1–17.9%. Unlike genetic data, we found minimal morphological distinction in these species' groups, indicating diverse lineages with conserved or convergent karst-associated morphology. Additional analyses and samplings across the distribution should be further conducted for clarifying taxonomic status and reveal the true diversity of *Cyrtodactylus* in Thailand which will strengthen conservation effort in Thailand.

A-0917 (Oral)
Community Accessible Treatment for Chytridiomycosis

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Batrachochytrium dendrobatidis (Bd) is a fungal pathogen that infects the skin of amphibians and causes the disease chytridiomycosis. Bd has been associated with the extinction of at least 90 species, and the decline of hundreds more. Whilst some antifungal treatments show high efficacy for clearing infections, these treatments can be cost-prohibitive when treating large numbers of animals and potentially toxic. Development of reliable treatments that are accessible at a large scale is necessary to protect vulnerable captive populations. F10SC is a veterinary disinfectant that is readily available, shelf stable, and cost effective. We conducted a clinical trial using F10SC at a 1:5000 dilution to treat green and golden bell frogs (Litoria aurea) that were experimentally infected with Bd. Our preliminary results suggest that F10SC is highly effective for clearing Bd infections and may have fewer adverse side effects than other antifungal treatment options.

A-0918 (Oral)
Frog Skin Evolution across Space and Species

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All organisms respire, and for terrestrial animals, respiration comes at a high cost. Balancing the need for gas exchange with the risk of dehydration is a universal constraint that creates predictable evolutionary trade-offs across the tree of life. Most tetrapods have relatively impermeable skin, sacrificing permeability for protection and water retention. Amphibians occupy the other end of this spectrum, with more permeable skin that allows cutaneous respiration but increases vulnerability to desiccation, physical damage, pollutants, and disease (e.g., fungal susceptibility). However, anuran species show striking variation in many skin features that are hypothesized to affect anuran gas exchange and water loss rates. The importance and variability of amphibian skin texture has long been recognized but is typically categorized into a few groups, such as "smooth," "tuberculated," "granular," "warty," etc. Our study aims to move beyond these categorical descriptions to quantify external skin variation in an efficient and reproducible manner. We further use these new skin texture data to test whether skin varies in association with a species' microhabitat, climate or body size. In total, our study provides a way to measure and compare skin texture among anuran species and studies and begins to test whether amphibian skin has evolved in ways that allow anurans to thrive in a range of climates across the globe.

A-0919 (Oral)
A Framework for Protecting Endemic Reptiles from the International Wildlife Trade: An Australian Context

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The global pet trade is a rapidly growing industry that now involves thousands of species, the majority of which are not subject to international regulation. While many animals are sourced via sustainable captive breeding, there is a growing body of evidence that some trade is supplied by the unsustainable harvesting of wild populations, with over 3000 reptile species documented in wild-caught trade. Australian reptiles are particularly affected by this process due to the high proportion of species that are endemic or morphologically unique. In fact, despite regular interceptions of poaching and illegal export attempts by Australian authorities, new endemic reptile species continue to enter international markets, particularly in Europe and North America. To more effectively anticipate and prevent illegal reptile poaching, conservation researchers and practitioners require a detailed understanding of the taxa and regions that are most likely to be targeted by prospective harvesters. Here we outline our research framework to predict species-level poaching risk based on the risk-reward ratio from a poacher perspective, using Australia as a case study. We integrated data from online e-commerce advertisements, trade expo surveillance and government interception records to identify which endemic species are already involved in trade and quantify their market value. We subsequently analysed fine-scale morphological and macro-ecological traits to determine which species not-yet documented in trade may be desirable to future pet keepers. Finally, we conducted fauna surveys in regions with high diversity of desired species, complimented with historic and citizen science data, in order to quantify the survey effort of harvesting each species. By collaborating with authorities, we seek to identify at-risk species, optimise poacher detection and disincentivise unsustainable trade. Our framework has the potential to improve conservation outcomes for endemic reptiles not only in Australia, but also for other biodiverse regions similarly impacted by global trade demand.

A-0920 (Poster)
AmphibiaWeb - Connecting Amphibian Lovers to Data

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Amphibians are the most threatened vertebrate group on the planet and have been seen as harbingers of the Sixth Mass Extinction. It is with this alarm call that AmphibiaWeb was founded in 2000 and has been operating uninterrupted since then. AmphibiaWeb (amphibiaweb.org) is an non-profit initiative whose mission is to connect people around the world by synthesizing and sharing information about amphibians to enable research, education,

and conservation. We do this by providing up-to-date scientific information on amphibian natural history, conservation, taxonomy, and global decline. The website synthesizes information from scientists and experts with the latest in biodiversity informatics. Features include: up-to-date tracking of newly described amphibian species, expert-based species accounts for over 30% of the world's amphibians, some in multiple languages; dynamic species range and occurrence mapping; detailed pages on amphibian declines and its causes with ongoing literature updates; community- contributed multimedia files (sound, video and photos); and a community of scientists responsive to the latest taxonomic and research developments in amphibian biology and conservation to any inquiries from the public. Here we will provide a guide to how to effectively use this amphibian resource. We will outline how herpetologists like you can contribute and share your knowledge and photos!

A-0921 (Oral)
Thawing the Block to Freezing Amphibian Eggs and Embryos

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Reproductive technologies, including cryopreserving and biobanking gametes and embryos, offer important tools for amphibian conservation. They have the potential to reduce the risk of extinction, manage the genetic diversity of small and declining populations, and reduce costs of conservation breeding programs. Recent decades have seen strong progress made in developing protocols for the cryopreservation of sperm from a range of anurans and urodeles, with live progeny from cryopreserved sperm reaching sexual maturity in some species. However, success in cryopreserving amphibian sperm has not been repeated with oocytes, eggs or embryos, preventing the storage and retrieval of the maternal haploid and embryonic diploid genomes. The primary problem is the technical block to cryopreserving large, telolecithal eggs and embryos of aquatic species such as fish and amphibians. Even with rapid freezing by vitrification, these structures form intracellular ice during thawing which is lethal. Two fundamentally different strategies may overcome this block. Vitrification followed by ultra-rapid laser-warming has been successful with zebrafish embryos by preventing the formation of intracellular ice during thawing. This may be effective with amphibian oocytes and embryos up to 2000 µm in diameter, potentially allowing the application of the technique to about 60% of anurans, and around 50% of urodelan species. An alternative approach, also successful with fish, is the cryopreservation and transplantation of primordial germ cells and spermatogonial stem cells into host embryos, resulting in the development of sexually mature adults producing viable male and female gametes from the donor species. These approaches could potentially be applied to all amphibian species, irrespective of egg or embryo size, and would also capture and preserve the mitochondrial genome, which has not been possible with sperm cryopreservation alone. One or all of these approaches could provide game-changing technologies for amphibian conservation, complementing a suite of conservation initiatives already underway.

A-0922 (Oral)
Exceptional Gestation Length in a Nocturnal, Viviparous Alpine Gecko from New Zealand

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Understanding reproductive output and gestation length is crucial for the conservation of viviparous ectotherms, especially in the face of climate change and increasing predation pressure. Biennial reproduction (rather than annual) is increasingly reported for cool-climate lizard species at high latitudes or elevations, but gestation length is not known to exceed ~14 months. We evaluated female reproductive cycles in the Cascade gecko, a viviparous, nocturnal gecko of the genus *Mokopirirakau* at a remote alpine site (44°S, ~ 1,300 m asl) in Aotearoa New Zealand. We used abdominal palpation as the primary measure of reproductive stage, classifying adult females into five categories of reproduction (non-reproductive, vitellogenic, early pregnant, mid-pregnant and late pregnant) and documenting the number of reproductive structures. Using capture-recapture methodology and photo identification, we tracked known females over six summers. We utilised portable ultrasound technology on a subset to validate palpation findings. We made 171 captures of 100 individual females, of which 39 were captured multiple times (range 2–7). In any given sampling session, we found females in a range of reproductive stages, signalling that their cycle is neither annual nor biennial. The vast majority had two reproductive structures (range 0–2) and few were in a non-reproductive state, suggesting that years of skipped reproduction are rare. Ultrasound findings on 11 female geckos corroborated inferences from palpation. Gestation length was estimated to be 2.9 years (95% credible interval 2.4 to 3.6) by modelling pregnancy as double interval censored data based on 41 pregnancies among 35 females. We infer that reproduction is triennial or less frequent. Meanwhile, numbers of invasive mammalian predators (the key threat to these geckos) are increasing in the alpine zone with climate warming. In combination, exceptionally slow life-histories and escalating predation pressure underscore the extreme vulnerability of alpine geckos in a changing climate.

A-0923 (Oral)
Host-Pathogen Dynamics in the Wild – Lessons from Enzootic Chytridiomycosis in Indian Anurans

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Chytridiomycosis, caused by *Batrachochytrium dendrobatidis* (Bd), is one of the leading causes for anuran declines globally. The Western Ghats in India host 226 anuran species. We started a population monitoring programme in five seasonal streams in the Tillari Conservation Reserve (TCR), Western Ghats, Maharashtra, to understand whether Bd infection and intensity vary temporally in anurans, whether infection intensity affects anuran survival, and whether infections are cleared/reduced, allowing the anuran community to persist with Bd in TCR. We uniquely tagged anurans from 100 x 25 m transects in five streams in TCR using Passive

Integrated Transponder tags, in wet and dry seasons between 2018 and 2020. We collected skin swabs from all captured/tagged anurans within and between seasons, and used quantitative Polymerase Chain Reaction (qPCR) to measure infection loads. We categorized Bd infection loads into three disease states – 'No', 'Low' and 'High'. We used program MARK to construct models to estimate transition probability between infection states, anuran survival probability, and variation in capture probability among disease states. We present results from the first three years of the monitoring program, where we collected 1,785 swabs from 1575 tagged anurans comprising of 12 species. Overall Bd prevalence was 74.6% with a low average infection load of 49 to 700 zoospores/swab. Prevalence did not differ between wet and dry seasons. Infection loads reduced significantly during the dry seasons, however, it did not affect anuran survival. The transition probability from 'High' to 'Low' infection state was significantly high. Anurans with high infection load were captured more often than those with low infection loads. We found high Bd prevalence and low infection loads, resembling enzootic chytridiomycosis. High Bd loads in anurans affecting their capture probability suggests that Bd infection influences anuran movement/escape response. The role of sub-clinical infections on anuran ecology needs to be understood further.

A-0924 (Oral)
Sleeping Dwarf Chameleons (*Bradypodion*) are Thermal Conformers – The Ultimate Model Poikilotherms

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Heat transfer between animals and their thermal environments is important in setting their geographic ranges and responses to climate change. This is especially so when animals have limited ability to decouple body temperature (Tb) from environmental temperature. Dwarf chameleons (*Bradypodion*) are diurnal lizards that sleep throughout the scotophase on perches such as thin terminal branches of trees and shrubs, or near the tips of grasses, and they do not change position during the night. Because they are small-bodied (usually < 10 g) and ectothermic, they have few thermoregulatory options during the night. We hypothesized that their Tbs conformed closely to bulk temperature (in this instance, air temperature; Ta). We measured Tb in eight species during the scotophase and Ta near each perching site. Tb closely matched Ta (difference < 0.3°C in each species), and regression analyses revealed slopes close to 1 and Y intercepts close to zero. Thus, Tbs of sleeping dwarf chameleons follow the variation of Ta throughout the night and they qualify as model poikilotherms while sleeping. Because Tbs match Tas so closely, chameleons have to tolerate the lowest Tas of their perch site if they are to survive the night, and minimum Tas are likely to be an important factor in limiting their geographic ranges. Overlaying chameleon geographic distributions with minimum winter temperatures also allows for predictions of species-specific minimum critical temperatures. Analysis of winter temperatures across the geographic ranges of all dwarf chameleon species revealed that most are likely range-limited by temperature, but some occur in areas that become thermally challenging in winter and dip below zero, especially for high elevation species. There is evidence that individuals of these species can tolerate significant freezing of body water. Thus, it appears that tolerance to low temperatures is of fundamental importance to survival of dwarf chameleons.

A-0925 (Oral)
Urban Landscape Genomics and Connectivity in South-Western Australia

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Ecological theory suggests that by quantifying dispersal pathways, species traits, and landscape characteristics we can predict how alien invasive species may spread through a recipient landscape. By building a predictive model for a range of putative invasive taxa, we can begin to strategically identify and target priority locations for monitoring or management activities. Our aim is to build such a model for the metropolitan region of Perth, in south-western Australia. This model requires two main components: (1) a stack of high-resolution spatial GIS layers of landscape attributes (e.g. vegetation cover, urbanisation, waterbodies) and (2) maps of connectivity (landscape resistance) for a range of surrogate taxa within the study area. Here, I showcase the development of composite landscape resistance surfaces for two species of reptile and one species of mammal. Using tissue samples collected from many locations across a large (100 km by 50 km) geographic area, we were able to obtain high-quality DNA sequencing data for between 90 and 160 individuals per species. By genotyping thousands of SNP loci we were able to very accurate calculate pairwise genetic distances among individuals. Using the gdistance and ResistanceGA packages in R, we built and optimised resistance surfaces for each species using the expected random-walk commute time between locations, and the relationship between the resistance distance and the supplied spatial layers. We use the resulting maps of resistance to describe the key drivers of species connectivity in the Perth region, with emphasis on how such an understanding can be used to predict and manage invasive species into a changing and uncertain future.

A-0926 (Oral)
Nesting Ecology of King Cobras, with Special Focus on Nest Thermal Regimes, from the Western Himalayas of India

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The King cobra, world's longest venomous snake, is the only ophidian to build an aboveground nest. Despite being a large, popular, widespread species native to south/southeast Asia, we have limited knowledge on its ecology, especially regarding its nesting habits. Previous ecological research on this iconic snake has primarily been carried out in the tropical lowland forests of southern India and northern Thailand, with no prior study conducted on king cobra populations inhabiting cooler climates at higher elevations. Our study was based in the mid-elevation, subtropical forests of the Western Himalayas of India, a lesser-known but important habitat for this snake. Among abiotic factors, temperature is known to play a key role in determining hatching outcomes in oviparous reptiles. Thus, to better understand how temperatures inside nests respond to external environmental temperatures and influence hatching, especially in regions that witness higher diel/seasonal temperature fluctuations, we studied the thermal regimes of 35 King cobra nests from the foothills of Nainital Forest Division, Uttarakhand. Between 2009-2023, we studied the nesting ecology of 39 King cobra nests. We mainly collected data on nesting behavior (using focal animal sampling), thermal regimes of nests (via automatic data loggers), nest and habitat characteristics, and hatching outcomes (i.e., hatching success, hatchling size). Our results showed that King cobra nests offer a distinct thermal advantage to the developing embryos, by consistently maintaining warmer

(by ~3°C) and more stable incubation temperatures. Mean nest temperature was the best predictor of hatching success, and hatchling length was positively associated with nest temperature. Temperature data from 'failed' nests likely indicate a lower thermal threshold below which successful incubation does not occur. Our study thus provides unequivocal evidence for the critical thermal benefits offered by King cobra nests. We also highlight some novel behavioral and natural history observations made during this long-term study.

A-0927 (Oral)
How Many Collectors can make a Livelihood out of Collecting Turtles in Indonesia, when Done Legally?

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Those working in the international wildlife trade, including CITES, TRAFFIC and IPBES, often state that wildlife trade directly contributes to the livelihoods of harvesters and collectors. Certainly when it comes to turtles and tortoises little direct evidence is available for this assertion. We focus on Indonesia, a country rich in turtle species and one that exports a large number of species, sometimes in large volumes. We explored to what extend the legal harvest of freshwater turtles for the domestic and international meat trade supports livelihoods. Harvest and trade of freshwater turtles in Indonesia is regulated through an annually set province-by-province quota system and only four species are allowed to be traded for its meat: Amyda cartilaginea, *Cuora amboinensis, Cyclemys dentata* and *Dogania subplana*. For each province we calculated the total monetary value of turtles for collectors, and we divided this by the government's recommended minimum wage for each province arriving at the number of collectors that can legally earn a minimum wage by collecting tortoises and freshwater turtles. We find that, nation-wide, legal collection allows a maximum of 272 collectors to gain a year-round minimum wage (or 2,720 collectors make a tenth of a minimum wage). In practise, because of exports of turtles above the quotas, significantly more collectors may gain monetary benefits. Given that the legal trade in turtles provides so few people with a minimal amount of income, and given the increasingly imperilled status of numerous freshwater turtle species, and the decline in Indonesia's freshwater turtle species in particular, we question whether allowing this trade is an effective livelihood strategy and whether such unsustainable trade should continue to be promoted and allowed. This is a question that needs to be answered not just by Indonesia but by all those that work in the international wildlife trade

A-0928 (Oral)
Anuran Tadpole Diversity at Khlong Saeng Wildlife Sanctuary, Surat Thani, Thailand

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Thailand is located between the Indo-Burma and Sunderland biodiversity hotspots which are the places that serve as the home of fauna and flora. Although there are over 180 known frog species, only 56 have documented larval descriptions. This study focuses on the species diversity of tadpoles from Khlong Saeng Wildlife Sanctuary (KSWS), Southern Thailand. Tadpoles were collected from all available microhabitats, including both lotic and lentic habitats. The identification of tadpoles is based on external morphology and verified through molecular identification (i.e., CoI or 16s rRNA). The study revealed seventeen anuran tadpole

species in eight microhabitats, three of which are the new descriptions for Thailand. The study found that tadpole morphology is related to their preferred microhabitat. Furthermore, the morphology and mouth parts structure of the species were also discussed.

A-0930 (Oral)
Implications of Determinate Growth for Body Size, Life-History Evolution and Sexual Size Dimorphism in Lizards

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In contrast to mammals and birds, reptiles are considered to be indeterminate growers whose growth reflects a differential allocation between growth and reproduction. Recently, evidence for the determinate nature of growth in lizards has accumulated, necessitating a re-examination of models of the ontogeny of sexual size dimorphism and life-history evolution. We monitored growth, bone growth plate activity, hormonal profiles and reproductive activity in the male-larger gecko *Paroedura picta* and the female-larger *P. vazimba*. The closure of bone growth in females of both species correlates with the onset of reproductive maturation, and growth is likely feminised by ovarian hormones. On the other hand, growth does not seem to be influenced by male gonadal hormones. We propose a model to explain evolutionary switches in sexual size dimorphism based on bipotential effects of ovarian hormones. Low levels of ovarian hormones can promote bone growth, but high levels associated with maturation of the reproductive organs promote senescence of the bone growth plates and thus cessation of bone growth. The major difference in growth between endothermic and ectothermic amniotes appears to be in the magnitude of growth before and after the first reproduction, rather than in mechanistic processes such as senescence of growth plate cells. We also document the consequences of early female reproduction for offspring in *P. picta*. The offspring of young, immature mothers show similarities to mammalian offspring with low birth weight or early malnutrition, exhibiting catch-up growth and a predisposition to obesity, but ultimately reaching comparable sex-specific final body lengths as offspring of older females. We emphasise that models of growth, life-history and evolution of body size in many lizards should recognise their determinate growth and consider that female lizards may produce the most fit offspring only between reaching their final body length and the onset of reproductive senescence.

A-0931 (Oral)
A Global Mismatch Between the Media Framing of Snakes and the Health Risk Posed by Snakebites

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The fear of snakes (ophidiophobia) is one of the most prevalent animal-related phobias. While the distribution of potentially dangerous snakes, and the resulting prevalence of health risk, is uneven globally, snake phobia and fear is more evenly spread and universally found across cultures. Those negative emotions frequently result in the direct persecution of snakes, extending to non-venomous species as well, thus posing a significant conservation challenge. Mass media could be a powerful tool to promote correct biological information and awareness about snakes, ultimately fostering their conservation. Our aim was to verify if there existed a correspondence between the risk portrayed by the media and the real health risk posed by snakebites in those countries. We selected eight English-speaking countries around the globe that differ in the presence of deadly species and yearly human deaths due to snakebites. For each country, we collected a sample of online media news published in 2023 reporting about snakes and/or snakebites. We found that 38% of the news contained pro-conservation messages, especially those for which an expert on snakes was consulted by the journalist, whereas 21.6% were sensationalistic. The use of sensationalism and pro-conservation messages was comparable among countries, despite significant differences in the real risk posed by snakes in those areas. Persecution is a significant threat to snake populations worldwide. Improving communication about snakes could help bridge the gap between the real and perceived risks posed by these species, especially where the risk of being bitten by venomous snakes is low.

A-0932 (Oral)

The Influence of Fire Salamander Larvae on Benthic Organisms: Evidence of Habitat Specific Differences

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Salamander larvae can impose a great impact on benthic organisms as they are keystone predators in different kind of aquatic habitats. Gut analysis revealed that their diet consists of invertebrates from the water column and benthic taxa. The impact on endobenthic organisms, especially the meiofauna, is, however, not well understood yet, as these organisms are digested very quickly and can thus not be detected reliably. To avoid this, we investigated the impact of fire salamander larvae from two habitat types, ponds and streams, on meiofauna by analysing consumed prey items from a microcosm. We collected 20 larvae from both, ponds and streams from the wild and transferred them to the lab. We placed each larva individually into a microcosm with sediment and benthic organisms. We also added control samples without larvae. We kept the larvae either for one week or two weeks and counted the number of nematodes, oligochates and rotifers after we removed the larvae. Nematodes were influenced by pond larvae during the first week and larvae of both habitat types influenced the number of nematodes after two weeks. Oligochates were mainly influenced by stream larvae, but not by pond larvae, independent of the duration of the experiment. Rotifers were influenced by larvae from both habitats, but only during the first week and not during the second week. Our findings suggest that fire salamander larvae are able to reduce the meiofauna through predation. Furthermore, fire salamander larvae show habitat specific differences indicating an adaptation towards the different environmental conditions in the habitat of origin.

A-0933 (Oral)

Combining Computer Vision with Evolutionary Models to Examine Drivers of Color Pattern Variation in Lizards

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Pattern polymorphisms (PPs), denoting variations in color patterns among and within sexes, are commonly studied in males for their role in intraspecific competition. However, instances of female pattern polymorphisms (FPPs) and the ecological factors influencing such variations remain elusive. With 52 out of 448 species showcasing FPP, Anolis lizards exemplify this variation. Yet, the eco-evolutionary forces governing such FPPs are still unknown, possibly due to human-biased classification systems. Here, we employ a dataset of 1434 museum specimens from 72 species and introduce a framework that combines a Java-based image processing program with convolutional neural network (CNN) for the automated, repeatable, and unbiased classification of PPs from digital images. This method efficiently acquires high-quality data, laying the foundation for understanding the adaptive processes behind FPPs in these lizards and offering insights into similar phenomena in other species.

A-0934 (Oral)

A Century-Old Enigma – Unravelling the Natural History of an Endemic Frog from the Palawan Archipelago (Philippines): *Barbourula busuangensis* (Anura: Bombinatoridae)

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Barbourula busuangensis (Anura: Bombinatoridae) is an endemic and aquatic anuran, inhabiting fast-flowing rivers in the tropical rainforest of the province of Palawan in the Philippines. Still one hundred years later, after its discovery by Taylor and Noble in 1924, very little is known about this secretive species. Therefore, this study aims to investigate its natural history and attempt to uncover its reproductive mode. Our fieldwork was conducted on the island of Busuanga (Palawan, Philippines), where we monitored two populations through: (i) capture-mark-recapture with microchips and/or fluorescent elastomers, (ii) skin sampling to study Bd and microbiome, (iii) ethological studies in its habitat, and (iv) automated *in situ* climate data collection. Preliminary results show that *B. busuangensis* is abundant and not affected by Bd. Adults demonstrate philopatry, being able to return to their shelter when displaced up to 50 m. Moreover, and most importantly, contrary to past speculations, the reproductive mode is indirect, with lecithotrophic tadpoles possessing an oral disc to adhere to rocks, and the constant presence of an adult suggests parental care. These findings enrich our

understanding of the evolution of the Amphibia and provide information on the conservation status of the species to make recommendations to government agencies.

A-0935 (Oral)
Island Syndrome Deviations in Green-Spotted Grass Lizards on a Young Island near Taiwan

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Island syndrome predicts that insular animals tend to increase in size, reduce aggressiveness, display less conspicuous ornamentation, diminish sexual dimorphism, and adopt a more K-strategical life history. However, our study of the green-spotted grass lizard (*Takydromus viridipunctatus*) population on Guishan Island, a 7,000-year-old small island northeast of Taiwan, reveals a unique departure from these predictions. We found that their body sizes on the island are enlarged, with over 20% of insular adults surpassing the maximum size observed in Taiwan. The insular newborns were also 15% larger and 50% heavier. Morphological differences between the sexes are also smaller on the island than in Taiwan. Additionally, the overlapping demographic pattern suggests a longer lifespan and a more K-strategical life history on the island. However, insular individuals have significantly higher rates of injury and toe loss than Taiwanese populations, indicating heightened aggressiveness. Furthermore, both sexes on the island, surprisingly, including females, display greener, more saturated, and larger ornaments, in contrast to the distinct sexual dichromatism observed in Taiwan where only males display green spots. Our findings unveil a significant insular shift in morphology, ornamentation, sexual dimorphism, behavior, and life history of the green-spotted grass lizard on this young island. While certain aspects align with island syndrome predictions, others starkly contrast them. Future research will focus on confirming the heritability of these traits, assessing genetic differentiation among populations, and quantifying the ecological environment to further understand the proximate and ultimate causes of this unique phenotypic changes.

A-0936 (Poster)
Long Tail's Effect in the Grass: Locomotor Performance in Grass Lizards

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Grass-living lizards often possess remarkably long tails, possibly reflecting specific habitat requirements, as animal morphology and locomotion are typically finely tuned to suit the environments. However, despite previous autotomy experiments demonstrating the role of tails

in locomotion, the long tail's precise function in grass habitats remains unknown. Here, we investigated how tails influence the locomotion of green-spotted grass lizards (*Takydromus viridipunctatus*) in grassland by observing their runs before and after tail loss on tracks with and without grass-like obstacles. We analyzed the associations among various kinematic parameters and assessed the joint impact of tails and the grass environment on locomotion. The results revealed significant reductions in maximal sprint distance, stride length, sprint speed, body angle, and pause number following tail loss, while stride frequency and tail angle remained unaffected. Interestingly, we observed a substantial increase in pause frequency on tracks with grass-like obstacles for tailless lizards, denoting the critical role of long tails in facilitating grass lizard locomotion within grassland environments. This study provides a comprehensive evaluation of the impact of a long tail on grass lizard locomotor capabilities, offering insights into the interplay between various locomotor parameters. It also highlights a synergistic effect between the tail and the grassland habitat on locomotion, strongly implying that a long tail significantly contributes to their adaptation to grassland habitats at a biomechanical level.

A-0937 (Oral)
How to Choose in a Novel Environment? Social Information Use in Urban and Non-Urban Syntopic Lizards

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Urbanization is drastically transforming habitats worldwide and imposing novel challenges on animals. Social information can provide a shortcut to obtaining valuable information about the environment and may aid individuals in quickly responding to novel challenges while reducing the costs associated with individual learning. However, how the use of social information facilitates adjustments to urban environments remains poorly understood. The Italian wall lizard (*Podarcis siculus*) and the common wall lizard (*Podarcis muralis*) are urban dwellers, that can sometimes live in syntopy in both urban and non-urban habitats. This provides a unique opportunity to compare the strategies used by closely related species to cope with urbanization. To investigate whether urban and non-urban populations differ in their use of social cues, we conducted field experiments with native syntopic populations of male *P. siculus* and *P. muralis*. We exposed lizards to novel environments and conducted two preference tests using chemical scent cues from unfamiliar males: (test 1) conspecific vs control and (test 2) conspecific vs heterospecific. Additionally, as *P. siculus* is known for its invasive ability, often outcompeting other lizards, we performed the same tests on an urban population where P. muralis is absent. We predicted (test 1) that urban lizards would exhibit a stronger preference for conspecific cues, and (test 2) that all populations would prefer to use social cues from heterospecifics, which do not represent competition for mating opportunities. We found a significant effect of habitat and species in these preference tests. Our findings have broad implications for understanding how cities can reshape social behaviour within-and-between species and provide insights into factors shaping invasion success.

A-0938 (Poster)
Forever Young? Bone Staining Potentially Hints to Short Lifespan in Wild Tepui Summit Endemic Toads (Anura: Bufonidae: *Oreophrynella quelchii*)

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Age is an important life history trait that provides insight into population dynamics, growth rate and reproduction. Environmental and physiological factors can contribute to the aging process, and in harsh ecological conditions environmental factors might play a major role in shaping age-specific demographics in anurans. *Oreophrynella quelchii*, the pebble toad, is thriving in surprisingly high numbers on the summit of Roraima-tepui. Although their ecology and demography have been the focus of a few recent studies, their age structure remains scarcely explored. Here, we aimed to assess the presence of growth marks and/or so-called "lines of arrested growth" (LAGs) to estimate the lifespan of *O. quelchii* on Roraima-tepui. Given the difficulties and subjectiveness of traditional skeletochronology, particularly as applied to tropical organisms, we developed a more sensitive and less subjective methodology to investigate the longevity of *O. quelchii*, using acridine orange bone staining and confocal microscopy. We applied the same method to the only other anuran species present on the summit of Roraima-tepui, *Pristimantis aureoventris*, to examine for potential differences in growth marks between two taxa subjected to the same ecological conditions, but with drastically different demographics. We confirm that classical skeletochronology is not effective for age determination in tropical species since they lack typical LAGs. However, although various growth marks were found within the bone diaphysis in all the studied *P. aureoventris*, a single growth mark was detected in only one *O. quelchii* specimen, incidentally the largest female of our sampling. Although exact ages could not be inferred, our results potentially hint to a short lifespan in *O. quelchii*. We argue that a distinction should be made between LAGs and growth marks within skeletochronology, and that studies using this method on wild tropical and subtropical amphibian species should be more cautious in tentatively deriving exact ages.

A-0939 (Oral)
Traditional and Social Media Framing of Crocodilians: The Most Sensationalized Among Large Carnivores

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In today's digitally saturated environment, accessing news content via the internet has become an integral aspect of daily life. The way traditional and social media frames wildlife may substantially shape public perception, potentially influencing attitudes towards wildlife conservation. Despite crocodilian attacks on humans are rare, these incidents evoke strong negative emotions among the public, often fueled by an innate fear of large carnivores. However, such negative perceptions may be exacerbated by the sensationalistic framing employed by traditional and social media outlets. We conducted an analysis of 1775 online media reports detailing attacks on humans by terrestrial (bears, canids, and felids) and aquatic (crocodilians and sharks) large carnivores. We aimed to verify how the use of sensationalism differs among large carnivore species. Our findings revealed that sensationalism was widely used in traditional and social media, with crocodilians emerging as the most sensationalized group of species. Furthermore, our analysis identified social media platforms as a filter for sensationalistic news originally disseminated by traditional media sources. This media-driven amplification of fear and negative sentiment has the potential to undermine public tolerance

towards crocodilians and other large carnivores, thereby presenting challenges to conservation efforts. A comprehensive understanding of media dynamics is imperative for the development of effective communication strategies aimed at mitigating human-crocodilians conflicts and fostering coexistence.

A-0940 (Poster)
Morphological and Bone Adaptations to Gliding Behaviors in Flying Lizards

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Gliding vertebrates often exhibit distinctive external morphologies compared to other terrestrial species. Among them, the genus *Draco* stands out as one of the few taxa capable of using wing-like structures on its ribs to glide through rainforests. To investigate this adaptation further, we measured morphological characteristics and conducted micro-CT scans of the humerus and rib structures across 30 species within the Draconinae subfamily. The results indicated an overall trend of size reduction in flying lizards, particularly evident in the head and limbs when considering absolute values. Relative to snout-vent length, flying lizards also showed a decrease in overall size, with a relative increase observed only in the distance between forelimbs and hindlimbs. The reduction in size suggests a lighter body mass, thereby enhancing their aerial capabilities. The decreased head size facilitates a better adjustment of the center of mass, reducing the angle of attack during gliding. Their arboreal lifestyle and gliding strategy in rainforests likely minimize the need for investment in limb length. The observed relative enlargement of the distance between forelimbs and hindlimbs may be related to accommodating larger wing areas for gliding. The CT scans showed that ribs specialized for gliding tended to be thicker than non-specialized ribs in flying lizards. However, this trend became statistically insignificant when phylogenetic effects were considered, likely because the gliding behavior appeared only once in Draconinae. Furthermore, the CT scans revealed an allometric growth in the thickness of non-specialized ribs and the humerus in flying lizards, but not in non-gliding lizards, suggesting a constraint in flying lizards' bone development. These variances might stem from the trade-off between reducing weight and maintaining strength in flying lizards.

A-0941 (Poster)
Salinity as the Only Predictor of Spawning Site Selection in Japanese Treefrog (*Dryophytes japonicus*) in Coastal Habitat

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Anurans are not commonly observed in saline environments due to the risk of disrupted homeostasis and increased chances of desiccation, therefore, requiring local adaptation to thrive in this “abiotically unsuitable” habitat. The Japanese Treefrog, *Dryophytes japonicus*,

predominantly breeds in paddies but has also been discovered in coastal habitat recently, making the effect of salinity is more pronounced. However, data on their breeding site selection for optimal reproductive success in coastal breeding pools remains limited. Here, we investigated the presence of larvae of *D. japonicus* as a proxy of potential breeding pools in Jeju Island, Korea, to understand the impact of salinity and the other abiotic topographic feature of the pools as factors limiting their breeding site selection. Overall, we observed 840 tadpoles across 84 pools nested within five sites that varied in their distance from coastline and forest, depth and area, elevation, salinity, Dissolved oxygen, and temperature. The random forest decision tree analysis identified the most influential variables impacting the occurrence and abundance of tadpoles in the coastal pools: the distance from the coastline and forest, followed by pool area, pool depth, and salinity. Further increase in salinity negatively impacted the occurrence and abundance of the tadpoles in the breeding pools. At 0% salinity, the probability of presence was over 60%, but at 0.75% and above, the probability of presence dropped to less than 25%. However, considering salinity alone as the predictor of spawning site selection for the species in coastal habitats is a simplification, as other physical attributes of veal pools such as depth and distance from forest and coastlines also impacted the choice of species for breeding pool. The results highlight the adaptive ability of *D. japonicus*, which can significantly inform conservation actions specifically in habitats previously deemed unsuitable

A-0942 (Oral)

AI-Based Auto-identification of Native and Invasive Frogs: A Potential Tool to Detect Early Arrival of Invasive Species in the Caribbean Islands?

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Invasive species are one of the principal causes of the reduction in island biodiversity and ecosystem services. An early detection of invasive species is the best strategy in conservation programs both from economic and environmental points of view. In recent decades, an emerging tool to assist conservation efforts by the early detection and monitoring of invasive species is image- based automatic identification of species. This may allow non-experts to accurately identify species with the potential to rapidly identify invasive species at entry points. In this study we aimed to test the potential of automated image identification tools to identify invasive frogs of the Caribbean Islands from native frogs. This study was performed on two genera of frogs: *Rhinella* and *Eleutherodactylus*. The sources of our images were photos available on the internet. Initially, DenseNet121 models underwent training using the ImageNet dataset before being further trained on our frog database. The accuracy of the final model is 99% for training and 79% for testing. This study shows that tools like automated image identification may assist the early detection of invasive species with acceptable accuracy. The potential of image-based auto-identification for accurately identifying invasive frogs needs to be validated further but offers great potential for the early detection and monitoring of invasive frogs in the Caribbean Islands.

A-0945 (Oral)

Morphological Convergence of Body and Head Shape in Snakes: Does Life-Style Drive the Evolution of Body and Head Shape

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Convergence is one of the hallmarks of the adaptive evolution of organisms in response to the constraints imposed by the environment. However, the extent of this convergence between different taxa remains poorly understood. Snakes represent a spectacular radiation of lizards, with over 3,400 species occupying every continent except Antarctica. Few studies have attempted to understand whether and how morphological convergence occurs across ecological niches between different snake clades, and whether specific traits show convergence in response to habitat use across multiple species. In this work, we quantified body, head, and tail shape (linear dimensions) in over 300 snake species representing approximatively 10 % of the group's overall species diversity. Photographs of the head were additionally used to perform geometric morphometric analyses. Phylogenetic comparative analyses (PGLS, phylogenetic PCAs, and phylomorphospaces) were used to explore the data. We tested the phylogenetic signal for each variable and tested for differences between species occupying different habitats, using phylogenetic MANCOVAs. Our results show a significant difference between snakes occupying different ecological niches suggesting that habitat use is an important driver of morphological variation in this group despite the at first sight homogeneous body plan.

A-0946 (Poster)
Aircraft Collisions with Reptiles in the United States Over the Past 24 Years

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Airports are attractive to wildlife due to their location close to water and large areas of grassland. This increases the risk of aircraft strikes with animals creating economic and safety problems. Not all species are equally hazardous to aviation, however research focuses mainly on birds and mammals, excluding collisions with reptiles. This study aims to investigate aircraft collisions in the US based on the long-term data of the Federal Aviation Administration. The material contains information on 296,475 collisions of civil and military aircrafts with wildlife at 2,369 airports in the period from January 1990 and April 2024. 718 cases at 133 airports involved collisions with one of 34 reptile species. Turtles and alligators were the most frequent, while cases with lizards and snakes were less numerous. Most collisions occurred in June (i.e., June 23, 1st Qu May 21, 3rd Qu August 4). Medium-sized and herbivorous species are the least likely to be affected by collisions. The statistics showed also temporal changes, an increase in frequency from 2010 to 2020, when there was a decrease in the number of collisions. In turn, spatial distribution exhibits most cases in the region of Florida, the eastern-northern coast and the central part of the US. Aircraft collisions affected a small number of reptile species (i.e., 34) as according to the Reptile Database in the USA occurs 558 reptile species. Two species with reported collisions are invasive to the US, Iguana iguana

and Caiman crocodilus. The most vulnerable reptiles to aircraft collisions are the omnivorous species which may be related to foraging on insects or carcasses in airport aprons. The highest frequency of accidents coincides with the period of greatest herpetofauna activity. Further statistical analysis will investigate whether the greatest number of aircraft collisions occurs in the area of the highest reptile biodiversity.

A-0947 (Poster)
Genetic Complexity in *Indotyphlops braminus*: Investigating Hybrid Origins, Polyploidization and Parthenogenesis

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The most widely distributed and commensal blindsnake species, *Indotyphlops braminus* is the only known snake species to undergo obligate parthenogenesis with no male population and has been found to be triploid. These studies add to the growing evidences of research linking polyploidization and parthenogenesis with hybridization. However, much of this work done on *I. braminus* has been on populations outside India. Past research from the lab suggested that *I. braminus* originated in India, and preliminary analyses, including mito-nuclear discordance, discordance in nuclear gene trees, and the JML test, provided evidence supporting its hybrid origin. Additionally, the study identified a cryptic clade and it is unclear if further taxonomic revision of species is required. However, these findings were based on a limited number of molecular markers, indicating the necessity for broader genomic studies with larger sample sizes to fully comprehend the species' origin and evolution. Given this background, the work aims to study deeper into the interplay of hybridization, polyploidization, and parthenogenesis in the *I. braminus* evolution. One part of the study focuses on addressing the hybrid origin hypothesis using genomics approach. To this end, complete mtDNA genome and SNP data were generated from the putative hybrids (5) and parent species (5) collected from India. These data were subjected to genomic PCA, ploidy estimation, heterozygosity assessment, sex determination, and phylogenetic analyses. Preliminary findings indicate that the putative parthenogenetic lineage of *I. braminus* in India appears to be triploid, has higher heterozygosity and low interindividual genetic distance when compared to other Indotyphlops. This study will be expanded further to include more samples and also incorporating other tools such as karyotyping and species distribution modelling would help us to get more insights on the complex evolutionary dynamics.

A-0948 (Oral)
Surprisingly Complex Genetic Diversity in *Philautus mjobergi* Smith, 1925 from Borneo

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Bush frogs of the genus *Philautus* are a species-rich group of Asian tree frogs Rhacophoridae with a distribution ranging from central India, Myanmar and Thailand to the Philippines and the Greater Sunda Islands including Borneo. As part of a previous phylogenetic study of the Bornean Philautus including the description of *Philautus nepenthophilus*, our analyses revealed an unexpectedly high genetic diversity with a complex distribution pattern in Philautus

mjobergi. This species is a little-known frog from isolated montane forests from 1500 to 3000 m elevation of the island of Borneo. Using mitochondrial and nuclear markers, we identified five clades with an uncorrected sequence divergence of more than 5% in the 16S barcoding gene. Surprisingly, three of these clades occur syntopically at three different localities in the Gunung Murud massif. Due to the also high variability in coloration, color pattern and size within and among the respective populations, it was not possible to distinguish these clades based on external characters. Based on the phylogenetic hypothesis, we assume that the current distribution pattern is the result of earlier allopatric isolation events. Climatic fluctuations since the Miocene influenced the tropical montane ecosystems in Borneo and thus also the distribution of the *P. mjobergi* group that is restricted to upper montane forests. As a result, the populations of this group became isolated due to the spatial fragmentation of their habitat and started to diverge. Repeated changes in climate and thus vegetation zones, leading to several episodes of isolation and subsequent range expansion and secondary contacts, are probably the main reasons for this complex distribution pattern of the *P. mjobergi* group at Gunung Murud. Further studies using genomic data are urgently needed to determine the extent of reproductive isolation or gene flow between these clades and the taxonomic status of the different clades.

A-0949 (Oral)

Treatment of Snakebite Envenoming with Small Molecule Therapeutics – What is in the Pipeline

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The only specific treatment currently available for snakebite envenoming are animal-derived polyclonal antibodies called antivenoms. The therapies have conceptually remained unchanged for more than a century. The production process of antivenoms is complex and expensive and side effects are frequent and possibly life threatening. Most likely due to their large molecular size, antivenoms have limited effects against local cytotoxicity and established neurotoxicity. To address some of these considerable challenges, next generation snakebite therapies are urgently needed. Beside the development of toxin-specific monoclonal and lab tailored antibodies, repurposed small molecule therapeutics (SMTs) are a promising approach to improve snakebite envenoming outcome. Toxin groups with high toxicity and high abundance like secretory Phospholipases A_2 (sPLA$_2$s), snake venom metalloproteinases (SVMPs), Snake Venom Serine Proteases (SVSPs) and three finger toxins (3FTxs) are a good target. Three repurposed drugs initially developed for other conditions have shown particular promise as potential candidates for treatment of snakebite envenoming: the SVMP-inhibiting metal chelator 2,3-Dimercaptopropan-1- sulfonic acid (DMPS), the Matrix Metalloproteinase Inhibitor Marimastat and the Phospholipase A_2 inhibitor Varespladib. DMPS is a licensed drug used for heavy metal intoxication. Marimastat has been tested extensively for treatment of different types of cancer. Preclinical data with DMPS and Marimastat showed promising effects against Snake venom Metalloproteinases. Varespladib and the oral formulation Varespladib-methyl was tested in Phase III clinical trials for acute coronary syndrome and extensive preclinical data support the hypothesis that Varespladib is a broad-spectrum direct toxin inhibitor of secretory Phospholipase A_2 in snake venom of different species. All three drugs can be given orally in a pre-hospital setting. They are promising candidates to be tested in clinical trials for treatment of snakebite envenoming caused by Malayan pit viper, green pit viper, cobras and kraits in Asia.

A-0950 (Oral)
Improving Biodiversity Observations in Citizen Science with Free Online Identification Courses

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Citizen science initiatives play a crucial role in gathering biodiversity data for assessing the occurrence and distribution of various life forms. However, ensuring the reliability and quality of such data is vital for its effective use in research and conservation efforts. Addressing these challenges, the NABU|naturgucker.de citizen science platform has launched the NABU|naturgucker-Akademie, a free of charge online learning platform aimed at enhancing species knowledge and promoting conservation awareness. The NABU|naturgucker-Akademie's recent course, launched in December 2023, focuses on reptiles and amphibians. This comprehensive course provides participants with in-depth species knowledge, covering species identification, preferred habitats, distributions, and ecological insights such as life cycles, feeding strategies, hibernation patterns, and bioacoustics. Moreover, the course delves into threats like BSal, invasive species, human impact, and conservation measures that can be applied in the participants own gardens. Led by an interdisciplinary team of over 30 experts in didactics, graphics, natural sciences, and species expertise, the academy ensures a robust curriculum and engaging learning materials. Participants benefit from interactive tools and freely accessible content, enabling flexible engagement based on their location and schedule.
The course not only enhances participants' observational skills and species identification abilities but also encourages active participation in conservation projects. By fostering scientific understanding and promoting collective responsibility for preserving natural heritage, this initiative contributes to bridging the gap in species expertise and advancing conservation efforts. Through the NABU|naturgucker-Akademie, participants gain valuable insights into the fascinating world of amphibians and reptiles while contributing meaningfully to conservation science - a testament to the power of citizen science in biodiversity conservation and environmental stewardship.

A-0951 (Oral)
Temporal and Population-level Variation of Tetrodotoxin in Hong Kong Newt (*Paramesotriton hongkongensis*)

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Newts from the family Salamandridae possess a potent neurotoxin - tetrodotoxin (TTX). The levels of TTX have been studied intensively, aiming to reveal the function and origin of TTX in this family. Research has found within- and between-population variations in North American newts like *Taricha*, which is possibly related to several life history traits (e.g. sex and life stage) or co-evolution with its predator. However, our knowledge about TTX levels in the Asian newt clade is relatively limited. To fill this gap, we investigated the variation of TTX levels in Hong Kong newt (*Paramesotriton hongkongensis*) and explored its ecological context with reproduction status, sex, population, life stage, and body condition. We collected 931 skin biopsy samples from six populations, of which 831 were from the breeding season and 100 were from the non-breeding season. Preliminary results show male newts have a higher level

of TTX in the breeding season compared to the non-breeding season while females do not. However, the inter-sex difference is only prominent in the non-breeding season, with the TTX level being roughly four times higher in the female newts. Additionally, TTX level differs significantly between breeding populations. We also found higher TTX correlates with lower body condition. Overall, these outcomes illustrate the variability of TTX in *P. hongkongensis* at the population level and contribute to a better understanding of the ecology of TTX for Asian salamanders.

A-0952 (Oral)
The Caecilian Holobiont from Genomics and Transcriptomics

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Species do not live in isolation. Every organism interacts with its environment and with other organisms of the same and other species. When different species establish a close intertwined interaction, symbiotic relationships arise. Symbiosis is ubiquitous and mainly dominated by microorganisms living inside and on the surface of multicellular organisms while playing essential roles in the host ecology and evolution. With the advent of high throughput sequencing technologies, symbionts can be described from tissues of any host species. In this study, we provided the first molecular characterization of the skin and gut symbionts of two species of the most unknown amphibian group, the caecilian amphibians (Gymnophiona). We compared existing genomics and transcriptomics resources for *Rhinatrema bivitattum* (one skin and one foregut samples) and *Microcaecilia unicolor* (two skin and one foregut samples) to identify mRNA data potentially from the skin and gut microbiome of these caecilian species. We annotated these sequences using a taxonomic classifier with bacterial, archaea, viral, fungal, and protozoan databases. We analyzed the list of these microbial species per taxonomic level across samples, identified common and unique operational taxonomic units (OTUs), and calculated diversity metrics per sample. This study illustrated how genomics resources can be applied to gain further insights into the life of more obscure amphibians, such as caecilians.

A-0953 (Oral)
Freshwater Turtle Conservation in Malaysia: What Works?

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The Southern River Terrapin (*Batagur affinis*) is a species of freshwater turtles that is listed as one of the top 25 most critically endangered tortoises and freshwater turtles in the world. *B. affinis* is found only in southern Thailand, Indonesia (Sumatra), Cambodia and Peninsular Malaysia. Wild populations of *B. affinis* was extirpated and depleted in much of its former range and Malaysia seems to harbour the only viable wild populations of this species. In 2011, the Turtle Conservation Society of Malaysia (TCS) initiated a community-based conservation project in Kemaman, Terengganu, Malaysia, to restore the depleted populations of *B. affinis* in the wild. A group of local villagers who call themselves the "Terrapin Guardians" patrol nesting banks and collect *B. affinis* eggs for incubation. Upon emergence, hatchlings are head-started for a few months before they are released into the river. An annual release event is hosted in the village to celebrate the terrapins and it is fast becoming a tourist attraction. Additionally, the Society also carries out research projects and trains student interns and

volunteers, as well as rehabilitates injured turtles surrendered by the public. Education programmes—affectionately known as "Turtle Camps"—are conducted to in schools to spread turtle conservation awareness among school students. A community empowerment programme was initiated in 2019 to empower local women in the communities to be financially sustainable, and at the same time produce turtle-batik merchandise to raise funds and awareness. This paper also briefly discusses the challenges faced by grassroots-level conservation organisations and the lessons learned from the past two decades as project leader of a turtle conservation non-profit.

A-0954 (Oral)
Species Distribution Models for the Conservation of Micro-Endemic Animals: The Contribution of Regional Land Cover

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Micro-endemic animals face higher extinction risks than most other species. Species distribution models (SDMs) may contribute to implementing successful conservation strategies. However, building effective SDMs is often hindered by the low resolution of land cover data. Here, we assessed the efficacy of a composite land cover dataset assembled from different regional sources, versus two widely used continental land cover datasets (Corine Land Cover and Sentinel-2 Global Land Cover), in predicting habitat suitability for an endangered, micro-endemic, fully terrestrial amphibian, namely Salamandra atra aurorae, which survives in an area of 31 km^2 in the European Alps. We built three SDMs with a resolution of 100x100 m using the same topographic and microclimatic predictors but varying the land cover dataset to describe the diversity of forest classes (a composite regional dataset, the Corine Land Cover and the Sentinel-2 Global Land Cover) and compared their capacity to identify the known ecological requirements of the species. The three models performed comparably, identifying elevation, land surface temperature, and tree composition as primary drivers of habitat suitability, predicting suitable habitats in similar parts of the study area. However, while both models with continental land cover datasets recognized coniferous forests as more suitable than broadleaf forests, only the model built with the more detailed forest classes of the regional land cover recognized differences among coniferous forests. Notably, the regional dataset identified old-growth stands with Abies alba as the most suitable, aligning with previous ecological studies. Our case study highlights the limitations of widely used continental land cover datasets in recognising key environmental features influencing habitat suitability for micro-endemic animals. We showed that the incorporation of regional land cover data can enhance the accuracy of SDMs providing more detailed ecological information to guide conservation efforts.

A-0955 (Poster)
Conspicuous or Concealed? Assessing Detectability and Survival Rates of Seasonal Color Patterns in *Takydromus stejnegeri* (Squamata: Lacertidae)

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Animal color signaling often involves a trade-off between enhanced communication with conspecifics and increased predation risk. Our study assessed the detectability and survival rates of color morphs in *Takydromus stejnegeri*, a polymorphic lizard with seasonal and individual color variations. During the non-breeding season, most lizards display a plain brown coloration, while in the breeding season, they exhibit four main morphs: green flanks with and without white stripes, and brown flanks with and without white stripes, patterns typically dominant in females (green flanks) and males (white stripes) but present in both sexes. Previous experiments have shown preferences for both brown and green flank colorations in mate choice. We utilized spectrometry to measure the color contrast between the lizard's flanks and the seasonal backgrounds of green and dead leaves, and digital image analysis to assess the detectability of each morph from a predator's perspective. Furthermore, using the Cormack-Jolly-Seber (CJS) model with 4-year capture-mark-recapture data, we estimated the survival rates of each morph, linking these to our findings from color and detectability analyses. Our results reveal that during the breeding season, the brown-flank morph shows greater chromatic and achromatic contrast compared to the green-flank morph against the leafy background, and exhibits higher achromatic detectability than other morphs, which yields survival rates following the pattern of B < BS < G < GS. Conversely, during the non-breeding season, the green-flank morph displays higher chromatic contrast but lower achromatic contrast than the brown-flank morph, with detectability remaining relatively consistent across morphs. Additionally, most individuals transform to brown morph during this season, resulting in uniform survival rates. These findings suggest that variations in detectability across color morphs are ultimately reflected in differences in survival rates. The trade-off between selective forces may indicate how the polymorphism is maintained.

A-0956 (Poster)
Habitat Partitioning of *Limnonectes* Frogs in Singapore

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Microhabitats, critical for resource partitioning among related or ecologically similar species, play a pivotal role in shaping species distributions. The genus Limnonectes, comprising over 70 species exhibits a wide distribution across East and Southeast Asia. In Singapore, four Limnonectes species—*Limnonectes blythii, Limnonectes malesianus, Limnonectes paramacrodon*, and *Limnonectes plicatellus*—coexist despite the lack of pristine habitats. This study aims to elucidate the microhabitats preferred by each species, their abundance, and preferences enabling adaptation to urban environments. Surveying four habitats—freshwater swamp forests, secondary rainforests, urban parklands, and coastal forests in Singapore, we employed Visual Encounter Surveys (VES) to observe frog populations at night. The Shannon-Wiener Index assessed species diversity, while microhabitat variables such as substrate type, proximity to water, and canopy cover were analysed. *Limnonectes blythii* emerged as the most prevalent species, predominantly observed in secondary forests yet occurring in coastal forests and urban parklands unlike the others. *Limnonectes malesianus* favoured swamp forests, whereas *Limnonectes paramacrodon* and *Limnonectes plicatellus* exhibited specific habitat preferences within freshwater swamp forests, highlighting microhabitat specialization within the genus. Our findings support species-specific microhabitat preferences and underscore the importance of conservation efforts, particularly for Critically Endangered species like

Limnonectes plicatellus and *Limnonectes paramacrodon*. However, the survey results' comprehensiveness is limited by the absence of water quality data, suggesting avenues for future research to incorporate such parameters and delve deeper into the microhabitat preferences of *Limnonectes* frogs.

A-0957 (Poster)
Unveiling Cryptic Diversity: Acoustic Divergence of *Gekko hokouensis* Complex in Taiwan

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Acoustic signals are crucial for species-specific recognition and the identification of cryptic species. They play a significant role in shaping distinct identification patterns and understanding the evolutionary processes underlying biodiversity. In the *Gekko hokouensis* complex in Taiwan, genetic divergences have been observed among populations from different biogeographic locations despite their morphological similarities. However, the acoustic characteristics and the recognition system of courtship calls have not been systematically documented. Here, we integrated mitochondrial DNA 12S ribosomal RNA sequences with morphological characteristics and acoustic properties of male courtship calls, alongside female mate preferences in playback experiments, to investigate the acoustic signal utilization and its impact on speciation. Our phylogenetic analysis revealed the existence of six genetic clades distributed across Taiwan. Despite this, each lineage has varying degrees of differentiation in morphological traits, male call characteristics, and female preferences. These findings will contribute to understanding signal transmission, reproductive isolation, and speciation of the *Gekko hokouensis* complex in Taiwan.

A-0958 (Oral)
***Natrix natrix* After Dark: Citizen Science Sheds Light on the Common Grass Snake's Nightlife**

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Activity patterns in animals are often species-specific, and can be generally categorized as diurnal, crepuscular, or nocturnal. Understanding these patterns provides insight into ecological adaptations and behaviors. The Common grass snake (*Natrix natrix*), one of the most common and widespread European snake species, is traditionally considered diurnal, with

scarce evidence of its crepuscular and nocturnal activity. We aimed to document the distribution, environmental conditions, and potential phenotype associations of nighttime activity in *N. natrix*. We used citizen science data from iNaturalist (1992–2022), Observation.org (2012–2022), together with personal field observations (2010–2023) to collect 127 crepuscular and nocturnal activity records. Most observations occurred between May and August, coinciding with the peak activity period of grass snakes across their distribution range. Statistical analyses revealed no significant difference in mean daily temperatures between crepuscular and nocturnal observations. However, striped individuals displayed nocturnal activity at higher temperatures, consistent with their distribution in warmer regions, but failed to register any difference when tested on a geographic subsample, that accounted for sympatry of the phenotypes. Surprisingly, we found no significant impact of moon presence or moonlight on nighttime activity or age class, contrary to expectations based on other snake species' responses. While our study reveals that nocturnal activity in the common grass snake is geographically widespread, further research is warranted to understand its drivers and ecological implications. This study highlights the value of citizen science platforms for biological and ecological research, offering unparalleled spatial and temporal coverage by their users. In conclusion, our work extends the knowledge of nocturnal behavior in *N. natrix* and underlines the critical role of citizen science in discovering behavioral aspects of common and widespread species.

A-0959 (Oral)

The Melanistic Color Morph in Terrestrial Polymorphic Snakes: A Global Meta-Analysis and Systematic Review

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Color polymorphism is an excellent model system for testing ecological and evolutionary hypotheses, as alternate colorations are associated with differences in various biological, behavioral, and life-history traits. Melanism is the most common and most obvious form of polymorphism and, in reptiles in general (and snakes in particular), thermal melanism has been a popular hypothesis used to explain the appearance of black individuals, suggesting a trade-off between superior thermoregulation and reduced protection through the loss of crypsis. Surprisingly, despite the growing body of literature available, to date there are only two qualitative reviews on the evolutionary significance of melanism in reptiles and no quantitative synthesis. We conducted the first systematic review and global meta-analysis summarizing the current knowledge on melanism in polymorphic terrestrial snakes and synthesized the evidence for an adaptive advantage of the melanistic morph. Mean global prevalence of melanism is 31% with no significant differences between species. Annual precipitation was a significant moderator of melanism prevalence. Our results revealed no significant differences in odds ratios of melanism between sexes or in mean body size. Environmental plasticity can be considered the primary cause for melanism, possibly as a result of seasonal climatic variations, a result corroborated by the formal meta-analysis conducted. Conclusions from the meta-

analysis are that melanism in snakes follows Gloger's rule, as is the case in birds and mammals, and as opposed to the thermal melanism hypothesis. Further, our findings do not lend support for other predictions from the thermal melanism hypothesis, such as skewed frequency of melanistics in favor of males or females, or larger body sizes in black individuals. Our results hold implications for the future diversity of animal populations, as climate change is predicted to decrease the degree of color variation.

A-0960 (Oral)
Altered Seasonality Intensifies Population-Level Infections and Host Movements

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Climate change alters temperature and precipitation cycles in unpredictable ways, potentially affecting host-pathogen dynamics, especially for ectotherms. However, only a few studies have long-term data to examine how deviations in environmental conditions influence processes that lead to increased or decreased infections. Here, we test how seasonal variation in temperature, precipitation, and infection with the pathogenic chytrid fungus *Batrachochytrium dendrobatidis* (Bd) modulate the population size and movement of the tropical direct-developing frog, *Eleutherodactylus coqui*. In Puerto Rico, Coqui populations initially declined after pathogen emergence but seem to have gradually recovered with persistent infections. We hypothesize that density-dependent compensation associated with seasonality may be a mechanism promoting persistence. To address this question, we conducted monthly capture-mark-recapture surveys to track individuals and their infections over three years. Then, we applied multi-state models to estimate survival, detectability, and host movements. To classify climatic data into seasons and identify events with significant deviations from historical data, we implemented a multivariate approach that recovered the typical cool-dry and warm-wet seasons, but also periods of altered seasonality when cool-wet (9 events) or warm-dry (10 events) conditions prevailed. Overall, the models showed an increasing trend in population size despite significant changes in the number of hosts between seasons. The models also provided evidence for demographic buffering by increasing recruitment because survival did not depend on infection status. We confirmed strong site fidelity in this species, limited to frogs moving 0–5 m from the capture site. However, Bd infection increased the probability of movement, perhaps due to displacement by healthier competitors or behavioral fever, as infected frogs might seek warmer microhabitats to limit the growth of heat-sensitive pathogens. Learning how altered seasonality leads to conditions that may favor pathogens or hosts can help us recognize other processes of climate change that affect the dynamics of emergent pathogens in wildlife.

A-0961 (Oral)
Engaging Communities and Providing Alternative Livelihoods to Save the Southern River Terrapin in Malaysia

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Turtle Conservation Society of Malaysia (TCS) was initiated in 2011 to protect and conserve depleted freshwater turtle populations in the country, in particular the critically-endangered Southern River Terrapin (*Batagur affinis edwardmolli*). This is achieved through a multi-pronged approach, including conducting research and conservation projects; hosting "Turtle Camps" to spread turtle conservation awareness to rural school students; participating in public outreach campaigns; and empowering women in the local communities to be financially sustainable by producing and selling turtle-batik souvenirs. This paper highlights the strengths of two community-based initiatives and how they contribute to the successful partnership between a conservation organisation and the local communities. The first initiative commenced shortly after a population of Southern River Terrapin was discovered in Kemaman in the state of Terengganu. Through a questionnaire-based survey in 2010, a group of former poachers were recruited to the then-pilot terrapin conservation project. They later called themselves the "Terrapin Guardians." Through this project, we have secured more than 8,200 river terrapin eggs for incubation in a protected *ex situ* hatchery. From these, more than 5,000 headstarted terrapin hatchlings have been released into the Kemaman River. From an initial group of five "Terrapin Guardians," we now have a team of 14 villagers. From protecting just one riverbank in 2011, we have expanded our operations to protect four riverbanks in 2024. Today, this remains as the only river terrapin conservation project in Malaysia that is led by a non-governmental organisation. The second initiative was launched in 2019 to support and empower women in the local communities to earn a sustainable living by producing turtle-batik souvenirs, which are then sold to raise funds to support our terrapin conservation efforts. To date, our turtle-batik products have been shipped to various countries. Subsequently, our women tailors have also doubled their earnings from 2022 to 2023.

A-0962 (Poster)
Detection of Ranavirus and Assessment of its Spatiotemporal Pattern in Amphibians of Bangladesh

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Infection by the ranavirus (Iridoviridae) is a major threat in amphibian population decline. Finding the infected frogs and especially those who are carriers is essential to stop and manage outbreaks. Recently, the use of non-invasive method through PCR was proposed as an alternative to the more frequently used lethal liver sampling. This research attempted searching for ranavirus infection in the wild frogs of Bangladesh and investigating spatio-temporal pattern using non-invasive method. A total of 50 swab samples out of 200 targeted samples were collected from 50 adult individuals of 13 species. Sampling was done in two national park areas (i.e., Lawachara National Park and Satchari National Park) and two non-protected areas (i.e., Sher-e-Bangla Agricultural University and University of Dhaka) during monsoon. Bangladesh has seven unique biogeographic regions based on habitat characteristics. The sampled protected areas are situated at the northeastern region while the non-protected areas

are located at central region of Bangladesh. The rest 150 samples are planned to be collected from other five regions of Bangladesh covering all major habitats. PCR testing for ranavirus DNA was performed on all samples but no positive case was detected. All frog samples were observed healthy during field inspection except one *Fejervarya asmati* from Dhaka University campus. The lack of ranavirus positive samples was unexpected since chytrid infection was detected from Lawachara National Park earlier. Our results imply that either the infection levels are extremely low in the frogs in the tested area or the frogs themselves are poor reservoirs (carriers) for ranavirus. The upcoming sampling in other areas will focus chytrid affected areas (i.e., Kaptai National Park, Chittagong University Campus, northwestern Bangladesh etc) since co-infection with chytrid fungus is evidenced from other countries.

A-0963 (Oral)

Environmental DNA Enhances Infectious Disease Surveillance in Traded and Wild Amphibians

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Amphibians are threatened globally, with dramatic declines reported in many species due to the deadly pathogens *Batrachochytrium dendrobatidis* (Bd) and Ranavirus (Rv). Both pathogens have spread through international wildlife trade networks, which remain largely unmonitored, presenting major conservation and welfare challenges. Environmental (e)DNA methods can provide highly sensitive non-invasive pathogen surveillance for both traded and wild amphibians. To investigate the relationship between eDNA detection and environmental pathogen persistence, pathogen eDNA decay rates were quantified across a range of temperatures (15-25ºC). Results demonstrate that eDNA decay is rapid for both pathogens (T99 between 18.9-52.4 hours), and that temperature does not significantly affect decay rates. Low levels of pathogen eDNA remained detectable for the duration of the experiment (> 28 days). We consider high concentrations of eDNA to represent viable pathogen in the environment, sustained due to active shedding from infected individuals. This demonstrates the usefulness of eDNA for the monitoring immediate population-level infection status. We used eDNA methods to identify and monitor cyclical Bd infections in a large *Xenopus* research facility (Portsmouth, UK). We temporally sampled a subpopulation of *Xenopus laevis*, collecting four types of eDNA and swab data for ~60 animals over 10 days. We used compartmental mathematical disease models to investigate the relationships between environmental detection, prevalence and individual loads. Positive Bd eDNA signals were consistently detected in tank-water, although detection appeared more variable in other eDNA sample-types (i.e. sump/sludge/sock). The utility of eDNA methods was additionally tested in a naturally coinfected system with challenging fieldwork conditions, to explore the predictors of temporal-spatial pathogen distributions (Serra da Estrela Natural Park, Portugal). Ultimately, an improved knowledge of both the potential and limitations of pathogen eDNA can be transferred to other challenging disease systems for improved pathogen monitoring and safeguarding of amphibian populations worldwide.

A-0964 (Oral)
Collaborative Biobanking in Europe: A UK Zoo's Approach

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Biobanks are invaluable resources for the scientific and conservation community by providing access to high-quality biological material such as blood, tissue, DNA and reproductive cells to inform population management strategies and support research in zoo and wild animal populations. The Royal Zoological Society of Scotland's (RZSS) Biobank facility, based at Edinburgh Zoo, works in partnership with the EAZA Biobank and the CryoArks Initiative to support the long-term storage of genetic samples and facilitate sample access across the zoo and research community. As the EAZA Biobank's regional Hub for the UK, the RZSS Biobank regularly receives sample submissions from participating EAZA member institutions for processing and storage and facilitates sample access for research projects. Approved projects have to demonstrate a link to *ex-situ* programmes that inform population management and/or conservation research. The RZSS Biobank currently holds over 4,000 samples representing over 350 species, including many on the IUCN Red List. The potential value of biobanks within conservation strategies has recently been acknowledged by the IUCN for their value in preserving *in-situ* and *ex-situ* genetic diversity, in line with the One Plan approach, to ensure the long-term survival of threatened species. By contributing to biobanking initiatives, zoos and aquaria can not only increase their current conservation impact but can also help secure genetic diversity and resources for future species recovery efforts. In the face of global population declines, biobanking is more important than ever and increasing the inclusion of under-represented taxa, such as amphibians and reptiles is vital. Find out how you can get involved!

A-0965 (Oral)
Survey of Ranavirus in Reptiles and Amphibians of Western Colombia

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Ranaviruses are important wildlife pathogens that infect and can cause mortality in amphibians, reptiles, and fishes. There has been limited sampling for ranaviruses in South America to date, including only one published survey in Colombian amphibians, and none with respect to lizards and snakes. The current study surveyed ranavirus in reptiles and amphibians in two western departments in Colombia, Nariño and Atlántico. We collected toe and tail tissues from 30 reptiles and 30 amphibians in each department for a total of 120 individuals. We extracted, purified and quantified DNA in all samples, and tested for the presence of ranavirus DNA using quantitative polymerase chain reaction (qPCR). We detected ranavirus in 9 out of 30 frogs (30% prevalence) from Pasto, Nariño (~2,500 m elevation; southwest) but not in any reptiles collected from Tumaco, Nariño (sea level; southwest). We did not detect ranavirus in any of the amphibians or reptiles sampled outside of Barranquilla, Atlántico (sea level; northwest).

This study contributes to scant literature on the South American distribution of ranaviruses, pathogens that can cause significant morbidity and mortality in wildlife.

A-0966 (Oral)
Characteristics of Nesting Sites and Formed River Channels of the Japanese Giant Salamanders

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Japanese giant salamander, *Andrias japonicus*, is a fully aquatic amphibian threatened with extinction. One of the conservation issues is river alterations destroying its nesting sites, such as burrows with narrow openings along stream banks. Although there are several reports on the structures and overview of nesting sites, few studies explored the river channel characteristics suited for nesting. Therefore, the aim of the present study is to clarify the characteristics of the nesting sites and river channels as well as the factors that contribute to the nest success or failure of *A. japonicus*. The survey was conducted in a third-order stream in Tottori Prefecture, Japan. There were 10 nesting sites in the survey area where we confirmed spawning in 2022, with five breeding successes and five failures. We recorded the location of the nesting sites in the river. In addition, we measured the physical environment variables in the burrows, including entrance width, entrance height, burrow depth, flow velocity in front of the burrow, and flow velocity from deep inside the burrow and also river channel characteristics, including water depth and river channel width. We compared these physical factors between the successful and failed nests. As a result, nesting sites were primarily distributed in straight channels, on the runs, and along the water's edges that were closer to the streamflow centers. There were significant differences in entrance width and flow velocity in front of the burrows between successful and failed nests. In this presentation, I will discuss the factors contributing to the breeding success or failure of *A. japonicus*. Understanding these factors is critical for the conservation of the species.

A-0967 (Oral)
Evolution of the Musculoskeletal Feeding Anatomy in Replicated Transitions to Subterranean Environments in *Eurycea* Salamanders

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Organisms can adapt to changes in their environment by either evolving novel structures that can appear at any stage of ontogeny (e.g., changing the shape of existing structures), or by changing the time and order that structures appear during development (i.e., heterochrony). Groundwater salamanders (genus *Eurycea*) can serve as a model system to understand how shifts in habitat influence morphological evolution due to their repeated independent transitions of subterranean habitats. One of the demands that has likely shifted with invasions to subterranean habitats is the difference in feeding ecology due to changes in abiotic (light availability) and biotic (prey availability) between surface and subterranean environments. Here, we compare differences in the musculoskeletal system among species

of *Eurycea* salamanders (*E. rathbuni, E. latitans, E. pterophila, E. sosorum*, and *E. nana*) to test how independent shifts to cave environments result in changes to feeding morphology through ontogeny. We compare divergent species through development to identify differences in the timing and patterns of muscular development. We utilize diceCT to reconstruct cranial elements in 3D and use VolumeGraphics Studio to isolate musculoskeletal structures.

A-0968 (Oral)
Genome Size Evolution and Phenotypic Correlates in the Poison Frog Family Dendrobatidae

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Adaptive and neutral processes have produced a spectrum of genome sizes across organisms. Amphibians in particular possess a wide range in C-values, from < 1 pg to over 125 pg. However, the genome size of most amphibians is unknown, and no single family has been comprehensively assessed. We provide new estimates for 32 poison frog species representing the major lineages within Dendrobatidae using Feulgen staining of museum specimens and flow cytometry of fresh tissue. We show that genome size in Dendrobatidae has likely evolved gradually, with potential evolutionary regime shifts in the genera *Phyllobates* and *Hyloxalus*, which respectively possess species with the largest (13.0 pg) and second smallest (2.6 pg) genomes in the family. Phylogenetically controlled regression analyses indicate that genome size is positively correlated with snout-vent-length, oocyte number, and clutch size, but negatively correlated with active metabolic rate and metabolic scope. While body size and metabolic rate are also correlates of toxicity, we found no relationship between genome size and the evolution of chemical defense within Dendrobatidae. Our assessment of genome size in Dendrobatidae provides insight into the processes shaping genome size evolution over short timescales and establishes a novel system in which to study the mechanistic links between genome size and organismal physiology.

A-0969 (Oral)
Passive Accumulation of Alkaloids in Putatively Non-toxic Frogs Challenges Paradigms of the Origins of Acquired Chemical Defenses

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Understanding the origins of novel, complex phenotypes is a major goal in evolutionary biology. Poison frogs of the family Dendrobatidae have evolved the novel ability to acquire alkaloids from their diet for chemical defense at least three times. However, taxon sampling for alkaloids has been biased towards colorful species, without similar attention paid to inconspicuous ones that are often assumed to be undefended. As a result, our understanding of how chemical defense evolved in this group is incomplete. Here, we provide new data showing that, in contrast to previous studies, species from each undefended poison frog clade have measurable yet low amounts of alkaloids. We confirm that undefended dendrobatids regularly consume mites and ants, which are known sources of alkaloids. Further, we confirm the presence of alkaloids in two putatively non-toxic frogs from other families. Our data suggest the existence of a phenotypic intermediate between toxin consumption and sequestration—passive accumulation—that differs from active sequestration in that it involves no derived forms of transport and storage mechanisms yet results in low levels of toxin accumulation. We discuss the concept of passive accumulation and its potential role in the origin of chemical defenses in poison frogs and other toxin-sequestering organisms.

A-0970 (Oral)
Histopathology of Amphibians Treated with Select Natural Fungicidal Remedies?

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Chytrid fungi (*Batrachochytrium dendrobatidis*, Bd and *Batrachochytrium salamandrivorans*, Bsal) can be deadly to amphibians because they cause damage to keratinized skin, resulting in electrolyte imbalances that lead to cardiac collapse, and make them vulnerable to opportunistic pathogens. Treatment is difficult and generally requires manipulation of temperature or application of chemotherapeutics, both of which may be possible for amphibians under human care but nearly impossible in the wild. Thus, there is a need for effective treatment that is easy to apply and not harmful to non-target species. It also is important that they be safe and not cause harm to the amphibians. To that end, we tested plant-derived compounds (allicin and curcumin) considered to have fungicidal effects and presumed to be safe for animals. We compared histological changes within adult newts (*Notophthalmus viridescens*) exposed to

these compounds and then also those infected with Bsal. Additionally, skin lesions were compared in newts treated with curcumin either simultaneous with Bsal exposure or 3-days post-exposure, which revealed that effectiveness of treatment seems to be reduced once infection is established.

A-0971 (Oral)
Fusarium, an Emerging Fungal Threat to Leatherbacks (*Dermochelys coriacea*)

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Fungal diseases are a rising health problem globally, in humans, nonhuman animals, and plants. Emerging fungal diseases have been associated with mass mortality events. A recent example of fungal disease pathogenicity is sea turtle egg fusariosis (STEF). STEF has been linked to fungi within the *Fusarium solani* species complex (FSSC). This complex is composed of over 45 phylogenetically identifiable species commonly found in the environment. Species within the FSSC lineage have been isolated from the nests of multiple sea turtle species and are linked to decreased hatching success in all seven of the extant sea turtle species. Fungi within this lineage are also known to cause cutaneous and subcutaneous infections in immunocompromised humans and animals. Thus, these fungi are not only a threat to sea turtles but also to all other animals, including humans using the waters and beaches favored by *Fusarium* spp. The presence of *Fusarium* spp. has not been investigated on southeastern Florida beaches which are fundamentally important for at least 3 sea turtle species that nest there in large numbers. We demonstrate that *Fusarium* spp. are likely present in Leatherback sea turtle nests in Boca Raton and Juno Beach, Florida, and are affecting neonatal Leatherbacks even after emergence, based upon findings in captive individuals.

A-0972 (Oral)
Climatic Data Sources Influence the Prediction of Past Habitat Suitability and Niche Comparisons for Two Distantly Related Lungless Salamanders

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Ecological niche models (ENMs) and niche analyses have become popular in ecology and biogeography and have been applied to numerous phylogeographic studies. In these analyses, one set of climatic data is usually selected from several widely used climate databases, but the influence of data choice on the results is rarely investigated. In this study, we implemented

MaxEnt modeling and niche analyses to gain insights into niche overlaps and historical processes of range formation for two distantly related lungless salamanders endemic to the Korean Peninsula: *Onychodactylus koreanus* and *Karsenia koreana*. In doing so, we assessed the influence of climatic data choice on the results of these analyses by comparing the results based on two popular global climate databases, WorldClim and CHELSA. The MaxEnt models for both species predicted current suitable habitats that closely matched the known distributions of the species. However, the prediction outcomes under the current climate differed as much by 20% for *O. koreanus* and 47% for *K. koreana*, depending on which climatic data were used. Furthermore, the results of niche comparisons between the two species were highly sensitive to the input climate data, either suggesting niche divergence or niche equivalence depending on whether WorldClim or CHELSA data were used. Model projections to paleoclimatic conditions of the Pliocene and Pleistocene resulted in poor model transferability. Most notably, models based on both climatic databases failed to predict suitable habitats during the Last Glacial Maximum (LGM) and Last Interglacial (LIG). The poor model transferability is likely due to the failure of the macroclimatic variable to capture the true climatic niches of the species rather than methodological errors. Therefore, our results highlight the limitations of ENMs and demonstrate the importance of careful data selection and rigorous model testing.

A-0973 (Oral)
Health for all: Inclusion of Herps in One Health Approaches

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One Health is an approach to tackling wicked problems. It considers that human health, animal health, plant health, and environment health are interconnected such that the health of one is impacted by and impacts the health of the others. This multi-disciplinary approach brings together people with diverse expertise to investigate and develop solutions for problems that are far too complex for any one discipline to solve. But how do we identify the skill sets necessary to solve these complex problems, and are there entire groups that are being ignored? Specifically, why is herptile health rarely integrated into a One Health approach despite the fact that Ecosystem health is often indicated by the health of amphibians and reptiles? Is this because we know so little about them or because they lack the charisma of other animals? Or is it perhaps that they are viewed to be of lower value than other species. To begin to elucidate this issue, herpetofauna experts representing various countries from across the globe have joined together, sifted through the literature, and identifying some key factors. This presentation will summarize the results of these initial findings and the call to action generated by this effort. It will conclude with a case study integrating herptile species into a One Health approach.

A-0974 (Oral)
Dwarf Water Cobras from the Congo: A Distinct Species or Ecological Adaptation?

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Cobras (*Naja*) are divided into several subgenera, with the African subgenus Boulengerina having terrestrial, semi-fossorial, and semi-aquatic representatives. The semi-aquatic cobras or water cobras occur in Central Africa and are represented by three nominal species: *Naja annulata, N. christyi*, and *N. nana*. The latter taxon has only recently been described as an endemic of Lake Mai-Ndombe in west-central Democratic Republic of the Congo based on morphological differences, particularly small body size and colouration (Dwarf water cobra). Molecular genetic information was not used in the species description. Preliminary analyses of conventional molecular markers found no substantial differences between *N. nana* and *N. annulata*, offering a possible explanation of recent local ecological adaptation in the Lake Mai-Ndombe environment. We therefore used a genome-wide approach, resulting in capture of approximately 400 loci (700,000 bp), where *N. nana* forms a highly-supported clade but only shallowly diverged from Congolian populations of *N. annulata*. These results indicate a relatively recent evolutionary diversification event that was probably caused by adaptive speciation, that is, a very young species (?). In contrast, populations of *N. annulata* from Gabon are highly divergent, making *N. annulata* paraphyletic with respect to not just *N. nana* but also the Lower Congo riverine *N. christyi*, suggesting the existence of further hitherto unsuspected diversity among the water cobras.

A-0975 (Oral)

Fire Salamander Research in a Suburban Hotspot: A Case Study for the Use of a New and Free Photographic Identification Software, the Amphibian and Reptile Wildbook

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Individual identification is an important tool and a prerequisite, not only to estimate population sizes, but also to acquire information about individual differences in behaviour and life histories. This information is lacking for many species, despite the fact that many species are threatened by factors, such as habitat fragmentation, pollution or novel pathogens. Gaining knowledge about population sizes, individual differences in behaviour and life histories will allow us to develop tailored measures and interventions. Individual identification often involves some type of invasive or non-invasive marking. In some species, however, individuals

already carry an individual identification signature on their body, e.g., individual-specific colour patterns, which allows individual identification via photographs. New technologies including computer vision algorithms and deep learning speed up the process of photographic identification. The Amphibian and Reptile Wildbook (ARW) is such a platform that uses machine learning and AI. This platform is free to use and currently used by over 160 scientists and more than 60 citizen scientists for the identification of Fire salamanders (*Salamandra salamandra*) and Yellow-bellied toads (*Bombina variegata*). Here we present a case study of a suburban fire salamander hotspot in Germany. We take photographs of each encountered individual during our population monitorings,. The ARW identifies the individual on each picture and compares it with all the pictures in the database to find potential recaptures. This enables us to estimate population sizes and understand individual movement and activity patterns as well as home range sizes.

A-0978 (Oral)

The Efficacy of Two Novel Treatments (Ponazuril and Humatin) for Reducing Cryptosporidium Related Mortality in Captive Western Painted Turtles *Chrysemys picta bellii*

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An annual *ex situ* hatching and rearing program for Western Painted Turtle *Chrysemus picta bellii* has been ongoing in British Columbia, Canada, since 2011 as part of recovery efforts for the endangered Pacific Coast subspecies. Guided by the provincial recovery team, the program has grown steadily from 20 individuals headstarted and released per year to support wild populations, to more than 200 in 2023. In recent years there have been increasing occurrences of what has been colloquially called "soft shell" within the headstarted turtle cohorts while in captivity. While the shell's appearance looks normal, after several months the natural soft carapace and plastron of the young hatchling does not harden as expected. Instead, the shell becomes increasingly soft, leading to elevated mortality for affected individuals. When first observed in 2014, 8% of the hatchlings were affected by soft shell, but this rose to 51% in 2020. Initial pathology reports suggested a generalized diagnosis of Metabolic Bone Disease (MBD), but further lab analyses resulted in a diagnosis of intestinal cryptosporidiosis. These protozoan infections are not well characterized in reptiles, and there have been limited studies on infections in turtles. Treatment with anti-parasitic medication and disinfection of equipment with a non-chlorine based oxidizing agent can decrease or eliminate parasitic load in the individual and the *ex situ* environment. Here, we present the results of a hatchling treatment trial using Ponazuril and Humatin to decrease parasite load and increase survival in hatchling western painted turtles. This work resulted in a reduction in mortality from 36% to 2% and increased growth rates in treatment groups, showing high efficacy for these two novel treatments for *Cryptosporidium*. Use of this treatment for "soft shell" caused by cryptosporidiosis may have potential for reducing mortality in other *ex situ* turtle programs.

A-0979 (Oral)

There's Something in the Water: Understanding Breeding Cues for the Oregon Spotted Frog (*Rana pretiosa*) Leads to a Leap in Production for Species Recovery

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Restricted to declining fragmented populations in British Columbia (Canada) and Washington and Oregon (U.S.A) the Oregon spotted frog *Rana pretiosa* is classified as Vulnerable by the IUCN. Habitat loss and transformation from agriculture and development, pollution, and invasive species are primary drivers in population declines. As a result, the Oregon spotted frog is Canada's most imperiled amphibian, classified as Endangered by COSEWIC. Conservation breeding and reintroduction are necessary to support dwindling wild populations. Ongoing *ex situ* recovery efforts since 1999 have had moderate success. Despite adaptation of captive breeding techniques from other conservation breeding programs, such as headstarting, hormone induction, individual and group pairing, and the use of outdoor mesocosms, the program has faced significant challenges with reduced egg laying, low fertility, and egg binding. However, new methods implemented in 2021 resulted in a striking increase in egg production and fertility. Number of tadpoles per egg mass increased from an average of 64 to 538 after implementation of the new methods while number of tadpoles per adult female increased from 20–46 prior to 364–547. Egg fertility increased from 11–26% to 76–78%. Egg binding also decreased thereby positively impacting the long-term survival of females in the *ex situ* breeding colony. These improvements are attributed to changes in captive population management. One key factor was the continued use of water from females' overwintering enclosures throughout the breeding season, indicating that there were biochemical changes to the water in the non-breeding season that supported increased reproductive success. This resulted in the conservation program producing significantly more animals for release, from an average of 1,600 young (2018–2020) to 22,000 (2021–2022). These leaps in production, provide confidence in our ability to successfully recover wild Oregon spotted frog populations in Canada and the methods can be adapted and applied to other globally threatened ranid conservation programs.

A-0980 (Oral)
New Tools and Methods for Studying Herp Embryology and Learn About Anatomy, Development and Evolution

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Just as CT scanning was firstly used as a biomedical device and later adopted for the study of vertebrate anatomy, new microscopy technologies and tissue processing techniques developed and used in the context of the study of cancer or neuroscience hold enormous potential to greatly expand our knowledge of embryology, anatomy, and evolution. Biomedical, developmental biology or neuroscience research have made gigantic advances using these methods, allowing the labelling of different proteins or RNA molecules and the visualization of samples ranging from cells to whole embryos or even adult tissues. Similar to the story of Ct scanning, these methods also hold enormous potential to greatly expand our knowledge of comparative embryology, anatomy, and evolutionary biology. Ongoing research on the development, anatomy, and evolution of the musculoskeletal system, in particular that of the usually left-behind amphibians and reptiles, will be used to exemplify how different approaches to the investigation of embryonic anatomy can lead to new understanding of

overlooked aspects of tetrapod evolution, from the diversity of reptile myology to the uniqueness of amphibian limb development. Collaboration with zoos, breeding centers and local herpetologists and communities will be instrumental to the expansion of comparative embryological exploration across the phyletic diversity of amphibians and reptiles. Against the usual strategy of areas like developmental biology, comparative embryonic anatomy does not need model systems, past nor new, but rather access to as broad a sample as possible and to operate within a well-informed phylogenetic and evolutionary context. While a deep and detailed visualization of the adult anatomy fueled a revolution in our understanding of biological diversity, a new look into comparative embryology can help us understand the deeper aspects behind that diversity, including mechanisms of evolutionary change and morphological diversification.

A-0981 (Oral)
Tackling the Reptile and Amphibian Trade: Challenges, Implications, and Paths to Conservation

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An increasingly long list of reptiles and amphibians are threatened by a seemingly insatiable demand for these animals as pets. The trade, often carried out illegally and unsustainably, is facilitated and enabled by weak legislation at national levels, abuse and inadequate use of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), corruption, lack of political will, compounded by a general lack of evidence to support conservation action and misguided attempts at conservation captive breeding. The use of the internet to facilitate trade has not only simplified trade in live reptiles and amphibians, but it has further globalized the trade – one can obtain almost any species online, legally or illegally. Monitoring, regulating, and curbing this trade is difficult, to say the least. The illegal and unsustainable trade in reptiles and amphibians for pets unfortunately remains a little-known conservation crisis and there is a lack of current information and evidence to support policy change, enforcement efforts and demand reduction strategies. Many species are being pushed rapidly towards the brink of extinction without any effective conservation actions being developed and implemented. We urgently need to change this narrative and tackle the illegal and unsustainable trade in reptiles and amphibians with a more collaborative and coordinated approach.

A-0982 (Oral)
Unfolding the Ontogenetic Trajectories of Adaptive Immunity in Salamandrids

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The adaptive immune system of jawed vertebrates (AIS) is a major evolutionary innovation. It enables the identification of virtually any non-self (including pathogen-derived) antigen and has "memory", which promotes quick, specific, and potent response to a previously encountered threat. On the flip side, AIS requires formation of a vast anticipatory repertoire of antigen receptors (ARs) early in life, which is both time-consuming and resource-intensive.

This developmental constraint may be particularly pronounced in small amphibian larvae which hatch in pathogen-rich aquatic environments. Further, metamorphosis remodels tissues, changing the antigenic landscape of "self", which could provoke in adults an autoimmune response of an AIS educated at a larval stage. Thus, an early larval investment in AIS could be wasteful, and extensive research in *Xenopus* frog has indicated that a complete development of AIS may be delayed in amphibians until after metamorphosis. Furthermore, early studies on skin graft rejections and lymphocyte responses *in vitro* indicated that Urodeles' adaptive responses were generally subdued compared to anurans. Given the ongoing decline in amphibian populations, it is imperative to gain a deeper understanding of the developmental timeframe of amphibian AIS and to explore the reasons behind Urodele-specific suppression. Recent advancements in transcriptomics now enable us to explore these patterns in a broad phylogenetic context. Here, we study how the AIS unfolds during the larval development in four salamandrid genera: *Ichthosaura, Lissotriton, Pleurodeles* and *Triturus*. We find marked differences between taxa, with a gradual increase in expression of key components of the AIS through larval development and metamorphosis of *Pleurodeles*, and a more rapid onset nearing the metamorphosis in the remaining species. Additionally, we studied trajectories of larval *Pleurodeles* TCRα (key AR of T lymphocytes) repertoire development, observing steady increase in its estimated size from a few hundreds to a few thousands distinct clonotypes.

A-0983 (Oral)
Tolerance to Infectious Diseases in Wildlife - Insights from Studies on Herpetofauna

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Tolerance and resistance are complementary host defences against infectious diseases. While resistance prevents or limits the intensity of infection, tolerance permits the host to better withstand the detrimental effects of infection, without limiting pathogen growth. The study of infection tolerance in wild vertebrates has expanded dramatically over the last decade, owing to (1) its important implications for co-evolutionary stability in host-pathogen systems, (2) increasing acknowledgement of the role of reservoirs and superspreaders in community disease dynamics, and (3) the conflicting ecological role of tolerance; where within-species heterogeneity can lead to ecological rescue and persistence, whereas between-species heterogeneity can lead to declines and extinctions. Here, we present an overview of the concept of infection tolerance, and a synthesis of the current challenges and opportunities unique to the study of infection tolerance in the field of wildlife diseases. We also used a systematic quantitative approach to explore the existing empirical literature, summarising key findings and identifying research gaps. We found that reptiles were under-represented in studies of infection tolerance amongst vertebrates. However, infection tolerance was frequently found to be an important mechanism of defence for herpetofauna, particularly in the context of chronic exposure with infection endemism, against macroparasites in combination with other stressors, and during developmental life stages. Species, age, sex, nutrition, environment, body condition and size characteristics, but not the presence or absence of corticosteroid, were found to mediate variation in tolerance. Improving our understanding of infection tolerance and resistance promises powerful new strategies for understanding and mitigating infectious diseases of wildlife.

A-0984 (Oral)
Passive Acoustic Monitoring for Biodiversity Assessments in Australian Frogs

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Amphibians are currently the most threatened group of terrestrial vertebrates globally, highlighting the urgent need for effective biodiversity monitoring methods to enhance conservation initiatives. Passive Acoustic Monitoring (PAM) has recently gained traction as a promising remote sensing technique for surveying vocal fauna, permitting efficient biodiversity assessments across extensive spatiotemporal scales. However, the efficacy of PAM compared to traditional observer-based methods (OBM) in assessing frog biodiversity remains unclear. In this study, we evaluated the performance of PAM against traditional OBM in six diverse locations across eastern Australia over a two-year period. By integrating PAM with the deep learning model BirdNET, we detected a higher number of frog species compared to OBM. Additionally, this remote sensing method proved to be exceptionally cost-effective and time-efficient, consuming only 0.1% of the time required by traditional methods to compile species inventories. Our findings underscore the potential of passive acoustic monitoring as a powerful, efficient tool for assessing frog biodiversity, promising significant implications for advancing conservation action for this threatened group of vertebrates.

A-0985 (Oral)
Thermal Ecophysiology of Three Snakes from Central Mexico with Contrasting Lifestyles

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Physiology is highly temperature dependent, so maintaining body temperatures at an optimal range is crucial for performing biological functions. Reptiles have diverse lifestyles, behaviors, and thermoregulation mechanisms that allow them to exploit multiple thermal environments. Elucidating this interplay between environment, behavior and function is key, especially in a group as functionally diverse as snakes. We studied the thermal ecophysiology of three common snakes of Central Mexico with contrasting lifestyles: the terrestrial *Crotalus polystictus*, the semiaquatic *Thamnophis melanogaster* and the fossorial *Conopsis lineata*. We used data on operative, preferred and body temperatures to calculate thermoregulation efficiency indexes. Posteriorly, we assessed the thermal sensitivity of performance and

metabolism by measuring swimming speed and resting metabolic rate (RMR) across five thermal treatments (from 15°C to 36°C). We developed thermal performance curves, and analyzed RMR with general linear mixed models and the Q10 index. *C. lineata* and *C. polystictus* demonstrated active and precise thermoregulation, while *T. melanogaster* did not. We propose that C. lineata selects thermally favorable retreat sites to thermoregulate and that the semiaquatic lifestyle of *T. melanogaster* supports easier maintenance of body temperatures due to the thermal homogeneity of water. All three species maintained high levels of performance over a wide temperature range. The optimal temperature for locomotion of *C. polystictus* is near its critical thermal maximum, which suggests that it can thrive in warm conditions, but the overheating risk is high. RMR augmented with each thermal treatment but Q10 was the highest at the lowermost and uppermost thermal treatments, which suggests that physiology is more heavily influenced by temperature at the extremes. This could be an adaptation to maintain physiological performance in suboptimal temperatures, and to facilitate responses to heat stress. These results exemplify how ecophysiological traits are linked with both lifestyle and the environment.

A-0986 (Oral)
Disease Outcomes of Coinfection by Ranavirus FV3 and *Batrachochytrium dendrobatidis* in Model Frog *Hymenochirus boettgeri*

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Individual hosts frequently experience infections from multiple pathogenic species or strains in nature, a phenomenon with profound potential to shape disease dynamics. Despite the shared susceptible host species, overlapping ranges, and high rates of observed coinfection, the impacts of mixed infection by the two most threatening global amphibian pathogens, *Batrachochytrium dendrobatidis* (Bd) and Ranavirus (Rv), remain severely understudied. This study investigated individual-level disease outcomes resulting from simultaneous and staggered co-exposures of Bd and Rv using *Hymenochirus boettgeri*, a new model organism for studying amphibian disease. Our results indicate that the order and timing of exposures can elicit contrasting disease outcomes, with animals previously exposed to sublethal Rv displaying the highest mortality after developing a subsequent Bd infection. In contrast, animals simultaneously exposed to both pathogens experienced higher survival probability compared to those singly-infected, likely connected to slower Bd growth and establishment. Enhanced competition or cross-immunity between the pathogens may explain the relative protection of simultaneous inoculation, while the lowered resistance to Bd incurred by pre-existing Rv infection may suggest synergistic immunopathology or pathophysiology, or immune suppression by Rv. These results suggest that, depending on the timing of exposures, communities with persistent, sublethal Ranavirus infections may be at risk of more severe mortality events from Bd. Our study provides insight into how Bd-Rv coinfection can shape disease dynamics, highlighting the urgent need for increased monitoring of mixed infections to improve management efforts for conservation.

A-0987 (Oral)
Long-Term Data Reveals a Breakpoint in Buffering Capacity of Thermoregulation

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Determining a species response to global warming often entails comparing contemporary data on thermoregulation with predicted future climates based on global circulation models. However, the use of long-term data collected during a period of increasing temperatures provides direct evidence for the ability of species to use behavioral buffering to cope with rising temperatures. We used a 38-year long record of field-active body temperatures (Tb) measured on Tree lizards (*Urosaurus ornatus*) from Saguaro National Park (SNP) to assess temporal variation in the thermal quality of the habitat, effectiveness of thermoregulation and hours of restriction and hours of activity. Tree lizards at SNP are arboreal and establish territories on mesquite trees (*Prosopis* spp.), Acacia (Acacia constricta), and Palo Verde (*Parkinsonia microphylla*). The trees provide shade except during droughts. We also measured thermal preference in a photo-thermal gradient and quantified operative environmental temperatures (Te) to assess whether selected temperatures changed over time. Finally, we obtained historical records for drought intensity. The mean and variance in Tbs remained showed remarkable consistency between 1987-2015. Preferred temperatures remained constant at ~ 37°C until 2012 when it increased to 39°C. Despite substantial temporal variation in operative environmental temperatures, the effectiveness of thermoregulation showed limited variation in the same period mainly due to a 2 degree increase in preferred body temperature. However, the buffering capacity of thermoregulation shifted after 2015 with the highest Tbs recorded between 2016–2022. We also noted an increase in nocturnal temperatures during the study period. The effectiveness of thermoregulation declined during this second period. The fluctuation in hours of activity and restriction was explained by cycles of drought. Our data suggest limits in the ability of behavior to buffer lizards from future increases in environmental temperature.

A-0988 (Oral)
Small Frogs with Big Problems: Threatened Mountaintop Nursery Frogs and the Climate Crisis in the Australian Wet Tropics Bioregion

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The climate crisis is accelerating population declines and local extirpations across many taxa and environments globally, but the projected outlook is especially conceing for tropical montane species. In the Australian Wet Tropics bioregion, multiple threatened nursery frog species in the genus *Cophixalus* are found on mountaintops where conditions remain relatively cool and moist throughout the year. These small terrestrial-breeding frogs represent nearly one-third of Critically Endangered frogs listed under Australia's federal environmental legislation and are threatened almost exclusively by climate change. Suitable habitat will likely contract to higher elevations, leaving nowhere to go for low-dispersal species already restricted to mountaintops like these nursery frogs. Until recently, fundamental knowledge gaps surrounding nursery frog ecology have hindered conservation actions. To address these gaps, we conducted comprehensive call surveys and passive acoustic and environmental monitoring along an elevational gradient on two representative mountaintops in the region. We determined current elevational limits (and whether these have shifted in the past two decades), as well as

temporal patterns in calling activity along the gradient for the most threatened *Cophixalus* species. Understanding how these species will respond to climate change, including possible elevational and distributional shifts or altered breeding phenology, is crucial for planning future conservation management actions for these and other mountaintop restricted species.

A-0989 (Oral)
Unraveling the Mechanism Behind the Sequestration of Alkaloids in the Most Toxic Vertebrate on Earth (*Phyllobates terribilis*, Dendrobatidae)

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Poison frogs from the Dendrobatidae family acquire their toxins through the diet in a process known as toxin sequestration, in which alkaloids are accumulated in specialized granular glands in the frogs' skin. However, sequestration selectivity, metabolization, and the mechanism of transportation from the mouth through the skin are unknown. Recently, a groundbreaking discovery has revealed the critical role of an alkaloid-binding globulin (ABG) from plasma in explaining this mechanism. This investigation aims to test the metabolism of the most toxic vertebrate on earth (*Phyllobates terribilis*) to understand the mechanism by which they eat and sequester one of the most potent natural toxins in the world. The study will also use a biochemical strategy called photocrosslinking to test toxin binding to specific plasma proteins. First, we orally fed frogs with daily doses of batrachotoxin (BTX), a synthetic derivative of batrachotoxin (tBTX), and a toxic cocktail of ten compounds, over the course of seven days. Subsequently, we measured toxin absorption, distribution in blood plasma, metabolism, and excretion in different tissues using spatial Metabolomics based in LC-MS/MS. From these experiments, we discovered that *P. terribilis* can selectively sequester most of the toxins into the skin and other organs with different efficiencies, while caffeine, nicotine, and ouabain are excreted (not sequestered) into the skin. We also detected for the first time several potential BTXs byproducts, possibly resulting from frog metabolism. In addition, we have discovered that a plasma transporter protein shows crosslinking and competition with all toxins, being BTX and calycanthine (two natural habitat-acquired alkaloids) the ones with higher affinities. Annotating this plasma protein in *P. terribilis* would provide insights into the evolution of the selective sequestration mechanism of alkaloids in poison frogs. It could also determine whether this protein is the same ABG recently discovered in other species that naturally lack batrachotoxin.

A-0990 (Oral)
Fomite Environmental DNA as a Tool for Detecting Illegal Turtle Trade

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The illegal wildlife trade presents significant challenges to wildlife conservation due to its large impact on population and species persistence. Forensic technology plays an important role in detecting and prosecuting such trade, but has lagged behind human forensics where trace genetic evidence is important in conviction and exoneration. At present, most genetic applications in wildlife forensics focus on identification of taxa or populations via whole tissue samples or visible trace material (e.g., blood, hair or feathers). However, enforcement officials

may encounter common household objects that are suspected to be used in capture, transport, or holding of wildlife, but without visible evidence of wildlife presence. Here, we demonstrate that environmental DNA techniques can be used to detect trace DNA from turtles on both plastic and fabric fomites with high confidence for at least six months following only an hour of exposure. Sampling location and subsequent swabbing did not impact detection probability. While the two substrate types observed were very different in DNA concentration, conclusions were relatively similar. The lack of substantial DNA decay observed during this experiment suggests a very long window in which DNA may remain detectable to law enforcement officials under common gear storage conditions.

A-0991 (Poster)
Rapid Ecotype Formation under Gene Flow in a Toad-Headed Agama

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Understanding how different ecological types within a species are formed and sustained is a key question in evolutionary biology. This study examines a species of toad-headed agama (*Phrynocephalus putjatai*), which occurs in three distinct morphological forms associated with desert, semi-desert and meadow habitats in the northeastern Qinghai-Tibetan Plateau. Through comprehensive resequencing of the genomes of 90 individuals, we reveal a recent emergence of these ecotypes at ~10,000 years ago. Our analysis identified 1351 candidate SNPs associated with ecotype differentiation. These SNPs reveal a potential key locus encompassing the MYH gene under directional selection, constituting approximately one-third of the total candidates. A large amount of these candidate SNPs are polymorphic in all three ecotypes, originating prior to their divergence, suggest that local adaptation primarily used existing genetic diversity. This study underscores how selection acting on ancestral standing genetic variation can drive rapid local adaptation and diversification despite gene flow.

A-0992 (Oral)
Environmental DNA as a Tool for Detection of the Estuarine Crocodile (*Crocodylus porosus*) in Queensland Australia

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The Estuarine crocodile (*Crocodylus porosus*) is one of the world's largest reptile species and one of Australia's most efficient predators. As a top predator, the estuarine crocodile plays a key ecological role in aquatic ecosystems. Since the cessation of culling in Australia in the 1970's estuarine crocodile numbers have slowly recovered to pre-hunting levels. As crocodile populations have recovered in Queensland, increasing encroachment into crocodile habitats will lead to increasing need to monitor and manage populations. Understanding how estuarine crocodile are using waterways in and around human population centres is therefore an important aspect of managing human-crocodile conflict. The Estuarine crocodile is a cryptic predator relying on ambush to capture prey, traditional survey techniques make detecting and

locating individuals moving into discrete areas difficult. We aimed to determine the feasibility of using environmental DNA (eDNA) to detect the presence of the estuarine crocodile in Queensland waterways. eDNA surveys allow detection of target species from trace amounts of DNA shed into the environment. We designed a quantitative PCR assay from the mitochondrial ND4 gene that is suitable for use across the entire estuarine crocodile Australian geographic range. Our assay is highly specific and highly sensitive to estuarine crocodile DNA both in the laboratory and in initial trials using water samples from a captive facility in Queensland. We discuss future directions and challenges for this research including upcoming testing of water samples from captive facilities and from waterways around Northern Queensland.

A-0993 (Oral)
Impacts of Coal-mine Induced Iron-staining on Tadpoles

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Iron flocculent staining of fresh waterways is a natural process that can be exacerbated by human activities such as mining and indicates high levels of iron within the water. At high concentrations, iron can have negative toxicological impacts on aquatic biota. However, there are relatively few studies investigating the impact of iron flocculent on stream vertebrates. This study looked at field concentrations of iron and manganese within a highly iron-flocked stream, where iron-staining was triggered by underground longwall mine activity. This iron-rich water was also used to house tadpoles for two weeks in a controlled laboratory experiment to investigate how this level of iron would affect the development and behaviour of a larval amphibian, Peron's tree frog (*Litoria peronii*). The uptake of metals into tadpole tissue was also assessed. Concentrations of iron within the flocked stream were up to 20 times higher than national park control streams, reaching levels of 34.4 ppm. Manganese was less abundant (max 3.7 ppm) in the iron-flocked stream but was at concentrations 71 times higher than national park control streams. During the controlled study, these metals readily accumulated in tadpole tissue, reaching levels 16 times higher than in that of animals held in control rainwater treatments. There were no statistical differences in growth or development between tadpoles held in the two water treatments, however, there were changes in activity and swimming performance that may indicate acute physiological stress. If human activities are going to increase the occurrence of iron-flocculent staining, it is important to understand what impact these high levels of metal may have on vulnerable fauna.

A-0994 (Oral)
Comparison of Life History Parameters among Japanese Frog Species Estimated by an Amphibian Metamorphosing Model

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Optimizing the size and timing of metamorphosis is a critical strategy for enhancing the fitness of amphibians. This strategy is greatly influenced by growth and survival rates in aquatic and terrestrial environments, yet directly measuring these values through field surveys is often challenging. Tadpoles are expected to determine metamorphosis points based on their aquatic growth rate, alongside evolutionarily anticipated terrestrial mortality and growth rates of the species. Consequently, with actual metamorphosis point data spanning various aquatic growth

rates, it may be feasible to reverse calculate the terrestrial growth and survival rates that each species anticipated when determining the metamorphosis point. In this study, a recently developed metamorphosis model was employed to estimate growth and survival rates by reverse calculating from actual metamorphosis points obtained through rearing experiments. The model encompassed growth and survival rates of both aquatic and terrestrial stages in the fitness equation. Tadpoles from four species representing four families of Japanese frogs were reared until metamorphosis in a laboratory, with three or four distinct food amount treatments. By regarding the actual metamorphosis points as "correct answers" for each growth trajectory, the parameters of the fitness equation were determined using a genetic algorithm, to minimize the deviation between calculated optimal metamorphosis points and the correct answers. Subsequently, the estimated aquatic and terrestrial growth and survival rates were compared among the four species.

A-0996 (Oral)
Towards Complete Morphological Descriptions of all Reptile Species

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More than 14,000 species and subspecies of reptiles have been described. The Reptile Database now provides descriptions for about 10,000 species as well as live photographs of more than 6,000 species. Online links to GenBank for ~8,700 species and to IUCN for ~10,000 species provide DNA sequences and range maps for even more detailed descriptions, respectively. In order to fully describe species, we have started to work on two further improvements. First, a reference database of standardized images will allow users to directly compare species to each other. Our pilot project includes 16,000 high-resolution images of more than 1,000 species based on preserved specimens. Since these images do not show live colors, it complements the images of live images in the Reptile Database. However, we have also started to systematically collect color information on snakes to make this information searchable. Second, we are working to convert textual descriptions of species into a structured database of traits, so that characters can be also compared and analyzed more systematically. A preliminary analysis of this corpus by ChatGPT and other LLMs will be described. When integrated with geographic range maps, species identifications can be substantially simplified and made available also for non-experts. Finally, in combination with phylogenetic trees our dataset will allow detailed macro-ecological and other biological studies.

A-0997 (Oral)
Unexpected Maintenance of the Long-Wavelength Sensitive (LWS) Cone Opsin in Caecilians: An Ancient Group of Fossorial Amphibians

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Vertebrate visual systems are finely tuned to an animal's ecology, having evolved for specific light environments and visual needs. Ecological shifts such as the transition from above-ground to fossorial lifestyles can relax selection on species' visual systems that are less dependent on visual acuity and color perception, while exerting strong selective pressures against detrimental traits such as large and protruding eyes. Such selective forces can result in the reduction of eye size and sophistication. Caecilians (Order Gymnophiona)—highly specialized, limbless and elongate, fossorial amphibians—possess tiny eyes which are covered by skin and even bone in some taxa. Given that these animals live mostly underground and in pitch-black habitats, it is thought that caecilians have limited visual capabilities to light and dark discrimination, lacking the ability to produce a focused image and being unable to discriminate colors. Our results, however, challenge these assumptions, as we identify the presence of the long wavelength sensitive (LWS) opsin gene in 11 species of caecilians spanning eight of 10 recognized families as well as the expression of LWS mRNA in the retina of *Caecilia orientalis*. Molecular evidence supports that these opsins appear to be intact and functional—containing a single start and stop codon and lacking large indels or frameshift mutations. Anatomical observations, based on retinal photomicrographs from five different caecilian families also evidence highly organized retinae even in families with the most 'vestigial' eyes. In addition, we observe notable differences amongst taxa in their retinal morphologies and highlight unexpected photoreceptor morphological diversity. We discuss our findings in the context of recent work on fossorial snakes as well as previous findings on photoreceptor adaptation and transmutation resulting from shifts in light environment in other taxa.

A-0998 (Oral)
Conservation of the Magnificent Broodfrog

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The Australia Wet Tropics (AWT) rainforest is renowned for its rich biodiversity, which has encouraged intensive research to the area. However, a lesser studied habitat within the AWT are the tall, open, wet sclerophyll woodlands, which are situated on the western boundary. These woodlands are limited to a narrow, fragmented strip, approximately 400 km in length, often extending for just a few meters, with its widest point being ~4 km. These high altitudinal woodlands have been subject to intensive change over the last 100 years, with ~50% already lost. New impending threats to the woodlands are climate change, and more pressing are proposed wide-scale industrial developments, in the form of wind farms. These developments have the potential to clear hundreds of hectares of remnant vegetation within the next 10 years. Unlike the rainforest the woodlands are under sampled, despite supporting a suite of endemic species. One species of relevance is the Magnificent Broodfrog (*Pseudophryne covacevichae*), a small semi-terrestrial frog restricted to this narrow, fragmented habitat. Historically, this species has not been the focus of intensive research and as such details of its ecology, such as distribution and breeding biology, remain unknown. We have attempted to resolve the species' broad geographic distribution with the use of a species distribution model, investigating the environmental and climatic drivers that determine its occurrence. Additionally, we have performed an analysis on the environmental conditions that enhance the species detection probability, to assist in the development of field surveys and provide assurance of the species

presence in a location. The results of our work will assist in clarifying the species distribution in the AWT, as well offering practical guidance for efficient on-ground surveys, reducing false absences and informing targeted conservation efforts in the face of imminent habitat alteration.

A-1000 (Oral)
Case Study: United States v. Kang Juntao

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The United States v. Kang Juntao is a case study highlighting an example involving high volumes of CITES protected turtles, high dollar values, the complexity of the various roles individual actors can play, and the scope and scale of illegal transnational networks engaged in illegal activities. In this case, thousands of North American turtles were illegally collected from the wild and sold. This case can also be used to highlight typical but significant animal welfare concerns of turtles in the illegal trade. The offender recruited a network of poachers, shippers and middlemen to illegally obtain and export turtles to be sold illegally in the Chinese pet market and sentenced on a federal money laundering conviction.

A-1001 (Oral)
A Sea Snake in a Freshwater Lake: Proteomics, Toxicity, and Venom-Prey Relationship of the Lake Taal Sea Snake (*Hydrophis semperi* Garman 1881)

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Numerous investigations have recorded the proteomics, and venom toxicity of sea snakes, of the genus *Hydrophis*. Yet the venom of the freshwater sea snake, *Hydrophis semperi* has never been studied. This present study evaluated the proteome profile, toxicity, and venom-prey relationship using *Danio rerio* for the first time. In the venom composition, Sodium Dodecyl Sulphate-Polyacrylamide Gel Electrophoresis (SDS-PAGE) revealed that low molecular weight proteins (< 15 kDa) formed the bulk of the crude venom, which are most likely from Phospholipase A_2 (PLA_2) and Three-finger Toxin (3FTx). To examine the toxicity of *H. semperi* venom (HseV) in eukaryotic cells *in vitro*, this was tested against *Sacchoromyces cerevisiae*, and *Candida albicans*. HseV reduced the yeast colony viability revealing a

concentration- and time-dependent toxicity. To assess the toxicity in vivo and the underlying venom-prey relationship, HseV was administered intraperitoneally in *D. rerio* and evaluated the LD50, behavioral changes, and histopathological alterations in the brain and liver. The in vivo toxicity of HseV demonstrated a dose-dependent relationship and exhibited higher lethality (LD50 = 0.044 μg/g) than other *Hydrophis* species. Based on the Kaplan–Meier survival curve, HseV has a rapid onset of action, with mortality within 20 mins. Behavioral alterations revealed three stages following buoyancy problems, posture loss, loss of ventilatory movement, loss of motility, and death. In zebrafish survival, the response to HseV can be delineated into two key aspects: resistance and survival time. Hence, natural selection will favor a sea snake with highly toxic and rapidly acting venom and prey with high resistance. Zebrafish histopathological investigations showed dose-dependent lesions in the brain and liver characterized by hypertrophy, degeneration, vacuolation, and necrosis. Overall, HseV exhibited high lethality, hepatotoxicity, and neurotoxicity against *D. rerio*. These results contribute to a better understanding of the pathological effects of sea snake envenomation.

A-1002 (Oral)

Physiology, Mites and Microbiomes: Parthenogenetic Geckos and their Sexual Parental Population

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The success of parthenogenetic populations is facilitated by high fecundity but may be hindered by a lack of genetic diversity. Previous studies show parthenogenetic hybrids can express traits of compromised fitness compared with their parent species, such as higher rates of evaporative water loss and susceptibility to ectoparasites. Recent works highlight the importance of microbiomes on host health and show that both host lineage and environment (including parasites) contribute to an animal's acquired microbiome. Given the influence of host lineage, we hypothesised that parthenogenetic hybrid lineages would differ from their parent species in microbiome composition. We investigated how reproductive mode and the presence of mites affect evaporative water loss in sexual and parthenogenetic populations of the gecko *Heteronotia binoei* from the MacDonnell Ranges in central Australia. We also investigated divergence in the skin microbiome using amplicon sequencing. We collected sexual (n = 17) and parthenogenetic (n = 66) *H. binoei* to measure evaporative water loss, record mite infestations, and collect skin microbial swab samples from a subsample of individuals (n = 17 per reproductive mode). Only parthenogenetic individuals had mites, but mite infestations were not severe at our site. We found that neither reproductive mode nor mite load affected evaporative water loss in our study populations. Microbiome analyses found that reproductive mode significantly predicted community structure and beta diversity. However, the collection subsite within the area explained more of the observed variation than other variables. These findings challenge previously observed differences in phenotypes between parthenogenetic and sexual *H. binoei*; however, we found support for ectoparasite susceptibility in parthenogenetic individuals. Our microbiome results reinforce that even in sympatry, host lineages harbour

unique microbiomes, although, the environment largely influences the community structure and beta diversity in our study system.

A-1003 (Oral)
Gecko Skincare: Insights into Microbial Patterns on Lizards Considered to have Clean Skin

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Environmental surfaces are covered with bacteria that can inoculate passersby with taxa that may become vital members of their microbiomes. Despite a growing understanding of the importance of microbes in and on animal hosts, our knowledge of host-associated microbiomes is limited to few focal systems, particularly within the context of emerging diseases. Previous work in reptiles found relatively high diversity on lizard (including gecko) skin compared with sympatric frogs, despite studies suggesting that gecko skin has self-cleaning properties. In this study, we investigated skin bacteria on northern Australian geckos to reveal spatial and temporal patterns. We sampled seven gecko species (*Heteronotia binoei* and six *Gehyra* spp.) where possible at five sites along an aridity gradient in both wet and dry seasons (n = 230 total). As reported for other host groups, we predicted species-specific differences in bacterial communities, which could be influenced by factors such as host microhabitat and skin characteristics. We also predicted that site and season effects would be explained by climatic variables, specifically that elevated temperature and rainfall prior to sampling dates would impact skin bacteria. Using amplicon sequencing, we showed that while host species significantly predicted community composition, species, season, and their interaction explained only up to 38% of the variation among samples at a site. In species sampled at multiple sites, site and season were often significant predictors of beta diversity, but the spatial and seasonal patterns within species were not largely explained by the climatic variables analysed. Interestingly, at the site where five species were sampled, bacterial communities on species were more similar in the wet than the dry season, suggesting a climate association. Low variation explained in our analyses indicates that additional, unmeasured variables, or stochasticity, explain much of the bacterial assemblage of geckos.

A-1004 (Oral)
Lurking in the Litter: Systematics of *Subdoluseps* (Squamata: Scincidae), with Description of a New Genus and Five Cryptic New Species

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Skinks or lizards of the family Scincidae are an excellent system for studies in comparative ecology and evolution on account of the huge diversity in species and multiple morphological and life-history traits, combined with a wide distribution in the tropics and subtropics across a variety of habitats. Subdoluseps is a recently described genus of Lygosomine skinks with six species known from Southeast Asia and two from peninsular India. We conducted a revision of Indian *Subdoluseps* based on range-wide sampling across peninsular India including 89

specimens from 33 localities. We use multi-locus sequence data (two mitochondrial, three nuclear markers), 58 morphological characters, as well as ecological data to reconstruct the evolutionary history of Indian *Subdoluseps* and assess their diversity and distribution, besides providing more general insights into lygosominin biogeography. We describe the Indian clade as a new genus, *Dravidoseps* gen. nov., and transfer the existing species *Riopa goaensis*, *Subdoluseps pruthi* and *S. nilgiriensis* to *Dravidoseps*, designating neotypes for the former two. We formally name five new species from Tamil Nadu using an integrative taxonomic framework – *D. gingeeensis* sp. nov., *D. jawadhuensis* sp. nov., *D. kalakadensis* sp. nov., *D. srivilliputhurensis* sp. nov., and *D. tamilnaduensis* sp. nov. *Dravidoseps* are the first known viviparous skinks from peninsular India and the only known viviparous lygosomininns apart from a few east African *Mochlus*. The Lygosomini have a Southeast Asian origin and began diversifying in the Eocene with three dispersals between India and Southeast Asia. Species level diversification in *Dravidoseps* gen. nov. was likely driven by a combination of niche conservatism, paleoclimate and past forest distribution. The discovery of a new genus and five new species reiterates the high diversity and endemism in peninsular India as well as how much more remains to be discovered.

A-1005 (Poster)

Utilizing Museum Collections to Uncover Key Features of Infectious Disease Dynamics across three Major Pathogens found in North American Frogs

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In the order Anura (frogs and toads) infectious diseases caused by pathogens such as the fungus *Batrachochytrium dendrobatidis* (Bd), viruses in the genus *Ranavirus* (Rv), and the protozoan Amphibian Perkinsea (Pr) have been associated with localized and species-level host declines and extinctions. Since their respective discoveries, exhaustive research has uncovered patterns of differential infection across hosts and identified factors relating to infection risk and outcome. These studies, however, are often at limited taxonomic and geographic breadth and investigate only single infection types. Here, we leverage museum frozen tissue collections to 1) describe infection dynamics across multiple pathogens and host taxa and 2) identify key features related to infection risk in North American anurans. We use established qPCR protocols to determine prevalence and intensity of Bd, Pr, and Rv pathogens in three abundant and broadly distributed host families across the Central and Eastern U.S. (Bufonidae n = 320, Hylidae n = 456, Ranidae n = 505, total n = 1,281), and use Balanced Random Forests to identify and compare variable importance relating to pathogen-specific host infection both within and across host families. We found ~20% of individuals were infected by at least one pathogen type, and that Bd had the highest abundance across all host types (16.8%), followed by Rv (4.38%) and Pr (1.06%). We also found unique patterns of Bd and Rv prevalence and intensity across host taxonomy, age class, and environmental variables relating to latitude and seasonality. This was further supported by our Random Forest output, which identified taxonomic rank, latitude, and temperature variability as important predictors of infection status, however features differed across family groups and pathogens. Overall, our study highlights the use of museum specimens and abundant species with high geographic and environmental variation to further examine the complex landscape of infectious disease in North American anurans.

A-1006 (Poster)
The Great Escape: New Zealand Cobble Skinks (*Oligosoma* aff. *infrapunctatum*) 'Cobble' Break Free from an Evolutionarily Stable Sex Determination System

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Reptiles are renowned for their extremely variable sex-determining systems, with some groups such as geckos (Gekkota) exhibiting all major genetic and environmental systems. Skinks, however, show stability in their sex determination systems over deep evolutionary time. So far, all tested skinks (family: Scincidae) have been found to share a stable, yet poorly differentiated XX/XY chromosome pair (male heterogamety), which suggests this system has been around for roughly 85 million years. Cobble skinks (*Oligosoma* aff. *infrapunctatum* 'cobble') are a rare skink endemic to New Zealand. In 2016, in a last ditch attempt to save the species, every cobble skink that could be found in the wild (a mere 36 individuals) were taken into captivity at Auckland Zoo. Seven years later, despite some breeding success and newly discovered wild populations, cobble skinks remain nationally critical, and successful captive management is crucial for the species' survival. New Zealand's reptiles are slow to reach sexual maturity, hence sexing individuals for successful captive management is challenging. Here, we identified the sex determination system in cobble skinks, which will be used to develop a quick molecular method of sexing this species. We used genetic samples from wild-caught, known-sex individuals, along with genomic techniques to compare millions of markers across both sexes. Unexpectedly, our results demonstrated that the cobble skink does not possess the stable XX/XY sex determination system of the Scincidae family. These findings have global implications for understanding the evolutionary history of sex chromosomes. Further, the ability of sexing newborn skinks, that will not mature for several years, has crucial implications for captive population viability.

A-1007 (Oral)
Morphology and Ontogeny of Pelvic Girdle and Hind Limb of Thread Snakes (Serpentes: Leptotyphlopidae)

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Threadsnakes (Leptotyphlopidae) retain pelvic and hindlimb elements despite of their limblessness. These minute structures can now be studied in detail thanks to novel techniques such as contrast-enhanced micro-CT. In this study, we provide detailed inter- and intraspecific comparisons of the anatomy of the pelvic girdle and hindlimb elements for thirteen species of leptotyphlopids, including ontogenetic and sexually dimorphic variation in Freiberg's thread

snake, *Epictia australis*. Leptotyphlopids show different degrees of development of their pelvic skeleton, as it might be formed by three elements (ilium, ischium, pubis) with a well-developed femur (*Epictia, Leptotyphlops, Trilepida*), one rod-like pelvic rudiment of unknown identity attached to a rounded element assigned to the femur (*Tricheilostoma*), or a single triradiate element (*Myriopholis*). Intraspecific variation is present in length or robustness of the individual elements, and asymmetries are found in those species having the largest degree of reduction of the elements. In *Epictia australis*, the ilium is long, posterodorsally directed and curved, its distal end is cartilaginous and can present two different forms. The ischium is posteriorly directed, rod-like, and its distal end is covered by a conical cartilage. The pubis is short, conical and extends anteriorly in opposition to the femur. The femur is the stoutest bone, it exhibits a thin cartilage covering its distal tip, and a rounded protuberance on its proximal region which is directly linked to a keratinized claw. As in other snakes such as boas and pythons, claws are present both in males and females, located anterolaterally to the cloacal region and slightly protruding between scales. This analysis provides new perspectives to discuss the functional and ecological value of pelvic and limb elements in snakes and, therefore, will shed light on relevant topics such as limb loss or vestigial organs as a source of morphological novelties in vertebrates.

A-1008 (Poster)

What Happens to Toxic Metals during Frog Metamorphosis? An Investigation of Cadmium Bioaccumulation Dynamics in *Limnodynastes peronii*

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Cadmium pollution poses a significant threat to aquatic ecosystems due to its persistence, toxicity, and tendency to accumulate in living organisms. This study assessed the complex dynamics of cadmium uptake, accumulation and distribution across anuran development to provide new insights into the fate of cadmium burdens during metamorphosis and compare the susceptibility of different life stages to cadmium accumulation. Tadpoles of various developmental stages were exposed to dissolved 109-cadmium and depurated in clean water in a series of experiments. Temporal changes in whole-body and tissue concentrations were analysed using gamma spectroscopy, and anatomical distributions were visualised using autoradiography. Results showed that animals exposed at the onset of metamorphic climax (forelimb emergence) retained significantly less cadmium than animals exposed through larval stages. After exposure, cadmium partitioned predominantly in the skin, gills and remains of metamorphs, whereas larvae accumulated cadmium predominately through their gut. This shows a shift in the primary route of uptake at the onset of climax, which relates to the structural and functional changes of uptake sites through metamorphosis. During climax, some cadmium was redistributed in tissues developing *de novo*, such as the forelimbs, and concentrated in the regressing tail. Our findings emphasise the need to better understand how the drastic morphological, physiological, and functional transformations associated with metamorphosis influence the bioaccumulation of toxicants. Such knowledge is essential for assessing toxicity risks, informing predictive biokinetic and toxicodynamic models, and developing conservation measures that protect the most vulnerable life stages, as bioaccumulation directly influences the susceptibility of organisms. This is important as amphibians are among the most threatened animal groups and are found to be more vulnerable to some stressors during metamorphic stages. Additionally, our findings highlight the significance of understanding the fate of

contaminant burdens through ontogeny, as toxicants can be transferred across ecosystem boundaries through predation and metamorphosis.

A-1009 (Oral)
Biochemical Ecology of the Prairie Rattlesnake (*Crotalus v. viridis*)

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Rattlesnake venoms have been the subject of intense study, but despite this, major questions remain regarding intraspecific variation in toxin composition among species. Rattlesnake venoms are generally rich in lytic enzyme toxins, but they may fall along a continuum of degradative to highly toxic activities – resulting in the potential for venom phenotypes to be evolutionarily labile. The Prairie Rattlesnake (*Crotalus viridis*) is a medium-sized pitviper with a broad geographic distribution spanning the Great Plains of North America. In other broadly distributed rattlesnakes, major compositional variation in venoms has been characterized across spatial scales. Here, we investigated the venoms of the Prairie Rattlesnakes across its geographic distribution. We characterized two spatially disjunct venom phenotypes: a myotoxin-rich "northern" phenotype and a degradative "southern" phenotype, with inversely related biochemical compositions. We found upregulation of the taxon-specific myotoxin a in the northern phenotype and demonstrate that myotoxin a exhibits high lethality to mammalian models but low lethality to squamate models. We determined that venom phenotypes are related to abiotic (climate), biotic (prey), and phylogenetic factors. We then assayed a suite of coevolved prey species occurring in locations with each venom phenotype for resistance against the sympatric and allopatric phenotypes. We found surprising patterns of resistance (or lack thereof) against rattlesnake venoms in the diversity of prey species assayed. Finally, we tested for venom resistance in a suite of predators: raptorial birds of the orders Accipitriformes, Falconiformes, and Strigiformes. We found a widespread lack of venom resistance, suggesting that resistance dynamics with avian predators may not represent a strong source of selection on rattlesnake venom composition. This integrative study illustrates the complexity of selective pressures that may drive the evolution and maintenance of venom variation and underscores the need to study compositional variation in the venoms of medically important snakes.

A-1010 (Oral)
Addressing a Critical Conservation Threat with the Collaborative to Combat the Illegal Trade in Turtles (CCITT)

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North America's native turtles are being illegally collected and traded at an alarming scale. The challenges this issue raises are variable and complex, and confronting them requires a multidisciplinary socio-ecological approach among law enforcement personnel, biologists, legal professionals, social scientists, and other experts. In response to this need, the Collaborative to Combat the Illegal Trade in Turtles (CCITT) was established in 2018 with the goal of advancing efforts to better understand, prevent, and eliminate the illegal collection of

North America's native turtles. Currently, the group has over 200 members from across the United States and Canada and is composed of five interdisciplinary working groups: Confiscation and Repatriation, Data and Research, Human Dimensions and Communication, Judiciary and Regulations, and Law Enforcement. Here we describe how regional concerns over the illegal collection and trade of native North American turtles led to grassroots efforts that continue to grow into transnational conversations, broad strategic thinking, and coordinated action across sectors and geographies. We discuss the biological vulnerability of turtles to collection, what is known about the scale of illegal collection, the structure, function, and recent initiatives of CCITT, and the development of strategies intended to make a meaningful impact in reducing illegal collection and trade.

A-1011 (Oral)
Climate-Induced Elevational Range Shifts of Amphibians: A Study Along a Tropical Gradient in Peru

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Climate change is causing many species to shift their elevational ranges to track their optimal temperatures. Among all species, tropical ectotherms may face the highest vulnerability to rising temperatures due to their physiological specialization in narrow thermal niches. This is especially concerning for tropical amphibians inhabiting the lowlands below 1,500 m asl, as they inhabit areas with ambient conditions that are closer to their critical thermal limits. Despite this, there is a notable lack of studies on elevational range shifts, particularly for amphibians in the tropical lowlands, mostly because the tropics suffer from a lack of historical baseline data to compare present-day patterns. In this study, we investigated the elevational range shifts of the amphibian community along an elevational gradient in the Peruvian tropical lowlands within the Manu Biosphere Reserve. We replicated the survey effort of a study conducted a decade ago, following the same methodology and using the same transect locations. We compared this historical dataset to our contemporary data with the goal of detecting potential shifts in amphibian elevational ranges. We found that amphibian species along this elevational gradient have shifted upslope in mean elevation and at low and high elevational limits, where some species expanded their ranges, while others contracted. Furthermore, contrary to the historical study, our findings revealed an increase in species abundance with increasing altitude along the gradient. This unexpected pattern is driven by the high abundance of a few species at higher elevations along the gradient. This may suggest that some species are thriving at expanding their elevational ranges, while others are not. Currently, we are assessing the ecological and behavioral traits that may be driving these patterns. Overall, our findings support the projections that warming is driving elevational shifts, and species close to the mountaintop are running out of space and contracting their ranges.

A-1012 (Oral)
Do Invasive Plague Skinks (*Lampropholis delicata*) Elevate Predation of Native Lizards in New Zealand?

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Conservation in the face of invasive species is an ongoing global challenge and herpetofauna can be particularly sensitive to predation, competition, and habitat destruction resulting from introductions. Within the web of altered interactions that invasive species initiate, it is often the direct impacts that we, necessarily, concentrate on. However, there is unfortunate scope for many indirect impacts as well. *Lampropholis delicata* have been present in New Zealand since the 1960s and continue to expand their range. They reach high densities in protected areas and people's backyards, and are of particular concern on offshore island nature reserves. *L. delicata* occupy the same habitats as many endemic lizards, and are prey for native and introduced predators. We reviewed literature focussing on altered predator behaviour following invasion of introduced prey species. Our hypothesis is that highly abundant, non-cryptic introduced prey species might elevate predation of cryptic native prey species of the same general morphology. 'Hyperpredation' has been implicated in native species extinctions in New Zealand, Guam, and Australia. Researchers measured and modelled impacts of predation pressure during control of invasive prey. They observed negative impacts of prey switching to native prey across times of lower invasive prey abundance, and found long term control (e.g., of rabbits) could lead to local extinctions. This was exacerbated when remaining species (e.g., rats) competed with native prey for food, increasingly altered habitat, particularly refuges, or when alternate prey were ephemeral (e.g. nesting seabirds). Reviewed results highlight the necessity of understanding multi-species interactions within invasive species impacted ecosystems; their complexity and the need for sufficient data to manage interactions and benefit native species. We recommend investigating the proportion of lizards consumed by predators in matched sites with and without L. delicata using dietary DNA, stable isotope, observation (direct and camera trap), pellet, scat, and predator stomach content analyses.

A-1013 (Oral)
Environmental Drivers and Genomic Constraints to the Recurrent Evolution of Colors and Patterns in Frogs and Toads

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Certain colors and color patterns are found across numerous distantly related anurans lineages around the world, indicating shared evolutionary constraints at the ecological, physiological or molecular level. This is the case, for example, of the vertebral stripe pattern and the green dosal coloration, two ecologically-relevant color traits thought to provide camouflage in certain circumstances. Here we combine histology, genome- and transcriptome-wide analyses with order-scale phylogenetic comparative analyses to study the ecological factors and molecular mechanisms that drive the evolution of these two common color traits. We show that these traits have evolved recurrently in the evolutionary history of anurans and are selected for in certain habitats. We then pinpoint the genomic variations linked to these traits in a polymorphic African grass frog species, *Ptychadena robeensis*, and demonstrate their regulatory functions during the development. Finally, we compare the genomic architecture of these traits in taxa across various divergence times and show that the two traits are subject to strikingly different evolutionary constraints and selection regimes.

A-1014 (Poster)

Exploring Mitonuclear Discordance: Ghost Introgression from an Ancient Extinct Lineage in *Odorrana swinhoana*

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Ghost introgression, a hypothesis of mitonuclear discordance, has captured the attention of researchers in recent studies. This phenomenon occurs when genetic material from an extinct or unsampled lineage was introduced into the gene pool of a related species through hybridization, leaving behind a "ghost" signature in the form of introgressed DNA. By using mtDNA and RADseq analyses, we explored the evolutionary history of Odorrana swinhoana complex (Anura: Ranidae), which comprises *O. swinhoana, O. utsunomiyaorum*, and a deeply divergent mitochondrial lineage recently discovered in eastern Taiwan. The mtDNA data showed a group of eastern Taiwan populations forming an early diverging lineage, indicating that *O. swinhoana* is not a monophyletic group; whereas the RADseq data demonstrated a close relationship between all the populations in *O. swinhoana*. Using demographic modeling and genome-wide SNP data, we inferred that this discordant pattern might be the consequence of an eastward expansion from western *O. swinhoana*, which replaced an ancient and extinct *Odorrana* species, leaving its distinct mtDNA and small parts of nuclear genome. The presence of two deeply distinct mtDNA lineages suggested that this expansion likely occurred twice, through both north and south routes. These findings unveiled one of the first cases of ghost introgression observed in amphibians. This study also suggested that relying solely on mtDNA for phylogeny reconstruction or species delimitation could lead to erroneous results, and incorporating nuclear loci would depict the evolutionary history of species more completely.

A-1015 (Oral)
Will Culling Crocodiles Reduce Attacks on Humans?

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Although rare, large predator attacks typically illicit intense media and public attention, prompting calls for population culling despite little evidence supporting a consistent link between large predator density and attacks on humans. Our study assessed the effectiveness of population culling for human safety by examining how the density of Estuarine crocodiles (*Crocodylus porosus*) was correlated to the frequency of attacks in the Northern Territory (NT), Australia. Over the last 50 years, the NT estuarine crocodile population has been closely monitored to track its recovery from only a few thousand to over 100,000 non-hatchling individuals, allowing us to examine how attack frequency shifts over a wide range of crocodile densities. We found that attack frequency was correlated with crocodile density during the population's initial recovery. However, once crocodiles reached a density that they reoccupied most waterways in the NT, the frequency of attacks plateaued despite the crocodile population continuing to grow. We argue this shift from density dependence to independence was due to

a combination of factors, including changes in human behaviour around waterways, the institution of government initiatives to mitigate crocodile attacks (i.e., education programs, the removal of bold individuals, the exclusion of crocodiles from urban centres), and crocodiles saturating the environment (i.e., the attack risk to humans is similar whether there is one or ten crocodiles in a waterbody). By further modelling the relationship between crocodile density and attack frequency, we also demonstrate that it would be necessary to cull 90% of the current crocodile population to reduce attack frequency from 2.16 to 1.16 attacks per year. Altogether, this study highlights the importance and effectiveness of management strategies that promote coexistence between humans and large predators (i.e., public education, removal of problem individuals) for mitigating the inherent risks posed by large predators such as crocodiles.

A-1016 (Oral)
Successful Integration of Sperm Biobanking in an Amphibian Breed-for-Release Program

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Biobanking of sperm can play an important role in conservation by providing cost-effective, long-term genetic resources for conservation breeding programs (CBPs). For amphibians, the pathway to effective integration of biobanking into the genetic management of species is close to reality with a rapid increase in the development of effective protocols for spermiation, sperm cryopreservation, and IVF using frozen-thawed sperm over the last decade; so much so that the IUCN recognises biobanking as a beneficial tool in a comprehensive approach to protecting amphibian species worldwide. Between 2017 to 2020, much of Australia was experiencing lower than average rainfall reaching critical drought conditions in some areas. In late 2019, an emergency extraction of Northern Booroolong Frogs (Litoria booroolongensis) was undertaken across extant populations in its northern range due to the severity of the drought in the spring/summer of 2019-2020, the sharp decline in population numbers, and the lack of breeding in the wild. Adult animals (n = 60) were extracted from eight creek/streams across 2 catchment areas and translocated into care at Taronga Zoo, Sydney to establish a CBP. Our aim was to create a sperm biobank for this species whilst maintaining targets for the generation of offspring. It was crucial to begin biobanking within the first 12 months as animals were of unknown age at collection. We applied an established hormone-induced spermiation protocol, refined sperm quality assessment and developed a suitable sperm cryopreservation protocol during the first breeding season *ex-situ*. In subsequent years, we have simultaneously biobanked sperm from all 30 male founders whilst producing offspring (n=1294) for release; withholding F1 generation representatives (2.2 per male founder) for population management. Data across four breeding seasons shows that hormone-induced sperm collection can be conducted in the same season as natural breeding without a reduction in male fertility (sperm production, or natural fertilisation rate).

A-1017 (Oral)

Herpetological Natural History - An Artform of Science

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To be a successful field herpetologist, academic achievements mean very little. Instead, what matters is how well you gather evidence and enact it to make observations contributing to our knowledge of a species. Herping provides the perfect situation to utilise creative thinking, skills and exploration to improve our observations. Unlike other areas of science there are no hard rules to follow, instead utilising the herper's talents to succeed making us more akin to artists and athletes. The goal of this presentation is to encourage creative survey methodology by sharing innovative herping meta developed through many groundbreaking expeditions, searching for snakes across south-east Asia and to discuss how small adjustments can help increase your ability to make discoveries. While so much remains unknown of these secret and undetectable animals. As scientific interest and funding in exploratory natural history wanes, I believe it's important to revitalise the drive and storytelling of zoologists before innovating upon their methods, to make significant discoveries into the future. There is still so much to learn.

A-1018 (Oral)
Mitonuclear Discordance Causing Taxonomic Confusions in Japanese Hynobius Salamanders: A Case in the *Hynobius bakan* Species Complex

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Mitochondrial DNA has traditionally been widely used as a useful genetic marker for phylogenetic and taxonomic studies. However, discordance in mtDNA and nuclear genome caused by hybridization and introgression presents a significant challenge in species and boundary delimitations. Consequently, integrative taxonomy, which incorporates multiple information, such as morphology, multilocus genomic data, ecology, etc., has become a common approach for taxonomic decisions. *Hynobius bakan* sensu lato is a salamander distributed in westernmost Honshu and northeastern Kyushu of Japan, and is parapatrically distributed with *H. nebulosus*. Recently, Sugawara et al. (2022) further divided this species into three species (the *H. bakan* complex) by describing two new species, *H. nagatoensis* (Honshu + northern Kyushu) and *H. nihoensis* (NE-Kyushu), and range of *H. bakan* sensu stricto was delimited in very small area of Honshu. They also included *H. nebulosus* in N-Kyushu in *H. nagatoensis*. However, these taxonomic changes were based on the monophyly of mtDNA phylogeny without any nuclear data, and this led to taxonomic confusion in recognizing species identity and range boundaries of populations. We examined the population genetic structure of the *H. bakan* complex and *H. nebulosus* based on mtDNA and nuclear SNPs and reexamined their taxonomic status. As a result, six mitochondrial lineages were found in general agreement with the previous study. On the other hand, only three groups, *H. bakan* (from Honshu including *H. nagatoensis*), *H. nihoensis* (from NE-Kyushu), and *H.*

nebulosus (from N-Kyushu) were recognized by nuclear SNPs. These results indicate *H. nagatoensis* is a "ghost lineage" only found in mitochondrial DNA. In conclusion, the *H. bakan* species complex includes only two species, *H. bakan* in Honshu and *H. nihoensis* in NE-Kyushu, and this case clearly indicates the risk of mitochondria-based taxonomy and range delimitation.

A-1019 (Oral)
Amphibian Diversity in Indonesia: What we Know to Date and their Significance for Conservation

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Indonesia is among the most biodiverse regions on earth with a high number of endemicity. This holds true also for amphibians. Over the years, more and more amphibian studies were carried out in various regions in Indonesia. Consequently, numerous species have continuously been described, adding to the current knowledge of amphibian's diversity in Indonesia, especially in the last two decades. The advance in the methods for biodiversity research and the increasing number of collaborations are considered to influence the results in revealing the true diversity of amphibians in the region. However, there are no available sources that put together amphibians' diversity in Indonesia to date and assessed its significance for conservation. In this study we compiled data for amphibian species of Indonesia from various available databases and generated the most updated checklist. Additionally, we discussed its significance for conservation and shared our perspectives on improving the efforts in understanding amphibians diversity of Indonesia as an integrated unit, which could further help to effectively design conservation actions in this biodiverse region.

A-1021 (Oral)
Trends, Biases, and Future Directions in the Analysis of Life-History Data to Assess Climatic Vulnerability in African Vipers

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Biodiversity loss is accelerating globally due to anthropogenic activities such as habitat modification and climate change. As climate change threatens further ecosystem disruption and biodiversity loss, understanding the direct and indirect impacts of climate change on species persistence is crucial for effective adaptive management and intervention. Climate change vulnerability analyses (CCVAs) are commonly used to assess species vulnerability, with trait-based CCVAs often informing IUCN Red List assessments. However, the necessary ecological data to conduct trait-based CCVAs is often lacking, especially for understudied groups. We conducted a literature review to identify key ecological traits used to assess climate change vulnerability in reptiles and performed a gap analysis of these traits for African vipers to identify which species, geographic regions and ecological fields should be prioritised for further research. Out of the 18 traits identified as being useful to assess vulnerability, six did

not have data for any species. These traits were mostly physiological traits including measures of operative body temperature and critical thermal maximum. Among the studied species, *Bitis gabonica* and *Bitis schneideri* had the most comprehensive ecological data, yet even these were incomplete, with only 55% and 61% of traits recorded, respectively. Atheris hetfieldi, Atheris mongoensis and Echis hughesi were among those with the least known traits, missing information for all but one or two traits. Geographically, species occurring in sub-Saharan Africa had higher completeness scores than the Sahel region after accounting for species richness. These results highlight key knowledge gaps for African vipers limiting our ability to predict how they may respond to climate change. They also emphasise the need for targeted research, particularly of the most under-studied species to help inform conservation strategies.

A-1022 (Oral)

Complete Mitochondrial Genome of *Dryophytes flaviventris* and Comparison with *D. suweonensis*

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There are three tree frog species in the Republic of Korea. In the case of *Dryophytes flaviventris*, which was listed as a new species in 2020 and is a sibling species of *D. suweoenesis*, there is a lack of comparative studies between D. suweonensis and D. flaviventris. Furthermore, no studies have been conducted on its mitochondrial genome. In this study, we analyzed and compared the complete mitochondrial genomes of two *D. suweoenesis* and two *D. flaviventris* living in the Republic of Korea. The complete mitogenome size of *D. suweoenesis* were 15,421−15,422 bp, and *D. flaviventris* were 15,421 bp, the mitogenome of two species consisting of 13 protein−coding genes (PCGs), two ribosomal genes, 22 transfer RNA genes, and a D−loop. Base composition of the overall sequence of four individuals were 56.5% for A + T content and 43.5% for C + G content. Most of the PCGs used ATG as a start codon, except for the COX Ⅰ and ND3, which used the GTG start codon. Base composition and component of mitogenome of *D. suweoenesis* and *D. flaviventris* are the same. Comparison of the secondary structure of the tRNA genes of the two species revealed no sequence differences and no structural changes. Based on four datasets and two methods (maximum likelihood and Bayesian inferecne analysis), we constructed a phylogenetic tree to investigate the taxonomic status of the species and the phylogenetic relationship between *D. suweoenesis* and *D. flaviventris*. Our results indicated that four individuals are the monophyletic Therefore, the phylogenetic relationship among them is difficult to determine. These results suggest that there are no significant genetic differences in the mitogenome between *D. suweoenesis* and *D. flaviventris*, and that further phylogenetic studies using multiple nuclear DNA will need to be conducted.

A-1023 (Oral)

Female Japanese Tree Frogs Discern Chytrid-Infection Status of Potential Mates by Listening to their Calls

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Asian amphibians appear largely immune to the pathogenic chytrid fungus *Batrachochytrium dendrobatidis* (denoted Bd) that threatens amphibians elsewhere in the world. Nonetheless, recent studies suggest that the Bd pathogen may affect life-history strategies of apparently healthy frogs. Male Japanese tree frogs (*Hyla japonica*) increase their calling effort when infected by Bd, but whether females respond differentially to these calls has not been studied. We collected male *H. japonica* from four populations, tested them for Bd infection, and recorded their calls. We compared the calls of infected and uninfected frogs upon initial collection and after experimental treatment: uninfected frogs were inoculated with endemic Bd culture (BdAsia-1), while infected frogs were cleared of Bd infection by heat treatment. We found that calls of infected and uninfected males differed in several temporal properties. Under anechoic laboratory conditions, we allowed females to choose between playbacks of calls of the same males recorded before and after their experimental treatment. In the first treatment group, females preferentially approached calls recorded from males before they were infected with the Bd pathogen. However, in the second treatment group, females showed no preference between the calls of males that were infected when collected and the same males recorded after they were cleared of infection. These results suggest that Bd may have long-lasting effects on frogs even after pathogen clearance. When allowed to choose between synthesized calls, female responses corresponded most closely to males' note repetition rate, indicating that this call parameter may reveal infection status. Our results suggest that females can discriminate between calls of infected and uninfected males, potentially counteracting the enhanced calling effort of infected males. To determine the causes of amphibian population declines and extinctions, multifaceted studies of the effects of pathogens, such as Bd, on host physiology, behavior, life history, and population recruitment are needed.

A-1024 (Oral)
Fragments Maintain Similar Herpetofauna Richness and Diversity to Continuous Habitat, but Community Composition and Traits Differ

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Human disturbance has transformed ecosystems globally, yet studies of the ecological impact of landscape modification are often confounded. Non-random patterns of land clearing cause differing vegetation types and soil productivity between fragments in modified landscapes and reference areas—like national parks— with which they are compared. We sought to explore the influence of land modification on herpetofauna communities using multiple biodiversity measures—species richness and diversity, individual species abundance, and community composition. We also aimed to investigate the role of traits such as diet, habitat breadth, and litter size in moderating species responses to land modification. We established 100 sampling sites to survey herpetofauna in 11 fragments in an agricultural landscape compared to 11 ecologically equivalent 'pseudo-fragments' in a nearby national park in south-eastern Australia. We selected pairs of fragments and pseudo-fragments of the same size and vegetation type, and used identical survey methods to sample pairs simultaneously, thereby controlling for numerous confounding factors. Species richness and diversity were similar between fragments and pseudo-fragments. Despite this, we found community composition differed markedly—driven by the varying responses of individual species—indicating a shift in herpetofauna communities associated with land modification. Fossorial habit, omnivorous diet, and broad habitat requirements led to higher abundance in fragments whilst arboreality, carnivorous diet, and narrow habitat requirements led to higher abundance in pseudo-fragments. Although fragments hold similar numbers of species to continuous areas, they contain distinct and novel communities, and sustain high abundances of some species. These diverse communities are dominated by native species, including threatened species, and their distinctive composition is shaped by traits conducive to persistence amidst land modification. These novel communities may provide a reservoir of resilience in the face of environmental change and should be viewed as complementary to conservation areas.

A-1025 (Poster)
Occurrence of Invasive *Trachemys s. elegans* in Rio Grande Adjacent Artificial Waterways of the Trans-Pecos

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Trachemys s. elegans is a widespread turtle that has become an established and invasive species across the globe as a result of the global pet trade. Such introduction events have elicited alarm to the level that they were listed within the '100 of the World's Worst Invasive Species' (GISD, 2021). Introduction events of *T. s. elegans* within the Big Bend Region and Rio Grande River have placed them in competition with the closely related *Trachemy gaigeae* (Big Bend Slider) where hybrids between the two closely related species have been found (Vamberger et al., 2020). For the purpose of this study sampling was conducted with 30.5 cm hoop nets, 91.4 cm hoop nets, and solar traps which were placed within artificial waterways of Brewster County Texas on the Black Jack Golf Course to collect data regarding the occurrence of *T. s. elegans*, *T. gaigeae*, and *T. s. elegans* X *T. gaigeae* hybrids in periods of activity. Of particular interest was the number of pure vs apparent hybrid turtles collected giving the classification of *T. gaigeae* as Vulnerable (van Dijk, 2011) and the fact hybrids are known to remain reproductively viable (Iftime and Iftime, 2023). Our work from the survey's suggests that the introduction of *T. s. elegans* into these waterways has had an adverse effect on the native T. gaigeae with the habitat surveyed being dominated by *T. s. elegans* X *T. gaigeae* hybrids while few pure *T. gaigeae* remain. As introductions of *T. s. elegans* have occurred in a wide area of

T. gaigeae range of the Rio Grande this genetic pollution for this native slider range wide is of major concern.

A-1026 (Oral)
Museum Biobanks Play a Vital Role in the Conservation of Wildlife

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Natural history collections (NHC) house a vast record of our planet's biodiversity, including type specimens upon which nearly two million scientific names are based. These materials allow us to determine the rich genetic variation in wildlife, but do not preserve it in living form. Advancing collections beyond simply documenting loss of genetic variation requires the indefinite storage of cryopreserved (−196°C) live cells. These cells will provide an *ex-situ* safeguard against declines in genetic variation and open vast areas of new research across the diversity of life housed in museum collections. Museums Victoria is transforming museum practice by developing and disseminating protocols that enable the routine collection and cryopreservation of living cells from animals, shifting museums to the role of preserving genetic variation in living form. We are 1) developing reproducible protocols for collecting living cells under field conditions for diverse fauna. 2) Establishing cell culture practices for cryopreserving cells in liquid nitrogen for long-term storage and maintaining cell viability. 3) Disseminating methods and providing training and guidance to Australian and international NHCs to implement cell cryopreservation as standard practice. We have successfully collected and cryopreserved live cells from amphibians, reptiles, birds and mammals using low-invasive sampling such as ear snips, toe snips, and hair as well as sampling from salvaged/deceased animals. We have developed protocols for live-cell collection from remote locations, including slow freezing and fast freezing (vitrification). Samples sent to our cell culture facility are processed for primary cell culture or immediate cryopreservation, cell lines are frozen and transferred to the Biobank for long-term storage. Future research includes reprogramming fibroblasts into induced pluripotent stem cells (iPSCs) which can contribute to the genetic rescue of endangered species. Primary cell cultures are being used to assess genetic diversity, identify at-risk populations, and produce high molecular weight DNA for whole genome sequencing.

A-1028 (Oral)
Location, Location, Location: Clarifying the Distribution and Conservation Status of the Endangered Perth Slider, *Lerista lineata*

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The conservation status of the Perth slider, *Lerista lineata*, has long been shrouded in controversy. The IUCN Red List classifies the species as Endangered based on Criterion B: Small Geographic Range Size (i.e., confined to the Perth region, in Western Australia [WA]). However, some Australian authorities argue it is Least Concern, with three *L. lineata* specimens collected from Woodleigh (~750-km north of Perth) in the early 1990s potentially indicating it has a broader distribution. The validity of the Woodleigh specimens has long been questioned, with suggestions they were misidentified or catalogued in error, yet without confirmation of this hypothesis it remains unclear whether the species is a major conservation

priority. Here, we aim to resolve this uncertainty by examining the genetic and morphological similarity of *L. lineata* specimens from Woodleigh (n = 3) and Perth (n = 64). Four different analyses were conducted: 1) genetic distance calculations between specimens; 2) morphological comparisons (mensural, meristic, qualitative characteristics); 3) comparing *L. lineata* genetic structuring with that of similarly distributed *Lerista* species; and 4) statements from experienced WA herpetologists on the Woodleigh specimens' validity. The Woodleigh specimens showed more genetic similarity to Perth based individuals than to each other, indicating they likely originated from Perth. This hypothesis was further supported by three more findings: 1) considerably less genetic structuring within *L. lineata* than in similarly distributed *Lerista*; 2) no morphological differences between the Woodleigh and Perth specimens; and 3) all surveyed WA herpetologists stating that the Woodleigh specimens likely represent locality errors. As such, we conclude that the *L. lineata* Woodleigh specimens were indeed a location cataloguing error, and that the species is confined to Perth and Endangered. Ultimately, our study represents a unique case where cataloguing errors have long impacted conservation efforts of a species, re-emphasising the importance of careful data collection in natural history collections.

A-1030 (Oral)
How Far Can Snake Ranges Really Shift? An Agent-Based Modeling Approach and Case Study using Cape Cobras (*Naja nivea*)

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As global climatic conditions change, the geographic ranges of many organisms are also expected to shift. Particularly, there is growing literature assessing how the geographic ranges of medically-important snakes might change in the future, primarily because of the implications for public health. I used an agent based model to investigate biologically realistic dispersal limits for snakes. The model simulates dispersal distance of a population based on movement parameters (mean daily displacement; directionality) that can vary seasonally. I explore the parameter space and show that directionality (measured as the distribution of turning angles in snake paths) is exceptionally important in setting dispersal limits, with long range dispersal only possible when snakes exhibit extreme directionality. Thus, the internal state of snakes (in this case the psychological/physiological state that drives directional persistence) is likely to have a bigger effect on maximum dispersal distance than the motion capacities of the animals. Next, I parameterize the model with measures of movement from a medically-important African snake, *Naja nivea*, collected using radio-telemetry. I show that Cape cobras rarely showed directional persistence, opting rather to use a wide range of turning angles. Under such conditions, with seasonally adjusted measures of mean daily displacement, the range edge for these snakes only expands at a rate of 19.9 ± 1.3 km every 50 years. Any substantial range expansion would thus require important changes in the behavior of the snakes compared to their typical movement behaviors. Given that dispersal is additionally limited by landscape attributes, my results suggest that mean dispersal rates are more likely to be just a few kilometers per decade, rather than hundreds of kilometers per decade as assumed in some publications. I encourage those modeling the effects of climate change on range shifts to think critically about their assumptions of dispersal distance.

A-1031 (Oral)
Dynamic Visual Signal Evolution in Asian Toad-Headed Agamas (*Phrynocephalus*)

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Toad-headed agamas (*Phrynocephalus*) have a broad distribution across Asia, particularly in open, xeric habitats and are particularly well-known for their iconic social display behaviour, which centres around the tail display. A typical display consists of tail coiling and lashing in multiple directions and with varying speed, frequency and duration. We studied the structure and complexity of social displays in 104 individuals from 16 taxa representing all major clades by staging interactions between focal males and an unfamiliar male intruder. For each display, we generated x-y co-ordinates for the tail tip and extracted display duration, average display speed, and maximum display speed, which we analysed in a phylogenetic framework. Tail coiling and lashing was conserved across species, but the structure and variation of displays and signal modifiers varied. We document independent gains and losses of signal modifiers across species. Species with longer tails tended to have more complex signals, suggesting correlated selection on tail length and signal complexity. We also found links between aspects of display complexity on both the degree of sexual dimorphism (an index of sexual selection) and cerebellum size, suggesting that social selection may be driving signal complexity.

A-1032 (Oral)
Slimming the Gender Gap or How to Train your Dragon (Society)

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Amphibian populations are declining globally, with India being a hotspot for threatened species. This presentation explores the unique challenges faced by women in India in the field of amphibian conservation. The challenges range from social and cultural barriers, like gender bias and lack of recognition, to financial and resource constraints, such as limited funding and equipment. Additionally, fieldwork safety concerns and knowledge gaps due to restricted access to advanced training and scientific literature can further impede progress. Despite these hurdles, women in India are making significant contributions to amphibian conservation. Drawing from personal experiences, this presentation will showcase successful strategies employed to overcome these challenges. Building strong partnerships with local communities, universities, and international NGOs can provide crucial support, funding, and expertise. Involving local people in conservation efforts fosters understanding and builds a sense of

shared responsibility. Community outreach programs that educate and involve local people in conservation efforts can foster understanding and create allies. Acquiring governmental support and community support by understanding their values are crucial. Finally, finding allies and mentorship from established conservationists, especially women who have navigated similar challenges, can offer invaluable guidance and encouragement. This presentation highlights the challenges faced by women in amphibian conservation in India but also initiates dialogue on gender disparity. By sharing successful strategies,this talk aims to encourage more women to join the field of amphibian conservation in India and beyond.

A-1033 (Oral)

The Relative Influence of Habitat Availability, Landscape Configuration and Spatial Sorting on Population Expansion in *Xenopus laevis*: A Simulation Test

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Population expansion into new areas is a common phenomenon driven by changes in ecological conditions. It also increasingly results from human-assisted introduction of propagules into novel environments, which leads species to spread into areas where they did not evolve and cause various ecological and socio-economic impacts. Spatial sorting (the enhanced dispersal capacity in expanding populations over time) and landscape configuration are two factors that largely influence the way organisms move across a landscape and reach locations to complete their life cycle. While both factors have been frequently studied independently, their relative influence to modulate the spread rate of expanding populations has been significantly unexplored. We simulated the spread of an invasive amphibian, *Xenopus laevis*, in various landscapes of its colonized ranges and surroundings in western France. By using the software UNICOR, we ran colonization simulations on 30 x 30 km cells of an experimentally parameterized resistance layer at three settings of spatial sorting. Results show that habitat availability (ponds density) and spatial sorting positively affected the rate of population expansion in the cells and interacted: higher spatial sorting and pond density increased the invaded area, number of colonized ponds and maximal traveled distance per time unit. In contrast, none of the four landscape configuration metrics improved the models, suggesting that this factor has limited influence on population expansion. The effect of spatial sorting on population spread was enhanced by pond density but not by landscape configuration. These results may partly reflect the high density of ponds and the relative contribution of landscape configuration may be reevaluated in different landscape types. Nevertheless, these highlight the importance to consider jointly habitat availability and spatial sorting in predictive modeling of the spread process in expanding populations, such as those that characterize many alien species.

A-1034 (Oral)

Putting Frogs on the Map: How can we Gather FrogID Citizen Science Data across a Continent to Better Understand Australian Frogs?

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Citizen science has become a powerful tool in understanding the distribution of biodiversity data. The Australian Museum's FrogID project provides a leading example in this space for frogs, having engaged more than 40,000 participants in gathering over one million expert-verified frog records across Australia in just six years. While this represents a significant strength of the project, FrogID also faces inherent limitations in citizen science datasets, such as taxonomic, temporal, and spatial biases. To address some of these challenges, over 1,200 FrogID participants were surveyed to understand data collection behaviour, motivations, and their willingness to change where and when they record frog calls with the FrogID app. Participants were overwhelmingly motivated by the project's aim to collect frog records useful for science and conservation, and they displayed a high willingness to change both where and when they recorded frogs, if provided guidance. Building on these insights, we implemented a map-based "nudging" framework to assess the effectiveness of an adaptive sampling protocol, creating dynamic maps that highlighted priority areas with insufficient frog species richness data. We updated these maps every two weeks to reflect recent contributions. Over a year, significant differences were observed between dynamic map and control regions, improving frog data coverage. These encouraging outcomes were more pronounced when a leaderboard was incorporated and demonstrated that citizen scientists are willing to adopt innovative data collection approaches that improve frog biodiversity sampling. The FrogID project will continue to leverage these findings by incorporating them into cost-effective approaches such as monthly eNewsletters, social media engagement and annual FrogID Week events. By understanding the motivations behind FrogID participants, sharing results and leveraging innovative and cost-effective methodologies, Australia's FrogID project demonstrates the high potential for citizen science to map and gather meaningful frog biodiversity data across a continental scale.

A-1036 (Oral)
Description and Variation of Skeletal Characteristic in a Hynobiid, the Setouchi Salamander, Endemic to Japan

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Detailed description and variation of the complete salamander skeleton of the lentic hynobiid, *Hynobius setouchi* Matsui et. al. 2019, an endemic in central Japan, are presented. Skeletal characteristics of hynobiids are important for conducting taxonomic, phylogenetic, and paleontological studies. However, previously skeletal information was based on a few individuals without considering intraspecific variation. Most of the character states have never been evaluated for their taxonomic importance, or revised, until now. Here, we described the complete skeleton and revealed the variation in *H. setouchi*, a type genus in the family Hynobiidae. Skeletons were cleared and stained, and CT scans preformed to allow examination of the skeleton. The cranium, which contains most of the important taxonomic characteristic of the family Hynobiidae, is composed of 17 bones. The septomaxilla and stapes, not always described in previous studies, are always present. Skeletal variation was present in the entire skeleton of these salamanders and is related to body size (snout-vent length) in some cases. The articular, part of the hypobranchial I, part of the coracoid, pubis, carpus, and tarsus were

cartilaginous in small individuals and partly or completely ossified in large individuals. The degree of ossification varied in the operculum, basibranchial II, and the ascending process of the palatoquadrate none of which are correlated to body size. Additionally, the lacrimal and ossified manus and pes exhibited varying degrees of articulation or fusion irrespective of body size. The confirmation of skeletal variation, as discussed above, is essential for conducting taxonomic studies because these characters are used to differentiate salamanders at the specific or generic levels.

A-1037 (Oral)
Changes in Cannibalism Behaviour of Cane Toad (*Rhinella marina*) Tadpoles along a Global Invasion Pathway

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Cannibalism is a common behavioural trait in anuran tadpoles, and typically is opportunistic in nature, often occurring in response to adverse environmental conditions such as waterbody desiccation or limiting food resources. However, targeted cannibalism may also be favoured in invasive populations (of any taxonomic group), as invasive populations typically have higher population densities than native populations, and cannibalism can provide a mechanism for reducing intraspecific conflict. We have recently documented that, in Australia, tadpoles of the invasive Cane toad are highly cannibalistic and have developed a method of cannibalism not documented for any other amphibian species: tadpoles locate conspecific hatchlings by chemical cues (maternally derived toxins) leached from hatchlings into the surrounding water. These chemical cues not only elicit strong attraction response by toad tadpoles, they also increase the predatory behaviour of Cane toad tadpoles in general. The global history of introduction of cane toads is well documented, providing us with an opportunity to assess the cannibalistic behaviours of this iconic invader species in native versus multiple introduced populations. Here, we conducted replicated, common-garden cannibalism experiments for cane toad tadpoles from multiple populations in the native range (French Guiana) and sequentially introduced populations (Puerto Rico, Hawai'i, Australia). We compare the cannibalism responses of Cane toad tadpoles (propensity for cannibalism, attraction to conspecific hatchlings) along this global invasion pathway and present evidence documenting the ongoing evolution of these traits across populations from the native range (where cannibalism is relatively rare and opportunistic) to invasive populations in Australia (where cannibalism is intense and targeted).

A-1038 (Oral)
Homing Behavior and Home Range of Reeves' Turtle *Mauremys reevesii*

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The Reeves' turtle, *Mauremys reevesii* inhabits in freshwater bodies of Korea, China, Japan, and Taiwan. The population and distribution of *M. reevesii* are continuously decreasing due to habitat destruction for development, competition and predation by invasive species, roadkill

and illegal poaching. For these reasons, the Korean government has designated this species as an endangered wildlife to protect them. Understanding the behavioral characteristics such as homing behavior and home range is important to the conservation of *M. reevesii*. So, we monitored movement characteristics of *M. reevesii* using GPS telemetry in two types of habitats, reservoir (n = 6) and river (n = 6) from April through November 2022. And we examined the site fidelity of *M. reevesii* (n = 7) using GPS telemetry in reserviors from May 2023 until now. Although the size of home range (MCP, Minimum Convex Polygon) of *M. reevesii* in the river was the largest at 204,242㎡, there was no statistical significant difference (Wilcox rank test, p = 0.589) in those between the river (75,301 ± 72,899㎡) and the reservoir (41,568±29,729㎡). This is because *M. reevesii* in the reservoir not only stayed within the reservoir but also were active outside the reservoir. We found *M. reevesii* showed the homing behavior, leaving the initial point and returning to their original habitat in both reservoir and river. And we noted *M. reevesii* at distances of 200 ~ 700 m from center of reservoirs, two of them returned homing only being displaced 200, 300 m away until now. It is necessary to develop practical conservation strategies for *M. reevesii* considering the homing behavior and home range clarified by this study.

A-1039 (Oral)

Sex and Infection: Do Sex Hormones Affect Parasitic Load in Bisexual and Parthenogenetic Rock Lizards?

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The Red Queen hypothesis states that species must continuously evolve fast enough in order to survive (Sole, 2022). This rule predicts stronger selection pressure on asexual than bisexual species by parasites (Hamilton, 1980). Indeed, parthenogenetic individuals of Heteronotia binoei were observed to be more mite-infected than bisexual individuals (Moritz et al., 1991). Surprisingly, hemoparasite loads in females of syntopic parthenogenetic and bisexual species rock lizards (*Darevskia*) were almost equal, while bisexual males were parasitized even more (Arakelyan et al., 2019). We suggest that immunosuppressive effects of testosterone (Opplinger et al., 2004) and progesterone (Xu et al., 2011) may be the reason for observed phenomena. To test this hypothesis we collected blood smears, blood plasma and genetic samples in three parthenogenetic (*D. armeniaca*, n = 126; *D. unisexualis*, n = 32; *D. dahli*, n = 105) and three bisexual (*D. valentini*, n = 116; *D. nairensis*, n = 92; *D. portschinskii*, n = 134) species of rock lizards from natural populations in Armenia, where parthenogenetic and bisexual species coexist, in May, June, and September. We measured levels of testosterone in plasma of males and progesterone in females and counted parasitic load by microscopic assay as described in Arakelyan et al. (2019). Progesterone concentration in plasma was much higher in parthenogenetic *D. armeniaca* than this in females of syntopic *D. valentini* (M-W test, p = 0.013), *D. portschinskii, D. nairensis, D. unisexualis*, and *D. dahli* (Dunn test, p < 0.001 in all cases). The highest concentration of testosterone in males was in May in studied populations. We did not find significant differences in parasitic load between species and sexes, but observed a non-significant (M-W test, p = 0.272) decrease of parasitic load between May and September in sampled populations. Hence, we suppose that concentration of progesterone does not affect parasitic load.

A-1040 (Oral)
Ontogenetic Shifts in Sex Ratios Support an Adaptive Explanation for Temperature-Dependent Sex Determination

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Temperature-dependent sex determination (TSD) is found in all reptile groups, but its adaptive significance is a mystery. This is because most TSD reptiles feature extreme longevity, so assessing lifetime fitness is incredibly difficult. Here we combine classical sex ratio theory with a dataset of stage-specific sex ratios from a diversity of wild reptile populations to infer patterns of sex-specific mortality (fitness) across ontogeny. We compile 682 natural sex ratios representing 182 species from 601 populations, ranging from sex ratios at birth, during the juvenile period, and adulthood. We analyze stage-specific changes in sex ratios in a Bayesian framework, allowing us to disentangle whether there is a single or multiple adaptive explanations for TSD, provide insight into what those explanations are, and align the adaptive explanations with major reptile clades. Sex ratios were largely female biased at birth and even at adulthood, suggesting a general pattern of female-biased mortality through ontogeny. However, patterns differed among major reptile clades. Specifically, we find that TSD evolved in turtles and crocodilians so that males develop in high-quality patches, supporting an extension of the Trivers-Willard hypothesis where the fitness of males under sexual selection is more sensitive to body condition than female fitness. In squamates, no clear sex-ratio bias is evident at any stage, suggesting that TSD is either not adaptive or that different adaptive explanations exist at a taxonomic level lower than Squamata. We suggest if TSD evolved in long-lived reptiles because incubation temperature is a pervasive agent that influences stress, then it may be embryonic stress in general, not just thermal stress, that is the fundamental driver of TSD evolution.

A-1042 (Oral)
Integrating Species Biodiversity and Threat Patterns to Identify Critical Hotspots of Amphibian Diversity in Asia

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The current network of protected areas is often inadequately covering species presence, and fails to address conservation priorities for amphibians. This is especially true in Asia, a diverse continents in terms of species and landscape, with varying conservation priority. Therefore, establishing knowledge of species diversity and threat patterns can help identify critical conservation hotspots to mitigate the ongoing amphibian biodiversity loss. We integrated estimations of diversity metrics and linear-based regression models from open-database distribution data from the IUCN Red List of Species to identify and rank key biodiversity hotspots, targeting all Asian amphibian species. We analyzed five biodiversity indices

encompassing congruence of species richness, IUCN threatened species richness, proportion of IUCN threatened species, total weighted endemism and species rarity. We found a significant correlation between the five biodiversity indices but limited overlap with the eight critical hotspots we identified. Our results reveal hotspots for species- and threatened species-richness concentrated in East, South and Southeast Asia. We pinpointed six areas as critical hotspots of amphibian diversity in Asia, characterized by exceptionally high species richness and species endemism. Our integrated approach highlights areas of high conservation priority based on combined species richness, endemism, and threat status. These findings have broader implications for conservation strategies in Asia, and other regions facing similar challenges, and can be used as a roadmap to contribute to the target of the Biodiversity Framework in yielding the "30x30" level of protection by 2030.

A-1043 (Oral)
Genomic Disparity of Amphibian Genomes

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Genomic architecture has played a key role in the evolution of biodiversity. Structural comparisons of genome sequences have informed the study of supergenes, sex chromosomes, and some of the earliest divergences in the tree of life. However, multi-species comparisons of whole genome sequences still have many computational and analytical limitations. To study conserved regions of vertebrate genomes, we developed a computationally non-intensive approach that generates disparity scores using ultraconserved elements (UCEs) as genomic landmarks. This 'geno-metric' method captures structural differences in chromosomes across different species using chromosome-level genome assemblies. To demonstrate the comparative potential of this method, we analysed data from more than 20 amphibian genomes. Based on our results, we discuss what disparity analysis can reveal about genome assembly quality, chromosomal rearrangements, UCE evolution, synteny levels, and phylogenetic relationships amongst amphibians.

A-1044 (Oral)
Does Habitat Transformation Impact Microbial Diversity in Amphibians?

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Human activity is a major cause of biodiversity loss, notably, by triggering land use changes, environmental contamination, climate change, and the spread of infectious diseases. The consequences on host health through the alteration of microbial communities has been demonstrated. Anthropogenic disturbances can consequently affect the survival and reproduction of wildlife. As the microbiome is strongly impacted by the environmental context of the host, landscape changes such as urbanisation and agriculture may result in a modification of the microbiota community affecting animal health. Amphibians are particularly vulnerable

to land use changes. Because of their biphasic life cycle, most amphibians need terrestrial environments for hibernation and aquatic habitats for reproduction. Here, we aim to gain a better understanding of the impact of habitat transformation on (1) the potential risk of disease and (2) microbial diversity. To do so amphibians were sampled across 52 sites including four habitat types (natural, agricultural, urban, and mixed) in the Ile de France region in France. Buccal and cloacal swabs were taken from 14 species of amphibians for a total of 893 individuals. Samples were analysed by Illumina Miseq sequencing of the 16S gene V4. Alpha and Beta diversity analyses are conducted to study to the composition of the microbiota community in function of habitat type. Preliminary analyses on part of the data suggest a significant decrease in microbial diversity in transformed (urban and agricultural) habitats as well as an increase in the relative abundance of taxa known to induce diseases in other amphibian species.

A-1045 (Poster)
Scales and Tales: Improving Public Perception of Herpetofauna, One Storybook at a Time

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The Raffles Institution's Raffles Ecological Literacy Programme has published several children's books on Singapore's biodiversity and ecology. Two of these books, published in the last 5 years, have showcased some of Singapore's herptiles. These books aim to dispel myths surrounding herptiles, as well as improve the public's perception of these often misunderstood animals. The books are aimed at children, and depict the featured herptiles in a way that would appeal to a younger audience. One of these books, 'The Herp Squad and the Mystery of the Missing Bluebird', was chosen for the Nparks' Biodiversity Week for Schools Programme in 2020, where the book was adapted into a version which had stickers and more activities within. This book was then distributed to all government-run preschools in Singapore. This poster covers more about the programme and the books published in detail.

A-1046 (Oral)
Unique Species but Common Threats? The Case of the Nimba Toad (*Nimbaphrynoides occidentalis*)

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Around 7,700 anurans are currently known to science, but only a single species is presently known to be matrotrophic and pueriparous. This means that during a gestation period of nine months nutrients are passed from mother to offspring retained inside the female and these are giving birth to fully developed froglets. So far such a unique biology is only exhibited by the Nimba toad (Bufonidae: *Nimbaphrynoides occidentalis*) which lives in a habitat restricted to the montane grasslands above 1,200 m asl on the West African Nimba mountains. Due to its very small distribution range and observed population decline, it is listed as Critically Endangered by the global IUCN Red List. The reasons for the decline are not yet fully

understood. We present our current knowledge, based on standardised long-term monitoring data (2006-2023). Juveniles are the most dominant group observed throughout the years and recruitment is of critical importance because of the low average life expectancy (three years) of the toad. Several aspects affecting Nimba toads and their habitats, directly and indirectly, such as climate, fire and vegetation, all have changed over the past 70 years. These factors may be interacting and thus are challenging to disentangle, however, changing climate might be the main reason endangering the species. Ongoing conservation efforts for that species by Guinean and German partners have and will take that into account to ensure the long-term survival of this unique anuran.

A-1047 (Poster)
Success Rate and Characteristics of *Ex-situ* Breeding of Rote Snake-Necked Turtles (*Chelodina mccordi*) in Kupang

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Rote snake-necked turtle (*Chelodina mccordi*) is listed as one of the 25 most endangered turtles in the world. Rote's turtle threatened status requires conservation efforts to restore their population in the nature, one of which is through program in *ex-situ* facilities in Kupang. An important indicator used to monitor the success of Rote's turtle breeding is through analysis of the *ex-situ* breeding characteristics. Data related to breeding had been collected like the number of eggs laid; egg characteristics in the form of weight, length and width; data collection on incubation period; and observing embryos using the candling method. Data was analyzed using descriptive statistics and it was found that throughout 2023, Productive female had laid 160 eggs. The condition of the eggs was 133 eggs in good condition (83.12%), 5 cracked eggs (3.12%), and 22 broken or stunted eggs (13.75%). The percentage of egg hatching was: 48.8% of eggs hatched and 51.2% of eggs did not hatch. This percentage is not evenly distributed among each turtle parent, one of the most productive female had 81,9% successful egg hatched. Egg incubation period showed the longest incubation period being 115 days, shortest 87 days. Based on this, we see that the *ex-situ* breeding facilities in Kupang have potential in breeding rote's turtles. We suggest that ongoing studies are needed to determine breeding trends of rote's turtle in *ex-situ* facilities to ensure that there is a stable population of rote's turtle that can be effectively reintroduce to nature.

A-1048 (Oral)
A Network of Arks for European Fire Salamanders (*Salamandra salamandra*)

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European fire salamanders have a relatively large spatial distribution but their abundances show huge variations among localities. In addition, throughout its range numerous subspecies are recognised, which can exhibit very different ecologies. These range from Iberian

populations in harsh dry landscapes or with births of fully developed salamanders (juviparity) to Central European populations favouring mixed forests and larvae developing predominantly in streams. Besides habitat alterations, especially of forest streams and their sources, a new threat, the chytrid fungus *Batrachochytrium salamandrivorans* (Bsal), is expanding its impact from the border between Germany, the Netherlands and Belgium. Bsal has the potential to extinguish fire salamander populations in a short time. Currently no methods are known to prevent Bsal from pushing the species to the brink of extinction in its natural habitats. Thus, a network of arks is being created. Using the Central European populations of fire salamanders we show that we have all means to be pro-active, should not wait until disasters strikes but to safe the species and its diversity (e.g., three genetic lineages are present in Germany). Together with partners, comprising zoos, conservation NGOs, universities as well as private experts, we are developing a "one plan conservation strategy". The main aim is to join forces under the umbrella of "Feuersalamander.Net", learn from each other and use all our expertise to make sure that one of the most iconic species in Europe will be protected in its diversity.

A-1049 (Oral)

Feeding Habits of *Fejervarya limnocharis* Tadpoles During their Developmental Stage

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Tadpoles are diverse and abundant component of many freshwater ecosystem, but little is studied about their feeding ecology and trophic status. The aim of this study was to analyse the diet in *Fejervarya limnocharis* tadpoles during their developmental stage (Gosner stage 26-40) which were collected from the streams of Kangchup Hills, Manipur, India. The collected tadpoles were fixed and preserved in 8% formalin. The food items were collected from the entire length of the gut and examined. The diet in *F. limnocharis* tadpoles of Gosner stage 26-32 revealed the dominance of Diatoms (Bacillariophyceae) and desmids due to the presence of *Gyrosigma, Navicula* and *Closterium*. While the tadpoles during the Gosner stage 33-40 revealed that it consists mostly of blue green algae and green algae comprising Microspora, Mougeotia and Phormidium. We observed that there is a change in pattern of diet during their developmental stage where it started feeding on rotifers at the later stage. It is also imperative to note that stream-dwelling tadpoles hold biological conservation significance and the results of the present study provide important information on the biology of the tadpole of this species.

A-1050 (Poster)

Trace Elements Accumulation and Oxidative Stress in *Pelophylax* sinkl. *hispanicus* (Ranidae) from Two Sites in the "Lago di Tarsia and Foce del Crati" Natural Regional Reserves (Southern Italy)

Agostino Brusco[1], Roberto Marchianò[1], Pierluigi Serravalle[1], Mariacristina Filice[2], Alessia Caferro[2], Sandra Imbrogno[2], Alfonsina Gattuso[2], Concetta Milazzo[2], Francesco Luigi Leonetti[2], Samira Gallo[2], Marco De Luca[2], Gianni Giglio[2], Donatella Barca[2] and Emilio Sperone[2]
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Bioaccumulation of 14 trace elements and evaluation of stress condition in the muscle of 17 *Pelophylax* sinkl. *hispanicus* (Ranidae), in the water ad in the soil of two different sites within the "Lago di Tarsia and Foce del Crati" Natural Regional Reserves (southern Italy) during July

2023 was performed. Trace element concentrations were measured using inductively coupled plasma mass spectrometry. For most elements, the highest concentration was recorded in the frogs inhabiting the first site, according to the outcomes obtained from the soil but not with the results for the water. This location also showed the highest values for dangerous elements like lead, cadmium, and arsenic. The trend of trace element concentration in the muscle based on the overall of samples can be represented as follows: Fe > Zn > Ni > Al > Sr. Physiological assays were also carried out on the muscle samples to investigate a possible stress condition. Again, site one showed significant differences (p value < 0.01) showing statistically higher results in SOD assay and statistically lower results in TBARS assay. Correlating, by linear regression, the results on bioaccumulation and the results obtained on stress, it was found that a) no statistically significant correlation has been found between TBARS and trace elements; b) three elements showed a positive correlation with SOD values (Al, Cd and Ba); c) lead showed a positive correlation with aldehyde OMP values; d) lead and barium showed a positive correlation with ketone OMP values. In conclusion, from the values obtained from the frog muscle and from the soil of the different locations, the first site appears to show pollution from trace elements more than the second. Some of these elements, especially lead, cadmium, barium, and aluminum, statistically significantly increase a stress condition in the target species.

A-1051 (Oral)

Herpetofauna: Native Species in the Rainforest Zone between Taman Safari Indonesia and National Park

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Geographically, Taman Safari Indonesia Bogor is adjacent to Gunung Gede Pangrango National Park. The rainforest between the national park and the Taman Safari Indonesia has a great diversity of species, especially herpetofauna. In order to gather information and conduct research, Taman Safari Indonesia conducted a habitat assessment to learn more about the biological conditions of the rainforest zone within the Taman Safari Indonesia territory. The biophysical conditions, vegetation analysis, mammals, avian, and herpetofauna monitoring are all included in the habitat assessment that was conducted. Using the herping method, herpetofauna monitoring was carried out in several places in the Taman Safari Indonesia and the border area with the national park. The results showed that 183 individuals were found consisting of seven species of Squamata and 13 species of Anura. One of the species that has been discovered the most and has attracted the most attention is the bleeding toad which has critically endangered status by IUCN and is the only amphibian protected by the Indonesian government. Considering that the role of amphibians is very important in the ecological ecosystem of rainforests in national park and Taman Safari Indonesia, Taman Safari Indonesia collaborates with the government to conduct additional research and studies and develop future strategies.

A-1052 (Oral)

West African Rainforest Refugia: Tracking Population Dynamics in Rainforest Frogs to Inform Conservation Strategies

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West African rainforests have undergone a turbulent climatic history. Understanding the impact of rainforest cover fluctuations on the diversification and distribution of rainforest taxa is of great importance, particularly in the face of global warming. Frogs of the genus *Conraua* present an excellent opportunity for understanding the effects of climate-driven landscape changes on contemporary biogeographic patterns. All species of the genus are highly dependent on rainforest and exclusively inhabit forest streams. In this project, we study the evolutionary history of the West African *Conraua* species using a population-level dataset consisting of genome-wide loci. Using *de novo* RAD sequencing data, we detected marked phylogeographic structure which is consistent with biodiversity patterns observed in other rainforest organisms occurring in this region, strongly supporting common underlying biogeographical processes. Building further on these results, we used demographic modelling to trace demographic trends over time and analyze gene flow patterns across the landscape. Our findings suggest that local environmental factors have played a key role in shaping population diversification and connectivity, with fluctuating population sizes supporting the refugia hypothesis. The results provide insights into the distribution of climate refugia, at both the macro- and microscale, and demonstrate how population genomic analyses in non-model organisms can be used to identify regions of long-term evolutionary importance. These insights are particularly relevant in relatively understudied areas, such as West-African rainforests, and have important implications for conservation management and prioritization.

A-1053 (Oral)
Three Crested Newt Species in the Focus of a Detection Dog Team in Austria

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The Crested newt species complex comprises many highly endangered species in central Europe. To attribute causes for their decline and improve conservation measures, we need to better understand their terrestrial habitat use, which is often underrepresented in science and practice. In order to contribute to new insights into the terrestrial habitat use of crested newts in Austria and thus to improved protection measures for these habitats, I have trained a crested newt detection dog as an addition to traditional monitoring measures. I am focussing on *Triturus dobrogicus*, but *Triturus carnifex* and *T. cristatus* also belong to the target species. The training is part of the various modules of the NATURSCHUTZHUNDE association. In addition, I am in close contact with colleagues working with newt detection dogs in Germany and the UK since the beginning of the training. In this presentation, I will give an overview on the challenges and obstacles for training a newt detection dog up to field assignments and deployments. This includes steps from a training odour up to the actual target odour. Training with live newts is necessary for an operational dog, and a special permit has been obtained for this. Both the amphibians and the sniffer dog need to be handled with the utmost care, diligence and responsibility. Initial field assignments confirm the potential of the newt detection dog "Scooper", that for example, together with the experienced German Border Collie "Zammy",

has detected 48 *T. carnifex* quarters, that could not have been found without the dogs. My Lagotto (Italian water dog) is also being trained as a school dog to act as an ambassador for the urgently needed protection of our amphibians.

A-1054 (Oral)
The Victorian Grassland Earless Dragon and The Price of Rediscovery

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For over half a century, the Victorian Grassland Earless Dragon (*Tympanocryptis pinguicolla*) remained elusive, and was thought to be extinct. Then in the summer of 2023, one individual was opportunistically found, reigniting hope for this long lost species. Threatened species conservation and human n(gr)eed are in a constant battle, but with over 99.9% of its grassland habitat destroyed and one of the Southern Hemispheres fastest growing urban sprawls on its doorstep, have we pushed it too far to save? Here, we will discuss conservation breeding and recovery through the lens of a species thought to be extinct and what it means to secure a population that may be the last on Earth while competing against the swell of the human tide, and prevent history repeating.

A-1055 (Poster)
Using the Past to Protect the Present - Phylogeography and Conservation Genetics of an Archaic Frog Genus (*Leiopelma* spp.)

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Leiopelma is a unique, evolutionarily distinct frog genus endemic to New Zealand. Together with their sister taxon Ascaphus, they represent the most basal of all living Anurans, diverging over 200 million years ago. Six leiopelmatid frog species are thought to have been widespread across New Zealand at the time of human settlement around 1,300 CE. Now, only three species persist in patchy, remnant populations. Our understanding of *Leiopelma* taxonomy and genetic diversity remains extremely limited. Morphometric analyses cast doubt on the taxonomic validity of the living Hamilton's and Archey's frogs, as well as the extinct Aurora frog. Further, preliminary genetic data indicated the possible existence of cryptic species and suggested living populations lack genetic diversity. *Leiopelma* frogs require intensive conservation management, and a clear taxonomy is required to prioritise at-risk populations and guide management actions. Phylogeographic analyses can provide conservation-relevant insights when there is little knowledge of population trajectories. We aim to clarify the taxonomy of *Leiopelma* and investigate how genetic diversity within the genus has been impacted by New Zealand's dynamic geological, climatic, and human history. We will construct a molecular-dated whole mitogenome phylogeny for *Leiopelma*, encompassing all six species across their entire geographic and temporal ranges. In addition to sequencing modern samples, we will employ specialised non-destructive ancient-DNA extraction, hybridisation capture and high-throughput sequencing techniques to sequence subfossil mitogenomes. Using whole mitogenomes, we will define lineage divergence times, resolve the taxonomy, and assess

haplotype diversity across species. We will present our comprehensive phylogenetic analyses of *Leiopelma* that will help to inform conservation management of this unique genus across New Zealand, but also contribute to a global understanding of early Anuran biogeography and evolution.

A-1056 (Oral)
Context Dependent Vocal Sequences in Two Anurans of the Western Ghats

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Acoustic communication in animals involves a signaller and a receiver. Acoustic signals convey context-dependent information to receivers. Birds and mammals combine diverse sounds into complex sequences to communicate, but the role of temporal sequencing of signals remains understudied in other taxa. Anuran vocalizations are a prominent feature of their life history and function in defense of territories and to attract mates. However, there is little data on whether anurans pattern their calls into sequences, and whether temporal sequences convey context-specific information. Here, we investigated the context-dependent vocal repertoire and the use of vocal sequences by two anuran species belonging to different lineages. We compared frogs vocalizing alone and in the presence of a territorial rival. Using a robust analytical framework, we present evidence that both species modify their vocal sequence structure according to context. Specifically, one species (with a smaller repertoire, from a more basal lineage) appends notes to generate more complex sequences, whereas the other (more recently diverged and with a larger repertoire) shifts to different note types, resulting in different sequences for different contexts. Thus, despite differences in repertoire size, both frog species are capable of adjusting the temporal sequence of vocalizations to communicate in different contexts. Vocal sequences and context-dependent 'syntax' may be more common in anurans than previously thought, and our workflow presents a paradigm to study the evolution and function of these complex vocal patterns among other anurans as well as other taxa.

A-1057 (Oral)
Sperm Characteristics in the Last of the Rhynchocephalians

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The Tuatara (*Sphenodon punctatus*) is the last extant member of one of the four orders of reptiles, Rhynchocephalia. Endemic to Aotearoa New Zealand, tuatara are culturally significant and a species of conservation concern. Unique amongst reptiles, the tuatara lacks a male intromittent organ, instead using cloacal apposition during mating. Conservation of such distinct species of concern relies on foundational knowledge of both male and female physiology, but this is not always present. We present the first study to characterize the morphology, viability, and swim speed of mature tuatara sperm. Ovulation occurs 1-2 months after mating in Tuatara, and multiple paternity, polyandry, and polygyny have all been

recorded. Tuatara are therefore likely to experience selection pressures of cryptic female choice, sperm storage, and inter-male sperm competition. We collected sperm from mating tuatara in the wild across two mating seasons. We found Tuatara sperm to be filiform with the three-part structure seen in many other species. Relative to other reptile species, tuatara sperm are long and fast. Sperm morphology was relatively conserved, but sperm swim speed and viability varied significantly among matings. We found a negative relationship between midpiece length and sperm swim speed. Head length, tail length and sample viability were positively associated with increased swim speed. Tuatara sperm viability fell within the lower range of that seen in other wild reptile species. Male Tuatara mating displays are elaborate, and although the males in our study had successfully accessed and mated with a female, male fertility varied considerably between mating males. Several instances of apparent anejaculation were also noted. We suggest this variation in male fertility in wild Tuatara should inform future conservation management of this species.

A-1058 (Oral)
Assessing a Freshwater Turtle Nest Protection Method Against an Invasive Predator

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In regions of south-eastern Australia, The Eastern long-necked turtle (*Chelodina longicollis*) and Murray River turtle (*Emydura macquarii*) have declined by more than 60%. The red fox (*Vulpes vulpes*) destroys up to 95% of freshwater turtle nests in these regions, potentially exacerbating the declining recruitment of young turtles needed to replenish populations. Over two nesting seasons, artificial turtle nests were used to investigate the effectiveness of protecting individual nests with mesh grids to mitigate fox predation in the mid-Murray catchment, Victoria. We compared wire against plastic mesh as a more durable substitute for the nest protection method and investigated differences between two populations of foxes in Victoria. These populations included a population naïve to turtle nest protection and one previously shown to destroy the plastic mesh. Lastly, we tested if the plastic mesh was a cue for predators to turtle nests by using combinations of sensory cues associated with a protected nest (mesh, eggs, turned soil) to see which nests and cues are destroyed. Our results show both wire and plastic mesh provided similar nest survival rates, and either is better than leaving a nest unprotected. We found no difference between 'experienced' and 'naïve' fox populations in targeting and destroying nests. Lastly, egg presence in nests was likely the cue that resulted in the most destroyed nests, rather than mesh presence. The findings will help to optimise conservation practices to increase the survivability of turtle nests against an invasive mammalian predator.

A-1059 (Oral)
Illuminating Reptile and Amphibian Trade Dynamics through Comprehensive Data Visualisation

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In the realm of wildlife conservation, harnessing the power of data visualisation is increasingly recognised as a valuable tool for understanding and addressing complex issues such as the trade in reptiles and amphibians. This presentation demonstrates how data can offer invaluable insights into the global, regional, and national dynamics of this trade, by integrating data from disparate sources to provide a holistic view. Traditionally, data on reptile and amphibian trade are siloed within individual sources such as CITES trade data, species assessment data, and wildlife legislation data. However, by consolidating these diverse datasets, and creating a dashboard with visualisations we offer a comprehensive understanding of trade patterns, volumes, and legislative frameworks. This synthesis of data not only enhances accessibility but also facilitates a deeper understanding of the complexities underlying the trade. Through the interrogation of trade data, this dashboard unveils previously obscured patterns and trends, shedding light on trade routes, volume fluctuations, and shifts in commodity types. Such as an increase in the use of Tokay Gecko, *Gekko gecko* for traditional Asian medicines. By making this information accessible and digestible, users can identify areas of concern and prioritise conservation efforts and accordingly. This functionality is invaluable for informing assessment and research, guiding conservation strategies, and facilitating evidence-based policymaking. The dashboard has been built as a free resource and will be readily available for users to try out live at the symposium (some devices will be available). The integration of data visualisation techniques with reptile and amphibian trade data offers a transformative approach to understanding and addressing conservation challenges. By bridging gaps between disparate data sources and unveiling hidden insights, dashboards and visualisations empower conservationists to make informed decisions, ultimately contributing to the preservation of these species and broadening research opportunities.

A-1060 (Oral)
Status and Conservation of a Suburban Population of Jefferson Salamanders (*Ambystoma jeffersonianum*)

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Jefferson Salamander (*Ambystoma jeffersonianum*) populations in Ontario have declined by 90% over the last 3 decades and the species is Endangered in Canada due to habitat loss. In this project, we revisited a population in the Peel region that was last comprehensively assessed 40 years ago. The surrounding area has experienced rapid urbanization and there are changes to breeding pool hydrology that could affect the population. Our study aims to determine the population's status and assess current threats to salamander populations at the study site. We replicated the previous study's design by using a drift fence with pitfall traps to capture and mark individual Jefferson Salamanders for population estimates. We also examined egg survival, juvenile recruitment, movements, and collected tissue samples to determine the proportion of Jefferson-dependent unisexual salamanders sharing the breeding ponds. To assess potential threats, we monitored vertebrate predators, water quality, hydrology of the breeding pools relative to salamander development, prey availability, and road mortality. Our first year of data suggests that one of the primary threats facing this population may be a loss of males. Across 40 years, the sex ratio went from approximately 6% of the population being male to 0.8%. Additional threats identified include depredation of eggs by human-subsidized waterfowl, depredation of adults by human-subsidized mesocarnivores (e.g., raccoons,

skunks), and road mortality. Our study will inform conservation action items, such as habitat remediation, to enhance this population's long-term survival.

A-1061 (Oral)
Climatic Patterns of Blood Parasite Abundances in Western Mediterranean Lizards

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Parasites are an important component of biodiversity and there is a lack of knowledge about the environmental factors that influence geographical variation in the susceptibility of hosts to infections. This is especially true for parasites that infect lacertids while parasite intensity is interpreted as a measure of how hosts tackle infections. In this study we examine whether environmental variables can explain the geographic variation in susceptibility of lizards to infections by blood parasites. Data on infection intensity of the two genera of blood protozoa that most frequently infect European lacertids were analyzed: *Schellackia* (Apicomplexa: Eimeriorina) and *Karyolysus* (Apicomplexa: Adeleorina). The sample was 1,932 blood smears of 10 species of lacertids from 41 localities in the western Mediterranean and collected between 2005 and 2020. Remote sensing methodologies were used to characterize the habitat and climatic conditions of the sampling sites. Higher *Karyolysus* mean intensities were found upon higher rainfall and colder climates, while *Schellackia* mean intensities were lower upon higher thermal oscillation. These climatic patterns will help to understand geographic variation of blood parasites in western Mediterranean lacertid lizards.

A-1062 (Oral)
Apparent Coordinated and Communal Hunting Behaviours by Erabu Sea Krait

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Understanding the foraging strategies of predators within complex marine ecosystems is crucial for elucidating predator-prey dynamics and ecosystem functioning. This study investigates the foraging behaviour of Erabu sea kraits (*Laticauda semifasciata*), focusing on their utilisation of coordinated communal hunting tactics. Through opportunistic observations conducted at recreational dive sites in Southern Lombok, Indonesia, we documented 52

instances of communal hunting events involving interactions with conspecifics and other predatory fishes. Our findings provide evidence of intra- and interspecific cooperative hunting strategies employed by Erabu sea kraits, which likely enhance hunting success within the intricate reef habitats they inhabit. This study highlights the higher cognitive capacity of sea kraits, as evidenced by their ability to coordinate activities during communal hunting endeavours. The observed cooperative behaviours suggest a level of social complexity in sea kraits, expanding our understanding of their behavioural repertoire. While this study provides valuable insights, further quantification and analysis of these behaviours are needed in future research to comprehensively understand the extent and implications of cooperative hunting in Erabu sea kraits and other co-occurring marine predators.

A-1063 (Oral)

Genomic Architecture Underlying the Striking Color Variation in the Presence of Gene Flow for Toad-Headed Lizards in a Desert

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Adaptive divergence is a core process in evolution which leads to genetic and phenotypic differentiation for organisms and even speciation. However, the genomic mechanisms that facilitate adaptive divergence remain elusive, which requires ideal systems that allow the characterization and quantification of its driving forces. Guinan toad-headed lizard (*Phrynocephalus guinanensis*) provides an excellent model to investigate adaptive divergence. Being restrictively distributed in Mugetan Desert on Qinghai-Tibetan Plateau, this species shows striking color variation compared to related species outside the desert, including desert camouflage like color on dorsum, bright red or green color on ventro for adult males and females, and black color on belly. With whole-genome sequences of more than 200 samples, we found that *P. guinanensis* were diverged around 45.5 thousand years ago (Kya) from the lineage outside the desert. Demographic simulation indicated a continuous and asymmetric gene flow between them. More interestingly, we identified highly divergent regions (HDRs) of approximately 0.1% of the whole genome. Some of these major HDRs contain candidate adaptive genes enriched in functions related to pteridine synthesis of red ventral color in males, and melanosome transportation contributes to green ventral color in females. Furthermore, we identified significantly low recombination rates inside HDRs may maintain these adaptive coloration traits in the presence of gene flow. Our study suggests divergence-with-gene-flow could be maintain by the interaction between directional selection and recombination.

A-1064 (Oral)

In Search of Water: On the *Rhinella* Toads' Ability to Find Water Sources

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Dehydration is considered a potent stressor in amphibians, affecting the physiology and behavior of individuals. In this context, the ability to perceive water is an important characteristic that may vary between species. Therefore, we investigated how sensory perception acts as a mechanism in the water homeostasis of terrestrial Toads. Herein we investigate whether toad species of the *Rhinella* genus residing in low water availability environments exhibit a superior capacity to locate water in comparison to species inhabiting environments with higher water availability. For this, we used three species that occupy different environments in terms of water availability. *Rhinella icterica* and *R. ornata* are from wet environments, and *R. dypticha* is from dry environments in the southeast of Brazil. We investigated, under controlled conditions in the laboratory, in a labyrinth experiment, the diversity of search strategies and the ability to find water sources when individuals are subjected to moderate dehydration. We observed that toads from dry environments took longer to engage in water-finding behavior and spent more time finding the water source. Toads from dry environments were also more active and spent less time near the water resource after finding it. Additionally, toads from wet environments showed a better ability to detect considerably low water levels. Our results do not demonstrate that the ability to find water is greater for the species from dry environments. However, we suggest a possible association between water-finding behavior and the effect of dehydration on these *Rhinella* species studied. Given the observed differences, we understand that the increase in efficiency in locating and remaining near water resources among toads from wet environments could optimize their water balance and increase individual survival during dehydration.

A-1065 (Oral)

How NOT to Induce Australian Snake Neck Turtles (*Chelodina longicollis*) to Lay their Eggs

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Oxytocin has been used for decades to induce turtles to lay their eggs. Unfortunately, it often yields partial clutches or fails to work at all. Oxytocin also causes delays in producing the next clutch and false nesting. We found oxytocin had a success rate of only 37% with a variety of Trachemys species that we induced at the Concordia Turtle Farm in Louisiana, USA. After trying a wide variety of alternative agents on thousands of North American Trachemys, Chrysemys and Graptemys at the turtle farm we found that Lutalyse (prostaglandin F2 alpha) alone is far more effective (94% success rate) than oxytocin alone (37% success rate) and the Lutalyse is free of reproductive side effects. When we tried using Lutalyse on Spiny soft shells (*Apalone spinifera*) the success rate was only 48%. But, if we administered the alpha agonist Sedivet (romifidine) 20 minutes before the Lutalyse, the success rate rose to 80%. Then we established a colony of eleven snake neck turtles (*Chelodina longicollis*) at our home in New Zealand. We tried inducing them with a wide variety of drugs at various injection sites over a period of six seasons. We included all the drugs we had used with the American species plus several more. We also had to find an effective injection site since the snake neck's anatomy made our usual injection sites unsuitable. Unfortunately we only had nine females and eight clutches per season (at most) to experiment with. We did find suitable injections sites but none of the drugs we experimented with proved to be consistently effective. I'll discuss the drugs we tried, illustrate the injection sites, and present the outcomes. There will be a few minutes left at the end to review any suggestions you might have.

A-1066 (Oral)

Wallace was Right! [Frog] Colours have Many Secrets to Unfold to Us

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Alfred Russell Wallace is known for his fundamental contributions to the theory of evolution as we know it. He was an exceptional naturalist who carried out extensive fieldwork in places acknowledged nowadays as biodiversity hotspots, which led him to ask key questions on the geographic distribution of animals. However, some of its most influential ideas relate to the function of the wide array of colours and patterns found in animals and plants. Wallace ventured into classifying such colours into five categories, most of which continue to be valid to date. During this talk, using poison frogs as a study system, I will focus on the evolution of one such categories, warning colours. These often bright and conspicuous colours are not only key signals in predator-prey interactions but also co-opted as sexual signals in some species. I will show examples of how the colour patters of some aposematic frog species allow them to avoid predators, provide info on the possession of chemical defences (qualitatively and, sometimes, quantitatively), can correlate with fitness-related traits such as movement patterns, generate visual illusions, and enable them to exploit key resources. I will end by discussing the implications that anthropogenic activities have on animal coloration and its signalling function(s).

A-1069 (Oral)
Movement Patterns and Home Range Size of Cape Cobras (*Naja nivea*) in the Kalahari, South Africa

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The geographic distribution of studies examining movement patterns and home range sizes of snakes shows a geographic and phylogenetic pattern, with most studies focusing on species in the Northern Hemisphere. This research bias contributes to a significant gap in our knowledge of how snakes in different regions relate to their environments. We examined the movement patterns of cape cobras (*Naja nivea*) in southern Africa to gain more knowledge on the biology of the species, especially as it applies to extreme environments. We telemetered 33 cobras at Tswalu Kalahari Reserve (Northern Cape Province, South Africa) and tracked their movements, collecting 2025 GPS coordinates over two years. Home range estimates were calculated using dynamic Brownian Bridge Movement Models, which generated a 99% probability contour for each snake. We tested if home range area was impacted by sex, body size, and tracking duration. We also examined variation in movement distances relative to sex and season, while accounting for inter-annual variation. Home ranges of male and female cobras differed significantly, with female snakes occupying smaller home ranges (70.7 ± 43.5 ha) than males (145.9 ± 88.8 ha). Distances moved by individual snakes were significantly affected by sex and season. We showed that snakes move furthest in spring and autumn. Interestingly, we noted that movement distances in summer were not significantly different from those in winter. Measures of home range area and movement patterns were consistent with broader patterns reported for snakes showing that (i) males tend to occupy larger home

ranges and move further than females, and (ii) that animals in low-resource areas are likely to occupy larger areas than those from resource-rich landscapes. Thus, our findings suggest that cape cobras in southern Africa match general spatial ecological patterns of Northern Hemisphere snakes.

A-1070 (Oral)
The Effects of Fire on the Amphibians and Squamate Reptiles of Brazilian Savannas and how these Animals Live with and Survive Fire

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The Cerrado comprises tropical grasslands and savannas occurring in central Brazil (over 2 million km^2). It harbors a high diversity habitats, being the most diverse savanna in the world (including 292 amphibians and 370 squamate reptiles). As fire is an important ecological factor in the Cerrado, we review the effects of fire on amphibians and squamate reptiles (A&SqR) and the ways these animals live with and survive fire. This review is based on literature and unpublished data. The information available indicates that populations of Cerrado A&SqR are generally resilient to fire, with small or no changes in population densities and species richness after fires. To avoid direct fire effects, A&SqR usually seek shelter in refuges underground. Several species commonly bury themselves in sandy soils or utilize cavities within termite mounds and pre-existing burrows constructed by mammals as refuge sites. However, under some conditions, such as high fuel loads, squamate reptiles may have difficulty for escaping or finding shelter before lethal temperatures are reached, and relatively high mortalities may occur. Thus, in contrast to other vertebrates, A&SqR generally persist in burned areas, instead of moving away and recolonizing the area after the fire. Fire often benefit squamate reptiles typical of grasslands and savannas, by keeping the vegetation sparser. As a higher richness of A&SqR is found in more open vegetation types, fire supression tend to be detrimental to their communities due to woody encroachment. Finally, most data on fire effects on Cerrado A&SqR indicate that a mosaic of patches of different fire regimes at the landscape scale may result in a higher species richness. Given the potential positive, neutral or negative effets of fire on the Cerrado herpetofauna, additional studies are needed to support conservation actions focused on this fauna.

A-1071 (Oral)
Towards a Deeper Understanding of the Diversity and Evolution of Snake Retinas

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The > 4,000 living species of snakes display an astonishing variety of visual cells and retinal patterns. Using mostly light microscopy, many data for snake retinas were generated in the twentieth century on outer retinal photoreceptor (rod and cone) complements, and on the relative thickness of the major retinal cell layers. Research in the latest twentieth and early twenty-first century provided new information from DNA and RNA, and from immunolabeling

of retinas, especially on the complement and expression patterns of visual-opsin genes. Until now, a major component lacking from studies of snake retinas has been insights into the diversity and connectivity of the other (non-photoreceptor) elements, including horizontal, bipolar, amacrine and ganglion cells. Gathering and analysing such data might be expected to yield new insights into the diversity, function and evolution of snake visual systems. This should facilitate better understanding of phenomena such as unusual patterns of visual-pigment coexpression, transmuted rod-like cones and cone-like rods, variation in the thickness of retinal cell layers, and a reduction of elements of the visual system during the lizard-snake transition and subsequent elaboration within Caenophidia. Employing a comparative approach, we used electron microscopy and immunohistochemistry to scrutinize photoreceptor terminals and their connectivity patterns with inner retinal cells. This has allowed us to develop a toolkit to investigate snake inner retinas and to generate preliminary data on the diversity of their post-receptoral pathways. We identified multiple immunohistochemical markers for snake inner retinal cell types, some of which are lineage-specific, and some that display differential labeling patterns in duplex and all-'cone' retinas. Variation in the retinal architecture of snakes appear to be explained by diel activity patterns and phylogeny. Our new data provide a first view into the initial steps of visual processing in snakes.

A-1072 (Poster)

The Enigmatic Decline of the Achala Toad: Gathering Efforts to Conserve Remnant Populations of an Argentinean Endangered Species

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The Achala toad (*Rhinella achalensis*) is an endemic species from the high-altitude grasslands in central Argentina. Since the early 20th century, several populations have disappeared, and nowadays, the species is the rarest amphibian in the area, with only 15 small populations remaining. This sharp decline triggered, in 2019, the listing in the IUCN's species conservation status from Near-threatened to Endangered. Although the decline causes remain uncertain, some factors appear as the most likely threats affecting populations: the disease caused by the pathogenic fungus *Batrachochytrium dendrobatidis* (Bd) and the co-occurrence with exotic species (invasive fishes and livestock). In 2022, we created the Sapo de Achala Project aimed to assess the extent and severity of threats in the framework of collaborative work to develop bottom-up conservation actions to protect the Achala toad populations. Preliminary results obtained in the framework of this study indicate that some of the populations have managed to persist in coexistence with the presence of exotic salmonids and livestock. Therefore, we formulated a comprehensive series of studies to examine the presence of Bd in remnant and extinct populations of the Achala Toad within the context of salmonid invasion. These studies encompass the investigation of Bd infection patterns in both larvae and adults across all species within the amphibian communities. Additionally, we work on the identification of Bd in specimens collected from historical localities, as well as on the detection and quantification of Bd in water samples (using eDNA). Complementarily, we perform population genetic studies aimed at characterizing genetic diversity patterns, estimating effective population sizes, and

inferring demographic processes undergone by the populations. Finally, this strategy is accompanied by long-term monitoring of known populations and expeditions to new sites to detect potential remnant populations involving park rangers and local communities.

A-1073 (Oral)
Similar Reptiles Show Dissimilar Responses to Habitat Transformation

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Habitat transformation is widely recognised as the leading driver of global biodiversity loss, but is commonly measured at broad spatial scales for a limited subset of species. Reptiles represent a large proportion of terrestrial vertebrate diversity and contain a high number of threatened species, yet we know little about how they are responding to global change. Current rates of habitat transformation are highest, but most heterogeneous, in less economically developed countries, where the overlap with regions of high species richness is pronounced. As such, there is an urgent need to obtain robust, fine-scale data on the impact of habitat change on underrepresented taxa in these regions, such as reptiles. While assessing the impact of change in vegetation structure and composition on a reptile community in south-eastern Zimbabwe, we observed unexpected responses in two wide-ranging, ecologically similar skink species (Scincidae: *Trachylepis damarana* and *Trachylepis striata*). We interrogate these responses by applying an abundance modelling approach (N-mixture modelling) to data from multiple surveys at two different geographic scales. We find that the abundance of *T. striata* is positively correlated with homogenised woody plant cover, while the inverse is true for *T. damarana*, indicating that sympatry between the two species is mediated by natural and anthropogenic variation in habitat structure. We discuss the potential ecological mechanisms behind this trend, and highlight the value of measuring habitat change at multiple scales in order to evaluate its impact for a broader range of taxa. We conclude that doing so provides important nuance in assessing the status of global biodiversity.

A-1074 (Poster)
Defining the Morphology of *Trimeresurus purpureomaculatus* (Gray, 1832) Sensu-stricto

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Trimeresurus purpureomaculatus a mangrove-associated pit-viper with a wide geographic range across Singapore, Malaysia, Thailand, Indonesia, which makes it a good candidate to be investigated for cryptic speciation. This study presents a morphometric approach to redefining *Trimeresurus purpureomaculatus* sensu-stricto from across its known geographic range with specific focus on the type locality. The holotype is herein redescribed with first ever published photos with additional information on the mensural measurements. Notes and comments on the preparation of hemipenal structures of topotypic specimens which differ from what is presented in the current literature is also recorded. The recently described *T. ayeyarwadiensis* highlights the importance of studying material from the type locality to elucidate and resolve taxonomic species complexes across the region.

A-1075 (Oral)
In Search of the Missing and Feared Extinct Frogs on the New England Tablelands, Australia

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The New England Tablelands of eastern Australia have undergone dramatic changes in frog species composition in the last 50 years. Two species endemic to the Tablelands, the Critically Endangered Peppered Tree Frog (*Litoria piperata*) and the Yellow-Spotted Bell Frog (*Litoria castenea*) are missing and feared extinct, having not been seen for over 40 years. Several other frog species underwent dramatic population declines on the Tablelands at the same time. As a result, this area has become a priority for frog research and conservation and in October 2016, the Australian Museum began intensive frog surveys in the region. To date, we have conducted over 330 surveys over almost 200 nights on both private and public land. Although we have not yet rediscovered the missing species, we rediscovered Booroolong Frogs (*Litoria booroolongensis*), and Tusked Frogs (*Adelotus brevis*), the first records of these species on the Tablelands in decades. These rediscovered populations are all on private land. Since rediscovering these populations, we have extended the known range of both species, and have successfully engaged the public in detecting additional sites by recording calling frogs for the FrogID citizen science project. To help inform the conservation of these important populations, we have incorporated disease surveys, radiotelemetry and population genetics into our monitoring. Community engagement and support remains vital to this project, both in terms of land access and recordings submitted to the FrogID project. Together with the community we hope to rediscover the Peppered Tree Frog and the Yellow-Spotted Bell Frog.

A-1077 (Oral)
Colors and Genes: The Genetic Differences between Color Morphs of a Poison Dart Frog from Panamá

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Animal coloration has attracted a lot of interest over the last years. Amphibians display all ranges of color and often color polymorphism is observed between populations. The lesser known poison dart frog species *Oophaga vicentei*, exhibits a wide range of diverse color morphs in a small area of its overall distribution in mainland Panama. *Oophaga* frogs are known for their aposematic or cryptic coloration and its facilitation in antipredation strategies. Color in amphibians is directed by a chromatophore layer, however, the genetic basis mediating coloration is not well known. Our aim was to identify the genetic basis of diverse *O. vicentei* color morphs and connect gene expression profiles to phenotypic colorimetric traits. We measured skin spectral reflectance and sampled skin and liver from 21 males of red, brown, green and aquamarine color morphs of *O. vicentei*. After RNA extraction and sequencing, a de-novo transcriptome was assembled and gene expression was measured for each tissue and each color morph. A differential gene expression analysis was performed between morphs. The

aquamarine morph showed the most differentiated expression profile for both tissues. In total, 116 genes related to pigment synthesis and chromatophore differentiation were differentially expressed between morphs. Genes related to carotenoid uptake are more expressed in red frogs while genes related to carotenoid degradation are only expressed in the other color morphs. A pteridine synthesis gene was found to be highly expressed in red frogs while another pteridine synthesis gene was only expressed in liver of brown frogs. Our results show the complex nature of gene regulation mechanisms underlying the color variation in poison frogs. As the coloration can convey an aposematic signal or serve as camouflage to avoid predation in these frogs, our results enhance our knowledge on the evolution of contrasting anti-predation strategies.

A-1078 (Oral)
Threats to Brazilian Vipers and How They are Being Addressed: A Review and Perspectives

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Brazil harbors a high diversity of vipers, with 32 species of *Bothrops*, one of *Crotalus*, and one of *Lachesis*. Many threats are known to affect Brazilian vipers, although these were never comprehensively reviewed. Aiming at contributing to the conservation assessment and actions directed at Brazilian vipers, here we review (1) the threats to Brazilian vipers available in red lists (IUCN and Brazilian, BR) and in literature; (2) the uses that humans make of vipers; and (3) the conservation actions that benefit these snakes. Our review focused on these three aspects within the Brazilian territory, and for all three, we used the classifications provided by IUCN. To detect additional threats, we used the MapBiomas land use database to check the overlap of viper distributions with strictly protected areas and indigenous lands, as well as the occurrence of fires from 2003 to 2022. We found 28 different threats affecting Brazilian vipers, the most frequent being related to habitat loss (mainly for agriculture and livestock farming) and killing by humans or human activities (mainly persecution and roadkill). About one-third of Brazilian vipers are kept in captivity as pets, three are known to be used in traditional folk medicine, and we found no information about use for the remaining species. We found 17 types of conservation actions that benefit Brazilian vipers, the most common being protected areas and law enforcement against illegal capture and killing. We hope that the results of our study can help optimize the way in which threats to Brazilian vipers are being addressed, as well as highlight conservation gaps for species that have not been comprehensively assessed. Furthermore, we expect that the information reviewed here, which is spread across several sources, will be incorporated into the BR and IUCN conservation assessment processes.

A-1079 (Oral)
Identifying Key Factors for Heat Tolerance: Genome Sequencing and Gene Function Analysis of "Hot-Spring Frog" *Buergeria japonica*

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The temperature adaptation is one of the driving force behind the biodiversity and increasing importance in the recent global warming. Recently, we discovered that tadpoles of the Ryukyu Kajika frog (*Buergeria japonica*) live in hot springs with temperatures exceeding 40℃ on Kuchinoshima in the Tokara Islands. Although this species inhabits the entire Ryukyu Islands, it is the only amphibian on the Tokara Islands, and is thought to have expanded its distribution to these islands by drifting and dispersing from Amamioshima. On the other hand, Kajika frog, *B. buergeri*, a congener of this species, lives in clear streams in the mountains of Honshu. Therefore, these species are an ideal research subject to approach the propositions from the early days of biology: temperature adaptation and distribution expansion. In this study, for elucidating the molecular mechanism of high temperature tolerance in Ryukyu Kajika frog, we determined new genomes of Ryukyu Kajika frog and Kajika frog, and conducted gene expression analysis. Hybrid genome assemblies using x100 short read and x 20–30 long read data were conducted for each species and the draft genomes approx. 1 Mb N50 scaffold length were obtained. Differential gene expression analyses using RNAseq were conducted for tadpoles of both species which exposed to 20–35℃. As a result of comparative analysis of their genomes, a group of genes whose copy number had increased in one species was found. Furthermore, gene expression analysis revealed that in the Ryukyu kajika frog, epigenetic factors increase expression under high temperatures, leading to large-scale changes in gene expression patterns.

A-1080 (Oral)
How Sea Snakes Find and Identify Their Prey in Water

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Fully aquatic adaptation of amniotes generally leads to changes in the sensory systems drastically such as the acquisition of echolocation in dolphins. Terrestrial snakes rely heavily on chemical cues to locate and recognize prey, but little is known about how sea snakes find and identify their prey fishes in water. Sea snakes of the genus *Laticauda* and *Hydrophis* snakes are fish-eating marine elapids that adapted from land to water approximately 5–10 million years ago. Here, we performed behavioral experiments to test chemical and visual preferences using amphibious (*Laticauda*) and fully-aquatic (*Hydrophis*) sea snakes in an aquarium. These experiments show that *Laticauda* snakes can recognize and discriminate their preferred fish species by using olfactory cues. *Hydrophis* snakes can also find and identify their preferred fish species solely by using olfactory cues. However *Hydrophis* snakes rely on visual cues, not on chemical cues, to locate places where their preferred fishes may hide. These results suggest that *Hydrophis* snakes use visual cues prior to use olfactory cues upon foraging. Our findings suggest that *Hydrophis* snakes have changed their sensory systems drastically on becoming aquatic.

A-1081 (Oral)
Larval Anuran Assemblages in Tropical Rainforest Streams in Borneo

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We investigated the diversity and factors influencing species composition of larval anurans within rainforest streams of northeast Borneo. We sampled tadpoles at 50 riparian plots for a combined period of 10 months. A total of 17 tadpole species representing six anuran families: Bufonidae, Dicroglossidae, Megophyridae, Microhylidae, Ranidae, and Rhacophoridae were recorded. Of the 15 habitat variables measured, we found that stream velocity, microhabitat width, and number of odonate larvae were significantly associated with the composition of the larval assemblage. Based on these environmental variables, we assigned larval anurans into five habitat guilds: Open-pool species, 2. Rock-pool species, 3. Generalist/gravel-bed species, 4. Torrent species, and 5. Small microhabitat: side-pool/riffles/mini-waterfall species. This study provides the first quantitative data on the species organization of larval anurans in Borneo. This finding is both of ecological interest and of practical importance for future conservation and management of frogs in species rich tropical ecosystems.

A-1082 (Poster)
The Mitochondrial Genome of *Hemidactylus platyurus* (Gekkonidae) Reveals a Putative Cryptic Species Complex

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Hemidactylus platyurus is one of several widespread house gecko species, naturally occurring in Eastern India, Bangladesh, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, Indonesia and Philippines, and introduced in Florida and Guam. We sequenced the mitochondrial genome of *H. platyurus* from Bangkok, Thailand, to provide a resource for phylogenetic studies of this important species. The obtained genome is 16707 bp long, and includes 13 protein-coding genes, 22 tRNA genes, two rRNA genes and the control region. The base composition is 30.1% A, 30.8% C, 15.4% G, and 23.6% T. The phylogenetic analysis of the sequences of 12S rRNA, cytochrome b (CYTB) and cytochrome c oxidase I (COI) gene fragments of H. platyurus specimens from Bangkok and from other localities, published before, shows the presence of two species inside what is now called "*H. platyurus*". The specimens from Eastern India and Western Myanmar form a well-supported clade with average 20% cytochrome oxidase I p-distance from the specimens from the rest of the range, and this North-Western clade is putatively closer to other species of the "*H. platyurus*" species group, such as the *bowringii/karenorum/garnotii* lineage, than to the South-eastern *H. platyurus*, albeit with low support. The South-eastern specimens show up to 11.6% p-distance between each other, but do not form well-supported clades. Wider sampling of *H. platyurus* and related species and sequencing of longer mtDNA fragments are required to rigorously resolve the phylogeny of *H. platyurus* and the "*H. platyurus*" species group.

A-1083 (Poster)
Ectoparasites of Racerunners (*Eremias* Fitzinger, 1834) from the Caucasus and Adjacent Territories

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Racerunners of the genus *Eremias* is one of the most widespread genera of lacertid lizards: its representatives live in Europe and Asia from the Western Black Sea region (Romania) to the Korean Peninsula (South Korea) and northeastern China. In addition, this is one of the most numerous taxa of genera in the subfamily Lacertinae: currently about 45 recent species have been described, and this number is regularly increasing. Racerunners typically inhabit sandy and clayey deserts, rocky foothills, dry grassy steppes and other open landscapes, almost never found among dense woody or shrubby vegetation. Literary data on parasitic fauna of *Eremias* species are scattered and fragmentary. Previously, a review of the parasitic fauna was made for *E. arguta* (Kotenko, 1993) and species of Soviet Central Asia (Markov, Bogdanov, 1961). This study is the first detailed investigation on ectoparasites infesting racerunners from the Caucasus and the adjacent territories. We examined a total of 856 specimens of *E. arguta, E. persica, E. pleskei, E. strauchi*, and *E. velox* from the collection of the Zoological Institute of the Russian Academy of Sciences and Dagestan State University. Altogether our and literature data contain registration of nine species of three orders: Ixodida (5 species: *Haemaphisalis punctata*, *Haem. sulcata, Haem. parva, Hyalomma marginatum, Hyal. aegyptium*), Mesostigmata (1 species: *Ophionyssus saurarum*) and Trombiculidae (3 species: *Ericotrombidium caucasicum*, *Neotrombicula tragardhiana, Odontacarus armeniensis*). Tick species *Haem. punctata* have been recorded for *E. strauchi* for the first time, and tick *Hyal. aegyptium* have also been recorded for *E. arguta* and *E. velox* for the first time. Compared to other Caucasian lacertid lizards (*Darevskia, Lacerta*), we identified a smaller number of ectoparasite species in representatives of genus *Eremias*.

A-1084 (Oral)
The Congo River Divides the Morphospace of Central African Rainforest Puddle Frogs, *Phrynobatrachus auritus* (Phrynobatrachidae)

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Phrynobatrachus auritus is a representative of the second most species-rich amphibian genus in continental Africa (96 species). This medium-sized (30–40 mm), predominantly terrestrial species differs from most of its congeners by its wide distribution across rain forests of Central Africa from southeastern Nigeria in the west to Uganda in the east. It represents one of the few

species of this genus that can be found in rain forests of the central Congo Basin (left bank of the Congo River). However, preliminary results indicate that this taxon consists of at least five evolutionary lineages, probably species. Therefore, this species complex is an interesting model for phylogeographic studies and research on morphological variation. Our research investigates the geographic morphological variation of this species complex across its range using morphometric analyses of museum and recently collected and genotyped material (over 300 individuals). The results of the morphometric analyses divide this species complex in two main groups, more or less separated by the course of the Congo River. The 'northe' group comprises three genetically divergent and parapatrically distributed lineages, which display minimal geographic variation in body shape. This state of morphologically uniform but genetically divergent lineages may have arisen from the separation of three ancestral populations during Plio-Pleistocene climatic fluctuations (genetic divergence) while maintaining their original ecological niche (morphological uniformity). The 'southern' group comprises two evolutionary lineages that are not only morphologically distinct from the uniform 'northern' group, but also relatively different from each other. This morphological diversification of the 'southern' group is likely related to the differentiation of the ecological niches of the two lineages, which occur nowadays largely in sympatry. However, further research will be needed to understand whether the two lineages have different microhabitat preferences, trophic niche or behaviour.

A-1086 (Poster)

Age Structure and Growth Pattern of the Kishinoue's Giant Skink, *Plestiodon kishinouyei* (Squamata: Scincidae), Inferred by Skeletochronology

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Plestiodon kishinouyei is a large sized skink endemic to southern part of the Ryukyu Archipelago, Japan and total length of adult males sometimes reach to 40 centimeters. Despite its large size, our knowledge of the growth and age structure is very limited. In this study, we investigated the age structure and growth pattern in the population of *P. kishinouyei* from Iriomote Island by use of the skeletochronological approach. We used the phalanx of the third toe of the left forelimb, which was obtained from the temporary captured live skinks, because this species is protected by the national law. The phalanges were paraffin-embedded, sectioned into 5μm-thick sections, and stained with hematoxylin solution. First, we confirmed that a single growth arrest line (LAG) is usually formed every winter by counting the number of LAGs in two phalanges of both sides, each was collected two successive years from same individual as well as by comparing ages inferred from recapture records and the number of LAGs. We examined phalanges from 110 free ranging skinks, and the ratio of individuals that survived for more than 48 months was 43% for males and 27% for females, and the oldest one was a male of 112 months old with 166 mm in SVL and the oldest female was 95 months old with 146 mm in SVL. Analysis using von Bertalanffy growth curve revealed significant sexual difference in growth rate, with males continuously grew until 60 months, whereas female growth rate was decelerated after 24 months. This difference causes the remarkable sexual size dimorphism in this species.

A-1087 (Poster)

A New Record of the Enigmatic Earless Monitor Lizard (*Lanthanotus borneensis*) from Brunei Darussalam

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We document a northernmost record for the Earless monitor lizard, *Lanthanotus borneensis*, an enigmatic, monotypic species in the lizard family Lanthanotidae. This is the first record of its occurrence in Brunei Darussalam. The specimen was found 185 km northeast of the previous record (Niah Caves). The individual was found on land at night during a heavy storm. Water quality measurements of the nearby rocky stream suggest habitat differences to other known localities. The individual had a body size of 16.11 cm (snout-vent length) and a tail length of 18.55 cm. Head width at its widest was 1.53 cm. Gape width was 1.26 cm. Total body length of 34.66 cm is within the range of wild caught individuals. To observe its behavior, we placed the individual in a large stone-filled terraria filled with stream water. The Earless monitor immediately wedged itself under the rocks with just the nostrils and eyes above water and remained in this position for several hours. The Earless monitor lizard is protected under CITES Appendix II and efforts are underway to protect its habitat in Brunei.

A-1088 (Oral)
Insights Gained from a Multi-year Survey of Ranavirus Epidemics across an Amphibian Metapopulation

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Ranavirus can have devastating impacts on amphibian populations. However, our understanding of the causes and consequences of epidemics remains limited. Studies in natural settings where epidemics recur are important to increase our understanding of the factors driving disease-induced mass mortality events. We used a Wood frog (*Rana sylvatica*) metapopulation in Connecticut, USA, with a history of ranavirus epidemics to investigate ranavirus-driven die-offs and inform laboratory experiments to explore potential mechanisms. From 2021 to 2023, we surveyed wood frog tadpoles from 30–40 ponds to monitor for ranavirus die-offs. We surveyed ponds every two weeks, collecting tissue and environmental DNA (eDNA) samples for ranavirus testing. We will present the results of these surveys, including patterns associated with the observed ranavirus epidemics, experiments informed by specific observations in the field, and explorations of the effects of ranavirus epidemics on the gut microbiome. Across the three years of surveys (102 pond-years), we detected ranavirus die-offs at 12 ponds (11.7% incidence) Die-offs were associated with a spike in tadpole viral loads, but the relationship between infection prevalence and die-off timing was complex. Ranavirus eDNA concentrations closely tracked tadpole infection intensities, and we found that in many cases, ranavirus eDNA concentrations appeared to increase before tadpole infection intensities did. In almost all instances where detected prevalence surpassed 20%, a die-off eventually occurred; however, in eight instances, populations never experienced a die-off despite repeated detection of infection, and we found evidence of recovery in four populations that experienced die-offs. We detected ranavirus infection in at least one tadpole

in ~20% of ponds that did not experience a die-off. This work significantly advances our understanding of ranavirus field dynamics and provides a foundation for future studies that examine the mechanism underlying these events related to environmental conditions and the accumulation of virions in the environment.

A-1089 (Poster)
Temporal Variation in Acoustic and Visual Signaling as a Function of Stream Background Noise in the Bornean Foot-Flagging Frog, *Staurois parvus*

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High background noise can interfere with signal detection and perception. The Bornean foot-flagging frog, *Staurois parvus*, lives along noisy streams and uses both acoustic and visual signals to communicate. They have solved the problem of continuous broadband, low-frequency stream noise by modifying the amplitude, pitch, repetition rate and duration of notes within their advertisement call in addition to using numerous visual signals, foot-flagging being the most conspicuous. We hypothesized that acoustic signalling will be at an advantage under more quiet conditions and low light levels, whereas visual signals will prevail when the noise of rushing water is high after rains and when light levels provide the best contrast. We found that as predicted, male *S. parvus* increased foot-flagging when presented with playbacks of stream noise compared to less noisy pre-playback conditions. Such context-dependent dynamic selection regimes are recently gaining wider attention and enhance our understanding of the flexibility seen in the use of multimodal signals in frogs

A-1090 (Oral)
Species Assemblages and Avenues for Conservation on Solar Farms

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Habitat fragmentation is the primary driver of species loss, a process exacerbated by human development and the climate crisis. Despite this, natural areas will likely continue to be converted for anthropogenic uses. Nature-based solutions (NbS), approaches which incorporate the protection, restoration, or sustainable maintenance of ecosystems whilst benefitting people, have been identified to simultaneously tackle land-use conflicts. One such NbS is the implementation of conservoltaic systems— where traditional photovoltaic solar farms incorporate ecological elements to promote species conservation, ecosystem restoration, and create a multi-functioning landscape. We conducted biodiversity surveys (birds, mammals, reptiles, amphibians, and invertebrates) on a small-scale solar farm in New South Wales, Australia, over 3 years to identify the impacts of solar infrastructure on wildlife communities. Here, we focus on herpetofauna as an underrepresented faunal group. Species evenness, richness, and diversity was calculated to compare the community composition between solar arrays and the surrounding agricultural sites (controls). Overall, vertebrate species richness was greater in the agricultural sites than the solar arrays, whereas vertebrate diversity and evenness were similar across both land uses, indicating that the solar farm in their current state can support broad wildlife communities. For herpetofauna, however, agricultural sites were richer and more diverse than the solar arrays. The lesser presence of herpetofauna on solar farms may

be a result of high disturbance to ground vegetation. Vegetation management on this solar farm consisted of frequent mowing and the spraying of herbicide to limit shading and reduce fire risk. This may have a disproportionate impact on herpetofauna. The incorporation of artificial habitat structures such as artificial rock piles or other cover objects may increase habitat suitability for herpetofauna.

A-1091 (Oral)
Atelopus Survival Initiative: Fostering Locally-Led Groups and Empowering Local Communities in the Care of Neotropical Harlequin Toads

Luis Fernando Marin da Fonte
Atelopus Survival Initiative

The Atelopus Survival Initiative (ASI) is a collaborative effort of over 100 individuals and organizations from Latin America and beyond, committed to conserving Neotropical Harlequin toads of the genus Atelopus. Comprising NGOs, zoos, academics, conservationists, artists, local communities, and more, ASI employs a collective approach to implement a diverse array of strategies aimed at halting Atelopus extinctions. With a strong emphasis on locally-led initiatives and community involvement, ASI serves as a model for collaborative partnerships worldwide. However, managing networks with such diverse stakeholders and their different expectations presents significant challenges. For instance, donors may prioritize measurable outcomes and impact metrics, while grassroots organizations implementing conservation on the ground may struggle with weak institutional structures, reduced personnel, inadequate resources, and language and cultural barriers, leading to excessive pressure and stress. Also, local communities may rely on traditional knowledge and cultural land-use practices that may be perceived as obstacles by conservationists with academic mindsets, who emphasize research agendas, scientific rigor, and data-driven approaches. To implement successful conservation initiatives, we must navigate these complexities and sometimes seemingly contrasting perspectives. In this talk, I will share my experience as coordinator of ASI, exploring challenges and opportunities in fostering partnerships, supporting local groups, and empowering communities in conservation efforts. Our experience demonstrates that achieving successful conservation outcomes uniting the expertise, resources, and skills of donors, implementers, and local communities, while meeting their diverse needs and expectations, is indeed possible. It requires nurturing empathy, dialogue, and trust among all involved. Networks like ASI serve as invaluable platforms for mutual learning, cultivating an environment of understanding and support where all parties contribute to and benefit from shared knowledge. By recognizing and valuing the diversity of perspectives and practices within conservation networks, we can better address the complex challenges facing biodiversity conservation today.

A-1092 (Oral)
Updated Distribution and Habitat Suitability Modelling of the Black Softshell Turtle (*Nilssonia nigricans*) in the Brahmaputra Basin

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The Black softshell turtle (*Nilssonia nigricans*) is a large freshwater turtle (up to 91cm) with a range across the Brahmaputra River drainage in northeast India. This extremely rare turtle was downlisted from Extinct in Wild to Critically Endangered in 2021. The species is threatened by over-exploitation and habitat loss across its range; however, little is known about its distribution and habitat requirements. Herein, we report 18 new locations of *N. nigricans* across its range, which include 11 records from dedicated field surveys conducted in protected areas and associated wetlands in Assam in 2019-2024. We also compiled a total of 32 confirmed occurrence records (1 km^2 spatially rarified) of wild black softshell turtle from published literature and community science data across northeast India. We developed presence-only distribution and habitat suitability models using these records and correlated them with six environmental variables using maximum entropy modelling. We predicted 23.4% of the area as suitable for the occurrence for *N. nigricans* in northeast, primarily in states of Assam, Nagaland, Arunachal Pradesh, and eastern parts of West Bengal, with Assam having the highest habitat suitability index. We also evaluated whether the current network of protected areas (PAs) across its range is effective for the protection of this rare and critically endangered species. The models predicted a wider probability area for species presence outside PAs, indicating that they alone are not sufficient for conservation interventions necessary for this species. The base models generated can be used to focus survey efforts in high probability areas of occurrence, and they should be considered for management planning. Additional presence and fine scale habitat data will help prioritize habitats for the conservation of this threatened freshwater turtle.

A-1093 (Oral)

The Elephant in the Room of Conservation: Unveiling the Ignored Impacts of Animal Agriculture on the Biodiversity and Climate Crisis

Luis Fernando Marin da Fonte
IUCN SSC Amphibian Specialist Group

While receiving minimal attention in conservation efforts, compelling scientific evidence underscores animal-derived food production as a major driver of both biodiversity loss and climate change, contributing to species extinction. Animal agriculture is the primary driver of habitat destruction through deforestation, land conversion, soil contamination and erosion, and water pollution. Moreover, it exacerbates climate change and facilitates the spread of invasive species and emerging infectious diseases. Animal agriculture occupies ~83% of the world's arable land, with meat production, including animal husbandry and feed production areas, covering ~75% of global agricultural land. Pastures account for ~25% of ice-free land, while ~33% of arable land is dedicated to producing animal feed. Notably, ~75% of total greenhouse gas emissions from agriculture stem from animal-derived food production, with domestic ruminant livestock alone contributing ~15% of anthropogenic emissions. Amphibians are the most threatened vertebrates, with ~40% of species at risk. More than half of the amphibian species evaluated by the IUCN face some form of threat related to animal production for human consumption. In this talk, I will present alarming scientific data on the negative impacts of animal-derived food production on biodiversity, with a particular focus on amphibians. Our eating habits must change if we want to preserve what remains of wildlife. Yet, biologists, researchers, and conservationists persist in ignoring the scientific evidence of the impacts of animal agriculture on biodiversity. This is the elephant in the room that, due to questionable reasons, our community insists on overlooking. Why? It is often easier to blame others for environmental destruction than to reflect on our own actions. Researchers and conservationists must lead this debate and set a positive example. As stewards of knowledge and advocates for

conservation initiatives, it is our responsibility to directly address the urgent matter of meat and dairy production and consumption.

A-1096 (Oral)
A Review of Conservation Translocations of Smooth Snake (*Coronella austriaca*) in the UK

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The Smooth snake *Coronella austriaca* (Serpentes: Colubridae) is of conservation concern in the United Kingdom largely due to a substantial reduction in range resulting from habitat loss, modification and fragmentation over the last century. Its range spans Europe and far-western Asia. The species is assessed as Least Concern globally using IUCN Red List criteria, yet it has a higher extinction risk in some range states, as in England where it is Endangered. In England it occupies open habitats, almost exclusively on lowland heathland with ericaceous species dominant. We reviewed information on the long term outcome of attempts to establish populations of *C. austriaca* within its presumed range in England via conservation translocation. Thirteen attempts where there is at least minimal information were assessed, with the release activity ranging from the 1960s to 2010. This period has seen a substantial shift in the understanding of, guidance on, and regulation of conservation translocations. The attempts that we document underscore this trend, with early efforts being purely voluntary with minimal state oversight, to later operations undertaken by professional conservation workers under strict permissions. All cases used a hard release, wild-to-wild translocation pathway. Founder size ranged from 10 to 28 individuals, typically including both adult and immature animals. Using monitoring data from the last decade, we assessed the translocation outcome as successful if there were repeated observations of presence and indications of breeding. Nine (69%) of the thirteen translocations were deemed successful. The outcome of the remaining four (31%) translocations was deemed uncertain, largely due to difficulties in securing adequate monitoring effort. In several cases habitat was damaged by fire after the translocation. We conclude that conservation translocation can be an effective tool in the recovery of *C. austriaca*, and recommend further research into issues including founder demographics and genetic considerations.

A-1097 (Oral)
Sensory System Cooperation Across Ecologically Diverse Snakes

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Sensory systems are expected to evolve in tandem, working with one another and corresponding brain regions to allow organisms to perceive the world around them. However, when a species is adapting to a new environment with unique sensory challenges, then optimizations for sensory specializations may require trade-offs between sensory systems due to metabolic limitations for investment in costly neural tissue. We tested how sensory organs

and their corresponding brain regions evolved across ecological transitions to new habitats in snakes, including assessing potential trade-offs between systems. Using diceCT scans of museum specimens distributed across the snake tree of life, we generated volumetric and surface area data for sensory structures in over 70 snake species from terrestrial, fossorial, aquatic, and arboreal habitats. We found convergent variation in sensory syndromes across habitats, with fossorial and aquatic snakes showing the most extreme positions in morphospace. The visual and chemosensory systems showed some evidence of a negative correlation between them, but in general, we found minimal trade-offs between sensory systems. Instead, we found a complex interplay between different sensory systems that may point to integration among the senses having played an important role in their profoundly successful ecological and evolutionary diversification.

A-1098 (Oral)
International Assisted Colonisation to Address Climate Change Effects: Views from a High Latitude Island State Reinforce the need for Global Guidance

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Climate change is altering species distributions globally, generating intriguing dilemmas for conservation policy. “Climate-tracking” species may expand or contract their ranges via local dispersal, but many species of herpetofauna cannot take advantage of altered climate envelopes thanks to poor dispersal abilities. Island states at high latitudes, such as the United Kingdom, frequently have a low terrestrial herpetofauna diversity. Their climates are changing such that they will potentially become suitable for species whose native range is at a lower latitude, but which cannot colonise except by translocation, i.e., international assisted colonisation. Pursuing or not pursuing such a tool will have far-reaching consequences; not acting in this way could allow catastrophic range reductions in higher latitudes, but acting so will generate risks associated with the establishment of novel communities in lower latitudes. The views of 131 herpetofauna conservation practitioners in the UK were canvassed in order to contribute to discussions on policy governing international assisted colonisation. There was broad yet heavily caveated support for further exploration of this intervention. There was increased support for it after climate change effects had been discussed (46% in favour before discussion, 70% after). There was only equivocal support (6%) for a change in the approach to existing UK populations of non-native species. Participants broadly agreed on the need for more research, international agreement, and on maintaining conservation efforts for native species threatened by climate change. Discussions also highlight concerns around climate impacts being deployed as a questionable pretext for justifying inappropriate translocations, and the risk of undermining climate adaptation efforts in current range states. Given the complexity of the topic, and not under-estimating the challenges and necessary debates, I echo recent calls for international, cross-taxonomic guidance on whether and when to consider international assisted colonisation to address climate change impacts.

A-1099 (Oral)
How Comfortable are Vipers in Europe? An Update Based on Regional IUCN Red List Status

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For the practical purpose of regional Red List assessment, the IUCN has defined Europe in a strict sense as spanning from Iceland in the west to the Urals in the east, and from Franz Josef Land in the north to the Mediterranean in the south. The region includes the Canary Islands, Madeira, and the Azores, but does not include the Caucasus region in the southeast. This relatively small region is currently inhabited by approximately a dozen species of the family Viperidae mostly belonging to the genus *Vipera*, but also including the genera Macrovipera and Montivipera. About half of all these species are endemic to Europe. The most recent update of the regional IUCN Red List (RL) identifies less than half of European viper species as Least Concern (LC), the rest of them being Near Threatened (NT), Vulnerable (VU), or Endangered (EN) within Europe. Reports on global threatening status of the world reptiles and on the global conservation priorities for vipers were published in 2013 and 2016, respectively, with an attempt to promote and strengthen their conservation worldwide. Despite this recent evidence, conservation status of European vipers has not improved until present: the proportion of species recognized as threatened and NT has increased since the last regional RL report published in 2009 and the proportion of non-threatened ones has nearly halved. Almost all threats impacting majority of European viper species are anthropogenic: Wide-scaled habitat alteration, loss, and fragmentation due to conversion of natural habitats to housing and urban areas, tourism and recreation, as well as to construction of transportation and service corridors (roads and railroads), followed by intentional use of species and persecution (despite the progress of citizen science and

ecological education). Additionally, about half of European viper species are threatened by habitat shift and alteration due to climate change.

A-1101 (Oral)
The Presence of Endemic Amphibian Lineages Underscores the Biogeographic Significance of the Hindu Kush Himalaya Region

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The relict, endemic spiny frogs of the *Nanorana* subgenus *Allopaa* and genus *Chrysopaa* are key elements of the Hindu Kush-Himalayan amphibian fauna and may share a common biogeographic evolution, rendering them valuable tools for reconstructing the paleoenvironmental history of the Himalaya-Tibet-Orogen. Likewise, members of the genus *Scutiger* and the *Nanorana* subgenus *Paa* in the western Himalaya are of biogeographical interest because of their disjunct distribution and unexpected phylogenetic positions. However, little is known about the taxonomy, phylogeography, genetic diversity, and distribution of these taxa. We provide new molecular data of Himalayan spiny frogs and species distribution models (SDM) for *N. hazarensis* and *C. sternosignata*. The results revealed a better resolved phylogeny of these amphibians. Genetic diversity within these taxa is relatively low. The results strengthen support for the recently proposed out-of-Tibet-into-the-Himalayan-exile hypothesis and a trans-Tibet dispersal of ancestral lineages during the Paleogene. Moreover, SDMs provide distribution maps of *A. hazarensis* and *C. sternosignata* and strong evidence for distinct niche divergence among the two taxa. Our findings highlight the biogeographic importance of the Hindu Kush Himalaya region.

A-1102 (Oral)
The Second Global Reptile Assessment: Updating Red List Extinction Risk Assessments to Advance Reptile Conservation

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The results of the International Union for the Conservation of Nature's first Global Reptile Assessment (GRA), published in 2022, were the result of more than 15 years of collaboration between IUCN and more than 960 herpetologists worldwide and compile Red List extinction risk assessments for more than 10,000 species of reptiles. The results of this work indicated that at least 21% of reptiles are threatened with extinction (with 15% Data Deficient) and identified both common pressures on reptiles and differences between higher taxa in their risk of extinction. The GRA made a valuable contribution to better understanding the conservation needs of reptiles, especially squamates whose extinction risk had previously been less well-documented than threats to crocodilians or turtles. To advance on this work and enact on the ground conservation, however, it is vital for Red List assessments to be up to date. The number of described reptile species now exceeds 12,000, and nearly a quarter of previously assessed species were last assessed for the Red List before 2014. Changes in taxonomy, newly available data, and the emergence or diminution of threatening processes – including the impacts of climate change, which are believed to have been understudied during the first GRA - all have implications for a species' Red List status, and require that Red List assessments be updated at regular intervals. The second Global Reptile Assessment is presently underway, with a planned completion of 2030, having so far completed reassessments for the Seychelles, the Philippines, Europe, and the snakes of China, and assessed newly-described species from these regions for the first time. Reassessments are underway for North Africa, Central America, the Albertine Rift, and the Arabian Peninsula. Priority regions identified for reassessment include Mexico, Madagascar, the eastern Mediterranean, West Africa, and the snakes of Southeast Asia.

A-1103 (Oral)
Uncovering the Cryptic Diversity of "Ugly Brown Frogs" (*Limnonectes* "*kuhlii*" complex) on Borneo: A Genomic Perspective (Part 1)

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With over 200 species, the island of Borneo is a hotspot of amphibian diversity. Remarkably, many genera show little morphological differentiation among species (i.e., "cryptic diversity"), a phenomenon that has widely been identified in Southeast Asian frogs. A particularly striking example is the *Limnonectes* "*kuhlii*" species complex (Anura: Dicroglossidae), which comprises up to two dozen genetically highly divergent, but morphologically cryptic evolutionary lineages. Together they form a monophyletic group whose distribution is restricted to Borneo. In a first step, using mitochondrial data (16S rRNA) derived from extensive geographic sampling, we found that between two and six cryptic, but distantly related lineages occur in sympatry across many sampled localities. While some are endemic to a particular mountain range, other lineages are widespread across Borneo. To further investigate the diversity and species boundaries of this complex, we used target-capture sequencing to acquire mitochondrial genomes (mt-genome) and over 13,000 informative nuclear loci. The mt-genome tree was largely congruent with the traditional 16S tree, while the nuclear species tree showed some discordance by recovering certain lineages as paraphyletic, thus suggesting that gene flow could be present. Species delimitation analyses on mt-genome data corroborated

results from previous studies, suggesting that up to 42 undescribed putative cryptic species could occur on Borneo. Subsequent analyses of the extent of gene flow will provide a comprehensive assessment of the taxonomic status of these lineages as potential candidate species. These results are particularly important for the long-term conservation of this hidden diversity, as formerly widespread species probably consist of many distinct lineages with more restricted distributions, which are therefore potentially threatened by habitat loss or climate change.

A-1104 (Oral)
Overcoming the Lack of Data for Rare Bromeliad-Dwelling Frogs from Brazil

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With over 40% of species threatened with extinction, the distributional range of most amphibians is still unknown, generating uncertainty whether species are naturally rare, under-sampled, or difficult to detect. With very limited distribution data available, bromeligenous frogs are a case in point. Restricted to South America, bromeligenous frogs are strictly dependent on bromeliads, where they lay their eggs and complete their life cycle without leaving the plant. We implemented a modelling approach that uses bromeliads as surrogates to predict the distribution of habitat specialist frogs that lack distributional data. We aimed to predict and survey potential new sites for the occurrence of a rare and microendemic bromeliad-dwelling frog from the Atlantic Rainforest of Brazil. We used Maxent to predict suitable areas based on climate and topographic profiles, combined with 21 occurrence records of bromeliads within which our target frog species (*Crossodactylodes itambe*) is strictly restricted. The bromeliad-based models identified four areas potentially suitable, and subsequent surveys revealed an entirely new species (*Crossodactylodes serranegra*) of a rare bromeliad-dwelling frog in one of the areas. We demonstrate that using easy-to-survey surrogate species that have a strong relationship with species that are hard to detect has enormous potential to reveal crucial information on the potential ranges and distribution of cryptic taxa. Such a surrogate modelling approach could be extended to other habitat specialist species that lack distribution data, such as amphibians restricted to specific refugia and/or reproduction sites. This could improve the targeting of surveys and increase understanding of the patterns of rarity and the drivers of species distribution, especially for areas with high endemicity and range-restricted frogs.

A-1105 (Poster)
Restoring the Endemic Burmese Roofed Turtle to the Chindwin River of Myanmar

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The Burmese Roofed Turtle (*Batagur trivittata*) is a Critically Endangered endemic to the larger rivers of Myanmar. Once abundant, populations were driven to near-extinction, and today < 10 naturally occurring reproductive females persist in the wild; are all confined to a remote stretch of the upper Chindwin River. In 2003, an emergency captive breeding program was established at the Mandalay Zoo to stave off biological extinction. In 2006, nest patrols commenced on the upper Chindwin to collect and incubate naturally-deposited eggs in a protected *in situ* hatchery at the Linpha field station for a head start initiative. Today, the species' restoration effort includes five assurance colonies in Myanmar and a sixth colony at Singapore Zoo. As of December 2023, a total of 2,195 Burmese Roofed Turtles have been secured amongst the six assurance and breeding colonies. And, in 2024, nearly 1,000 eggs were produced amongst all in-country breeding programs. In 2010, a trial reintroduction was undertaken, releasing seven headstarted males in an attempt to boost fertility in wild females. This was followed in 2015 with the release of two groups of 30 headstarted turtles into the Chindwin River and Nam Thalet Chaung, respectively. From 2018 to 2023, three subsequent cohorts totaling 120 subadult individuals were released into the Chindwin, and in March 2024, another cohort of 50 individuals was released into an acclimation-pen on the river. Results to date have been mixed, with the unknown whereabouts of numerous turtles affixed with VHF transmitters. However, in 2018 and 2020, successes were witnessed with the findings of two small wild egg clutches and a naturally-occurring wild female in a remote northern stretch of the river depositing fertile eggs after several years of infertility. These findings suggest that at least some of the headstarted subadult turtles survived and are now contributing to wild reproduction.

A-1106 (Oral)
Diversity and Evolution of Vocal Sacs in Frogs and Toads

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Of the many features that make frogs and toads unique, vocal sacs are among the most charismatic ones. Vocal sacs are inflatable chambers present in adult males of most species and play a crucial role in multimodal communication. For this study we surveyed the anatomical and histological structure of vocal sacs in all major clades of frogs, based on direct examination of museum specimens. We described the diversity of each layer of the vocal sac (the gular skin, the submandibular musculature and the internal mucosa) and defined homology hypotheses that were optimized in the most recent and broadly-sampled phylogenetic hypothesis available for Anura. Vocal sacs are highly diverse in Anura, with hundreds of transformations along its evolutionary history. Single spherical vocal sacs are the most widely distributed vocal sac shape, present in 63% of known species, although some degree of lateralization (i.e., bilobate or paired vocal sacs) evolved several times in almost all anuran families. Moreover, 18% of anuran species lack a vocal sac, which were lost between 147 and 197 times independently, an astounding number considering their biological relevance. Our

observations provide detailed characters useful for taxonomic purposes in all anuran families, and result in a large dataset to test biological hypotheses on vocal sac function and diversity.

A-1107 (Poster)
The Effects of Salinity on Amphibian Species Distribution, Disease, and Diversity of the Cutaneous Microbiome in Monterey, CA, USA

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Anthropogenic climate change and infectious diseases are leading causes of amphibian population decline around the world. Changes in precipitation and salinity have reduced habitat availability and altered physiological performances impacting amphibian survival. The salt refugee hypothesis however, proposes that amphibians have stronger abilities to defend against pathogens in higher saline environments. We tested and expanded this hypothesis across a salinity gradient in Monterey, California, USA, by quantifying 1) the distribution of the endangered/threatened *Ambystoma californiense, Ambystoma macrodactylum croceum*, and *Rana draytonii* and the common *Pseudacris regilla* and 2) the prevalence and intensity of *Batrachochytrium dendrobatidis* (Bd) and the composition of skin microbial communities on the model species *P. regilla*. We hypothesize amphibians will be found in higher salinity and have lower Bd rates with higher bacterial diversity. The presence/absence of these 4 amphibian species at 19 sites, with salinity from 0.5 to 30 ppt, will be utilized in the Bayesian hierarchical occupancy model to estimate the probability of species occurrence with salinity as the variate for detection. Ten skin swab samples per site were collected from *P. regilla* for Bd prevalence and intensity (using quantitative PCR) and bacterial community composition (by amplifying the V4-V5 region of the 16S rRNA gene using the Illumina Miseq platform). Statistical analyses, including Adonis method, Kruskal-Wallis test, and PERMANOVA test, will evaluate the interaction between salinity, Bd presence/absence, and microbial diversity. Spearman rank correlation and Mantel test will explore correlations between salinity, Bd infection intensity, and bacterial community structure. These results will provide valuable insight for amphibian conservation efforts where environmental conditions continue to change.

A-1108 (Oral)
Association of a Single Amino Acid Replacement with Dorsal Pigmentation in a Lizard from the Qinghai-Tibetan Plateau

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Reptiles can evolve adaptive colors in different environments, but relatively little is known about the genetic mechanisms. Here, we identified the MC1R gene and its association with intraspecific color variation in the lizard *Phrynocephalus erythrurus*. Analysis of the MC1R sequence in 143 individuals from dark South Qiangtang Plateau (SQP) and light North Qiangtang plateau (NQP) populations, revealed two amino acid sites that showed significant differences in frequency between two areas. One SNP, corresponding to Glu183Lys residue, was found to be a highly significant outlier and differentially fixed for SQP and NQP populations. This residue is located in an extracellular area in the second small extracellular

loop within the secondary structure of MC1R, which represents an "attachment pocket" part of the 3D structure. Cytological expression of MC1R alleles with the Glu183Lys replacement showed a 39% increase in intracellular agonist-induced cyclic AMP levels and a 23.18% greater cell surface expression of MC1R protein in the SQP relative to the NQP allele. Further in silico 3D modeling and *in vitro* binding experiments indicated a higher MC1R-α-MSH binding for the SQP allele, and elevated melanin synthesis. We provide an overview of how a single amino acid replacement leads to fundamental changes in MC1R function, and hence shapes variation in dorsal pigmentation in lizards from different environments.

A-1109 (Poster)
Estimating Amphibian and Plant Community Responses to Wetland Restoration Techniques in Georgia

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Conservationists rely on habitat restoration as a foundational management tool to counteract declines of threatened and endangered species. Adaptive management, which integrates management, monitoring, evaluation, and feedback, is important for managers to assess the effectiveness of restoration and specific management actions. The Coastal Plain of the southeastern United States has experienced widespread loss and degradation of geographically isolated wetlands (GIWs) through historic alteration of their hydrology and natural or anthropogenic barriers to fire that allow encroachment of woody vegetation. Many imperiled and endemic amphibian species' that rely on GIWs for reproduction are particularly sensitive to this canopy closure. Thus, there is high conservation value to restoring GIWs with mechanical or chemical hardwood removal and prescribed fire reintroduction to enhance regional biodiversity. However, there is limited information on the effectiveness of restoring these wetlands for wildlife such as amphibians. In this study, we are conducting acoustic and dipnet surveys to detect larval and adult amphibians among four landscapes in southern Georgia, including more than 30 wetlands across a gradient of conditions from reference wetlands representing historic conditions to unrestored and restored wetlands. Vegetation surveys will characterize pre- and post-restoration conditions using a belt-transect method. The data will be analyzed using an integrated Bayesian hierarchical community occupancy model in R, originally developed for forest buffer management, and modified for this project. We predict that restored wetlands will exhibit higher amphibian and plant species richness than non-restored wetlands. Wetlands treated with both mechanical hardwood removal and prescribed fire are expected to show the least hardwood regeneration and the largest change in community composition. The results from this study will inform future wetland restoration management in the southeast, providing quantitative insights into amphibian-plant community interactions within an adaptive management framework that targets key plant species and rare amphibian taxa.

A-1110 (Poster)
Metapopulation Dynamics of Gopher Frogs (*Rana capito*) in Georgia

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Habitat loss and fragmentation lead to the breakdown of important population dynamics that determine population resilience on a landscape. The longleaf pine-wiregrass ecosystem of the southeastern U.S. has been reduced to less than five percent of its original distribution, leading to the imperilment of endemic, pond breeding species like the Gopher frog. In Georgia, Gopher frogs now exist primarily in small, highly isolated populations with few managed sites large enough to support more than one or two breeding wetlands. We know little about how Gopher frog population dynamics function in large intact landscapes that would have supported metapopulations for which the species evolved. Particularly, there is a lack of information on historical patterns of gene flow across unfragmented landscapes that were characteristic of Gopher frog habitat prior to wetland draining and land conversion. We have a relatively poor understanding of the factors that are important for structuring Gopher frog metapopulations and what factors may be important for management focus to increase connections among breeding sites and increase population persistence. There are only two sites in Georgia with Gopher frogs that are logistically feasible to study metapopulation dynamics: Ceylon Wildlife Management Area and the Jones Center at Ichauway. These sites have extensive areas of managed open, pine forest habitats with abundant terrestrial refugia and a high density of wetlands suitable for Gopher frog breeding. We will identify metapopulations, subpopulation structure, and how dispersal among subpopulations is affected by various habitats through integration of genetic and historic occupancy. This will inform conservation actions by defining management units, prioritizing wetland and upland habitats for restoration, and identifying areas for future translocations to increase subpopulation connectivity. Knowledge from these two sites will be applied to restore metapopulation dynamics on additional managed properties where Gopher frog populations are imperiled or have gone extinct.

A-1111 (Oral)
From Academia to Conservation: Achieving Impact with Science-based Conservation Actions

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Durrell Wildlife Conservation Trust is a conservation organisation created in 1959 with a mission to save species from extinction. One of Durrell's operational pillars, our science team works across our mission to provide evidence to guide our conservation strategies, monitor effectiveness of our actions and evaluate the impact we are achieving. In this talk, I will give an overview of the SAFE Programme, one of Durrell's global programmes aimed to secure the survival of amphibians across world's priority regions where there is a high risk of species extinction. In particular, I will share my experience as a conservation practitioner and how an academic background facilitated the establishment of a science-based conservation project to protect a rare group of bromeliad-dwelling frogs from Brazil – the country with the most amphibian species in the world and one of SAFE's priority region. In Brazil we work to protect small mountaintop frogs that are strictly dependent on bromeliads, a plant in which they complete their entire life cycle. Previous research demonstrated that population ecology and dynamics are highly influenced by habitat structure, with stochastic fire events negatively affecting colonization rates. Habitat structure was also extremely important for species persistence and distribution. In the short-term, habitat conservation was considered a priority action when compared to climate change mitigation. These results paved the way to establishing management interventions and targeted field surveys that can significantly improve the conservation status of these poorly known frogs from isolated mountains of Brazil.

These actions are underpinned and guided by the best science but are also supported by a robust network of conservation organisations, local communities and governments, allowing us to deliver effective amphibian conservation measures at scale and do our bit to prevent species extinctions before it is too late.

A-1112 (Oral)
Reptile Body Condition Responses along a Woody Encroachment Gradient in the Kalahari Desert, South Africa

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Woody encroachment has become a threatening process to open systems across the planet, with demonstrated effects on local animal diversity. We aimed to measure the impact of woody encroachment on the body condition of reptiles in a Kalahari assemblage, by testing whether reptile body condition is correlated with woody encroachment. Additionally, we assess whether body condition can be used as an indicator for population abundance responses to encroachment, by testing whether body condition measures were correlated with abundance measures (produced during previous work). We conducted four 18-day reptile trapping surveys along a woody encroachment gradient at Tswalu Kalahari Reserve, South Africa. We generated body condition indices (BCI) for all captured reptiles across nine species. We modelled the effect of (1) canopy cover and (2) the number of trees > 2 m height on BCI using multiple linear regression, while controlling for season and inter-site substrate variation. We modelled the relationship between mean site-specific BCI and estimated site-specific abundance using linear regression. The BCI measures for *Nucras intertexta* and *Psammophis leightoni* were positively correlated with canopy cover but, BCI measures for *Ptenopus garrulus* and *Psammophis brevirostris* were negatively correlated with the number of trees > 2 m. Mean BCI was positively correlated with estimated abundance across sites for *P. brevirostris*, but showed no clear trend for *Agama aculeata, N. intertexta* or *P. leightoni*. Body condition appears to be impacted by woody encroachment in the Kalahari, but the responses vary across different species. Unfortunately, BCI analysis alone does not appear to be a robust indicator for the effects of woody encroachment on population abundance in small, squamate reptiles. The species-specific effects of woody encroachment on reptile BCI support the idea that woody encroachment has the potential to reorganise naturally open systems.

A-1113 (Poster)
Factors Affecting Gut Microbiota Across a Hybrid Zone of a Legless Lizard (*Anguis*, Anguidae) in Central Europe

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The gut microbiome is an integral part of the vertebrate body playing a critical role in host function. Disentangling the host-gut microbiome interactions and factors shaping the gut

microbiome is therefore key for understanding drivers of eco-evolutionary processes. However, while the mammalian gut microbiome has been extensively studied, the gut microbiome of non-mammalian taxa, particularly reptiles, is poorly understood, let alone in the context of host genetic and geographic heterogeneity. Here, we used 16S metabarcoding to investigate the role of species identity, genetic admixture, geographic distance and elevation in the variability of the gut bacteriome across the secondary contact hybrid zone of two slow-worm species, *Anguis fragilis* and *A. colchica*, in central Europe. We found little evidence for the effect of spatial distribution or geography on the gut bacteriome of slow worms. Instead, divergence in community structure of the gut bacteriome was best explained by species identity, degree of admixture, and elevation. Divergence in community structure was driven by the abundance of bacteria from the families and genera Lachnospiraceae, Rikenellaceae, *Clostridia, Parabacteroides* and *Bacteroides*, from which Lachnospiraceae, *Parabacteroides*, and *Bacteroides* comprise species and strains that are known beneficial digestive tract symbionts of vertebrates. Our results show for the first time in reptiles that rather than geographic spatial distribution, factors related to species identity and degree of admixture in their natural hybrid zone play a primary role in shaping the gut bacteriome of two hybridizing species of slow worms. Among geographic factors, we showed that it is elevation that most likely shifts the diet of slow-worm lizards and thus shapes their gut bacteriome community structure. This study is the first to make a significant contribution to understanding the factors that affect host-gut microbiome interactions and the eco-evolutionary processes that shape populations of reptiles across their hybrid zone.

A-1114 (Oral)

Kissing Cousins? Do Evolutionary Relatedness and Difference in Body Size Drive Global Misdirect Amplexus of Amphibians?

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Conspecific recognition is an essential step in species reproduction. Misdirected reproductive events involving heterospecific individuals (interspecific amplexus) have been reported for amphibians. These can impact populations by reducing the fitness of individuals involved since these will likely not generate viable offspring or by generating hybrid individuals. Thus, interspecific amplexus have important ecological and evolutionary consequences. Yet, this behavior is still poorly explored, especially regarding how amplected males select amplecting individuals or if these pairings are randomly assorted. Since phylogenetically-related species are more likely to be mistaken for conspecific females and since size is a proxy of female fitness, we test if amplecting males select individuals that are phylogenetically closer and with a larger body size. We used a previously compiled database of misdirected amplexus and used a buffer of 5 kilometers around each interspecific amplexus event to generate spatially-explicit local communities. We calculated both the scaled phylogenetic distance and the scaled difference in snout-to-vent length (SVL) between the recorded amplecting species and each potential amplected species in the community. We then tested whether these were different than expected by chance compared to those between the observed amplecting species pair using Wilcoxon signed rank tests. We also tested if phylogenetic and size sorting are correlated with local richness and whether these patterns differ between temperate and tropical regions. Our results show that amplecting males likely select individuals from closely-related species and that are larger than conspecific females. Neither phylogenetic distance nor differences in body size were correlated with local richness. However, in the tropical region males tend to select

individuals from species that are more phylogenetically-related than in the temperate region. Overall, we suggest that misdirected amplexus is likely not a random process and that it is influenced by evolutionary relatedness and morphology.

A-1115 (Poster)
Population Dynamics, Detectability and Behavior of Tiger Snakes (*Notechis scutatus*) in Perth's Urban Wetlands

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Wetland habitats can be affected by the changes brought about by urbanisation such as the alteration of wetland hydrology, surrounding habitat structures and the introduction of anthropogenic contaminants. The health of wetlands can be reflected by top predators that inhabit these ecosystems, and Western tiger snakes (*Notechis scutatus occidentalis*) in southwestern Australia have been shown to be an ideal bioindicator. The continued persistence of these top predator populations in these urban wetlands is impertinent towards a wetland ecosystems health. Understanding their population dynamics and behavioural ecology in response to anthropogenic activity is pivotal towards getting a snapshot into their continued persistence in urban wetlands and can induce better management and conservation of this top reptile predator. In this study, I investigated the population size, survival rates and rates of capture of western tiger snakes in three different wetlands in Perth, Australia. The wetlands differed in their degrees of urbanisation, environmental contamination levels and habitat structures. I used a mark-recapture method to investigate their recapture rate and population sizes using Jolly-Seber models. I also investigated the behavioural response of tiger snakes in response to different human interactions and incorporated environmental, snake body condition and human presence variables. I found that of the three chosen wetlands, the most urban-impacted wetland contained the largest population size and survival rate, while the most natural wetland that was located outside the urban matrix had no recaptures. I found no association in two of the three human-snake interactions with the predictor variables and found that despite the larger human densities in the urban wetlands, the snakes had no behavioural variation amongst the three sites. Future investigation needs to be carried out on urban snakes and if their response rates differ to natural wetlands and if higher anthropogenic activity brings about increased plasticity in these urban populations.

A-1116 (Oral)
Beyond Color: Ecological and Mechanistic Drivers of Eggshell Reflectance in Reptiles

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The great diversity of color and color patterns of avian eggs have been the subject of great interest to scientists for centuries. Camouflage and mimicry are well-recognized functions explaining this diversity. However, among the main risks to embryo survival is the exposure to extremely high or low temperatures and/or damage due to harmful radiation. Thus recently, other essential functions of eggshell reflectance including thermoregulation and photoprotection have become evident. These functions are mostly associated with the optical

properties of eggshells in the ultraviolet and near infrared regions of the light spectrum (beyond human-visible wavelengths). The optical properties of reptile eggs have never been investigated. However, reptiles reproduce in a wide range of environments and lay their eggs in sites that vary strongly in the degree of exposure to solar radiation. Reptiles also lack parental incubation, so their eggs develop under a microclimate that is completely determined by local climatic and edaphic factors. Thus, we could expect that reflectance of their eggshells correlates with nesting conditions. Here, we performed an analysis of eggshell reflectance across the UV-visible-NIR range of a broad sample of reptile eggs. We examined the association between nesting ecology, eggshell structure and their optical properties to test the hypothesis that if reflectance serves photoprotective or thermoregulatory functions, eggs exposed to solar radiation should have high reflectance in the UV (photoprotective) and NIR (thermoregulation) regions. Our findings show that eggshell structure is the strongest determinant of reflectance and that an association between the type of nest and NIR reflectance exists but in the opposite pattern to our predictions. We also performed a comparison with our previous findings from avian eggshells and discuss the relevance of this contrast in the context of the evolution of amniote eggs in relation to environmental change.

A-1117 (Oral)
First Evidence for Zoopharmacognosy in Amphibians

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The self-treatment of diseases in animals, known as zoopharmacognosy, has so far only been described for some insects and higher vertebrates like birds and mammals. In this study, we show for the first time that such behaviour is also exhibited by amphibians, in particular all five species of the West-African endemic Sabre-toothed frog family Odontobatrachidae. Saber-toothed Frogs regularly ingest leaflets of a particular riparian tree. The reason behind this unexpectedly peculiar and recurrent behaviour has thus far remained unknown. The leaflets are not eaten by syntopic frog species of similar size. We compared intestinal parasite loads in all five Sabre-toothed Frog species and the syntopic frogs *Conraua alleni*, *Astylosternus occidentalis* and *Sclerophrys togoensis*. All Odontobatrachus species had significantly higher parasite loads, indicating high selective pressure for a parasite remedy. In a feeding experiment we provided a standard diet of ants (control) adding a small number (low dose treatment) or a large number of leaflets (high dose treatment) to 120 *Odontbatrachus arndti*. Frogs were kept until defecation and the parasite load in the faecal sample was determined. High dosage group frogs excreted significantly more nematode parasites than control or low dose treatment frogs. In a subsequent experiment, we fed the leaflets to the South-African River frog *Amietia poyntoni*, a species inhabiting areas where the leaflet does not naturally occur. Leaflet treated *A. poyntoni* not only excreted a larger number of nematodes compared to the control treatment, but also other helminthic parasites, that never showed up in the faeces of control animals. Our experiments strongly support that the leaflet helps to eliminate helminthic parasites from the intestines of Saber-toothed Frogs. While the exact effect of the leaflet remains to be clarified,

we conclude that it constitutes a remedy against parasites and therefore represents first evidence for zoopharmacognosy in amphibians.

A-1118 (Oral)
Multi Stakeholders' Engagement in Conserving the Indonesia's Rarest Reptile, the Rote Island Snake-Necked Turtle (*Chelodina mccordi*)

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The Rote Island Snake-necked Turtle (*Chelodina mccordi*) is currently identified as the most critically endangered endemic reptile species in Indonesia. Historically, rampant exploitation has precipitated a drastic population decline, with no recorded sightings in surveys since 2010. This local extinction is compounded by the presence of the invasive species such as the predatory fish *Chana striata* and the poisonous Asian common toad *Duttaphrynus melanostictus*, resulting in further habitat degradation, and posing a considerable threat to hatchlings. Despite conservation efforts, such as the release of 40 individuals into Lake Peto in 2009, encountering challenges, including incomplete critical release phases. Ongoing endeavors to establish a viable population continue to receive support from diverse stakeholders. This study aims to comprehensively review the past and ongoing conservation initiatives for the species. To achieve this, several strategies have been proposed, including the repatriation of 500 captive-bred turtles over 10 years; the establishment of a colony assurance facility and on-island captive breeding program; protection of critical wetland habitats; development of a reintroduction and long-term monitoring protocol; and community engagement to reach conservation objectives.

A-1119 (Oral)
Genome Assembly of the Dyeing Poison Frog and Low-Input Genotyping using Transposable Element Insertion Sites

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Ongoing developments in sequencing technologies have decreased the costs associated with sequencing, greatly enhancing our ability to assemble large and complex genomes. Additionally, the development of new methods for building reduced representation libraries over larger parts of the genome is accelerating. In this talk, we briefly introduce the new high-quality genome assembly of the Dyeing poison frog, *Dendrobates tinctorius*. Despite the anticipated high prevalence of transposable elements (TEs), our assembly achieves a level of completeness approaching that of a chromosome scale assembly. Research on TEs has increased considerably over the past decade as it became evident that they can exert a

significant influence on evolution. TEs can increase mutation rates, influence the regulation of gene expression, and thereby contribute to adaptation or speciation. The quantification of the evolution of TEs in amphibians has the potential to enhance our comprehension of the role that TEs play in genome organisation and the evolution of phenotypic and ecological novelty. Leveraging this new genome assembly, we present a population-scale genotyping approach that uses the 5'-ends of selected TEs as anchor points to sequence the flanking region at insertion sites. This method, published in 2018 as MobiSeq, was developed for use on mammalian targets; here, we have adapted it for amphibians. This method allows us to investigate the surrounding genomic environments of TEs to explore SNPs for population genomics and kinship analysis. This enables us to gain a deeper understanding of the evolutionary potential via TE-mediated insertion events. Notably, MobiSeq requires minimal DNA, facilitating less invasive sampling. Finally, we discuss the challenges associated with the use of MobiSeq, particularly when genomes contain a high proportion of repetitive elements. We also provide recommendations for further improvements of the MobiSeq method.

A-1120 (Poster)
Morphological Diversity and Taxonomic Studies of Chinese Tadpoles

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Phenotypes are the foundation of understanding and studying biodiversity. Despite significant strides in understanding the taxonomy, ecology, and evolution of adult amphibians in China, research on tadpoles remains inadequate. Presently, 40 percent of Chinese Anura species lack descriptions of their tadpole phenotypes, while 70 percent cannot be identified due to the limited morphological characteristics described for tadpoles. Furthermore, there are some mistakes in identifications due to sympatric distributions or historical taxonomic changes of some species. Finally, the ecomorphological diversity of Chinese tadpoles remains unexplored. From 2021 to 2024, we collected over 7,000 tadpole samples and more than 15,000 tadpole photographs from 916 sampling points across China. Genetic sequencing of over 2,600 tadpole samples using the COI gene revealed the presence of more than 307 species belonging to 41 genera across eight families in China, covering about 75.9% of the total genus-level tadpole classification in China. A key to Chinese tadpoles has been unveiled, shedding light on their diverse living environments. Ecomorphological guilds for Chinese tadpoles were suggested using geometric morphometrics. A book and a website about Chinese tadpoles are being prepared.

A-1121 (Oral)
Amphibian Species Description Trends: What Affects Descriptions and Where do They Come from?

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In 1753, Linnaeus published a new taxonomic classification system which led to the start of what is now over 250 years of efforts to describe all species currently known on the planet. Amphibians are of specific interest when it comes to species descriptions, as they are the vertebrate group with the highest number of species threatened with extinction.

Simultaneously, they are still predicted to have one of the highest number of species that are not yet described. Previous studies have primarily focused on future descriptions, on smaller biogeographic regions or a shorter timeline. In this study we aimed to assess trends in species descriptions over time since the initial descriptions in the 1700's to present. We looked at every species description we could access and investigated patterns over time, how these vary by biogeographic region, and how patterns related to first authors in terms of how prolific they were as well as their gender, institute and country of origin. The result show that in some regions the number of species being described is still increasing rapidly, as is the representation of women in species descriptions and that the patterns of who is describing where is changing. The plateau expected for species descriptions have not been reached yet in multiple biodiverse regions around the world, however, gender representation appear to be improving and in some regions so is the local representation.

A-1122 (Poster)
Species Recovery Programme: Inger's Dwarf Toadlet

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Introduced in 2015, the species recovery programme is part of the Nature Conservation Masterplan which outlines NParks' plans to coordinate, strengthen and intensify our biodiversity conservation efforts. The species recovery programme aims to conserve native flora and fauna by targeting endemic, rare or threatened native species in Singapore though reintroduction, habitat enhancement and protection efforts. Some species targeted by the recovery programme occur in small populations in only a few places. The Inger's Dwarf Toadlet (*Pelophryne ingeri*) is one such species, and is known to occur in only a restricted area in Bukit Timah Nature Reserve, only approximately 163 ha. Little is known about the Inger's Dwarf Toadlet in Singapore. In fact, only until recently, it was recognised as a new species, previously known as *Pelophryne signata* (Matsui, 2019). To ensure the survival of the species, NParks has placed it in the Species Recovery Programme. This programme aims to conserve the Inger's Dwarf Toadlet through 4 steps: 1. Determine the distribution of the toadlet throughout Singapore through passive surveys and literature review; 2. Conduct a population study of toadlets at Bukit Timah Nature Reserve through traditional capture recapture as well as spatially explicit capture recapture (SECR) to obtain a baseline population estimate before any conservation measures are applied, and after; 3. Implement *in-situ* measures to promote breeding at Bukit Timah Nature Reserve through the placement of artificial phytotelms of varying heights; and 4. Explore the breeding and translocation of the species. This poster outlines the progress of the Species Recovery Programme thus far.

A-1123 (Oral)
Skin Microbiome on Asian Amphibian Hosts associated with Resistance to *Batrachochytrium dendrobatidis*

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Chytriomycosis caused by the two chytrid fungal pathogens, *Batrachochytrium dendrobatidis* (Bd) and *B. salamandrivorans* (Bsal), attributes to global amphibian declines. Both pathogens have originated in East Asia, a chytrid diversity hotspot, where native host species have evolved immunity to chytridiomycosis. It has been shown, outside of Asia, that host skin microorganisms provide protection from chytriomycosis. However, the potential factors for Asian hosts' resistance to virulent chytrids are poorly understood. We investigated the associations of host skin microbiome with Bd pathogen in Southern China where putative BdASIA1, BdASIA3 and BdGPL lineages coexist. We used 16S rRNA and fungal inteal transcribed spacer (ITS) gene sequencing to characterize the skin microbiome of four native Asian amphibian species and examined the relationships between Bd infection and their skin bacterial and fungal communities. We found that both skin bacterial and fungal community structure and compositions were significantly associated with infection status and intensity. The bacterial genera *Prevotella* and *Sphingomonas* positively correlated with infection intensity, and Prevotella was enriched in Bd-infected frogs. Furthermore, the bacterial genus *Bacteroides* and fungal order Helotiales were positively correlated with infection intensity, enriched in Bd-uninfected frogs. Richness and proportion of the putative anti-Bd bacteria correlated with Bd infection status and intensity. We also found that the microbial co-occurrence network of infected frogs was significantly different from that of uninfected frogs and was characterized by more keystone nodes and larger proportions in correlations between bacteria, suggesting stronger inter-module bacterial interactions. These results indicate that the interactions between Bd and certain microbes and the interplay between bacterial and fungal communities pose critical effects for Asian hosts' resistance to the multiple Bd lineages.

A-1124 (Oral)
Phylogenetic Network of Malagasy Gemsnakes (Pseudoxyrhophiidae)

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Gene flow between organisms facilitates speciation and adaptation in many taxa across the tree of life. Stabilizing the genome after introgression happens quickly; successful introgression is found in areas of high recombination and is purged over tens of generations to uncouple deleterious gene flow from major parent ancestry. In some cases, like humans, less than 3% introgression remains after less than one million years. However, in many cases of hybrid speciation, considerable amounts of introgression persist within the genome for many millions of years. We explore the consequences of hybridization after this initial stage of stabilization by identifying many instances of hybrid speciation that occurred between 1 and 15 million years ago in the family of gemsnakes (Pseudoxyrhophiidae). This ecologically diverse group was previously shown to have rampant hybridization, though identifiability of some events was

not possible with the limited AHE genomic dataset. Here, we sequenced the genomes of 109 species of the gemsnakes to infer a whole genome phylogenetic network for the group. With non-overlapping adjacent sliding windows, we inferred the network using summary statistic and likelihood-model methods.

A-1125 (Oral)
Intergenerational Plasticity, as Well as Within Generation Plasticity, Influences Thermal Preference of *Ambystoma mexicanum* at Three Time Points

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Genetic change via evolution can take many generations, but intergenerational plasticity (IGP) can allow parents to produce offspring with phenotypes that match current environmental demands in a single generation. Parental effects on offspring in response to environmental cues are well documented in general. However, whether parental thermal environments can prime offspring to adapt to thermal conditions is largely unknown. To assess this capacity for thermal intergenerational plasticity, as well as within generation plasticity, we created a half-sibling design and performed a randomized block experiment with two temperature treatments over three different exposure stages using the axolotl, *Ambystoma mexicanum*. We tested how maternal, incubation, and late-rearing acclimation temperatures and their potential cumulative interactions affect offspring thermal preferences. We found that egg incubation temperature was positively correlated with offspring thermal preference immediately after hatching, consistent with a developmental acclimation effect. In older larvae, both late-rearing temperature and the three-way interaction among maternal, incubation and rearing temperature positively affected offspring thermal preference. Larvae with a consistent thermal history at 18°C had the lowest thermal preferences, almost 2°C lower than their counterpart larvae raised consistently at 21°C, which had the highest thermal preference. Our results demonstrate thermal IGP and within-generation plasticity in amphibians. With the positive cumulative interaction between maternal, incubation, and rearing temperature, larvae can quickly increase thermal preference in response to rising temperatures, providing a potential physiological buffer to climate change. We demonstrate that thermal IGP is a real possibility, which is critical because growing evidence suggests that IGP might be an essential adaptation available to organisms needing to escape climate change. This information will be useful to more accurately predict future population level extinction probabilities, alter management decision to focus on species lacking IGP rescue, and continue to broaden our understanding of the importance and complexity of IGP.

A-1126 (Oral)
Multi-Omics Insights on the Evolution of Aposematic and Cryptic Phenotypes in *Oophaga* Poison Frogs

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Aposematism and crypsis are two radically different predator-avoidance strategies. In *Oophaga granulifera* and *O. pumilio*, two polytypic poison frog species, some populations display aposematic (red) while others display cryptic (green) phenotypes. We hypothesized that these divergent phenotypes are the product of differential gene regulation that can be revealed by integrative analyses of gene expression and multivariate phenotypic traits. We generated comprehensive transcriptome assemblies of each species and quantified the expression of orthologous genes to test the relationship between gene expression profiles and skin coloration and alkaloid defense traits across species. We found that multiple color-associated genes in the carotenoid metabolism, melanin, pteridine, and guanine synthesis, plus other coloration-associated genes, are differentially expressed between red and green phenotypes of each species but only a reduced fraction of these genes were shared between the two species. Using cross-species coexpression network analyses, we were able to identify conserved gene modules across species and propose new candidate genes associated to color and alkaloid sequestration traits. Multi-omics integration analyses allowed the identification of the main changes in gene expression associated with the variation in colorimetric and alkaloid composition variables. Our findings support the polygenic nature of the skin coloration phenotypes in *Oophaga* frogs and suggest that shifts from aposematic to cryptic phenotypes involve different regulatory mechanisms in these frogs.

A-1127 (Oral)

Digital Imaging of Historic Slide Collections Provides an Essential Online Resource for Herpetology: Bringing Dark Data to Light

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The Harvard Museum of Comparative Zoology (MCZ) has in the last few years acquired several historic slide collections that were the basis for hundreds of published studies of the evolution, development, morphology and systematics of vertebrates. Among these collections are several of particular interest to herpetologists, including those of Angus d'A. Bellaiirs (reptile morphology and development), Inez Whipple Wilder (salamander metamorphosis), R. Glenn Northcutt (neuroanatomy and embryology of amphibians and reptiles), and James R. Stewart (lizard viviparity), among others. These slides are now being prepared as digital images that are freely accessible online. We use a high-throughput, semi-automated, whole-slide imaging (WSI) workflow developed jointly with the Harvard Center for Brain Science. Digital media are available via two Internet portals configured with software tools for image viewing, downloading and analysis: MCZbase, MCZ's permanent specimen database; and MorphoSource, an NSF-supported online repository for specimen digital imagery. Open access to the thousands of serial sections enables their routine use in fields ranging from comparative neuroscience to evolutionary developmental biology, from vertebrate morphology and systematics to computer science. Moreover, by employing both a WSI workflow that is applicable to other slide collections and protocols for access and visualization that utilize a shared online resource, we provide an exemplar method for rapid and cost-effective digitization that can be used by other natural history and biomedical institutions, whose slide holdings number in the millions, most of which remain dark data. We encourage interested users to adopt these materials in their research and teaching. Supported by the U.S. National Science Foundation, award no. DBI-2122620 to James Hanken.

A-1128 (Oral)

Diversifying Conservation Leadership to Protect Earth's Most Unique and Irreplaceable Herpetofauna

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Equitable and effective conservation outcomes require a diverse cohort of leaders from around the world. For almost two decades, ZSL's EDGE of Existence programme has been supporting emerging conservation leaders from the Global South–known as EDGE Fellows–to become champions for some of the most unique and threatened reptiles and amphibians on Earth. EDGE has supported conservation work on 35 amphibian species since 2009 and 22 reptile species since 2017. Here, I will give an overview of EDGE's model for supporting early career conservationists, discuss the history and achievements of EDGE Fellows over the past 15 years, highlight the priority EDGE amphibians and reptiles in Asia and beyond, and outline how early career conservationists from the Global South can engage with the EDGE programme.

A-1129 (Oral)
Reproductive Decisions by Anurans in a Changing Savanna Ecosystem

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Amphibians must overcome major challenges in order to survive and successfully reproduce in tropical savanna ecosystems. Each year they face harsh climatic conditions, including a rainy season with limited and unpredictable rainfall. The rainy season is particularly important for amphibian reproduction, and most pond-breeding species seem to select sites according to the requirements of their aquatic larvae (i.e., tadpoles). Using tadpole and (micro-)habitat data collected from 68 different ponds in Comoé National Park, West Africa, we show that breeding phenology is ultimately crucial for most savanna anurans. Water availability, habitat structure, but also pressure from predators and competitors, all change gradually during the rainy season, so most species tend to breed at specific times. In addition, Comoé National Park has recently experienced major ecosystem changes, which were most likely triggered by massive war-driven loss of large herbivores ca. 10–20 years ago. Using baseline data collected in the 1990s from the same sites, we show that amphibian communities shifted significantly in response to habitat changes. There was a near three-fold increase in average pond vegetation cover (from 16.0% to 45.6%), which for instance benefitted species of the leaf-folding genus Afrixalus, whereas other species declined. Those changes in anuran occurrence are not only a consequence of massive defaunation in the local area, but they are also related to interspecific differences in breeding requirements. Our results shed new light on the complex reproductive decisions that savanna anurans make to increase the survival of their offspring, and how reproductive success ultimately depends on other ecosystem components such as large herbivores.

A-1131 (Oral)
Observation of Turtles Feeding on Fig Fruits at Tawau Hills Park, Sabah, Malaysia

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Borneo is known for its rich biodiversity and unique wildlife. Freshwater and land turtles stand out as one of the most interesting and lesser observed species groups. Freshwater and land turtle are known for their diverse and opportunistic feeding habits, with a range of food sources taken. The observation was conducted to document the species of wildlife feeding on the fruits of the fig trees specifically on species of turtle. Tawau Hills Park is the study sites where these behaviour of the turtle foraging on fruits of few species of fig trees were observed. It is a primary rainforest located in eastern Sabah, Malaysian Borneo. The observation under the fruiting fig trees were done from the year of 2021 until 2023. Out of six different species of strangler figs observed which are *Ficus subcordata, F. stupenda, F. cucurbitina, F. dubia, F. sumatrana* and *F. forstenii*, four were consumed by the turtles. Overall, we recorded four species of turtles known as South Asian Box Turtle (*Cuora amboinensis*), Malayan Flat-shelled Turtle (*Notochelys platynota*), Asian Leaf Turtle (*Cyclemys dentata*) and Asian giant hill tortoise (*Manouria emys*) feeding on the fruits of the figs which are *F. stupenda, F. forstenii, F. dubia* and *F. subcordata*. The Malayan Flat-shelled Turtle was feeding on dropped ripe figs of *F. forstenii*. The South Asian Box Turtle was feeding on *F. stupenda*. These observations highlight the ecological importance of freshwater turtles for seed dispersal, as the undigested fig seeds are excreted by the turtles in different areas, aiding in the dispersal and regeneration of fig trees within their habitat. In conclusion, these observation shows that turtles have an important role in the ecosystem as seed dispersers.

A-1132 (Oral)
REAL: The Potential of Herpetofaunal Habitats for Community-based Tourism in Borneo

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Herping remains on the periphery of acknowledged niche tourism markets. This paper proposes a need to explore the potential value of herpetofauna habitat as a niche tourist attraction for community-based tourism (CBT) using the REAL model. Herping enthusiasts pursue this unusual hobby with the primary motivation to practice or enjoy this special interest encompassing elements of photography. Niche markets usually attract a small number of high yield, dedicated visitors willing to travel to rural areas where it is possible to find herpetofauna. Such tourists are highly motivated to consume meaningful experiences that are sustainable and provide Rewarding, Enriching, Adventuresome and Learning opportunities. This REAL model proposed by Read (1980) could be used to educate local communities about the potential of herping tourism. The four stages impart an understanding that tourists seek rewarding experiences initially to view and to photograph herpetofauna but at enrichment, tourists seek to learn and understand fauna in more depth. Adventuresome stage allows for some risks and challenges from seeking the fauna out themselves or clicking the perfect photo. The final stage allows for reflection to gain deeper understanding of the experience. Presently, CBT is on the rise in Sabah focused on hiking trails, waterfalls, and cultural aspects. We propose there is a need to first, impart an understanding of the REAL model and secondly, to identify herpetofauna on hiking trails to educate local communities about the range of reptiles and amphibians which may be present on these trails to open up a new avenue to hikers: herping

tourism as an additional offering. Imparting tourism knowledge would add to the meaningful experiences sought by rural tourists and herping enthusiasts. This would also encourage conservation of herpetofauna habitats. Opportunities abound to promote herpetofauna either nocturnal, arboreal, fossorial, or cryptozoic in tandem to hiking as a niche tourism attraction.

A-1133 (Oral)
Snakes of Tawau Hills Park With Identification Emphasis on *Calamaria*

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The most complete snake checklist has been produced for Tawau Hills Park, showing the remarkable snake diversity in this forest park. The current checklist is a significant increase compared to the first published species data from an expedition in the region 35 years ago. The checklist includes seven years of snake records from the author's team combined with credible sighting data from staffs, visitors, and past researchers in the park. A total of 62 species of snakes has been recorded in Tawau Hills Park, which includes six species of *Calamaria*, including a potential new species. The *Calamaria* genus is poorly recorded from this area due to its scarce sightings and identification complication. This checklist can include *Calamaria* species as there is finally proper trapping and identification methods done by the author's team. There is still possibility of new species record for the checklist but the current record is enough to demonstrates that Tawau Hills Park is one of the top snake diversity hotspots in Borneo.

A-1134 (Oral)
Integrated Mesocosm, Theoretical, and Field Approach to Understand Habitat Variation and Legacy of Past Disturbances on Wood Frog Susceptibility to FV3

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Infectious diseases are an important contributor to amphibian declines worldwide. Both habitat variation and exposure to pollutants can independently and interactively shape amphibian disease outcomes. For example, by enacting selective pressure on amphibian populations, the legacy of past disturbances, including pollutants, can lead to costs that can interact with habitat factors to shape disease outcomes. To understand how habitat factors and evolutionary responses to pollutants interact to shape disease outcomes in amphibians exposed to frog virus 3 (FV3), first, we conducted a mesocosm experiment that evaluated the interaction between habitat factors (complexity or depth) and evolutionary history with pollutants on wood frog susceptibility to FV3. Second, we used data from the mesocosm experiment to parameterize an agent-based model to better understand mechanisms for how habitat factors influence disease outcomes. Lastly, we conducted a field survey to explore our empirical and theoretical findings in a natural context. In the mesocosm study, as habitat complexity increased, survival rates increased. Additionally, pesticide tolerant tadpoles had higher survival than pesticide non-tolerant tadpoles but only in shallow and not deep mesocosm treatments. Our model suggests that decreased transmission of FV3 in more complex habitats is related to foraging behaviors-. Foraging hosts in more complex habitats had lower contacts rates than hosts in less complex habitats. Additionally, foraging hosts in shallower environments had higher contacts rates with

dead individuals due to their increased exposure to dead individuals at the bottom of the mesocosm. In the field, we found that plant richness (a metric of habitat complexity) was not associated with FV3 loads but ponds with higher amphibian richness had higher overall FV3 loads. Collectively, our studies underscore the complexity of factors influencing susceptibility to FV3 and highlight the potential strengths for utilizing an integrated lab, theoretical, and field study approach to study amphibian diseases.

A-1135 (Oral)
Detection and Processing of Infrared Stimuli in Snakes

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Infrared (IR) sensation allows for the detection of objects based on the amount of radiant heat they produce. Among vertebrates, three families of snakes have evolved IR sensitivity: boas, pythons, and crotalines. Snakes use IR sensing primarily in prey capture, although its use in nesting and thermoregulation has also been proposed. In all three groups, specialized pit organs on the snout detect IR stimuli using free nerve endings of the trigeminal nerve, which projects to nuclei in the hindbrain; IR information is then sent to the optic tectum (OT) where it is integrated with other sensory information to direct behavior. Previous research in crotalines has shown that IR sensing enables snakes to precisely strike warm objects in the absence of any other sensory input. The OT generates an egocentric map, allowing for high spatial accuracy in directing strikes. However, positional information alone is often not enough to guide behavior, as IR-emitting prey animals frequently move. We are using juvenile Python regius as a model to understand whether and how motion is used by the IR system to guide behavior. Using an electrically controlled heating device mounted on a robot, we can control moving IR stimuli similar to those a snake would encounter in a natural hunting scenario to examine responses to different types of motion. These results will allow us to examine the capabilities and limitations of the IR system, as well as to generate hypotheses regarding the function of IR responsive circuits that we will test through electrophysiological recordings from tectal neurons. This work is the first step in a series of experiments that aim to understand the processes underlying integration of visual and IR stimuli and shed light on the mechanisms that allow the construction of coherent representations of the world when multiple sensory inputs are involved.

A-1136 (Oral)
Of Toads and Toxins: Shrinking Toxin Glands but Stable Toxin Composition Indicate Directions and Constraints of Adaptation in Invasive Populations of an African Toad

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Many amphibian species use chemical defenses to avoid predation, yet, how these defenses vary between populations, or change as populations colonize novel habitats is not well understood. The Guttural Toad (*Sclerophrys gutturalis*) has established three invasive populations, located in Mauritius, Réunion, and Cape Town. All of these populations originated from a clade located at the port city of Durban in eastern South Africa, providing an excellent study system to examine how biological invasions drive phenotypic change. To investigate how toad chemical defenses may have shifted along their invasion path, we compared the relative size of the parotoid glands (as a correlate of toxin quantity) and the composition of the toxic secretions that exude from these glands (as an indicator of toxin potency) between native and invasive populations. While the two oldest invasive populations, Mauritius and Réunion, showed pronounced convergent decreases in gland size, the toxin composition remained stable between all populations. These results indicate that the invasive populations of this chemically defended toad may have experienced reduced predation pressure in their novel habitats, which resulted in reduced selection pressure for defense. Furthermore, within the native populations, gland size may also be a more variable trait than toxin composition. Integrating both quantitative as well as qualitative information will help us better understand the evolution of chemical defenses in animals and could aid in predicting if and how chemically defended invasive species colonize novel environments.

A-1137 (Oral)
Impact of Habitat Transformation on Eco-Physiological Traits of Endangered Poison Frogs from a Biodiversity Hotspot

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Changes in vegetation cover and land use caused by anthropogenic activities influence the way in which species interact. Novel or extreme conditions can generate changes in the behavior, morphology, physiology, and life history traits of species, generating a state of physiological stress that affects the health status of entire populations. Amphibians are a suitable model to evaluate the effects of habitat transformation. Their low dispersal capacity, the permeability of their skin, and their susceptibility to aquatic and terrestrial disturbances can cause more drastic changes in the ecology of their populations compared to other organisms. We used two critically endangered species of poison frogs from a biodiversity hotspot, the Colombian Pacific lowlands, to investigate whether there is a relationship between perch use, body condition and hormone-induced stress, and the transformation of natural ecosystems in which these frogs occur. We expected frogs from highly transformed habitats to use lower perches, and to have lower body condition and higher levels of stress hormones than frogs in undisturbed

habitats. We collected data on habitat use, water-hormone samples, and body condition from 24 individuals of *Oophaga histrionica* and 30 individuals of *Oophaga sylvatica* in three habitats differing in their degree of anthropogenic intervention. Our preliminary findings hint at differences in body condition and stress response, but not perch use, across the disturbance gradient. Our results contribute to understanding how landscape transformation is affecting different life history traits on species, populations, and individuals in the most globally threatened group of vertebrates.

A-1138 (Oral)

Global Variation in Thermal Tolerance and Thermal Risk of Amphibian Tadpoles. An Approach Based on Stardardized Methods and Microenvironmental Temperature Recordings

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Physiologically informed approaches are becoming crucial for addressing fundamental questions about how temperature extremes influence the distributional patterns of organisms and predicting which species and communities are at higher climatic risk. These questions have recently been tested through macrophysiological hypotheses, using databases that collate estimates of upper (CTmax) and lower (CTmin) thermal tolerance limits from studies with varying methodologies, along with estimates of temperature extremes from other realms (e.g. regional air temperatures). In this study, we examined these global predictions in amphibian tadpoles by collecting experimentally derived data obtained using an identical methodology, including pre-test acclimation temperatures, ramping rates, and end-points. We also gathered estimates of extreme temperatures (tmax and tmin) from the sampling aquatic sites. This allowed us to generate the most comprehensive database of critical thermal limits for amphibian tadpole species, including CTmax for 238 species and CTmin for 174 species, from temperate (Europe, Northern Africa, US), subtropical (Northern Argentina), tropical lowlands (Bahia state, Brazil), and tropical mountains (Andes of Ecuador) amphibian communities. We partitioned the variance in critical thermal limits between phylogenetic and geographic distances and habitats. Our findings revealed contrasting patterns in spatial variation between CTmax and CTmin. We observed larger latitudinal/elevational variation in CTmin than in CTmax, supporting Brett's hypothesis. However, we found similar or even larger variations in

CTmax at the local scale. We also found that extreme temperatures are predictors of critical thermal limits, but their effects vary between communities. CTmax varies with tmax in tropical and subtropical communities but not as much in temperate communities. CTmin varies with tmin to a greater extent in subtropical species, less so in temperate species, and independently in tropical lowland species. Heat risk varies more between habitats (higher for open vs. forest habitats) than across communities, while cold stress increases with latitude.

A-1139 (Poster)
Sexual Dichromatism and the Impact of Climate Change on the Coloration of Fire Salamanders in Germany

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The coloration of an animal can serve several functions simultaneously. Recent evidence has highlighted the role of animal coloration in predator avoidance, intraspecific communication (e.g., mate choice) and thermoregulation. Here we study differences in the black-to-yellow-ratio of Fire salamanders (*Salamandra salamandra*) comparing males and females from 20 populations in Germany. While the aposematic function of the black-and-yellow-coloration of these salamanders equipped with toxin glands is well understood, the coloration could also play a role in mate attraction as well as thermoregulation with the latter possibly being impacted by climate change. We found strong evidence for sexual dichromatism in this species with males being more yellow than females. Furthermore, fire salamanders from locations that have warmed up more in the past 50 years were significantly more yellow. These results indicate a possible role of fire salamander coloration in mate attraction as well as the role of climate change as an evolutionary driver of color variation highlighting the multi-modality of animal coloration. Future studies should address the role of coloration in mate choice of aposematic species as well as the evolutionary responses of color traits to climate change.

A-1140 (Oral)
Restoring the Critically Endangered Burmese Star Tortoise as a Functional Member of Dry Zone Landscapes in Myanmar

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The Burmese Star Tortoise (*Geochelone platynota*) is endemic to the Central Dry Zone of central Myanmar, an arid region formed by the rain shadow of the western mountains. Historically common, G. platynota was driven to functional extinction by a combination of long-term subsistence harvesting and rampant over-collection for the high-end pet trade. By the early 2000s, viable wild populations no longer remained. An in-country captive-breeding program using tortoises confiscated from illicit trade has produced large numbers (> 20,000) of offspring for headstarting and reintroduction. In 2012-13, reintroduction efforts began at a wildlife sanctuary in central Myanmar using a soft-release approach in which subadult headstarted tortoises are penned *in situ* for 12 months before being liberated. To date, 3,800 tortoises have been released into two sanctuaries. Regular monitoring indicates post-release survival is high and most tortoises remain within 1-2 km of the release site. Reintroduction is coupled with an intensive community education program, including the participation of Buddhist monks who incorporate local Nat (= Earth Spirit) ceremonious worshipping practices. Numerous instances of reproduction amongst released tortoises have been documented at both sites. Furthermore, in 2017, we commenced an egg translocation program at both sanctuaries, transplanting clutches from our breeding colonies into artificial, caged *in situ* nests. This effort continues to show success, with translocated egg clutches successfully producing hatchlings that immediately integrate into the recipient habitat. Our ultimate objective is to restore viable populations of *G. platynota* to every protected area of historical inhabitance within the Central Dry Zone.

A-1141 (Poster)
Distribution of Extracranial Endolymphatic Sacs across Gekkotans

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The endolymphatic apparatus consists of bilateral ducts extending from the sacculus of the inner ear and connected to endolymphatic sacs (EDS), which are membranous structures that accumulate calcium carbonate in the form of aragonite. EDS are found inside the braincase of many squamates, but they are prominent and extracranial in many iguanians and gekkotans. Several explanations for the presence of EDS have been proposed, including regulation of inner ear pressure, transmission of sounds to the ear, and storage of calcium to meet increased metabolic demands, especially in females and hatchlings. Traditionally, the presence of extracranial EDS has been considered a character that is prevalent in gekkonoidean geckos, and not very frequent in pygopodoideans or eublepharids. Given the modern classification of geckos and the advanced CT scan techniques, the configuration of EDS was determined through the review of High Resolution Computed Tomographies of 120 specimens, spanning representatives from most described gekkotan genera. On this basis, we report a generalized pattern of distribution of these structures. In pygopodoideans, there is a tendency to develop intracranial EDS, often under the skull table or between the braincase and the eye, although in some genera, there are large endolymphatic sacs in the cervical region (e.g., *Eurydactylodes*). Among eublepharids, we only found calcium-containing intracranial EDS in *Aeluroscalabotes*

felinus. Among the Gekkonoidea, extracranial EDS are predominately found in the cervical region. There is a general pattern of distribution of EDS, which is congruent with current higher-level classification within Gekkota, but the function of the hypertrophied EDS remains uncertain.

A-1142 (Poster)
Updated Checklist of Amphibian and Reptile Species in Mount Mantalingahan Protected Landscape, Palawan, Philippines

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The ultramafic forests of Mt. Mantalingahan Protected Landscape (MMPL) serve as the last stronghold of herpetofaunal diversity in Southern Palawan. Decreasing forest cover and habitat quality threaten herpetofaunal species with extinction. Understanding these threats can be used to make informed management decisions through species conservation strategies. We present an updated checklist of amphibian and reptile species from MMPL compiled from recent and historical data. The results revealed a cumulative total of 73 herpetofaunal species, consisting of 23 frogs and 50 reptiles (20 lizards, 27 snakes, and three forest turtles). Notably, we report an endemism rate of 53% (39 species), including 36 island endemic species and 17 threatened species. This recent comprehensive checklist underscores that MMPL is an important habitat for Philippine herpetofauna and an essential part of UNESCO's Man and Biosphere Reserve in Palawan. Furthermore, the 2023 survey hinted at the presence of putative new frog (*Pelophryne* and *Philautus*) and lizard (*Cyrtodactylus*) species. We hope our findings will encourage further ecological and taxonomic studies of amphibians and reptiles in MMPL, and gather more information on morphology, ecology, and genetic characteristics to further define putative new species. This data will aid in updating the management plan of the protected area and strengthen biodiversity conservation initiatives through its integration into species action plans.

A-1143 (Oral)
Community Organization in Two Hungarian Meadow Viper Species across Two Previously Afforested Grassland Reconstruction Sites

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The Hungarian meadow viper (*Vipera ursinii rakosiensis*) has suffered population decline in the Carpathian Basin due to agricultural expansion and afforestation, heightening extinction risks from inbreeding and isolation. The LIFE project seeks to conserve the species by restoring gene flow between isolated populations. Grassland reconstruction efforts in a 20-hectare area in the Bócsa-Bugaci sandplain aimed to reconnect previously isolated populations. This study assesses the impact of grassland reconstruction on reptile communities by comparing sites in the reconstruction area with nearby reference grasslands. It investigates which reptile species colonized the area, differences in species composition between reconstruction and reference areas, changes in reptile community diversity post-reconstruction. Using repeated-sampling occupancy and n-mixture models, habitat occupancy indices and densities were estimated at sample sites. Non-metric multidimensional scaling analyzed habitat occupancy and density estimates. Community dissimilarity between intervention, reference sites was assessed using distance matrices, with the impact of time evaluated through linear models. Since reconstruction, the green lizard and Balkan wall lizard were the initial colonizers, followed by appearances of the sand lizard, smooth snake, and grass snake. Reptile species' habitat occupancy showed no separation between intervention sub-areas, with one resembling a reference area. However, the presence of the sand lizard and viper distinguished the intervention area. Significant differences in reptile species density were found between intervention sub-areas, with one resembling a reference area. Over four years, dissimilarity between intervention and reference areas based on habitat occupancy decreased significantly. Five species colonized the intervention area, making it similar to a reference area characterized by open sandy shrub grassland. Continued habitat reconstruction and monitoring are vital for creating suitable habitat and potentially observing spontaneous colonization by the Hungarian meadow viper. The study also explores habitat suitability for viper reintroduction.

A-1144 (Oral)
Field Hygiene in Amphibian Habitats: Insights from Invasive Neophyte Management in Large-Scale Projects

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Amphibian habitats are vital ecosystems supporting diverse flora and fauna, but they often face threats from invasive species, particularly neophytes – plants introduced to an area outside their native range. Insights from managing these invasive neophytes in large-scale projects offer valuable parallels for ensuring biosecurity in disease-infested amphibian habitats. Early Detection and Rapid Response (EDRR) strategies are crucial. I will present a methodology that can be directly applied. Vigilant monitoring allows for timely intervention, minimizing spread. Integrated Pest Management (IPM) approaches, incorporating mechanical, chemical, and biological controls, can inform biosecurity measures against amphibian diseases. Preventative measures are paramount. Proactive biosecurity protocols, such as equipment sanitation and quarantine procedures, mitigate unintentional pathogen introduction. Stakeholder collaboration is essential. Like neophyte management, addressing amphibian diseases requires coordination among agencies, researchers, and communities. Adaptive management principles apply. Continuous monitoring and assessment inform strategy adjustments, optimizing efficacy.

Implementing these insights enhances biosecurity, safeguarding vulnerable ecosystems and species from disease threats.

A-1145 (Oral)
Nesting Ecology, Habitat Use and Conservation Threats of the King Cobra, *Ophiophagus hannah* (Reptilia: Squamata: Elapidae): A Rare Case Study of Twin Nests from Guth Sallaghari Community Forest, Kathmandu, Nepal

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Ophiophagus hannah, the King Cobra, is recognized as the longest venomous snake in the world and is found across a wide range of regions. Despite its vital role in ecological balance, the study of their ecology, nesting behaviour and threats have been under studied and reported in Nepal. Through frequent field surveys that combine observations, camera traps and GPS mapping, this study documents the rare case of two female King Cobras nesting in close proximity (65 cm) to each other along with the photographic evidence where both females were also found in the single nest. The study indicates success rates; Nest 1 (96.96%) and Nest 2 (100%) after an incubation period of 70–75 days Notably, Nest 1 had larger hatchlings on average and higher internal nest temperatures compared to Nest 2 but the correlation of weight and length was found to higher in Nest 2 (0.95) as compared to Nest 1 (0.35). Analysis of changes in land use and cover highlights a worrying trend of increased built up areas due to ongoing developmental activities leading to habitat loss over time. By overlaying land use changes with kernel density estimates, it becomes evident that there is an increased risk of human wildlife conflicts, in areas where high kernel density overlaps with expanding built up areas. Major risks, to King Cobras involve the loss of their habitats, habitat fragmentation activities that alter the environment and persecution by humans. This research highlights the pressing importance of implementing conservation efforts to protect King Cobra habitats and address conflicts between humans and wildlife in GSCF area and other part of the country.

A-1146 (Oral)
The Illegal Turtle Trade in the United States: What We Know and What We Don't Know

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The illegal collection and trade of North America's native turtles is a pervasive problem with potentially severe conservation implications. Concerns over the illegal collection and trade of native turtles led to the formation of the Collaborative to Combat the Illegal Trade in Turtles (CCITT) in 2018. With work spearheaded by CCITT's Research and Data Working Group, we discuss the biological vulnerability of turtles to collection, the enormous global trade in turtles, the state of knowledge about the scale of illegal collection of turtles in the United States, case studies of poaching and trafficking, current and potential sources of data and trend prediction, and the development of strategies intended to make a meaningful impact in reducing illegal collection and trade.

A-1147 (Oral)
Endocrine Evolution and the Diversification of Salamanders

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The evolution of developmental mechanisms can impact the diversification of traits and species. However, there are inherent challenges to connecting such processes to macroevolutionary patterns. In this presentation I will discuss endocrine mechanisms of development, and the results of comparative hormone experiments on larval salamanders. Such experiments show how shifts to the timing of tissue transformation can reflect phenotypic variation across clades. I will put these results in a broader framework for understanding how developmental mechanisms affect trait diversification.

A-1148 (Oral)
Feeding Habits of the Smooth Snake (*Coronella austriaca*) and its Habitat Co-occupancy With Potential Prey Species in Central Hungary

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Even though the Smooth Snake (*Coronella austriaca*) is widespread in Europe and Western Asia, data on its ecology is scarce. The few studies that studied the diet of the Smooth Snake found that the Smooth Snake mainly preys upon lizards, but it also regularly consumes mammals, and occasionally snakes (including vipers), amphibians and invertebrates. Little information is available about the fine-scale habitat choice of the species, but it is thought that vegetation structure and topography of the habitat are the main factors determining the habitat occupancy of these snakes. As no data are available about the diet of this species from Central Europe and the Smooth Snake was considered as a potential predator of the endangered Hungarian Meadow Viper (*Vipera ursinii rakosiensis*) we conducted a study about the diet of the Smooth Snake in one of the most important habitats of the vipers. As the fine-scale habitat choice of the Smooth Snake is unknown, we conducted a study to test if the availability of

certain prey species is important for the snakes. Smooth Snakes were captured and kept separately until they defecated or for a maximum of two weeks to collect faeces samples, in which the remains were identified. In the obtained samples (n = 47) we found remains of lizards (65.71%), mammals (17.14%), Orthopterans (11.43%) and one case of beetle and Smooth Snake consumption (2.86%) each. We used multi-species occupancy models to test if the habitat occupancy of the Smooth Snake is linked to its prey species in the sampling quadrats used for reptile monitoring in the area. We found that the model that included the interaction of the Balkan Wall Lizard (*Podarcis tauricus*) and the Smooth Snake better fit our data than the model without such interaction. We found no interaction between the Smooth Snake and other reptile species.

A-1149 (Oral)

Using an Interdisciplinary Approach for the Range-wide Conservation of the Mojave Desert Tortoise

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Climate change and urban development in the southwestern United States are projected to rapidly impact the region. The effects of these stressors on ecosystems, such as the Mojave Desert and its inhabitants including the federally-listed Mojave desert tortoise, are of concern due to projected warmer and drier conditions and increased habitat fragmentation. While adaptation and acclimatization may help species like the desert tortoise persist under environmental disturbances, adaptive intraspecific genetic variation in combination with landscape level connectivity is not often considered in studies examining extinction risk under forecast models of climate change. The spatial distribution of adaptive genetic variation is a function of historical interactions between genetic drift, natural selection, habitat connectivity, and demography; therefore, adequately characterizing this variation for the tortoise, would benefit from pairing high-resolution genomic datasets with current and future habitat modeling efforts that includes functional connectivity. We used single-nucleotide polymorphisms (SNPs) as well as outlier detection and Genotype-Environment Association (GEA) approaches to identify potentially adaptive as well as non-adaptive loci associated with environmental gradients between various regions across the species range. These GEA analyses were then compared to regional and range-wide current and forecasted habitat suitability models built using an ensemble approach and also compared to connectivity models across the region. Results indicate that there may be greater adaptive genetic variation and extensive habitat loss along edge regions compared to core habitat as well as a loss of habitat connectivity within these areas, both currently and across all forecasted climate scenarios. While the tortoise shows range-wide isolation-by-distance, we documented variable magnitudes of genetic divergence and migration rates between some genetic clusters across the range. Overall, this integrated,

interdisciplinary approach helps us better understand the evolutionary rescue potential of this threatened tortoise and aids in improving management plans for it.

A-1150 (Oral)

Species and Lineage Richness of Amphibians and Reptiles of the Balkan Peninsula in Light of Current and Past Environmental Factors

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The Balkan Peninsula is one of the most biodiversity rich areas in Europe, with many endemic species and lineages of amphibians and reptiles. Due to its high geomorphological and climatic complexity, the Balkans served both as a speciation center and as an important refugium during glacial periods. Consequently, the Balkans is an excellent area for the study of evolutionary processes. In this study, we compiled a dataset of occurrence records of every amphibian and reptile species in the area and then calculated species richness in 25 × 25 km cells. To estimate lineage richness, we reconstructed phylogenetic trees for the species separately and with phylogenetic interpolation we split their occurrence records into allopatric lineages, which we then summed in the 25 × 25 km cells. We also calculated average branch length and average phylogenetic endemism for the species and lineages respectively. We then compared these biodiversity variables to environmental factors, as terrain ruggedness, current climate as

temperature and precipitation, past climate changes in the last 5.4 million years and climate change velocity from the Last Glacial Maximum. We found that terrain ruggedness always positively influenced the biodiversity variables. Current climate usually better explained current patterns of biodiversity than past processes, however branch length and phylogenetic endemism were usually higher in areas with more stable climate. Our study suggests that a better understanding of phylogenetic processes can greatly help in interpreting current patterns in biodiversity, which underlies their effective conservation.

A-1151 (Oral)
Effects of Anti-predator Netting on a Reptile Community in Central Hungary

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The Hungarian Meadow Viper (*Vipera ursinii rakosiensis*) was once abundant in the steppe meadows of the Carpathian basin, but the transformation of its habitats to arable land made most of its populations disappear by the second half of the twentieth century. In the past decades several conservation measures have been implemented to preserve these vipers, but despite the efforts no significant increase was detected in the population sizes of these snakes, partly because of predation pressure. As many of the predators of the viper are protected and threatened, their control by culling is not possible. In order to establish a strong subpopulation a total predator exclusion site was created at four hectares of one of the most important habitats of the viper. A 3 meters tall mesh net was built over the area in 2020, reinforced at the sides by a 1 meter tall steel fence that is able to keep out both avian and mammalian predators. Reptile habitat occupancy was monitored in a BACI design in 50 x 50 m sampling quadrats (n = 4 under the netting, n = 26 in control sites) between 2020 and 2023. We used multi-season occupancy models to estimate changes in habitat occupancy for the species inhabiting the area. The habitat occupancy of the Eastern Green Lizard (*Lacerta virdis*), the Smooth Snake (*Coronella austriaca*) and the Hungarian Meadow Viper increased through the years and was significantly higher under the anti-predator netting than in control areas. On the other hand, the habitat occupancy of the Sand Lizard (*Lacerta agilis*) significantly decreased throughout the years, and was lower at the predator exclusion site than in control sites. Based on these results we conclude that predator exclusion can be an effective way to increase population sizes of species highly threatened by predation.

A-1152 (Poster)
Integrating Research and Education to Understand How Salinization and Ranavirus Interact to Alter Amphibian-mediated Nutrient Cycling

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As amphibians continue declining globally there is growing appreciation that effective conservation efforts require integration across research disciplines and intentional communication and educational efforts that target diverse audiences. Towards this end, using an amphibian host-virus model system, we designed a research-education approach that combines: (1) an interdisciplinary research framework that integrates microbiology, disease ecology, ecotoxicology, and ecosystem ecology to evaluate how salinization can influence the role of FV3 in amphibian-mediated nutrient cycling with (2) an educational model that aims to improve educator and youth perception of topics in amphibian conservation through an immersive and sustainable experience. RESEARCH: Using a combination of cell/viral culture techniques, toxicological lab assays, and field disease surveys, we asked: How does a FV3 respond to environmentally relevant levels of salinity? Second, using lab infection and excretion assays, we asked: How does viral infection influence host excretion? Lastly, we integrated experimental data on a) viral responses to salinity and b) host excretion responses to viral infection with chloride field data from ponds in Madison, WI to parameterize a model that explores and visualizes how salinization can influence the contribution of FV3 to nutrient cycling. EDUCATION: First, we designed an immersive experience for a primary and secondary school educator that included participation in lab, field, theoretical, and research communication experiences associated with the salinity-FV3 research project. Next, building upon these experiences and using data collected from our research study, we designed a math lesson plan that meets national (U.S.) and international (International Baccalaureate Program) learning requirements while also communicating to youth about amphibian conservation. Collectively, this work offers a framework for coupling research-educational approaches to understand drivers and improve communication about amphibian declines.

A-1153 (Oral)

Alpine Viper in Changing Climate: Thermal Ecology and Prospects of a Cold-Adapted Reptile in the Warming Mediterranean

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Climate change represents a fundamental threat to species adapted to cold alpine environments. We studied the thermal ecology of the endangered Greek meadow viper (*Vipera graeca*), an endemic venomous snake of fragmented alpine-subalpine meadows above 1600 m of the Pindos mountain range in Greece and Albania. We measured preferred body temperature in artificial thermal gradient, field body temperatures and the availability of environmental temperatures in five populations encompassing the entire geographic range of the species. We

found that the preferred body temperature (Tp) differed between the northemost and the southemost populations and increased with female body size but did not depend on sex or the gravidity status of females. Tp increased with latitude but was unaffected by the phylogenetic position of the populations. We also found high accuracy of thermoregulation in *V. graeca* populations and variation in the thermal quality of habitats throughout the range. The overall effectiveness of thermoregulation was high, indicating that *V. graeca* successfully achieves its target temperatures and exploits the thermal landscape. Current climatic conditions limit the activity period by an estimated 1278 hours per year, which is expected to increase considerably under future climate change. Restricted time available for thermoregulation, foraging and reproduction will represent a serious threat to the fitness of individuals and the persistence of populations in addition to habitat loss due to mining, tourism or skiing and habitat degradation due to overgrazing in the shrinking mountaintop habitats of *V. graeca*.

A-1154 (Poster)
Male-biased Road Mortality of Eastern Green Lizards (*Lacerta viridis*) in Northeast Hungary

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During dispersal, individuals have to take the risk to leave their familiar home range which might result in increased mortality. We studied road mortality of lizards in NE Hungary on 58 km of roads once every two weeks for two years. We found that almost all of the roadkills were adult male Eastern green lizards (*Lacerta viridis*), while the other species, age groups and sexes were negligible. Mortality predominantly occurred in May and June which is congruent with the reproductive season of the species and increased mate searching dispersal of males. Roadside land use types had no effect, but traffic volume positively affected mortality. Road mortality remained low during the study period and we assume that it is not a conservation problem for these lizards.

A-1156 (Poster)
The Visualisation, Description and Analysis of the Vocalisations of Singaporean Frog Species

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The field of anuran bioacoustics focuses on the study of sounds produced by frogs. Vocalisations play an important role in the life cycle of anurans as they use it for attracting mates, establishing territory and conspecific competition. As such, these vocalisations can be used to further research in taxonomy, behavioural, evolutionary and conservation ecology. Foundational work on bioacoustics of a region includes the visualisation and description of these vocalisations (mainly the advertisement call) and the building of a reference library. Here we describe and visualise the advertisement calls of 26 species across seven families. The visualisation of the calls were carried out in the software Raven Pro 1.6. This body of work

represents an important step towards furthering anuran research in Singapore by providing a potentially foundational dataset.

A-1157 (Poster)
Diurnal Cycle of Plasma Corticosterone in Captive Rice Field Frogs *Hoplobatrachus rugulosus*

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In amphibian, corticosterone (CORT) is a hormone secreted from the adrenal cortex in response to stress caused by physical and biological factors. Corticosterone levels are not constant throughout the day, but rather fluctuated in rhythmic fashion and can be varied in different species, season, and environment. In case of severe stress, elevated levels of CORT can weaken the immune system and may result in abnormal health and various diseases. This study thus aims to investigate the diurnal rhythm of CORT level in captive rice field frogs during winter season in Thailand, when higher incidence of disease and lower growth rate were observed in farmed frogs. Blood samples from adult male and female rice field frogs were collected every other hour over 24 hours from the Huai Hong Khrai Royal Development Study Center in Chiang Mai Province, Thailand in 2017. Plasma samples were subjected to quantification of CORT by enzyme-linked immunosorbent assay (ELISA). The results showed that a significant difference in CORT levels was found between sexes (Mann-Whitney U-test, $p < 0.05$), with males exhibiting higher levels than females throughout the day. Comparison of CORT levels of each sex at 13 time points within 24-hour revealed no significant difference (Kruskal Wallis Test, $p > 0.05$), indicating that the frog has adapted to captive environment and its stress response has been altered. However, frogs tend to show unequal level of CORT within a day, with females had peak CORT level at 1:00 PM and the lowest levels at 1:00 AM and 3:00 AM. Males had peak CORT level at 2:00 PM and 8:00 PM, with the lowest levels from 4:00 AM to 12:00 PM. This diurnal change in CORT indicates allostatic adaptation to predictable factors and unpredictable factors. The result could be further applied to the development and improvement of rearing techniques in Thailand.

A-1158 (Poster)
Biomonitoring Genotoxicity in Non-Model Organisms with the Comet Assay

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There may be no habitat left on earth that remains untouched by anthropogenic activities, particularly synthetic chemical pollution. The toxic pollutants we continuously release into the environment impact the health of individual organisms and contribute to overall population declines. Active monitoring of these pollutants through the measurable, sub-lethal side effects they induce is key to reducing contaminant concentrations and managing exposure in non-target species. Genotoxicity is one well-documented side-effect of a broad array of environmental contaminants, including heavy metals, pesticides, and radiation, for a variety of

vertebrate species. A refined genotoxicity technique, the comet assay, is an ecotoxicological tool used to quantify DNA damage by measuring single- and double-stranded DNA breaks. This assay is commonly used in experimental dosing studies with mice or human samples but is less often used in environmental monitoring studies tracking natural toxin exposure. There are many different sample storage and preparation, and assay conditions possible for running comet assays that are often adjusted and validated for each specific sample type. There is a need for more standardized protocols for various organisms, specifically those with the potential to act as key indicator species. Here, we validated a modified, alkaline version of the comet assay for genotoxicity testing in traditionally non-model study organisms with nucleated red blood cells. This broad validation process will make the tool a more accessible option for future studies. We validated the comet assay for avian and reptile species, including the Diamond-backed watersnake (*Nerodia rhombifer*), the Pond turtle (*Trachemys scripta*), and the Loggerhead shrike (*Lanius ludovicianus*). This tool has promising potential for monitoring overall ecosystem health and pollutant impacts with minimal, non-destructive sampling of wild organisms.

A-1159 (Poster)

Influence of Vegetation Structure on Occupancy of the Hungarian Meadow Viper (*Vipera ursinii rakosiensis*)

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Identifying the factors that determine habitat selection is important in understanding the ecology of species. The endangered Hungarian Meadow Viper has lost the vast majority of its range and populations over the last century, and its abundance has not increased significantly despite many conservation measures. Previous research suggests that among others, vegetation structure might be a key factor that determines occupancy of the vipers. However, there is a lack of knowledge on the exact vegetation structural factors that determine viper habitat occupancy and a larger spatial and temporal study was needed. To cope with this, we collected viper and vegetation structure data in the habitats of Kiskunság (Hungary) during four spring and autumn seasons. We surveyed quadrats for vipers and also photographs were taken against a whiteboard placed in the vegetation to investigate the effect of the mean value of vegetation structure variables measured in each quadrat on viper habitat occupancy. To estimate occupancy, we ran occupancy models in which the probability of detecting vipers was explained by the mean operational temperature per survey and the probability of occupancy by vegetation structural factors. The best models included the height of closed vegetation (HCV), which had negative linear or linear and polynomial effects on viper habitat occupancy. The leaf area (LA) and foliage height diversity (FHD) showed weak negative effects. Operative temperature had a negative linear and squared polynomial effect on the viper detectability. This suggests that the occupancy of the Hungarian Meadow Viper may be affected by vegetation

structure factors, with a preference for more open vegetation beyond a minimum cover, where better thermoregulatory conditions are presumably present. It is likely that occupancy is determined by a combination of other effects. Conservation interventions and grazing may be important to ensure a heterogeneous, low density vegetation structure preferred by the viper.

A-1160 (Oral)
Exploring the Rich Diversity of Indian Amphibians by Unveiling Novel Behavioural Insights

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Amphibians exhibit a wide range of reproductive strategies compared to other tetrapod vertebrates. Comprehensive knowledge about their reproductive biology is crucial for the conservation of both the species and its habitat. India, one of the seventeen megadiverse countries, boasts a rich amphibian diversity comprising of 455 species, but their natural history remains largely either unexplored or understudied. Unfortunately, more than thirty percent of these Indian amphibians are currently listed in threatened categories as per the IUCN criteria. Over a period of ten years (2013-2023), I conducted field studies across India primarily during the monsoon months (June–September) to understand the reproductive behaviour of more than 30 species of amphibians in their natural habitat. The study also focussed on recording and understanding amphibian vocalization as it is an integral part of social interactions during the breeding season. My field studies revealed several novel behavioural adaptations of these Indian amphibians, some of which includes unique courtship behaviours, female calls, underwater vocalizations, rare call types, insights on territoriality, interesting oviposition strategies along with knowledge on their microhabitat preferences and activity periods. Further, almost all these species are affected by various anthropogenic activities such as habitat loss, climate change, pollution, roadkill, etc, and serious efforts are required to prevent their population decline in the near future. In this regard, a proper understanding of their breeding biology is important for planning and implementing effective conservation action plans.

A-1161 (Oral)
Evolutionary History and Genetic Variation of the Wood Frog (*Rana sylvatica*)

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As species confront changing climate conditions, our ability to understand and predict responses will depend critically on the use of evolutionary principles. Following the last glacial maximum, many species recolonized the landscape from southern refugia. Those poleward movements played a large role in shaping and structuring their genetic diversity. One of the earliest amphibian colonizers, the Wood frog (*Rana sylvatica*), is one of the most widely distributed amphibians in North America, and the only frog that occurs beyond the Arctic Circle. This species now exists in 11 USDA climate zones and thrives in extreme cold due to its remarkable capacity to freeze solid. In this work, we used genomic sequencing tools to reconstruct the evolutionary history of the Wood frog and its post-glacial movement. We generated ddRAD sequencing data from 260 wood frog samples across 238 unique localities

to investigate the phylogeography and genetic variation across the Wood frog's climatically diverse range. Results from PCA and Structure analyses show support for 3 clades (Western, Eastern, Eastern Maritime) that are broadly consistent with spatial structure revealed in a prior study based on mitochondrial sequences. Our new data also reveal evidence for a putative contact zone in the region of Québec, Canada. Time calibrated, Maximum likelihood phylogenetic tree analyses further support the presence of multiple clades, and suggest a pattern of isolation-by-distance across the dataset. This finding is also supported by a positive correlation between genetic distance and geographic distance. Insights from past range expansions during changing climate highlight species' evolutionary history and provide clues about the potential for future range shifts.

A-1162 (Oral)
Rewilding of a Critically Endangered Tortoise Species in a Heavily-Hunted Landscape in Bangladesh

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The critically endangered Asian Giant Tortoise (*Manouria emys*) is rapidly declining throughout its global range due to hunting and habitat destruction. In Bangladesh, this species was once found throughout the mixed-evergreen forests of the Chittagong Hill Tracts, but is now considered to be approaching functional extinction. Subsistence hunting and destruction of primary forest habitat are the major threats for this species in Bangladesh. Creative Conservation Alliance (CCA), in collaboration with Bangladesh Forest Department and Turtle Survival Alliance, initiated a groundbreaking effort to protect and restore the Asian Giant Tortoises in the country. In 2017, the first ever conservation breeding facility in Bangladesh for Asian Giant Tortoise was established in Bhawal National Park, Gazipur. There, the species bred in captivity for the first time in Bangladesh in 2019. On December 18, 2021, we released ten captive-bred juvenile Asian Giant Tortoises fitted with VHF radio transmitters into a 200-hectare community-managed forest in Menni Para, Matamuhuri Reserve Forest, with the goal of restoring self-sustaining wild population in the Chittagong Hill Tracts. Communities were incentivized through different livelihood packages, and a conservation agreement was adopted by the village to ensure protection of the tortoise and its habitat. Results show a minimum survival rate of 70%, with positive changes demonstrated in carapace and plastron length for all surviving tortoises. Stable home-range establishments have also been observed, with a mean area of 1.95 hectares across the habitat range, and their recorded locations show a strong preference for positioning near streams. No poaching occurrences have been observed and the clear enthusiasm of the local communities towards conservation during the first 18 months of release indicate initial success and a promising venture for the reintroduction effort. Based on the knowledge gained from the pilot project, future reintroduction efforts and monitoring of this species will be carried out.

A-1163 (Oral)
How do Morphology and Ecological Traits Influence Extinction in Lizards? A Long-Term Case Study on Artificial Islands in the Brazilian Cerrado

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Although considered a clean energy source, hydroelectric dams are considered to be responsible for environmental destruction, habitat fragmentation, degradation, and habitat impoverishment. Different stages of recently isolated communities caused by hydroelectric dam constructions have been shown to impact species loss, which is one of the most striking effects of human activities on biodiversity stability. To understand how human activities in dam construction impact biodiversity, reservoir land-bridge islands became a successful model for accessing the sound impacts of island formation on isolated communities belonging to different taxa. Herein, we used lizard species, which present low dispersal abilities across a variety of trophic niches to assess species' sensitivity to habitat structural change. To do this, we collected data on abundance and richness of lizard species predating the flooding and after the Serra da Mesa Dam reservoir filling. We also measured eight morphological traits from 369 lizards and used isometric-adjusted residuals to check shape differences. To allow us to test how habitat fragmentation drove local saurofauna to diversity loss, we used mixed-effect cox proportional hazards models to ask if larger lizard species had greater risks of extinction and found that larger lizard species had higher risk on island sites. We found that in Serra da Mesa islands lizard populations with large and long limbs (e.g., Teiidae and Tropiduridae) decrease in abundance, thereby increasing their extinction risk. We found a high abundance of small-bodied lizards (Scincidae, Gymnophtalmidae, Gekkonidae, and Sphaerodactylidae) in Serra da Mesa islands. Richness on the small islands became much lower, depicting communities typically composed of one gekkonid, one scincid, and one gymnophtalmid. A careful planning before the flooding initiation would be determinant to mitigate wildlife depletion due to habitat fragmentation.

A-1164 (Poster)

A Deep Dive into the Behavioral Thermoregulation Strategy of Tadpoles in a Big City

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Urban spaces experience higher temperatures due to increased heat retention by buildings. Increased temperatures in urban spaces can push species, especially ectotherms, to inhabit areas at the end of their tolerance, resulting in physiological stress. Organisms cope with increasing temperature by adapting or acclimating to the temperature regime or by thermoregulating to remain within the optimal temperatures. Optimal temperatures are quantified by the critical temperature maxima and minima beyond which there is a loss of function or death. Thermal adaptation and acclimation, however, operate over longer timescales, whereas behavioral thermoregulation, where the organism physically moves to a suitable temperature profile, can be a rapid response strategy. Anurans, especially tadpoles, are more vulnerable due to their constrained microhabitat and inability to move away. Thus, behavioral thermoregulation can be an effective strategy for tadpoles to avoid extreme temperatures. The common toad Duttaphrynus melanostictus is widespread in India and generally breeds in small puddles around a waterbody or in man-made fountain ponds in gardens. Given the rising temperatures and frequent heatwaves, these habitats will likely reach temperatures near the tadpoles' critical thermal maxima. We hypothesized that tadpoles respond by diving deeper into cooler waters. Wild-caught tadpoles from different localities in the city of Bangalore were exposed to a vertical temperature gradient, and their behaviors were compared against a homogenous control. Tadpoles altered their behavior and spent a significantly greater proportion of their

time in deeper, cooler waters when exposed to extreme temperatures. Behavioral thermoregulation, although effective, may have long-term life history consequences, such as the trade-offs between temperature avoidance and increased predation risk, missed foraging opportunities, and size at metamorphosis. Our findings give insights into how anurans may cope with urbanization as well as the increasing incidence of climate extremes in the tropics.

A-1165 (Oral)
Temporal Diversity of Amphibian Community in Nahá, Chiapas, Mexico

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Climate change causes organisms to experience changes in their life cycles. This has sparked significant interest and concern in quantifying biological changes over time. There is little knowledge about the temporal patterns of herpetofauna diversity at the community level. This study aimed to describe the temporal diversity and identify the most common temporal patterns of amphibian communities. Likewise, we try to determine if any environmental variable influences them. Over four months during the rainy season, we sampled six amphibian communities in Lacandon Jungle, Chiapas, Mexico. Sampling sites covered a quarter of a hectare, and a total of 114 times were carried out. Once a week, an active search method was used to record species and their abundances. Temperature and humidity were monitored during sampling. Temporal diversity analyses were conducted using time series analysis-based models and Hill numbers. A multi-model approach was used to identify which variables influenced each type of diversity. A wavelet-cluster analysis was conducted to determine the distinct types of temporal patterns. Different temporal diversity values and patterns were observed at each site, and temperature heterogeneity was the unique variable explaining a temporal diversity measure. These findings have important implications for conservation and climate change concerns because temperature directly affects ectothermic organisms.

A-1166 (Oral)
A Close Call of Shared Ancestry: The Bioacoustics of Two Closely Related Species of Microhylids from India and Thailand

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Acoustic signalling is the primary means of communication for amphibians and is used for species recognition due to its stereotyped properties. While thousands of anuran species have been described, there remains a gap in the studies documenting their acoustic behaviour. Microhylids are a taxonomically challenging group because of their diminutive size, cryptic morphology and wide distribution range. In this study, we aimed to quantify and compare vocalizations of two species of narrow-mouthed frogs, *Microhyla heymonsi* and M. kodial. *Microhyla kodial*, a species endemic to the Western Coast of India, has a very small distribution and its closest relative *M. heymonsi* is known from across the Southeast Asia. It has been posited that *M. kodial* was introduced to India through anthropogenic factors, namely through a port known for timber import from Myanmar where its sister species, *M. heymonsi*, is also found. We conducted a robust acoustic analysis using 20 call properties based on 537 calls recorded from 22 individuals of these two species, *M. heymonsi* (n = 15) from Ko Pha-ngan island in Thailand and *M. kodial* (n = 7) from Mangalore, India. Across temporal properties, average values of call properties for *M. heymonsi* were higher than those of *M. kodial*. For instance, call duration (433.3 ms vs. 352.0 ms), pulses/call (9 vs 7), pulse rate (20.4 pulses/s vs 15.9 pulses/s) were markedly higher in *M. heymonsi*. We found no significant difference in the spectral properties of these two species. Since variations in acoustic signalling precede genetic differences, studying such variations can help in understanding the factors that ultimately lead to genetic changes. Thus it can help resolve taxonomical uncertainties in microhylids and the data can further be used in conservation efforts for identification and monitoring population.

A-1167 (Oral)

Hiding Out in the Open: Conflicts in Gene Expression Underlying Countershading and Background Matching in an Amphibian Tadpole

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Animals with contrasting darker dorsal and lighter ventral surfaces are common in nature. The resulting 'countershading' pattern is phylogenetically widespread, with various hypothesized proximate and ultimate evolutionary functions. Among these, the melanization of light-exposed dorsal sides of the body is known to shield cells from damaging effects of UV radiation, while maintaining a lighter-coloured underside can improve crypsis through background matching and 'self-shadowing'. In vertebrates, this countershading pattern is largely mediated through the light-sensitive activation of the melanocortin 1 receptor (MC1R) in the skin and its regional inactivation through the antagonistic function of the Agouti protein. However, to improve crypsis through background matching, some amphibian tadpoles have evolved the ability to adjust their pigmentation levels to track changes in background brightness. Crypsis is improved by becoming darker in dark environments and lighter in light environments, and this therefore conflicts with the developmentally determined countershading pattern. How this conflict is mediated at the molecular level is not well understood. Here, through means of a differential gene expression experiment, we show that the tadpoles of Pelobates cultripes maintain their countershading pigmentation pattern through the expected MC1R-Agouti interaction. Interestingly however, in order to adjust pigmentation in response to background brightness, the light-sensitivity of mc1r expression is maintained,

but becomes decoupled from the downstream melanin-synthesis pathways. This highlights the potential for studying transcriptome-wide gene expression in plastically pigmented organisms to understand the evolution of conserved pigmentation patterns in the animal kingdom.

A-1169 (Oral)
Convergent Evolution of Cephalic Horns in Vipers

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Horn-like cephalic appendages evolved under various selective pressures among squamate reptiles. Yet, among snakes, where horns are most abundant in vipers, the functional and evolutionary significance of horns are poorly understood. Using a comparative phylogenetic approach, we showed that horns are evolutionarily labile with frequent fluctuations in the extent of character states as lineages diversified. Significant correlations with habitat type provides evidence of adaptive convergence in vipers. To understand the genomic basis of horns, we use the desert vipers (*Cerastes* sp.) as a model system. The genus comprises four recognized species, of which *Cerastes cerastes* and *C. gasperettii* are polymorphic while *C. vipera* is hornless and *C. boehmei* has tuft-like horns. Genome-wide association on *C. gasperettii* show that horn polymorphism is significantly associated with a single ≈20 kb genomic region among genes associated with head phenotypes in other organisms. The evolutionary history of this region among species suggests the independent origin of horn polymorphism through *de novo* mutations. Genomic scans for signatures of selection further shed light on the evolutionary mechanisms maintaining polymorphism in the genus.

A-1170 (Poster)
Same Same but Different: Cryptic Diversity of *Colostethus* cf. *pratti* in Panama

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New World frogs of the family Dendrobatidae are known for a diverse radiation of highly venomous and brightly coloured species that range from Nicaragua to southern Brazil. Species in this group have played a central role in developing and testing hypotheses on the evolution of mimicry and aposematism. However, surprisingly little is known about species boundaries and phylogenetic relationships within the cryptically coloured genera *Colostethus*, Silverstoneia and Allobates. *Colostethus pratti* (Boulenger, 1899) is a dendrobatid species whose range extends from northwestern Colombia through Panama to southeastern Costa Rica. Despite its wide distribution, this taxon has not been revised since its description more than a century ago. During our expeditions in the mountain ranges of central and eastern Panama, we collected abundant material to which we applied an integrative taxonomic approach consisting of molecular analysis of three genes (COI, 16S and RAGI), bioacoustic analysis of insertion calls and morphological analysis to reveal intraspecific differences between populations. Preliminary results suggest that the sample under study harbours several cryptic OTUs that are remarkably genetically distinct from the Colombian type locality material (K2p distances 5.99 - 7.74 for the 16S gene). These OTUs also differ from each other in bioacoustic parameters (high frequency: $t = -4.6889$, $df = 6$, p-value = 0.003365; low frequency: $t = -4.452$, $df = 6$, p-value = 0.00432). However, they are very similar in general morphology and colouration. The

phylogenetic relationships between these Panamanian OTUs are the subject of ongoing research.

A-1171 (Oral)
Investigating the Elusive Sex Ratio of the Shovel-snouted Lizard, *Meroles anchietae*

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The shovel-snouted lizard, *Meroles anchietae*, is endemic to the Namib Desert from southern Namibia to southwestern Angola. We conducted seven multiple day capture-recapture surveys of a population near Gobabeb, Namibia, from 1997–2009 to collect information on the natural history and population biology of the species. Two of the surveys revealed a significantly male biased sex ration, but five of the surveys indicated a 1:1 sex ration of males and females. Field observations showed that males are active on the surface more frequently and for longer periods of time than females. Subsequent modeling of survivorship, probability of detection, and population estimates using Program Mark support the hypothesis that the sex ratio is 1:1. These results indicate that short-term, single surveys may not be reliable for estimation of population variables and sex ratio.

A-1172 (Oral)
Heat Tolerance and Heat Hardening of Two Tropical Burrowing Lizards: A Sexual *Leiolepis belliana* and a Parthenogenetic *L. boehmei*

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As ectotherms, lizards are vulnerable to extreme temperatures, hence, many of them exhibit an ability to rapidly increase heat tolerance after experiencing high temperatures (i.e., heat hardening). This ability was thought to be specific to temperate species, but recent studies also found heat hardening in tropical species. In this study, I examined heat tolerance and heat hardening of two species of tropical burrowing lizards found in Thailand: a sexual *Leiolepis belliana* and a parthenogenetic *L. boehmei*. Both occur in hot and dry habitats, therefore, prominent heat tolerance and hardening were expected. The measurements showed that, although both species have similar heat tolerance, *L. belliana* had a wider range of CTmax than *L. boehmei*, indicating that their heat tolerance is mainly controlled by genetics. After being stimulated with sublethal temperatures, both species showed no conclusive evidence of heat hardening; only *L. belliana* with low initial CTmax increased their tolerance after 3 hours. The results suggested that both species do not rely on a hardening mechanism to withstand heat. The lizards might already have sufficient heat tolerances, 46.9 ± 2.2°C in *L. belliana* and 48.0 ± 0.6°C in *L. boehmei*, which are higher than most lizards. Moreover, while the temperatures of the open areas where *L. boehmei* occurs could exceed their thermal limit, I found that the shaded areas and inside the burrows were significantly cooler during the day. Therefore, the lizard might exploit these microhabitats to avoid being overheated, causing heat hardening to be unnecessary. These findings point out that, while both species might be prone to habitat

modification, *L. boehmei* could be more sensitive to climate change due to its low genetic diversity.

A-1173 (Oral)
Ecomorphological and Sensory Organ Diversification of Caenophidian Snakes

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Snakes represent an exceptionally diverse assemblage of squamates with a superficially simple body-form. Despite the presumptive functional constraints placed upon limbless vertebrates, snakes display an astonishing array of phenotypic diversity, particularly in craniofacial morphology. Nested within the cosmopolitan caenophidian snake clade is the world's only radiation of snakes that has experienced extensive *in-situ* diversification on an island, the pseudoxyrhophiid gemsnakes of Madagascar. This lineage fits many of the criteria of a classical adaptive radiation where morphology and, presumably, speciation are seemingly tied to ecology. This system presents an opportunity to investigate how natural history has shaped phenotypic diversification of the head, the region of the body most likely to experience shifts in morphospace driven by dietary, locomotory, and sensory pressures. We focus on testing if 1) craniafacial diversification is linked to ecology, 2) the extent of functional integration across the skull, 3) if sensory and dietary regions differ in macroevolutionary patterns, and 4) if convergent evolution is widespread across caenophidians more broadly. Combing phylogenomics and high-resolution CT scans, we quantified morphological diversification in pseudoxyrhophiids and other caenophidians. We find that ecology is strongly tied to craniofacial morphology regardless of the element, functional module, or niche examined. Geometric morphometric and comparative phylogenetic analyses strongly suggest strong integration of all elements of the skull with little heterogeneity in diversification rate when looking at caenophidians on the whole. Further, we find that ecomorphological convergence is potentially widespread across caenophidians, though the extent of which varies by cranial region. Our data suggest that the strength convergence amongst ecomorphs can differ between the suspensory elements of the skull and the neurocranium/facial region. These differences may correspond to differing selective pressures between regions of the skull that process food and those that house sensory organs.

A-1174 (Poster)
Terrestrial Frog Eggs under Climate Change: Hatching Plasticity, Synergistic Risks, and Developmental Effects

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Terrestrial frog eggs are vulnerable to dehydration, which kills embryos and can increase egg predation by invertebrates. With climate change, dry spells during rainy seasons are becoming more frequent, increasing the incidence of egg dehydration. However, the arboreal embryos of *Agalychnis callidryas* can hatch early to escape from egg-stage threats, including predation and dehydration. To understand the effects of changing rainfall patterns on *A. callidryas* early life

stages, we investigated the potential of hatching plasticity to buffer against the hazards of egg drying. Specifically, we determined the ontogeny of the escape-hatching response to acute drying, measured the effect of sub-lethal dehydration on latency to respond to a simulated wasp-predation cue, and assessed carry-over effects of embryonic drying for larval growth. At a developmental stage when flooded embryos always hatch, acute drying was lethal. Drying-induced escape-hatching began later and increased over several stages, paralleling the development of predator-induced, mechanosensory-cued hatching. Whether egg drying causes death or early hatching thus depends on its developmental timing. Moderate dehydration, itself insufficient to cue hatching, accelerated embryos' hatching response to a mechanosensory predation cue, revealing a synergistic effect of two distinct threats, and cue types, on hatching decisions. Finally, hatchlings from drying clutches were smaller than age-matched hatchlings from well-hydrated clutches, and remained smaller for over a week. This suggests that egg drying may have a direct and lasting effect on tadpole vulnerability to aquatic predators, independent of its effects on hatching timing. Our findings reveal that shifts in rainfall patterns with climate change will have complex effects on embryo survival, hatching timing, and subsequent development. Drying-induced hatching can reduce embryo mortality, sometimes, but does not prevent persistent effects of egg drying on tadpole development.

A-1175 (Oral)

In Search of the Golden Eggs: The Quest to Study Parental Care in Microhylid Frogs in Northern Australia

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In the Australian Wet Tropics bioregion in north-east Queensland, many of the montane frog species are terrestrial breeders with direct development (i.e., embryos develop to metamorphosis within the jelly capsules. The changing conditions caused by climate change may result in reduced moisture availability in terrestrial habitats, which could cause the desiccation of eggs and decrease survival rates. The predicted reduction in moisture due to rising temperatures and altered precipitation patterns make terrestrial breeding amphibians potentially at a heightened risk of climate change, compared to their aquatic breeding counterparts. Breeding success and behaviour are difficult to quantify because many montane terrestrial breeders occur in high elevation, remote, and inaccessible habitats. Additionally, they often live and nest in concealed places such as among rocks, in dense leaf litter and coarse woody debris, making locating individuals and nests problematic. We studied the Robust Whistling Frog, *Austrochaperina robusta*, a small (22–32 mm) microhylid frog, which is a terrestrial breeder with direct development that have been documented to perform male parental care. There is limited understanding of the level of parental care behaviour in this, and other similar microhylid species. We assessed different methods, such as installing artificial shelters, and tracking frogs using a harmonic direction finder, to test locating the nests of this cryptic frog species and enable the study of its parental care behaviour and microhabitat use.

A-1176 (Oral)

Thermoregulation and Metabolic Patterns in the Neotropical Lizards *Tropidurus*: How Valid is This Knowledge for Understanding the Impact of Environmental Changes?

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The occupation of diverse environments by organisms coincides with the emergence of phenotypic traits that allow animals to explore local conditions. However, rapid environmental changes may impose severe challenges to many animals given the limited capacity for response. Therefore, understanding the physiological flexibility in response to these changes is crucial for comprehending their potential effects on animal performance and survival. In this presentation, I will share our recent research findings on the variation in thermoregulatory and metabolic patterns among lizard species from the Tropiduridae family, which inhabit different habitats characterized by diverse structures and climates. Our investigation focused on behavioral and physiological traits within two complementary lines of inquiry: (1) examining thermoregulatory behavior and physiological responses to temperature, and (2) exploring the correlations between thermal sensitivity of physiological variables and the environmental thermal structure. Furthermore, we conducted an ecological niche analysis and formulated predictions regarding the implications of climate change on lizard biology. These findings provide valuable insights for discussing the broader impacts of environmental changes on biodiversity. Financial support: FAPESP (2020/12962-5; 2024/04225-1).

A-1177 (Oral)
A Novel Method for Addressing Difficulties with *Ex Situ* Breeding in the Northern Leopard Frog (*Lithobates pipiens*)

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The Rocky Mountain population of Northern leopard frogs (*Lithobates pipiens*) in British Columbia, federally listed as Endangered, is one of western Canada's most imperiled amphibian species. Despite high numbers of calling males present in the wild in 2023, only two egg masses were detected, resulting in the lowest count in the last 20 years. Given this result, it is possible that the adult male population in the wild greatly outnumbers the female population. Simultaneously, captive breeding success has remained quite low across the different breeding facilities of the northern leopard frog reintroduction program. In particular, observations have been made of seemingly mismatched breeding behaviors, with females frequently laying eggs independent of male amplexus, resulting in reduced fertilization rates of egg masses. Previous data also suggests that captive male northern leopard frogs produce lower quality sperm compared to their wild counterparts. Given the apparent abundance of male frogs in the wild and the poor performance of captive males, we proposed two novel trials to breed captive female frogs with wild male frogs. In an *in situ* experiment, captive females were transported to the field site to breed with wild males in enclosed pens within the wetland; the *ex situ* experiment involved transportation of wild males to the captive breeding facility to be paired with captive females. This innovative captive-wild breeding experiment is the first of its kind for northern leopard frogs. The first year of these efforts will serve as a proof of concept to determine feasibility of these actions and assess success. This approach may also be useful for other at-risk amphibian species currently facing difficulties with breeding in captivity.

A-1178 (Oral)
Molecular Evolution of Squamate Visual Systems

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Squamata, the clade that comprises lizards and snakes, is one of the biggest major lineages among land vertebrates, with huge ecological and taxonomic diversity. Multiple squamate lineages have undergone independent ecological transitions including switching between diel patterns, epigeal to subterranean habits, and land-to-sea lifestyles. However, despite the vast diversity of ecological niches, multiple ecological transitions and over 250 MY of evolutionary history, the study of the visual system of squamates is still poorly understood. Vision is a key sense for many animals, and the evolution of vision plays an important role in understanding ancient ecologies and is part of long debated theories such as the ancestral diel pattern of geckos or the origin of snakes. With the aim of improving understanding of the evolution and function of the squamate visual system, we generated eye transcriptomes and searched published genomes of more than 150 squamate species spanning many major lineages and ecotypes. Our results show multiple vision gene-losses across several squamate lineages, and positive selection in the phototransduction pathway as result of ecological transitions in some squamate lineages. This talk will discuss the evolution of vision among lizards and snakes as it relates to their phylogeny, ecology and exceptional retinal photoreceptor diversity.

A-1180 (Oral)

Sesamoids as Weapons: The Extreme Morphology of *Hoplophryne rogersi* and Other Interesting Trait Novelties in the Genus (Anura: Microhylidae: Hoplophryninae)

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Microhylidae is a globally distributed and rich family of frogs in terms of both number of species and phenotypic diversity. Among the 12 microhylid subfamilies, Hoplophryninae includes two genera, *Hoplophryne* (two species) and Parhoplophryne (monotypic, known only from the female holotype), that are restricted to eastern mountains of Tanzania, Africa. Species are known to breed in hollows of bamboos and on the axils of wild-banana leaves. The adults and tadpoles of Hoplophryne are known to exhibit modifications such as reduced fingers (adults) and ventral locomotory appendages (tadpoles), but their internal anatomy remains undescribed. Hoplophryne rogersi was originally described as bearing a spine-shaped prepollex, while H. uluguruensis bears large, keratinized spines on the hands. We used gross dissection, whole-specimen clearing and staining, and micro-CT scanning to study the internal anatomy of the forelimbs of Hoplophryninae, scoring osteological characters for all species and muscular characters for the species of Hoplophryne, and compared them with other microhylids and closely related taxa. Our analyses revealed that the spine on the hands of H. rogersi is not a prepollex, but a modified sesamoid. Additionally, the group exhibits several muscular modifications absent in other microhylids. In this presentation, we will describe the internal forelimb anatomy and present some synapomorphies for this poorly known clade.

A-1182 (Poster)

Scutavirus Testudinidalpha3 is Highly Prevalent in Free-ranging Wild Spur-thighed Tortoises in Absence of Obvious Clinical Disease

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Among the best characterized chelonian herpesviruses are Testudinid alphaherpesviruses, a group of four distinct, but genetically related viruses. Testudinid alphaherpesvirus 3 (now Scutavirus testudinidalpha3) is the best characterized of them, and it is overrepresented in *Testudo* spp. where it is associated with disease, especially fatal in Herman's tortoises (*T. hermanni*). Most knowledge about these viruses and their host-interaction comes from captive individuals. Very limited information is available on wild tortoises. Investigations of wild populations are critical to better understand the disease ecology and clinical significance of the infectious agents in their hosts in natural conditions. To fill this gap, we sampled a total of 157 tortoises over four years (2019-2023), year-round, collecting 157 oral swabs for PCR testing and 131 blood samples for serology (ELISA) from a wild population of Spur-thighed tortoises (*T. graeca*) on Sardinia Island, Italy. Forty-four of these samples were obtained from animals that were captured more than once (recaptures). One-hundred-fifty-three tortoises tested negative for PCR, while 4 were positive for Scutavirus testudinidalpha3. Forty-eight tortoises were serologically positive, while 68 were negative and 15 were doubtful. Of the recaptured animals, 12 were confirmed negative and 7 positive; one seroconverted and two samples originally positive, tested negative on a second sampling. Of the PCR positive tortoises, only one was seropositive. The overall seroprevalence of Scutavirus testudinidalpha3 was 41%. The absence of major detectable die-offs and of obvious signs of disease in the affected population suggest that Scutavirus testudinidalpha3 might not necessarily cause constitutively disease in this species in natural conditions, which may occur instead, secondary to stressors. Serological testing was crucial to obtain a realistic epidemiological picture of Scutavirus testudinidalpha3 in Spur-thighed tortoises, which could not be matched by current molecular tests.

A-1184 (Oral)
Finding Diagnostic Patterns in Morphologically Conservative New Guinea Groundsnakes (Genus *Stegonotus*): A Closer Look Reveals Undescribed Diversity

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Our recent work on the radiation of groundsnakes, genus *Stegonotus*, has shown that throughout Wallacea and New Guinea the diversity of these snakes has been underestimated.

With many populations falling into the category of "nondescript brown snake", and with a limited availability of molecular data, we have been forced to rely on a rather exacting morphological approach in order to elucidate the taxonomy of the group. By tracing the nomenclature and type localities of species occurring on the island of New Guinea, we found that incorrect species names have previously been applied to two populations from north of the New Guinea Highlands, whose morphology and molecular affinities clearly indicate that they are distinct, unnamed species. In the southwest of New Guinea's Bird's Head Peninsula are two populations, whose morphological distinctiveness from *Stegonotus ayamaru* indicate that they, too, are unnamed species. Lastly, a preliminary survey of Batanta Island revealed the existence of a third species, in addition to *S. iridis* and *S. derooijae*, which is distinct in both coloration and scale counts. The presence of three species in the areas under discussion is unsurprising, given that historical collections document the presence of *S. diehli, S. poechi,* and *S. dorsalis* in a relatively small area of Madang Province, PNG. It therefore appears that behind the conservative morphology of these snakes is hidden an unrecognized and undocumented resource partitioning ability.

A-1185 (Oral)
Eastern Collared Lizards (*Crotaphytus collaris*) Plastically Shift Toward a Faster Life History in Response to 30 Years of Climate Change

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Optimal life-history strategies arise from a complex balance of mortality risk and resource availability, both of which can be altered by ongoing climate change. Advances in spring phenology are the most-commonly observed biotic response to climate change but the downstream consequences of such changes for the rest of species' life histories are not well understood. We monitored reproductive cycles in female Collared Lizards throughout 30 consecutive spring breeding seasons (1992-2022) to examine factors that may influence the number of successive clutches produced by individuals along with survival and population demography. The onset of first clutch production advanced by nearly 3-wks over the 30y study and the number of seasonal clutches produced increased even though the total length of the reproductive season remained unchanged. Shifts in the timing and number of clutches were not repeatable indicating that observed changes could not result from adaptive evolution and likely represent phenotypic plasticity. Such plasticity appears to be driven by changes in body condition at spring emergence. Throughout the study, females that emerged in better condition began producing eggs earlier in the season, produced more clutches within a season, and were more likely to survive to the next season. However, at the population level, female lifespan decreased over the 30-y study and the frequency of 2-year or older reproductive females declining by 40%, despite the overall number of females not changing. Our results indicate that 30y of climate change has plastically induced a coordinated shift toward a faster paced life-history with female Collared Lizards producing eggs earlier, producing more eggs per year, and having reduced life expectancy.

A-1186 (Oral)
Lessons Learned from 16 Years of Amphibian Road Mortality Mitigation in a Large European City

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A specific problem resulting from urbanization and the expansion of the road network is road mortality of amphibians, which affects numerous species globally. This study aims to investigate amphibian road mortality in Poznań, a large city in Central Europe, on the basis of a long-term data set collected during road mortality mitigation actions performed by volunteers. Our database contains information on over 14,000 individuals from 9 taxa, recorded while crossing roads or detected as dead individuals from March 2008 to April 2024. In total, we worked in over 10 sites within the urban area at different times. In one case, the migrating population became completely extinct during the decade. The Common toad *Bufo bufo* was the species most affected by road mortality. Importantly, we are seeing a sustained decline in migrating amphibian populations in Poznan despite our conservation efforts. Despite the long duration of the project, the overall number of amphibians is relatively small when compared to other projects. However, our work was carried out in an urban area, where most of the monitored populations are not large and are subject to numerous negative impacts. Even though all amphibians living in Poland are legally protected, there is almost no will to mitigate road mortality on existing roads (the situation concerning newly constructed highways is more optimistic). Local authorities responsible for management of local roads almost never exhibit interest in solving the problem. Most actions are bottom-up and limited by the resources of the local communities providing volunteers. In our case, despite almost certain identification of migration routes, we have not managed to permanently secure any of the populations (e.g. by installing permanent fencing and tunnels). In 2024, for the first time, three local roads were temporarily closed during migration as result of many years of campaigning.

A-1187 (Oral)
Connecting the Dots Between Micro- and Macroevolution in Amphibians: The Eco-Evo-Devo Thread

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Evolutionary innovations refer to the emergence of major shifts in the traits of organisms, particularly as a consequence of sudden changes in environmental conditions. They can include the development of new morphological structures, functions, behaviors or other aspects of organisms. These innovations are the result of mutations, genetic recombination, or changes in gene regulation that occur over successive generations. Understanding how evolutionary novelties arise continues to be an interesting challenge in evolutionary biology. Morphological structures, functions, development, behaviors or other aspects of organismal biology often represent discontinuities across extant evolutionary lineages. Some evolutionary innovations in amphibians, at times highly complex traits, have evolved repeatedly in phylogenetically distant groups (e.g., direct development, limblessness or miniaturization). This convergence of evolutionary solutions to common environmental challenges, allows for the investigation into whether shared alternative developmental pathways have deviated in a predictable and repeatable manner. The expression of some such alternative forms may be plastic in origin, and

therefore the evolutionary rate of innovations, their recurrence and their reversibility may depend on the nature of the genomic regulation of the trait, its environmental sensitivity, and the selective pressure acting on the trait. Eco-evo-devo research often combines genomic analyses with experimental work to explore the dual role of the environment as both a selective sieve and a phenotypic inducer. It considers the possibility that environmentally-induced changes in the genomic regulation of traits during development may later evolve under selection into accommodated differences among taxa. These approaches may help us bridge the apparent gap between micro-and macro-evolutionary processes in amphibians.

A-1188 (Poster)

Anuran Conservation Planning in Priority Ecoregions of the Southern Cone of South America: An Integrative Approach of Life-History Traits and Biodiversity Threats

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Determining areas for conservation is essential to address the current biodiversity crisis. However, prioritization of areas considering species biological traits is still a challenge. Among vertebrates, amphibians are the most threatened, with the greatest diversity in reproductive modes. To adequately protected them, they would require distinct conservation strategies. The aim of this study is prioritizing areas to the anuran's conservation in Bolivian and Southern Andean Yungas (BY and SAY, respectively), combining geographic patterns of range sizes, species richness and life history traits. To achieve this, we obtained presence records sourced from museum collections, bibliographic data, and GBIF, and life traits data —body size, microhabitat preferences, life cycle, ecomorphological larval guilds, reproductive modes, locomotor modes, and overall diel activity patterns— from nearly 150 scientific articles; for all anuran species inhabiting in BY and SAY. We estimate species distributions trough ecological niche techniques to obtain a presence/absence matrix (PAM) to estimate spatial patterns of endemism (E) and species richness (SR). Linking the PAM with a multidimensional analysis of functional traits, we obtained functional richness (fr), functional evenness (fe) and functional divergence (fd) indices. High endemism level match with high fd, intermediate SR, fr and fe in BY, mainly at Cochabamba department in BY. On the contrary, the remaining areas of Yungas have low endemism with greater SR, fe and fr. Applying a weighted sum of the five layers we obtained targeting areas to prioritize. In a context of environmental changes, is mandatory to quantify potential changes of these patterns produced by climate warming and land uses changes, which are currently under analysis. These data and products constitute a solid baseline for the actions of governmental and non-governmental organizations, whose goal is the conservation of biodiversity based on rigorous data and objective analysis.

A-1189 (Oral)

Frontiers in Coral Snake Mimicry Studies: Experimental and Theoretical Advances

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The New World coral snake mimicry system encompasses around twenty percent of snake diversity in the Americas, comprising ~85 species of coral snakes (the venomous 'model') and over 150 species of colubrids (the 'mimics'). Early controversies over whether the system was truly mimicry, and not convergence due to other factors, revolved around several system deviations from theoretical expectation. Such difficulties include the high abundance ratio of mimics to models, the existence of mimics in allopatry to models, the high lethality of models, and the temporal patterns of models in relation to visual predators. Classical experimental work in the field and in the lab has steadily supported the existence of mimicry, and most recent work presupposes this. Some aspects of the system remain unsettled however, as we lack both a solid theoretical framework that addresses the aforementioned difficulties, and fine-grained empirical investigations of the system as a whole. In this talk, I discuss possible frontiers in the study of coral snake mimicry. I will give a brief review on the current state of the field, and then present some preliminary work that addresses unanswered questions at the intersection of evolutionary and ecological processes within mimicry systems.

A-1190 (Oral)

Testing the Influence of Habitat Succession and Lizard Age on Predation of Northern Prairie Skinks (*Plestiodon septentrionalis*) Using Clay Models

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Predation pressure has a strong influence on the evolution of prey phenotypes and is influenced by ecological factors. Under high predation pressures, prey species may alter behaviours that are critical for survival and reproduction to avoid exposure. Predation also influences prey habitat selection, and in highly fragmented habitats, may exacerbate negative demographic impacts. Northern Prairie Skinks are a Species-At-Risk lizard species in Canada, limited to mixed-grass prairie and aspen parkland in southwestern Manitoba, where they use a variety of habitats, including open prairie, aspen groves, and mixed-forest edges. Adults of this species are cryptically colored while juveniles possess bright blue tails, and given these different phenotypes, juveniles and adults may experience differences in predation. To determine whether Northern Prairie Skinks experience different predation pressures based on lizard age and habitat, we deployed clay models mimicking adult and juvenile lizards across a successional gradient from forest to open prairie in southwestern Manitoba, and quantified predator attacks through marks left in the clay. Clay models of Smooth Greensnakes were also deployed, to compare attack rates to a sympatric reptile species. Predation on clay models did not differ between adult and juvenile skink phenotypes; however, predation was significantly higher within forests relative to intermediate prairie habitats. Our results suggest that Northern Prairie Skinks are most vulnerable to predation in treed regions of the aspen parkland and mixed-grass prairie habitat of their northern range limit. This can inform conservation management of these habitats for this species, helping to prevent further declines.

A-1191 (Oral)

All (the Herps) the Earth will not Remember: How Geographic Gaps Pattern the Future Fossil Record of Reptiles and Amphibians

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We know the fossil record is incomplete, but just how much biodiversity does it miss? This question is crucial to paleobiologists and other researchers hoping to contextualize our modern world within the vast scope of Earth history, yet it is notoriously difficult to address. Here, we model the fossilization potential of extant tetrapods to better understand how to compare living and fossil biodiversity. We set out to better understand the selectivity of the fossil record by understanding what components of the modern fauna are not likely to fossilize. Since the primary control on fossilization is the sedimentary record, we attempt to produce a first-order estimate of how much biodiversity currently-forming sedimentary rocks might preserve. Furthermore, we seek to understand the biotic correlates of fossilization potential. To produce a first-order estimate of fossilization potential, we measured the degree of overlap between the geographic ranges of 34,266 tetrapod species and a map of modern sedimentary basin, where long-term persisting sedimentary rocks are forming. Using the resulting estimated "fossil geographic range," we investigate functional and ecological correlates of fossilization potential in a phylogenetic context. Among tetrapod groups, amphibians have by far the lowest fossilization potential, with fewer than 40% of amphibian species likely to enter the fossil record; this produces a highly misleading record of changes in diversity, as extinction risk and fossilization potential are negatively correlated. Moreover, traits that increase diversification rates (like small body size and preference for montane habitats) decrease fossilization potential, causing the systematic under-representation of phylogenetic diversity in the fossil record. The fossil record is far from a reliable accounting of life on land, but the results of this study and the perspective it affords us can help us make sense of its structure and bound our expectations of its content.

A-1192 (Oral)
Diversification in the Gray Zone of Speciation: Hybridization in *Liolaemus* Lizards (Squamata) and an in-depth Study in the *L. kingii* Group

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Understanding the origins of species lies at the heart of biological inquiry, with the gray area of speciation residing at the intersection of phylogenetics and population genetics. The advent of DNA sequencing catalyzed the emergence of phylogeography, seamlessly integrating these disciplines. Today, phylogeography serves as a vital approach, revealing cryptic diversity, spatio-temporal population dynamics, and the timing and extent of gene flow. Early studies in the 2000s, focusing on Patagonian lizards, hinted at interspecific gene flow as a possible explanation for observed patterns within *Liolaemus* clades. Over subsequent years, expanded geographic and taxonomic sampling, coupled with molecular and morphological data, strengthened support for this hypothesis across various taxa and regions. Recent genomic analyses have unveiled widespread instances of reticulation, showcasing complex evolutionary histories across different time scales. Our study of *Liolaemus kingii* exemplifies this phenomenon, utilizing dense geographic sampling and innovative computational approaches.

Analyzing nuclear RADSeq and mitochondrial data, we inferred phylogenetic relationships and demographic histories. Posterior predictive simulations assessed model fit, while a novel method calibrated a phylogenetic network, revealing mito-nuclear discordance and consistent support for a reticulated evolutionary history. Discussion within the context of the "gray zone" of speciation and Patagonian phylogeographic patterns enriches our understanding of evolutionary processes and informs taxonomic considerations. This study underscores phylogeography's power in unraveling the complex tapestry of species emergence and diversification, offering valuable insights into the dynamics of gene flow and rapid diversification events.

A-1193 (Oral)
Genetic Rescue of a Highly Endemic and Endangered Amphibian in Coastal California

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The Santa Cruz long-toed salamander, Ambystoma macrodactylum croceum, is a highly endangered salamander species that has a range limited to two counties along the coast of California, USA. Habitat destruction and fragmentation, due to urbanization and agriculture in the region, has led to the shrinking of populations, inbreeding, and loss of genetic diversity in the southern part of its range. This loss of diversity can lead to reduced capability to persist in an increasingly stochastic environment and can lead to an extinction vortex. Conservation efforts for this species includes a captive breeding program to test for outbreeding depression across populations and then supplement populations in the wild. We boost genetic diversity by crossing lower to higher genetic variation populations and releasing these larvae into shrinking populations. We are tracking the reproductive and survival success of released individuals through a genetic mark-recapture technique by developing microhaplotype genetic markers. These markers will help us build pedigrees to estimate relatedness between wild caught and captive bred salamanders and determine genetic diversity and success of various crosses. If our crosses are successful we can measure the impacts of added genetic diversity on population health and rank potential breeding locations and habitats. This novel approach will become a proactive genetic restoration method for the Santa Cruz long-toed salamander, and potentially other isolated, endemic species. These combined efforts could potentially stop the extinction vortex and contribute to population viability, both immediately and under future climate change.

A-1194 (Oral)
Exploring Immunomodulation in Toads: Differential Gene Expression Following Stimulation With An Emerging Pathogen

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Amphibian populations are endangered due to emerging infectious diseases worldwide. In addition, opportunistic pathogens take advantage of the host's compromised immune system to proliferate. *Aeromonas hydrophila* is an opportunistic bacterium that causes the red-leg syndrome in immunosuppressed individuals and is one of the agents responsible for the decline of amphibian populations in the wild and in captivity. Although this bacterium is widely spread and commonly found in freshwater ponds, little is known about its effects and interactions with the amphibian immune system. We aim to investigate differential gene expression in two primary immune organs (spleen and liver) of toads (*Rhinella diptycha*) injected with heat-killed *A. hydrophila*. For that, wild-caught toads were injected intraperitoneally with 300µL of a solution containing 3 x 108 bacteria, while the control group was not manipulated. Spleens and livers were collected six hours post-injection and submitted to transcriptomic analyses. We expect differential gene expression between the treated and control groups. More specifically, immune-related genes will be upregulated in the bacteria-injected toads. We hope to identify which genes and signaling pathways are activated in response to bacterial components, enhancing our understanding of pathogen recognition by the immune system in anurans.

A-1195 (Oral)
Prepare for Trouble, and Make it Double: Invasive Cane Toads (*Rhinella marina*) and Co-introduced Lungworms Host-Parasite Interactions across Australia

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Invasive species are severely detrimental to ecosystems but can be optimal models to study rapid evolution. Cane toads (*Rhinella marina*) were introduced to the east coast of Australia and expanded their range westward for over 80 years carrying along the co-introduced lungworm Rhabdias pseudosphaerocephala. Toads now range from Queensland (QLD; range-core) to the Northern Territory (NT) and Western Australia (WA; range-edge) and populations on the two extreme edges of the invasion show different morphology, behavior, physiology and immune traits. For example, range-edge toads are highly susceptible to lungworms and show lower metabolic investment in immune response than their range-core counterparts. To elucidate the mechanisms of parasite susceptibility and tolerance, we assessed innate immunity parameters (neutrophil:lymphocyte ratio – NLR, bacteria killing ability – BKA) and mRNA expression of naïve common-garden bred offspring derived from the range-edge and range-core families in response to an induced lungworm infection. Our preliminary results show that experimental parasite infection upregulated gene expression of pro- and anti-inflammatory cytokines in the spleen of infected toads compared to controls. Interestingly, naïve toads from QLD show overall lower immune parameters and gene expression compared to NT and WA toads. We suggest that the harsh environment at the front of the invasion range selects for higher constitutive immune traits to compensate for the novel challenges of long-distance

dispersal and colonizing new environments. Our study highlights the genetic adaptations during the dispersal of a successful invasive species while investigating how amphibians modulate immunity in response to new challenges.

A-1196 (Poster)
The Relative Importance of Environmental Variables in Predicting Activity Patterns of *Podarcis muralis* in a Large, Urbanized City

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Understanding how reptiles are affected by urban environments is important in predicting their occurrence and future use of these habitats, particularly as the degree of urbanisation increases. This study investigates the impact of various environmental variables on the daily activity patterns of the Common wall lizard (*Podarcis muralis*) in Budapest, Hungary. The objective was to determine how temperature, solar heating, habitat quality, disturbance and predation correlate with lizard activity, and highlight age-related differences. Field observations involved conducting 58 line transects across diverse urban habitats, over 19 days in August 2023. The presence-absence data for lizards were noted, along with measurements of environmental and confounding variables. Ambient temperature and light intensity were recorded using a device equipped with necessary sensors, while surface temperature was gauged with a contactless thermometer. General Linear Models (GLM) revealed that surface temperature was the most important predictor of lizard presence, complemented by light intensity. The optimal surface temperature for full sun exposure was lower than in normal daylight conditions, indicating that solar heating is an alternative to passive heat gain from warm surfaces. Lizards preferred moderately built-up areas across a broad range of surface temperatures, favoured less built-up environments under extreme temperatures, and had high presence in densely built-up areas within a narrow temperature range. The presence of passersby and wind had a significant negative effect on lizard presence. Further GLMs showed that juveniles were more sensitive to the presence of dogs and that they were excluded from habitats with the best thermoregulatory properties. These insights could inform urban wildlife management and conservation strategies, highlighting the importance of considerate urban planning to support species such as *P. muralis* within their native range.

A-1197 (Oral)
A Taxonomic Revision of the Unstriped Forms of the Asian Caecilian Genus *Ichthyophis* Fitzinger, 1826 (Gymnophiona: Ichthyophiidae) from Northeast India

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In this study, we conducted a comprehensive taxonomic review of unstriped Ichthyophis species occurring in Northeast India. Our study involved examination of both external and internal morphological features. We provide a detailed redescription, revised characterization, and diagnostic criteria for *Ichthyophis sikkimensis*, a species that has been inadequately

understood. This was achieved through direct re-examination of the type series and other historical specimens housed in the collection of the Zoological Survey of India, supplemented by the discovery of a previously unreported specimen at the Field Museum of Natural History, Chicago. Fieldwork conducted in the vicinity of the species' type locality yielded six additional specimens of unstriped *Ichthyophis*, revealing notable morphological variations, particularly in cranial characters and annular groove (AG) counts. These observed differences suggest the presence of a potentially undescribed species within the region. Additionally, we present findings regarding the phallodeum morphology of the studied species and document an adult specimen with morphological anomalies in its head and skull structure. Ichthyophis sikkimensis is confirmed as endemic to the westernmost part of northeast India, extending into far eastern Nepal. This study contributes valuable insights into the taxonomy, morphology, and distribution of unstriped *Ichthyophis* in the region.

A-1198 (Oral)
Establishment of Amphibian Cell Lines from Fresh and Cryopreserved Tissue

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Amphibians are the most threatened vertebrate class globally. Climate change, habitat degradation and disease have caused major deterioration and even extinctions of many amphibian species. To protect against continued losses, the generation of 'biobanks' –stored genetic information in the form of tissue or cell lines – is an important resource to safeguard against future declines of amphibian species. Cell lines in particular can be used to derive whole animals or for genetic engineering processes that aid in amphibian conservation. However, the development of amphibian cell lines is historically challenging, requiring deviations from common cell culture practices. I will discuss our efforts to derive cell lines from the critically endangered Australian corroboree frog (*Pseudophryne corroboree*) including culturing and cryopreservation considerations. I will also discuss the generation of cell lines from Cane toad (*Rhinella m*arina) and Smooth newt (*Lissotriton vulgaris*) — both species that have established invasive populations in Australia. I will discuss how cell lines derived from these animals can support the development of genetic biocontrol strategies to suppress or even eradicate their populations in Australia.

A-1199 (Oral)
Diversity of Scolecophidian Snakes

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Currently 474 scolecophidian snakes are recognized in five families: Anomalepidae, Leptotyphlopidae, Gerrhopilidae, Xenotyphlopidae, and Typhlopidae. In all scolecophidians strong selection associated with a fossorial lifestyle has led to cranial consolidation, miniaturization, and body elongation, resulting in worm-like habits – usually less than 30 cm in total length, and tiny skulls – often just a few millimeters long. Most scolecophidian species look superficially alike, and among all snakes, they are unsurpassed in difficulty of identification due to their low number of diagnostic characters and the difficulties in accurately illustrating and collecting morphological data due to their small sizes. Both, biologically and

taxonomically, the scolecophidians are the least studied group of snakes. The presentation gives an insight into external and internal morphological features of Scolecophidia with a special focus on osteological findings. Furthermore, it provides information on the limited data known so far on the biology and some exciting facts about these fascinating reptiles.

A-1200 (Poster)
Microhabitat Drivers of Californian *Hydromantes* Occurrence

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Cave salamanders of the genus *Hydromantes* represent an enigmatic case for biogeography. The genus comprises eight species endemic (or sub-endemic) to Italy and five species endemic to California. They usually retreat underground during warm and dry seasons but are active on the surface during wet seasons. Despite such similarities, their specific environmental preferences have never been compared. In January 2024, we sampled six localities where four Californian species (*H. samweli, H. shastae, H. wintu, H. brunus*) occur. We assessed microhabitat features across transects both on vertical surfaces and forest floors with daylight and conducted visual encounter surveys at night twice per transect. Individuals in reach were weighted and measured once per transect. Our objective was to uncover the relationships between salamander biometrics and occurrence and the biotic and abiotic habitat features examined. Considering all the species, transects exposed to the North were significantly associated with the highest number of salamanders, likely because they prefer cold and humid microclimates similar to their European counterparts. Moreover, higher weights were correlated with higher leaf litter depth, suggesting this variable may be a proxy of prey availability for the web-toed salamanders. Finally, the number of crevices showed some significance for *H. shastae* and *H. brunus*, while *H. samweli* appeared to be influenced mainly by the exposure to the North. No significant ecological variable was found for *H. wintu*, which was more abundant in transects inside or close to cave entrances, most probably due to the strong windy conditions encountered while sampling. These surveys provide a valuable basis for comparing European cave salamanders with Californian ones, both when they are active on the surface and when they shelter underground. Such comparisons can shed new light on ecological filters acting on related species from disjunct ranges affording similar pressures.

A-1201 (Oral)
They Really do Move in Herds: Evidence of Group Living in an Aquatic Turtle

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Sociality is a key aspect of the ecology of many species, and it has important implications for conservation. Nevertheless, research on vertebrate sociality has focused predominantly on mammals and birds, while reptiles have been largely neglected. Here we present some of the first evidence of group living in freshwater turtles outside of resource use or reproduction

contexts. We monitored the movements of clusters of juvenile Central American river turtles (*Dermatemys mawii*) and used simulations to compare our results to the null hypothesis of no social association. We found that turtles moved together non-randomly and formed tighter clusters than would be expected by chance. Indeed, in several cases, two juveniles were monitored moving closely together, apparently following one another. This work was conducted in an area with uniform habitat and little or no structure, and the results cannot adequately be explained by habitat selection, foraging behavior, or mating behavior. This leaves social clustering (i.e., group living) as the most parsimonious interpretation. This suggests that turtles are more social than generally assumed and expands our understanding of the contexts and taxa in which sociality arises.

A-1202 (Poster)
Are Facultative Cave Species Drivers of Metal Contaminants into Subterranean Environments? Presentation of the PRIN Project "METALCAVE"

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Subterranean environments are characterized by peculiar characteristics that make them unique but also extremely sensitive to human induced effects. Nonetheless, they hold a very rich and unique biodiversity. A few studies focused on assessing the potential pollutants of different nature into subterranean environments; surprisingly those focusing on metal contaminants are quite scarce. With this project we aim to perform the first assessment of metal contaminants in soil and organisms from different caves, as well as from surface soil in the proximity of each cave entrance, in order to evaluate the flux and accumulation of these contaminants across environments and trophic webs. To reach this goal, we will assess patterns of metal accumulation and gene expression in two facultative cave species living in highly polluted and lowly polluted (i.e., control) caves of the Apennines: the Italian cave salamander *Speleomantes italicus* (Amphibia; Plethodontidae) and the Laetitia's cave cricket *Dolichopoda laetitiae* (Insecta; Rhaphidophoridae). These two species often live in syntopy and occupy different positions in the subterranean trophic web; cave salamanders are top predators, while cave crickets are saprophagous that occupy the lowest trophic level. We have choosen 20 caves to measure the concentration of multiple metal contaminants in cave soil, as well as in the soil from the surroundings of the cave entrance. To assess the effects of metal pollution, we will analyse the metal-tissue burden and gene expression differences in both *S. italicus* (n = 24) and *D. laetitiae* (n = 24) living in two highly polluted and two lowly polluted caves. For each salamander, we will analyse gene expression differences by transcriptomics analysis (RNAseq) of three key tissues involved in metal uptake (skin) and metal storage and detoxification (muscle and liver). For the same tissues, we will measure the concentration of the biologically-available and potentially toxic metals by Mass Spectrometry (ICP-MS).

A-1203 (Oral)
A Needle in a Haystack: Using Passive Acoustic Monitoring to Identify Calling Activity Patterns of an Endemic and Endangered Poison Dart-Frog in Costa Rica

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Monitoring target species in vast areas can be challenging, especially in tropical environments where complex topography can make access difficult. Passive acoustic monitoring (PAM) provides a long-term option for the monitoring of cryptic species in remote locations. The endemic Golfodulcean poison frog, *Phyllobates vittatus*, has cryptic habits and recently has been reclassified as Endangered because of rapid habitat modification and its reduced distribution. In this work, we determined the presence and activity patterns of *P. vittatus* in seven watersheds across the Osa-Golfito region and (2) compare the efficiency of two monitoring techniques based on PAM: manual and automated call identification using a customized template detector. We detected *P. vittatus* in five of the seven sampling locations. The average calling activity pattern was between 0500–1700 h with the peak activity at 0800 h, however each population showed a particular activity pattern associated to rainfall. We found that the manual call identification was more accurate than the automated call identification as it provides a more precise identification of calls even under low signal to noise ratio circumstances. For the use of the automated method in future projects, we suggest improving the efficiency of the detector to spot signals in scenarios with loud background and overlapping noises. Despite this challenge, both PAM techniques were able to identify P. vittatus calls in natural conditions, making the automated identification method a good option to save time and human resources.

A-1205 (Poster)
Predator-Induced Changes in Body Shape and Coloration of the Japanese Tree Frog Tadpoles (*Dryophytes japonicus*)

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Tadpoles have long served as model systems for investigating induced defense mechanisms and predator avoidance strategies. Specifically, certain species within the genus *Dryophytes*, a member of the tree frog family, develop deep tail fins and bright orange tail coloration in response to dragonfly nymphs. These conspicuous tails are thought to attract predator attacks, protecting vital body parts from fatal injuries. However, it remains unclear whether this response varies with different predators. To explore this, I conducted an experiment on tadpoles of the Japanese tree frog, *D. japonicus*, examining whether the extent of the induced changes differs between various predators, including several dragonfly species with distinct feeding styles and habitats. Tadpoles, derived from adults collected in Kyoto, were reared with four different dragonfly species, water bugs, and water scorpions. Two weeks into the experiment, tadpoles reared with *Anax nigrofasciatus*, a sit-and-wait predator that climbs on water plants, exhibited deeper fins and bright orange tails. Three weeks later, tadpoles exposed to other odonate species, that forage at the bottom of the water, also demonstrated morphological and coloration changes, although to a lesser extent. No changes in tail shape and coloration were observed in tadpoles with non-odonate insects. These results indicate *D. japonicus* tadpoles specifically respond to dragonfly nymphs and that the degree and timing of this response differ

between dragonfly species. Furthermore, my observations of *Anax* larvae in tanks with equal numbers of normal and induced tadpoles revealed that larvae most frequently attacked the brightly colored tails of induced tadpoles, suggesting a lure effect. Therefore, the bright coloration in *D. japonicus* tadpoles appears to be a specific defensive response to visually adept predators, dragonfly nymphs. Tadpoles modulate their anti-predator phenotypes based on the relative predation risk, considering the predators' foraging styles and visual capabilities, thereby minimizing the energetic costs of induced traits.

A-1206 (Oral)

Thermal Tolerance Traits may Explain the Relative Abundance of Four Persistent *Pristimantis* Frogs from the Colombian Andes

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Thermal physiological constraints play a crucial role in shaping abundance and distribution of ectothermic species. In the Andean cloud forests, direct-developing frogs with limited geographical and altitudinal ranges might be especially vulnerable to climate change due to their narrow thermal tolerances. We assessed the thermal tolerance of four species of terrestrial frogs, *Pristimantis apiculatus, P. hectus, P. laticlavius*, and *P. verecundus*, that have persisted in a once distinctively rich amphibian community in the Andes of southern Colombia that suffered drastic declines, potentially caused by chytridyomicosis. Considering the evidence of rising temperatures and decreased precipitation in the area, we investigated whether differences in physiological responses to temperature and dehydration of these species could explain their abundance changes since they were last surveyed, almost four decades ago. We compared four hydrothermal parameters: critical maximum temperature (CTmax), operative temperature, jumping performance under various temperatures and two hydric regimes, and temperature selection. The two currently abundant species (*P. laticlavius* and *P. verecundus*) selected a wider range of temperatures along an experimental gradient compared to those that have declined (*P. hectus* and *P. apiculatus*); furthermore, *P. laticlavius* showed the highest CTmax, operative warming tolerance, and jumping performance. By contrast, *P. hectus* performed better at lower temperatures. Dehydration (5% body weight) did not produce significant changes in performance in any of the studied species. Our results point to differential vulnerability among these species under the current warming scenario, provide evidence for plasticity in thermal physiological responses of closely related species, and suggest thermal environmental changes as a potential driver of structural shifts in amphibian communities. Hydrothermal physiological studies are essential to understand and foresee the impacts of future climate change on amphibians, and to further examine its combined effect with other stressors, such as emerging infectious diseases.

A-1207 (Oral)

Ponds, Pools, or Puddles? Offspring Rearing-site Use in Bornean Frogs Breeding in Small Aquatic Microhabitats

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Rearing offspring in suitable habitats is crucial for the survival of many organisms, especially egg-laying species. For amphibians, selecting optimal sites for egg-laying or tadpole deposition is vital for the survival of their offspring. However, most studies providing insights on the use of small water bodies (ponds, pools, puddles, and phytotelmata) in frogs have focused on species found in the Neotropics, leaving a significant knowledge gap about species in the Old World tropics that use small water bodies for reproduction. Our study addresses this gap by examining the use of natural and artificial pools by a frog community in a mixed-dipterocarp forest in Brunei Darussalam. We characterized various physical and biological traits of these pools to identify abiotic and biotic factors influencing the presence of amphibian larvae in a given pool. We found that natural small water bodies are intrinsically scarce in the study area. Through a resource supplementation experiment with artificial pools, we found that three amphibian families—Rhacophoridae, Dicroglossidae, and Microhylidae—predominantly used these artificial sites. Understanding these usage patterns is crucial given the rapid environmental changes, such as temperature fluctuations and altered rainfall patterns, which can affect the reproductive behavior and survival of species dependent on these habitats. Our study underscores the importance of establishing baseline information on the species using these pools, their frequency of usage, and their habitat requirements. By understanding the factors that influence the availability and use of breeding sites, we can better predict the impacts on amphibian reproductive success and survival.

A-1209 (Poster)
Predicting Habitat Shifts of High-Alpine Amphibians in the Southern Rocky Mountain Region

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Global biodiversity is diminishing rapidly. The number of accepted "background" extinction rates range from 0.1 to 4 species per million per year. However, some authors have noted an increase in extinctions to 150–260 species per million per year since 1500. As the largely anthropogenic-induced global biodiversity crisis progresses, an abundance of taxa are faced with changing environments, decreasing population sizes, and/or extinction. Concerning amphibians, at least 43% of all species are experiencing population declines, with the 2008 Global Amphibian Assessment showing that 32% of all amphibian species are threatened or extinct. Populations of high-alpine amphibians in the southern Rocky Mountain region (i.e., Boreal toads [*Anaxyrus boreas boreas*], Tiger salamanders [*Ambystoma mavortium*], and Boreal chorus frogs [*Pseudacris maculata*]) have swiftly declined in recent decades due to high

susceptibility to diseases (e.g., *Batrachochytrium dendrobatidis* and ranaviruses) and changing environmental conditions. This study will focus on the effects of climate change by examining the habitat of these three amphibious species. A Maximum Entropy (MaxEnt) model is a commonly used machine-learning method of creating SDMs by accounting for the most uniform distribution and the provided predictors. Well-fitted models can be produced for different climatic scenarios by including climatic and environmental factors, or predictors, relevant to the species of interest, appropriately adjusting the regularization parameter and active feature classes for each model, and properly evaluating the models. By adopting this method of SDMs along with a decadal time-series approach, we demonstrate a larger-scale pattern of potential habitat shifts over time in this alpine habitat caused by climate change.

A-1210 (Oral)
Using Flow Cytometry to Compare Leukocytes in Three Species of Watersnakes

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Effective immune research is hindered by the lack of diversity in our model systems. Traditional model systems often use highly inbred strains of rodents, which has led to our inability to detect immunological responses that occur in natural populations. Therefore, investigating animal models displaying natural variability in immune function and responses will greatly improve our ability to better understand and predict responses seen throughout a broader range of taxa as well as in heterogeneous human populations. To specifically examine the innate immune system, studying organisms that prioritize the innate immune system, such as reptiles, can be highly informative. In this study, we quantified and compared proportions of three types of circulating leukocytes (azurophils, heterophils, and lymphocytes) before and after a standardized stressor among three species of watersnake (*Nerodia erythrogaster, N. fasciata*, and *N. rhombifer*) in North and South Arkansas, US populations. We additionally quantified plasma microbial killing ability against *Escherichia coli* for each individual and compared values between species and locations. We found high individual variability in leukocyte populations that were identifiable and repeatable across time, species, and sex in both North and South Arkansas populations. The level of repeatability and ability to isolate specific leukocyte populations provides strong evidence that the use of flow cytometry is a viable option to include in assessing immunological status of wild snakes. Our work demonstrates how results from combining a functional assay (bactericidal ability) and a quantification assay (flow cytometry) can inform predictions of immune responses in different species and environments to stress.

A-1211 (Oral)
Terrestriality Degree Drives Adaptive Evolution of Resistance to Water Loss in Frogs

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A long-standing question in the evolutionary history of amphibians is whether terrestriality degree (arboreal, terrestrial, amphibious) drives the adaptive evolution of the integument resistance (r_i) to water loss. Recently, in the first broad-scale comparative study of water loss resistance in frogs (> 200 species), average ri did not differ with microhabitat use. However, even though the effect of phylogeny was incorporated in this comparison of r_i across microhabitats, a formal test of adaptive evolution was not performed. Consequently, we do not know yet whether the evolution of r_i in frogs is driven by different selective regimes across microhabitats, which encompass different degrees of terrestriality. To answer this question, we modeled the evolution of r_i in the same frog species using an Ornstein-Uhlenbeck (OU) framework. OU models test for adaptive evolution of traits while also accounting for phylogenetic inertia, the effect of past adaptation on current phenotypes. We compared four alternative hypotheses for the evolution of r_i: a Brownian Motion model, a single optimum for r_i, three distinct optima among microhabitats farther away, moderate, and closer to water sources, and a model with five distinct optima for each microhabitat (arboreal, fossorial, ground-dwelling, stream-dwelling, and semi-aquatic). The best model for the evolution of r_i indicated strong phylogenetic inertia, with five distinct optima, suggesting that frog species have adapted to different selective pressures related to terrestriality degree. While physiological adaptations (skin secretions, cocoon-forming, aestivation), behavior (site selection), and strong phylogenetic constraints can either constraint or facilitate the evolution of r_i, our findings reveal that the evolution of r_i in frogs is adaptive and driven by ecological differences associated with microhabitat use. Despite many arboreal and fossorial frogs exhibit high r_i that allows them to reduce dehydration effects in their microenvironment, we showed that ecological factors also drive the adaptive evolution of r_i.

A-1212 (Poster)

Advancing the Knowledge and Protection of the Herpetofauna of the Caatinga (Northeastern Brazil), the Most Diverse Arid/Semiarid Region of the World

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The Caatinga is the largest seasonal dry tropical forest in the South America and also the most diverse arid/semiarid region of the world. and it has been historically neglected in terms of its biodiversity. Regarding herpetofauna, studies led the knowledge about the diversity and endemism in Caatinga, but detailed and updated general synthesis is still scarce in literature as well investigation on the impacts of climate change in the reptiles and amphibian's species. The action plan for the conservation of threatened species of the Caatinga herpetofauna is also little known, even in the scientific community. At first, we will present the most detailed and

up-to-date synthesis of knowledge about Caatinga herpetofauna by providing a (i) taxonomic richness patterns (ii) and spatial biases. Second, we will present the preliminary results on the impacts of future climate change in macro and some micro endemic species of the herpetofauna (by using Species Distribution Modelling) considering as a challenge for a dynamic spatial conservation prioritization of the Caatinga. Finally, we also present an outreach activity "Jewels of the Dunes of Velho Chico" we are developing along with the Caatinga community to try to protect five threatened species that occur along the São Francisco River. This overview presented to international community of herpetologists synthesizing the recent accumulated knowledge about the Caatinga herpetofauna is very important and the data crucial for accurate strategies for the conservation planning. It directs actions to advance our knowledge on Caatinga herpetofauna: to concentrate inventories in sample void areas; continuous update of the species occurrence database, advance in the generation of autoecology data for species. The basis for an effective conservation.

A-1213 (Oral)
Augmenting Spatial Predictions of an Emerging Disease in Snakes With Soil Microbiota Data

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Soil microbiota significantly influence the distribution of invasive organisms, yet are rarely included in spatial models. This is in part because soil microbes are highly dynamic and variable across the landscape. Recently, a handful of studies have incorporated soil microbes as predictors of organism occurrence while attempting to account for the microbial dynamics and variability. To examine the utility of informing species distribution models of invasive organisms with soil microbiota data we incorporated publicly available presence data for soil bacteria and soil fungi at sites across the United States into joint species distribution models predicting the occurrence of an emerging fungal disease in snakes, ophidiomycosis. Including soil fungi and bacteria that were predictable across the landscape (AUC > 0.70) and informative of target organism occurrence (R-squared > 0.375) into final models slightly increased model performance predicting ophidiomycosis occurrence across Texas. We also assessed model performance for ophidiomycosis predicted across the contiguous United States. We found soil moisture level and human modification to impact microbe occurrences. Human modification had the largest impact on the predicted probability of ophidiomycosis occurrence. In addition, we identified two bacterial genera and two fungal genera that accounted for the highest amount of variability in ophidiomycosis occurrence, the bacterial genera *Cellulosimicrobium* and *Glaciimonas* and the fungal genera *Amanita* and *Cenococcum*. While incorporating large scale soil microbiota data into our final models increased model complexity, our model performance indicated that we can feasibly account for microbiota dynamics and variability across the landscape. In addition, we were able to identify microbes that may be predictive of disease susceptibility. Given the dynamic nature of invasive and emerging organisms with the soil microbiome, informing disease risk models with soil microbe occurrences may be realistic and provide nuanced predictions that will benefit future conservation and management.

A-1214 (Oral)
Welcome to Miami: Reproductive Traits and Pathogen Potential of Introduced Caecilians (*Typhlonectes natans*) In Florida

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In 2019, a single Rio Cauca Caecilian (*Typhlonectes natans*) was captured in a canal in Miami-Dade County, Florida, representing the first record of a wild caecilian in the United States. Many individuals have since been captured in the same canal system, generating potential for new lines of research concerning the reproductive ecology and impacts of the introduced caecilian population. Here, we examined the relationship between body condition and reproductive effort in the introduced *T. natans* population. In addition, we evaluated the potential of *T. natans* to spread common amphibian pathogens. We necropsied *T. natans* collected in south Florida and generated a scaled mass index as a proxy of body condition. To estimate the fecundity of females, we measured the number and size of ovarian follicles. We screened skin swabs and tissue samples to detect the presence and intensity of Ranavirus and Batrachochytrium dendrobatidis using qPCR. We found a positive correlation between female snout-to-vent length and total follicle count as well as a negative correlation between total follicle count and the largest follicle diameter. Our findings provide insight as to the ability of *T. natans* to reproduce in south Florida, as well as their potential role as a vector of emerging pathogens to native amphibians.

A-1215 (Oral)
An Investigation of Developmental Toxicity Patterns in Rough-skinned and California Newts (*Taricha granulosa* and *T. torosa*)

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Pacific newts (*Taricha* spp.) are poisonous salamanders common to the west coast of North America. Taricha are chemically defended against predation by tetrodotoxin (TTX), a paralytic neurotoxin which may be synthesized by bacteria living on the skin of the newts and which is most concentrated in cutaneous granular glands. The existing literature shows a predictable pattern in toxicity across rough-skinned newt (*Taricha granulosa*) development, wherein TTX is present in eggs, declines after hatching and during larval development, reaches its lowest point in newly metamorphosed newts, and then dramatically increases in the first three years of adulthood. Granular glands develop during metamorphosis, and amphibian skin microbiomes typically change dramatically at this time as well, suggesting a relationship between morphological and microbial developmental changes and tetrodotoxin acquisition. We seek to investigate the role and timing of microbial symbiosis and granular gland development in *Taricha* toxicity. We collected skin biopsies from larval, metamorphic, and adult *T. granulosa* and *T. torosa* (California newts) found together in a breeding pond in Santa Cruz County, California in September 2023. While *T. torosa* followed the expected pattern of developmental toxicity, *T. granulosa* metamorphs were found to be more toxic than larvae. However, the conflicting results could be an artifact of sampling differences between the species. Additionally, we found that larval skin biopsies were lighter and thinner than those

taken from adults or metamorphs, which aligns with expected changes in skin structure and function. We will subsequently investigate changes in microbiome composition, host and microbiome gene expression, and skin morphology and TTX distribution across sampled age stages.

A-1216 (Oral)
The Impact of Severe Wildfires on Forest Amphibian Metacommunities in Eastern Australia

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Changes to the scale, frequency, severity, and location of wildfires because of anthropogenic climate change are predicted to have compounding negative consequences for ecological communities. While there is evidence of severe weather events such as droughts affecting amphibian communities there is less knowledge on the effect of wildfire. It is unknown which amphibian life history traits are the most vulnerable to fire impacts and hence which should be prioritized for conservation management in the aftermath of severe wildfire. We conducted visual encounter surveys and passive acoustic monitoring to determine the impacts of the 2019-2020 wildfires in eastern Australia on forest amphibian communities across a 102,500 km study region. We used multi-species occupancy models to analyze the impact of severe fire extent. As expected, the models demonstrated a negative influence of severe fire extent on meta-community occupancy. The north model had a weaker effect than the south which is likely reflective of the less intense fires which occurred in this region. Against our hypothesis, the occupancy of burrowing frogs were strongly negatively correlated with severe fire extent. As hypothesized, numerous rainforest specialists were strongly negatively correlated with severe fire extent, some from endemic Gondwanan lineages such as Philoria and Assa. Rainforest specialists were expected to be susceptible since they do not have an evolutionary history of encountering wildfire. Our experimental design could not disentangle whether impacts to species were due to the preceding drought or the wildfire. This underscores the need for long-term monitoring. Both threatened and common species were found to be impacted by severe wildfire, highlighting the importance of adaptive conservation strategies to account for common species after severe climatic events. It should be of international concern that climate change driven wildfires significantly reduced the distribution of entire forest amphibian communities.

A-1217 (Oral)
Mitigation Translocation, Hibernacula Construction, and the Movements and Overwintering of Two Threatened Canadian Snakes

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In Canada, a wide range of snakes use site-specific refugia (hibernacula) to survive lethal winter temperatures. To this end, snakes typically demonstrate fairly high levels of hibernaculum fidelity: after emergence in the spring, they disperse to spend the summer foraging and mating, later returning to the specific hibernating sites. The intentional or

unintentional destruction/disruption of natural denning sites is increasingly being compensated for through the construction of new artificial denning sites, without a corresponding uptake in research on the success of these measures. Late in 2020, a hibernaculum containing several species of snakes was inadvertently destroyed through the construction of an oil pipeline 'megaproject' in western Canada. Although some snakes were relocated to neighbouring natural dens, the onset of winter necessitated housing the majority of animals under artificial conditions. This presentation will showcase efforts made to learn from and mitigate this unfortunate disturbance event. The artificially-hibernated snakes were released with the seasonal return of warm weather, using a 'soft release' approach that incorporated artificial, newly-constructed hibernacula. Close to 50 snakes (*Pituophis catenifer* and *Coluber constrictor*) were monitored using radio-telemetry, including a set of 'reference' individuals drawn from neighbouring dens. We use these data to report on comparative survival and movement behaviour of the snakes, the extremely low percentage of animals that adopted the new hibernating site in the following year and, in many cases, the location and use of other natural hibernacula by the displaced snakes. We also used temperature-sensitive transmitters and thermal dataloggers to compare temperatures inside artificial and natural hibernacula. All told, this project will showcase the need for more thorough pre-emptive planning and precautions before the implementation of translocation and artificial hibernacula construction. At the same time, our work suggests a resilience of at least some portion of the snake population impacted by development.

A-1218 (Oral)
The Power of Community Engagement in Frog Conservation

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Frogs are one of the most threatened groups of animals on the planet, yet our current understanding of global frog species diversity, distributions and population trends remains poor. Professional biologists are working hard to gather the information needed to conserve frogs but cannot do it alone. In 2017, the Australian Museum launched FrogID, a national citizen science project based upon a smartphone app used to record calling frogs. In less than seven years, FrogID has revolutionised both our understanding of Australian frogs and public engagement in frog conservation. Tens of thousands of people have now participated in the project, gathering over million records of frogs. The dataset is growing rapidly, with a peak of over 6,200 frog records in a single day. The FrogID dataset has helped uncover the true diversity and distributions of Australia's frogs, along with the impact of threats such as fires, drought, climate change and habitat modification. The incredible value of the public in facilitating frog conservation was further demonstrated in winter 2021, when a mass frog mortality event occurred across Australia. Unable to travel to investigate due to COVID lockdowns, we relied on the public, many already engaged in frog conservation via the FrogID project, to report sick or dead frogs. That winter, we received more than 1,600 reports of sick or dying frogs of over 40 species. Amazingly, members of the public also collected hundreds of dead frogs for us and stored them in their freezers until travel restrictions eased. These samples have made it possible to investigate potential drivers of the mortality event including disease and pesticides. People across Australia have clearly demonstrated the power of community engagement in frog conservation.

A-1219 (Oral)
Unfolding the Ontogenetic Trajectories of Adaptive Immunity in Salamandrids

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The adaptive immune system of jawed vertebrates (AIS) is a major evolutionary innovation. It enables the identification of virtually any non-self (including pathogen-derived) antigen and has "memory", which promotes quick, specific, and potent response to a previously encountered threat. On the flip side, AIS requires formation of a vast anticipatory repertoire of antigen receptors (ARs) early in life, which is both time-consuming and resource-intensive. This developmental constraint may be particularly pronounced in small amphibian larvae which hatch in pathogen-rich aquatic environments. Further, metamorphosis remodels tissues, changing the antigenic landscape of "self", which could provoke in adults an autoimmune response of an AIS educated at a larval stage. Thus, an early larval investment in AIS could be wasteful, and extensive research in *Xenopus* frog has indicated that a complete development of AIS may be delayed in amphibians until after metamorphosis. Furthermore, early studies on skin graft rejections and lymphocyte responses *in vitro* indicated that Urodeles' adaptive responses were generally subdued compared to Anurans. Given the ongoing decline in amphibian populations, it is imperative to gain a deeper understanding of the developmental timeframe of amphibian AIS and to explore the reasons behind Urodele-specific suppression. Recent advancements in transcriptomics now enable us to explore these patterns in a broad phylogenetic context. Here, we study how the AIS unfolds during the larval development in four salamandrid genera: *Ichthosaura, Lissotriton, Pleurodeles* and *Triturus*. We find marked differences between taxa, with a gradual increase in expression of key components of the AIS through larval development and metamorphosis of Pleurodeles, and a more rapid onset nearing the metamorphosis in the remaining species. Additionally, we studied trajectories of larval Pleurodeles TCRα (key AR of T lymphocytes) repertoire development, observing steady increase in its estimated size from a few hundreds to a few thousands distinct clonotypes.

A-1220 (Oral)
Phylogenomics of Crotaphytid Lizards: Rampant Mitochondrial Introgression and Allele Surfing Versus the Introgression Conveyor

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We performed a phylogenomic analysis of crotaphytid lizards including the nine currently recognized species of *Crotaphytus* and the three currently recognized species of *Gambelia*, with dense intraspecific sampling for the more widespread species. Our previous research indicated extensive mitochondrial introgression has taken place within *Crotaphytus*, though it was difficult to distinguish introgression from lack of species monophyly in some instances (e.g., *C. nebrius* versus *C. collaris*). Further, our prior analyses suggested multiple waves of introgression from *C. collaris* into *C. bicinctores* in southwestern Arizona over the past few

million years, leading us to propose an "introgression conveyor" model to explain that pattern. Subsequently, the "allele surfing" model was proposed for another taxon, and this model clearly offers a compelling alternative explanation for collaris-bicinctores introgression. Here, we screen ~1100 sequence loci obtained via exon-capture to estimate the species level phylogeny of crotaphytid lizards. Analysis of these data returns a well-resolved phylogenetic estimate for Crotaphytidae while also (1) clarifying the extent of mitochondrial introgression in this system, (2) suggesting the possibility of at least one unrecognized cryptic species within *Crotaphytus*, and (3) tipping the balance toward the introgression conveyor model rather than allele surfing for the collaris-bicinctores introgression history.

A-1221 (Oral)
Acoustic Monitoring of Floodplain Frog Communities to Inform Water and Flow Management

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In floodplain ecosystems, frog species can be useful indicators of the effect that flooding, both natural and managed, has on floodplain biota. Thus, frogs are often targeted in biodiversity monitoring programs to report against management objectives. Acoustic monitoring has increasingly been adopted as a tool to survey and monitor wildlife. Although this technology allows us to monitor across large temporal and geographical scales, the large volume of data generated are challenging to process and interpret. We developed a modelling framework to automate frog species recognition in large acoustic datasets. Training data, incorporating individual frog calls, frog choruses and non-frog noises were collated and used to train a convolutional neural network model to recognise the calls of 16 target frog species. To improve efficiency in reviewing results, we developed an accompanying software tool to rapidly validate the performance of the neural network model at recognition of each target species. This approach is being implemented to evaluate species richness and temporal calling peaks of frog communities along the Murray River and its associated floodplains in south-eastern Australia, where we employ acoustic monitoring at ~150 sites for 4-6 months of the year. The developed workflow has identified the presence of threatened species such as the Growling Grass Frog, a range extension of the Endangered Sloane's Froglet, and the first records in many years for some species in some areas. This approach has improved efficiency in data processing, interpretation and reporting on frog populations in response to flood events.

A-1222 (Oral)
Charting the Sea Snake Diversity of a Forgotten Archipelago

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Sea snakes are the most speciose of extant marine reptiles and are mainly distributed across the Indian and Pacific Oceans, with their greatest species diversity found in northern Australia and the Indo-Malayan Archipelago. This ecologically diverse group comprises a critical component of the reef and coastal ecosystems that occur throughout their distribution. However, a

considerable fraction of their range remains under-surveyed with important gaps identified around the Southeast Asian region including the Philippine Archipelago. Situated at the apex of the global centre of marine biodiversity called the Coral Triangle, the waters surrounding the Philippine Archipelago are predicted to support an extremely high level of sea snake diversity. But the archipelago remains largely under-surveyed, with a significant deficiency in basic knowledge and species records spanning for over 50 years; making it a long-standing priority for important sea snake research. Here, we will present the history of sea snake research in the Philippines, the main challenges confronting the implementation of surveys around the archipelago, and some of the more recent studies that could propel the resurgence of this field of research in the country.

A-1223 (Oral)

Fire Shapes Reptile Community Composition and Drives Species-Level Responses in a Semi-Arid Mallee Landscape

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Fire is a primary driver of changes to vegetative habitat structure, impacting shelter availability, diversity, and value for individual species. Throughout Australia, and particularly in arid and mallee ecosystems, spinifex grasses serve as a crucial site for an enormous diversity of species but are uniquely vulnerable to the landscape-level fire events common in mallee ecosystems. Given that 93% of the reptile species in our study area utilize spinifex, with 20% being spinifex obligates, understanding fire-driven dynamics is crucial. This research assesses how fire influences reptile populations at Calperum Station, a conservation property in semi-arid South Australia, utilizing over 20 years of continuous fauna survey data across 118 sites, four fire histories, and covering nearly 4,000 km² of mallee habitat. Our findings indicate that community-level metrics, species richness, and Shannon's Diversity Index (SDI), decline immediately following fire events. These metrics then exhibit gradual recovery, fluctuating with varying annual conditions and typically peaking between 7-11 years post-fire before declining again. Modelling the variables acting on community and species-level response shows that time since fire and the 12-month preceding rainfall for mallee communities are the most significant drivers of change. When testing the effects of fire on individual taxa, we find that species-level responses are extremely variable, differing wildly even within single genera. This research enables us to not only determine how fire events shape the reptile community health and composition of mallee ecosystems, but to make species-specific recommendations, identifying vulnerabilities and optimising fire-management strategies for conservation outcomes.

A-1224 (Oral)

Searching for the Rarest: Standardized Methodology to Assess the Presence of Almost Extinct Large Softshell Turtles in Africa (*Cyclanorbis elegans*) and Asia (*Rafetus swinhoei*)

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Most of the global softshell turtles (Trionychidae), and all of the large softshell turtles, of tropical and subtropical regions are threatened according to the IUCN (2024) Red List. Notably, two of the largest species of softshell turtles are also among the most threatened: Africa's Nubian Flapshell Turtle (*Cyclanorbis elegans*) and Asia's Yangtze Giant Softshell Turtle (*Rafetus swinhoei*). The former was suspected to be extinct for almost 20 years, until it was rediscovered in South Sudan in 2017 by our team, which later extended its known range with the discovery of a novel population in northern Uganda. The second is almost extinct in the wild, with possibly a few individuals known/suspected to exist, and a single survivor in captivity. In this presentation, we will review the suite of field methodologies that were used to rediscover *C. elegans* and that have recently been applied to *R. swinhoei* in Vietnam, allowing us to gather photographic evidence and define an area of a possibly surviving population for the latter in northern Vietnam. We will demonstrate that our methodologies also provide for the collection of noteworthy data for numerous other species in Africa and Asia. We will outline the importance of a multidisciplinary approach, where substantial time and effort should be put into assessing communities and "wise experts" (mainly hunters and fishers) using statistical procedures, before enterprising into (i) standardized field techniques to evaluate turtle presence and abundance in the wild, and (ii) assessing their threats in a methodologically logical and sound way (Threats Analysis). We aim to produce a standardized methodology that can be applied anywhere in the tropical and subtropical world with large-sized softshell turtles. Using a same investigation procedure would also allow for a more meaningful comparison of conservation status between species, and even within species in different regions of their range.

A-1225 (Poster)
Environmental and Genetic Factors Produce Different Results in Toad Tadpole Kin Recognition Ability

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Several amphibian species are known to possess kin recognition (KR) ability. In this context, cooperative aggregation behavior against predators and mitigating intraspecific competition (kin competition) appear relevant. These species show a preference for associating with siblings over non-siblings and avoid cannibalism toward siblings. The tadpoles determine "who is a sibling" through scent-learning (odor cue), a process known as phenotype matching; both genetics and learning are crucial for kin discrimination. In this study, I tested the kin recognition system using tadpoles from two populations of Japanese common toads, which have different genetic structures. The tadpoles were reared under varied conditions of sociality and water environment: either in groups or solitary, and in tap or pond waters. The results differed between the two populations: no KR was observed in the population with low genetic

diversity, while KR was shown in the population with high genetic diversity. However, KR requires learning and depends on the water environment. These findings suggest that variations in previous studies on KR in closely related species may be attributed to differences in population genetic structure and learning conditions.

A-1226 (Oral)
Status of the Philippine Forest Turtle (*Siebenrockiella leytensis*) 20 Years After its Rediscovery

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The Philippine Forest Turtle (*Siebenrockiella leytensis*) was described in 1920 but never found at its type locality in Leyte, Philippines. It was believed to be extinct until it was rediscovered some 80 years later, and only then its race against extinction began. Just months after the rediscovery was published, in 2004, illegally sourced-out specimens were available at pet markets in Europe, Japan, and the United States. To prevent extinction Katala Foundation Inc., a local NGO working on highly threatened species in Palawan, adopted the species as its flagship species under its Palawan Freshwater Turtle Conservation Program (PFTCP) in 2006, with the overall goal of downlisting the species by 2020. Applying a One Plan Approach, the PFTCP includes research to comprehend the biology and ecology of the species, habitat protection and restoration, awareness raising and capacity building of stakeholders, distribution surveys, assessment of population sizes and monitoring of trends, assessment of threats, rescue and rehabilitation, post-repatriation monitoring, and the management of an assurance colony and conservation breeding. The present paper concentrates on distribution surveys to define extent of occurrence and area of occupancy, catch per unit effort over its range, population trends from 2007-2024, densities, and threats. Data at hand indicate that overcollection resulted in population declines and shifts in compositions, that the collection of adults had a greater impact than that of juveniles, that the populations of the species in protected areas show signs of recovery, and that the main threat to the species is shifting now from IWT to habitat loss. A downlisting is not yet justifiable.

A-1227 (Poster)
Host-Pathogen Interactions in Chemically Defended Amphibians: Tradeoffs of Chytrid Resiliency

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Microbial communities are essential for host health. Basic functions such as digestion, reproduction, and pathogen defense, depend on the stability of the microbiome. In amphibians, a taxa impacted by the chytrid fungus *Batrachochytrium dendrobatidis* (Bd), responsible for chytridiomycosis, skin microbiome health is critical for pathogen defense and survival. Alkaloids in the skin microbiota of chemically defended amphibians, can affect microbiota diversity and inhibit bacterial and fungal growth. While Bd infections are lethal for many amphibians, reports of stable chytrid-positive populations suggest that certain poison frog

species can survive Bd infections. To study the factors that may confer toxic dendrobatid frogs' resistance to chytridiomycosis, we sampled two populations of the toxic species *Oophaga sylvatica* and the sympatric non-toxic dendrobatid species *Hyloxalus awa* in two locations in Ecuador. From each location, we collected skin swabs from 15 individuals per species for 16S and ITS sequencing to identify bacterial and fungal taxa, and to identify the degree of Bd infection with qPCR. Additionally, we collected each frog's skin secretions to quantify natural alkaloids using gas chromatography/mass spectrometry (GC-MS) analyses. The results will allow us to compare the chemical profile and skin microbial communities' richness and abundance to the presence and degree of fungal infection. I expect to find differences in microbiota composition in the populations of the toxic frogs compared to the non-toxic individuals and anticipate finding differences in overall skin microbial community and chemical profile among the toxic frogs, which may be related to their ability to fight chytrid. This study will provide insight into how fungal infections can alter important biological functions and microbial communities, and how those communities react and adapt to survive possibly deadly infections. More broadly, this research informs our understanding of the effect of exogenous compounds on microbial communities, microbiome function and adaptability, and host-pathogen interactions.

A-1228 (Oral)
Ecologically Driven Differences in Head Morphology of *Plethodon cinereus*

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The red-backed salamander (*Plethodon cinereus*) is an important species, common in forests across eastern North America and even persisting in urban locations. Given the relatively broad geographic distribution, *P. cinereus* is likely to experience varying selective pressures on important features of its morphology. For example, head shape may be an important determinant of potential prey species that can be targeted by this predator. Therefore, the goal was to document head morphology as it might vary with changing environmental conditions. Cover-object searches were conducted to locate red-backed salamanders within and around New York City. When a salamander was found it was weighed and measured, and digital photographs were collected. Similar data were also collected from randomly selected fluid-preserved *P. cinereus* specimens housed at the American Museum of Natural History, sampled from New York and neighboring states. Side and top-view photographs of the anterior end for both living and preserved salamanders were analyzed using ImageJ to measure the dimensions of obvious morphological landmarks on the animals. When controlled for body size, some head measurements were found to be significantly different between groups. Salamanders from the most urban of locations showed some unique morphological characteristics. One possible explanation for these results is that the urban environment may be selecting for reduced head size for example, driven by a reduction in larger prey items. It would be interesting to compare populations more broadly, to determine if there is any further evidence of morphological adaptations to local conditions.

A-1229 (Oral)
Unraveling the Function and Evolutionary Driving Force of Green Coloration in a Female Asian Agamid Lizard, *Phrynocephalus guinanensis*

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As important signals, color plays a key role in social communication among animals, and experiences a multitude of communication-related selections. While recent research predominantly delves into the functions and evolution of male coloration due to its prevalence across species, our focus lies on elucidating the functions and evolutionary significance of green coloration in female *Phrynocephalus guinanensis*. This species has a rare sexual dichromatism; both sexes have bright colors with males being red and females being green. We used controlled experiments in the field and visual modeling to study the functions of the female color. The primary function of the female green color is for sexual recognition, and is likely driven by sexual selection. Both conspecifics and natural predators (birds) are capable of detecting the greenish color, as well as distinguishing the male red color from the female green color. Males display a clear preference toward females with green color, compared to females with green color filtered. Furthermore, the green color itself may not play a significant role in territorial defense. Rather, it is the interaction between the color and luminance that is important. Resident lizards display insignificant difference toward intruder with green color filtered and luminance reduced or intruder with only luminance reduced but with green color. However, residents reduce their defence displays toward intruder without any filtering. Overall, female's green color primarily function in sexual recognition as consequence of sexual selection, and not so much as consequence of natural or social selection. We further infer that the male red color are likely consequences of natural and social selection.

A-1231 (Oral)
Complex Biogeographic Origins of Rain Frogs (Craugastoridae: Pristimantis) in the Eastern Cordillera of Colombia

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The Eastern Cordillera is a complex mountain system that has presented an extensive orogenic history as well as being influenced by paleoclimatic events, which have facilitated the diversification and accumulation of endemic species in this Andean region. We used a phylogenetic framework to evaluate the possible diversification processes that have occurred in frogs of the genus *Pristimantis* present in the Eastern Cordillera based on 6 genetic markers, four mitochondrial genes (COI,16s, 12s, and Cytb), and two nuclear genes (Rag1 and TYR). We performed a phylogenetic reconstruction and estimation of divergence times to evaluate employing the time scale the possible historical processes that have promoted the diversification of high mountain frogs taking into account two main historical events: the uplift of the Eastern Cordillera and the climatic oscillations that occurred during the Pleistocene. Additionally, we evaluated the effect of the elevation gradient on the distribution of species and the possible speciation process that has been generated within this group of vertebrates in the Andean mountains. The species of *Pristimantis* present in the Eastern Cordillera originated in the Miocene, which is associated with the times of major Andean mountain building; however, the diversification of the genus extended into the Pleistocene, indicating that the oscillations that occurred in the glacial-interglacial period may have influenced the

diversification of the younger species. The species of *Pristimantis* present in the Eastern Cordillera occur mainly in allopatria.

A-1232 (Oral)
Establishing Temporal and Spatial Occupancy Trends in Wisconsin, USA, with 40 Years of Anuran Call Survey Data

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Amphibians are one of the most threatened vertebrate taxa and face several threats including urbanization, disease, and climate change. Understanding how these threats alter amphibian population and communities requires an understanding of their spatial and temporal patterns. Ideally, these patterns are studied across broad spatial scales that span multiple ecoregions and include time points before and after the introduction of a threat. However, due to financial and time limitations, surveys are often limited in spatial scale and are commonly initiated only after a threat has been established. To address this gap, a relatively easy data source gaining in momentum are anuran advertisement call surveys. These surveys can be used to determine species and site occupancy and can be linked to temperature and urbanization patterns. Furthermore, these surveys can easily incorporate citizen efforts to cover broader spatial and temporal scales. In Wisconsin, USA, the Department of Natural Resources has been partnering with citizen scientists to survey twelve anuran advertisement calls across the state for 40 years. Using this dataset, we examined trends in site occupancy across the state and identified factors contributing to the occurrence of anuran species using a Bayesian occupancy model. First, we found that some species (*Pseudacris crucifer* and *Anaxyrus americanus*), had relatively stable occupancy trends throughout, while species such as *Lithobates sylvaticus*, did not. Second, factors such as ecoregion were significant predictors of a species occupancy probability, and generally species richness decreased in higher latitudes. Third, using species cooccurrence patterns, we were able to improve estimates of species occupancy for data poor species. Lastly, we examined how urbanization decreased species richness in Madison, WI city area. Collectively, we show that citizen-collected anuran call survey data can be used to establish both spatial and temporal trends in twelve difference anuran species to inform priorities for anuran conservation efforts.

A-1233 (Poster)
Microhabitat Variability and Lizard Distribution along a Transition Zone at Serra das Confusões National Park, Piauí, Brazil

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Patterns in the spatial distribution of biodiversity arise from the interplay between dispersal, extinction, and speciation over historical and ecological timescales. In the Neotropics, high biodiversity is considered the byproduct of dynamic climates and landscapes and favorable energy, water, and productivity conditions. However, the role of ecotones in promoting species coexistence and maintenance has been underrated. In the pursuit of understanding the structure

and dynamics of natural communities, we evaluated how variation in microclimate affects lizard diversity along a gradient from open to forested environments. We sampled lizards using 50 arrays of pitfall traps with drift-fences across four transects. Microhabitat parameters, climatic variables, richness and abundance were recorded, derived, analyzed and summarized using statistical methodologies like PCA, nMDS, GLM, and GDM in R. We captured 770 lizards from 15 species and found higher abundance in open areas, which seem to favor generalist species. The results revealed a gradient across transects of high humidity and soil exposure, with low canopy and woody plant density. Species richness did not differ among transects, but forested areas were predicted to host additional species. We observed habitat use segregation, with certain species associated with specific microhabitats. Species turnover was influenced by microhabitat and microclimate variables, with leaf litter and canopy cover playing significant roles. This study contributes to improve our understanding of ecological dynamics within transitional regions, offering valuable insights into the intricate relationships between species and their environment, with implications for biodiversity conservation and ecosystem management.

A-1234 (Poster)

Molecular Phylogeny, Distribution and Systematics of the Parrot Snake (*Leptophis coeruleodorsus*) in Colombia

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Leptophis coerulodersus (Oliver, 1942) is a species native to the islands of Trinidad and Tobago which has a distribution adjacent to northern Venezuela. This snake has also been reported from Margarita Island and western Colombia, however, it has been suggested that these records need verification since in the case of Colombia it is assumed to be a misidentification of *L. a. occidentalis*. This species presents considerable morphological variation in its lepidosis between and within the populations where it is currently distributed, showing that aspects of its natural history such as its distribution, phylogenetic relationships, and morphological variation are still unknown. Likewise, the presence of this snake in Colombia remains uncertain. We present for the first time a phylogenetic and morphological review of the Colombian populations determined under the species *L. ahaetulla* and the subspecies *L. a. occidentalis* and *L. a. coerulodersus*. Using mitochondrial molecular markers (16S and Cytb) and the nuclear gene (PRLR, 490) we performed a phylogenetic reconstruction and estimated the divergence times of this species in order to validate the presence of the species in the country and to elucidate its phylogenetic relationships. Additionally, we carried out the morphological revision of different specimens from scientific collections in order to evaluate the morphological variation of the species. We validate the presence of the species *L. coerulodersus* in Colombia where it is distributed in the Orinoquia regions.

A-1235 (Poster)

Microplastic Accumulation in the American Bull Frog (*Aquarana catesbeiana*) Indicates Ubiquitous Pollution in South Korea Reservoirs

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Urbanization, with its population concentrated in cities, induces various changes that result in environmental pollution and contamination. Plastic pollution is significantly linked to human activities. Plastics undergo mechanical and chemical processes when exposed to the environment, breaking down into microplastics. These minute particles, due to their lightweight and small size, disperse widely across ecosystems, directly impacting numerous organisms. In previous studies, over 700 species of aquatic organisms worldwide are being adversely affected. Research on amphibians, which have been identified as potential pathways for the transportation of microplastics in previous studies, is scarce. This study focused on quantifying microplastics in the digestive tracts of *Aquarana catesbeiana* inhabiting reservoirs in the Naju and Gwangju regions of Jeollanam-do, South Korea. From September to October 2023, in Gwangju, we caught 7, 1, 3, 5, and 5 individuals from each of the five reservoirs: Hanseabong, Dongnim, Suwan, Bia, and Yongsan. In Naju, we caught 6, 5, and 4 individuals from each of the three reservoirs: Songhyun, Daeho, and Ogang. We dissected the digestive tracts of Aquarana catesbeiana and examined them for microplastics using FT-IR analysis. Results revealed a minimum of two and a maximum of 408 microplastics detected per specimen. The average number of microplastics per individual is 30.17. No significant correlation was found between the quantities of microplastics and the level of urbanization surrounding the reservoirs. This result underscores the ubiquitous nature of microplastic pollution, regardless of urban development.

A-1236 (Oral)
Landscape Level Ecological Restoration to Mitigate Drivers of Amphibian Decline, South Okanagan Valley, BC Canada

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Canadian Species at Risk policy utilizes a collaborative bottom-up governance with habitat stewardship, restoration, education, and outreach at the center of its priority actions. Amphibian conservation efforts in the South Okanagan Valley fall within the federal multi-species and priority places framework. Increasing regional land development, agricultural contaminants, invasive predatory species, and roadway expansion provide a multi-stressor landscape for amphibian species at risk. Research driven conservation efforts since 2003 have had various levels of social and ecological success. Within the valley bottom discrete wetland sites have very low species richness and relative amphibian abundance. Consequently, a collaborative multi-stakeholder approach to habitat restoration and species recovery was adopted through private landowner stewardship. The goal is to increase the quantity, quality, and connectivity of lowland wetland habitat by reconnecting known amphibian-breeding sites. Twenty-two wetlands were restored within the study area, effectively doubling the number of available fishless ponds and metamorphic success have been observed in thirteen of 22 restored ponds. Restoration outcomes include invasive predatory species mitigation for the American Bullfrog (*Lithobates catesbeianus*). Habitat restoration has increased the number of available breeding ponds within the study area, engaged landowners, and possibly aided species recovery. Yet, local threats to upland terrestrial and breeding habitat continue to escalate which impedes amphibian movement corridors. Particularly as road systems expand and the implementation

of mitigation fencing has limitations. Management challenges remain, namely enforcement of wetland protection measures and moving beyond like-minded collaborations and towards targeted stewardship of less motivated persons.

A-1237 (Oral)
Location Matters: Variations in Gut Microbiota Composition of Spatially Separated Freshwater Turtles

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The gut microbiota of vertebrates is malleable and may be shaped by both intrinsic and extrinsic factors. Here, the effect that geography has on the gut microbiota of a species of Australian freshwater chelonian, the Eastern longneck turtle (*Chelodina longicollis*), captured from waterbodies with different levels of anthropogenic pressure was investigated. We analysed the microbiota composition, structure and diversity through 16S rRNA gene amplicon sequencing. It was hypothesized that animals from less disturbed environments would harbour a more diverse gut microbial population. The gut microbiotas from 78 turtles from four habitats were analysed. The most predominant phylum was Proteobacteria. Gut microbiota alpha diversity varied significantly between *C. longicollis* from all habitats. Turtles from wetlands within the centre of Melbourne had the lowest alpha diversity metrics, while the highest alpha diversity values were seen in turtles captured from an undisturbed rural waterbody. Beta diversity, obtained by weighted UniFrac distance, showed significant differences between location of capture for turtles in this investigation. For *C. longicollis*, 91 biomarkers were identified responsible for explaining differences between locations and core community analysis revealed 49 and ASVs were shared between populations. In addition, we also discovered that differences in microbiota composition were correlated to differences in blood metabolomic levels. This study showed that gut microbiota composition of freshwater turtles was significantly influenced by locality and that the disrupted environments may reduce microbial diversity in these species. The results highlight the need to interpret chelonian microbiota data in the context of geography.

A-1238 (Poster)
Reintroduction of the Extirpated Pygmy Short-horned Lizard (*Phyrnosoma douglassi*) to the Indigenous Territory of the Syilx People of the Okanagan Nation, Canada

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Our goal is the reintroduction of the Pygmy Short-horned Lizard (*Phyrnosoma douglassi*) into the indigenous territory of the Syilx People of the Okanagan Nation, Canada. The pygmy short-horned lizard once existed in south-central British Columbia in Canada, and is still found in a few mid-western American states. The last verified record of *P. douglasii* in Canada is from 1957, and in 2021 the species was declared extirpated in Canada. *P. douglasii* symbolizes a lost connection with the land since colonialism. The project will be a collaboration led by the Nk'Mip Desert Cultural Center and the framework of "walking on two legs" will guide the research to advance the interconnected processes of Indigenous-led restoration and

reconciliation. The ecological and social success required to reintroduce *P. douglasii* is likely 10 to 20+ years and has both scientific and significant socio-political and economic challenges to address. Nk'mip has the facilities, educational expertise, strong federal history of success with species research, available habitat, plus transboundary nation partners for success. *P. douglasii* is a small (5-8 gm) species that inhabits open plains with sparse vegetation. They eat small insects, such as ants and beetles, are non-territorial, with high fecundity, and live bearing. This lizard species is highly charismatic and their ecological and land needs, captive rearing requirements, and strong educational value all increase the likelihood of project success. We are currently conducting a comprehensive literature review and preparing a feasibility and strategic meeting with stakeholders.

A-1239 (Oral)
Color Morphs, Mode of Reproduction and Diversification in the Lizard Family Phrynosomatidae

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Color morphs in lizards has been associated with different life history strategies, influencing social interactions, longevity, alternative reproductive strategies, and clutch size, among others. In *Uta stansburiana* (sensu lato), diversification among populations associated with color morphs was used to support a new mode speciation, morphic speciation. Color polymorphism is the ancestral trait and new species arise through independent loss of morphs to species or subspecies. Such losses give rise to evolution in traits and promoting divergence among population and ultimately, speciation. In addition, several studies have highlighted that the evolution of viviparity may spur diversification. The lizard family Phrynosomatidae consists of 171 species distributed from Canada through Panama, including habitats from deserts to cloud forest, from sea level to high elevations mountains. The family has multiple origins of color morphs and the presence of two reproductive mods, oviparity and viviparity. Viviparity has been documented to emerge five different times in the family, two in *Phrynosoma* and three in *Sceloporus*. Herein, we evaluate whether diversification rates are associated with the evolution of color morphs or through the evolution of viviparity. Few, if any studies considered whether an interaction between morphs and viviparity spurred diversification. For example, the species groups that evolved viviparity in *Sceloporus* consist of more species than oviparous sister clades. In addition, the viviparous clades consist of species with at least two morphs. Our results show that the viviparous forms are associated with high diversification rates, intrauterine embryo development in oviparous species associated with the clades where the viviparity evolves, and reproductive season shift in high elevation species that given rise to viviparous forms. Moreover, diversification rates are predicted by the interaction between the presence of morphs and viviparity. Viviparous species show a high diversification, particularly in mountain ranges and may invade from moderate to low elevation habitats.

A-1240 (Oral)
Analysis of Chemoreception Behaviors of Santa Cruz Long-Toed Salamanders to Eucalyptus and Newt Cues

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The Critically Endangered Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*), hereafter SCLTS, is a geographically unique species endemic to regions along the coast of Monterey County and Santa Cruz County in California, USA. SCLTS is currently facing extinction due to a variety of factors, including predation and competition from native and non-native species. Two specific invading species of concern occurring in SCLTS breeding sites with declining populations are Rough-skinned newts (*Taricha granulosa*) and Eucalyptus trees (*Eucalyptus globulus*). SCLTS ability to detect these invading species is unknown, though perception of chemosensory cues have been observed to mediate the behavior of salamanders in the genus *Ambystoma*. We evaluated the chemoreceptive behaviors of SCLTS larvae in response to chemical cues from both rough-skinned newts and eucalyptus trees. We used a two-choice, acrylic y-maze with a continuous flow of water introduced into each decision arm at a constant rate and a constant depth, with no mixing occurring between arms. 72 SCLTS larvae, reared as part of a parallel captive breeding program at UCSC, were acclimated and tested individually in the y-maze. During the test, one of the two cues were introduced into one decision arm, while DI-water was introduced into the control decision arm via a peristaltic pump, and larvae behavior was recorded using cameras. We will be analyzing chemoreceptive behavior results using an automated animal tracking software. We expect to find SCLTS larvae are able to detect and avoid environmental cues from predators or toxic invasive species known to harm amphibians in ponds. The results have the potential to provide insight into the behavioral responses of SCLTS to environmental threats and could help develop conservation mitigation strategies at breeding sites across the species range.

A-1241 (Poster)
Comparing Monitoring Techniques of New Zealand Geckos: Visual Searching Vs. Drones

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New Zealand's 125 endemic reptile taxa (skinks, geckos, tuatara) are behaviourally and morphologically cryptic, which can lead to difficulty in detection in the wild. Field surveys can also disturb the animals and environment, especially visual encounters and systematic searches that may require habitat disruption and potential degradation. Using drones for ecological fieldwork provides an additional approach to detecting cryptic species, such as arboreal geckos, which could increase our knowledge of their population distribution, monitoring outcomes, and status in the wild. Our study aims to investigate the effectiveness of drones as a detection and monitoring tool for wild geckos in New Zealand. Our study has three objectives: 1. To compare the effectiveness of night visual searching to the use of drones in detecting arboreal geckos; 2. Test the feasibility of using Deep Learning approaches to increase gecko detection

efficiency from canopy/foliage images captured by drones; and 3. To determine the population estimates and home range of arboreal geckos at a Regional Park using mark-recapture via photograph identification. Visual searches and drone flights will be conducted along selected pathways at a regional park every month between 2024 and 2025. Any geckos detected during the visual searches will be captured, and images will be acquired for individual identification, as part of the long-term survey in that park. All images, along with other gecko images will be used to train the Deep Learning model. We will compare the effectiveness of visual searches vs. drone surveys and manual searches vs. the results of the Deep Learning model. Our project will contribute to our understanding of the use of drones for conservation wildlife surveys detecting endemic reptiles and population, density, and movement.

A-1242 (Poster)
Geographic Variation in the Call and Morphology of the Red-eyed Tree Frog, *Agalychnis taylori* in Mexico

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Anurans have relatively simple calling patterns and high vocal variation between populations. Vocalizations are one of the main ways of communication in frogs transmitting relevant ecological and evolutionary information to conspecifics and possible threats. In many polymorphic species there is evidence of acoustic divergence associated with the morphological variation. For example, there are studies for the Red-eyed tree frog, *Agalychnis callidryas*, in Costa Rica and Panama that show that this is a highly polytypic species within the southernmost part of its distribution. However, this is a wide-ranged species, and the rest of its distribution is understudied. In 2019, researchers proposed the resurrection of *Agalychnis taylori* for populations in the northern edge of the distribution of *A. callidryas* based on morphological traits. *A. taylori* now ranges from Mexico to Honduras whilst *A. callidryas* ranges from Nicaragua to Panama. To our knowledge, call and morphological traits variation of *A. taylori* has not been studied across its distribution in Mexico. We studied the morphological and calling patterns of *A. taylori* in Mexico to 1) characterize populations using acoustic and morphological traits, 2) identify intra- and interpopulation variation in the populations, and 3) explore if the morphological patterns are associated with the calling patterns throughout the distribution range. We expect *A. taylori* to likely show geographic variation of morphological and acoustic traits as seen in her sister species.

A-1244 (Poster)
Call Description and Geographic Distribution of *Fejervarya triora* (Anura: Dicroglossidae) in Thailand

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The sandstone frog, *Fejervarya triora* Stuart, Chuaynkern, Chan-ard and Inger, 2006, was described from Phu Jong-Na Yoi National Park, Na Chaluai District, Ubon Ratchathani Province, northeastern Thailand. The species is currently known only from Ubon Ratchathani and Mukdahan Provinces, Thailand. In this study, we recorded and analyzed 120 calls of four male F. triora from Sirindhorn District, Ubon Ratchathani Province. The advertisement call has only one call type, which is composed of a single multi-pulsed note with a dominant frequency of 2.76–3.12 kHz. Each call lasts for 180.86–235.11 ms and is composed of 7.40 to 9.43 pulses (38.51–41.40 pulses per second). Additionally, molecular analyses of the mitochondrial 16S rRNA gene revealed that the specimens from Sakon Nakhon and Ubon Ratchathani Province were embedded within *F. triora*, with uncorrected pairwise genetic divergences within the *F. triora* lineage of 0.0–0.3%. These records extend the known geographic range of *F. triora* into Sakon Nakhon Province, Thailand.

A-1245 (Oral)
Creation of an Environmental Refuge for a Chytrid Susceptible Amphibian

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Successful ecological restoration for amphibians requires actions that boost species' resilience in the presence of landscape persistent threats. We explored how the creation of an environmental refuge might mitigate impacts of the amphibian-killing fungus on a chytrid-susceptible frog in the Hunter River Estuary, NSW, Australia. We translocated 12,000 Green and golden bell frog tadpoles (*Litoria aurea*) into a closed system containing 16 ponds that varied along two environmental gradients suggested to inhibit chytrid: water salinity dosed at 3 ppt and hydroperiod (permanent or ephemeral ponds). Frogs were free to move between ponds throughout the study period. Water salinity was achieved by dissolving marine-derived salt with a minimum of 99.5% sodium chloride into the ponds.The population persisted for five years in the presence of chytrid and despite incursions of predatory invasive fish in the third year. We found no evidence that *L. aurea* avoided ponds dosed with salt and frogs bred successfully in all created waterbody types. There was a general avoidance of waterbodies with depths less than 25 cm. Monthly probability of survival was the same between infected and uninfected individuals across the site and also between ponds treated with salt and those ponds not treated. This was unexpected given that salinity has previously been demonstrated in laboratory and mesocosm studies to reduce pathogenicity of chytrid, thereby improving host survival. Thus, the creation of artificial refuges that contain a complex mosaic of habitats that include chytrid mitigation elements may bestow a beneficial effect on the whole population through a complex interaction between frog movements, behaviour, environmental variables and disease transmission. This approach might be relevant for the management of other amphibian species that persist with chytrid.

A-1246 (Oral)
Comparative Cold Tolerance of Three Tropical Origin Gekkonid Species at Their Northern Range in the Ryukyu Archipelago

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Several geckos with tropical origins are highly human commensal and have spread their geographic range to higher latitudinal areas by human-mediated transportations. In the process of range expansions, the geckos may face novel thermal stresses that is critical for their survival, but it remains unclear whether different species exhibit similar responses to the cold stress at their northern range limits. In this study we investigated critical thermal minimum (CTmin) of introduced populations of three gekkonid species, *Gehyra mutilata* (Gm), *Hemidactylus bowringii* (Hb), and *Hemidactylus frenatus* (Hf) from Amamioshima of the Ryukyu Archipelago, Japan, where is the northernmost edge of their distributions. The results revealed that Gm exhibited significantly higher CTmin compared to the remaining two species and that Hb showed the lowest CTmin. These difference in CTmin among the species in the same northernmost island are interpreted as reflecting difference in human-commensality. The highest CTmin in Gm may reflect its high dependency on human houses and thus artificial heat sources. In contrast, the lowest CTmin in Hb reflects their preference for more natural habitats. The intermediate value of CTmin in Hf may reflect intermediate level of human-commensality, although we cannot rule out the possibility that it merely reflects recent colonization of this species there. The highest CTmin in Gm can interpreted as a behavioral thermoregulation that often delays adaptive evolutionary change. The cold tolerance data across these species suggests different strategies in thermal physiology as their distribution ranges expand.

A-1247 (Poster)

Effect of Release Approaches on Survival Rates of Translocated Captive-bred Canberra Grassland Earless Dragons (*Tympanocryptis lineata*)

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Reptiles are declining rapidly at a global scale with many species threatened with extinction. Translocations are a widely used conservation tool to enhance or re-establish populations of threatened taxa. However, the efficacy of translocations is questionable, particularly for reptiles, owing to high failure rates. Translocation may be a viable intervention when existing conservation management options become unsustainable for long-term population persistence. Numerous release techniques are currently used, however the rate of survival using these approaches is variable between species. Soft releases provide individuals with *in situ* enclosures to enable acclimation to a new environment, whereas hard released individuals are provided no acclimation and are released directly into new environments. Soft release studies have shown greater rate of survival, however, few studies have combined this technique with seasonal releases. We aimed to assess the effects of soft and hard release approaches on the survival of seasonally translocated captive-bred Canberra grassland earless dragons (*Tympanocryptis lineata*). We released and radio-tracked up to 50 captive-bred individuals into an area within their historical range in spring, summer, and autumn using two release approaches: soft release (individuals allowed 10 days of acclimation before release) and hard release (individuals experienced no acclimation and released into immediate habitat). We radio-tracked each individual for up to 21 days. We predicted that soft-released individuals would exhibit reduced daily movement and home ranges compared to hard-released

individuals. Moreover, we anticipated that release type and release season would impact movement and weight change over time, consequently affecting survival rates. We offer important preliminary insight into the effect of different release approaches on the survival of captive-bred Canberra grassland earless dragons. Information from this study will be used to inform future translocations of this species. Further studies should be undertaken to refine translocation methodology and optimise survival outcomes for endangered reptile populations.

A-1248 (Oral)
Osteological Description of the Skull of *Megophrys nasuta* (Anura: Megophryidae)

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Megophrys nasuta is a large sized terrestrial horned frog, living on the leaf litter of the forest floor, and known for their rostral and eyelid projections to camouflage as leaves. They have a wide distribution across the Sunda Shelf, from the Thai-Malay Peninsula, Singapore, Sumatra, Natuna to Borneo. They also exhibit sexual size dimorphism, whereby females are significantly larger than males. The osteological characters for most of the genus and in particular, this species, have not been examined before, hindering the understanding of morphological diversity in the genus. This study describes the osteological characters of the skull of *M. nasuta* based on specimens from Malaysian Peninsula using micro-computed tomography scan. Through this study, we found that the skull is weakly ossified, with the absence of hyperossification and the presence of integumentary-cranial co-ossification of the skull roofing bones with the skin of the head, in larger extents for females. The skin behind the head is calcified with osteoderms/dermal bone and extends towards the dorsum. Other features include the presence of premaxillary and maxillary teeth; absence of teeth on the mandible; well-developed vomerine ridges and two vomerine teeth present on enlarged posterior end of each vomerine ridge in two well-separated, rounded groups; thin nasals separated from each other and not completely attached to the sphenethmoid. The skull osteology will provide phylogenetically informative morphological characteristics for the genus *Megophrys* and aid in the revision of their taxonomy.

A-1249 (Poster)
Developmental Plasticity under Thermal and Desiccation Stress of *Exerodonta xera*, a Microendemic Frog of México

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Plasticity is the ability to express different phenotypes from a single genotype in response to environmental conditions. Amphibians, with their complex life cycle, serve as ideal models for studying plasticity. In this study we analyzed the morphological plasticity induced by high temperatures and desiccation during the larval development of *Exerodonta xera*, a frog endemic to Mexico. We collected 50 tadpoles at GS25 and randomly assigned them to four experimental treatments and a control group, which had constant water volume (4L) and

temperature (22°C). Two desiccation treatments (D1 and D2) consisted on a weekly 200 ml reduction from an initial water level of 4L and 2L, respectively. Two thermal treatments (T1 and T2) consisted of high water temperatures of 29°C and 31°C, respectively. We measured 7 morphological traits weekly, time to metamorphosis (M) and growth rates. Plasticity values of all morphological traits among treatments differed from the control group, exhibiting a slope ≠0, nevertheless the slopes varied being positive and negative according to certain traits. Significant differences of traits values were expressed only in left forelimb length and snout vent length compared to the control, particularly in GS42 and GS46, respectively. We registered higher M in T1 compared to the control, whereas T2 was lower (CT2E. xera exhibits differential plasticity in both metamorphosis time and growth, with thermal treatments showing the most significant differences. Therefore, temperature may act as an inductive signal influencing the plasticity of this species.

A-1250 (Poster)
Evaluating an Anti-*Batrachochytrium dendrobatidis* Probiotic under Climate Change Temperatures

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Amphibian populations are declining globally, in part due to emerging fungal pathogen *Batrachochytrium dendrobatidis* (Bd) and climate change impacts. Some amphibians have symbiotic skin microbes that produce anti-Bd metabolites that may protect the host from severe Bd infections. Research on symbiotic microbes as probiotics to protect amphibians has rarely considered climate change interactions. We used culture-dependent and culture-independent methods to obtain bacterial isolates from Pacific chorus frog (*Pseudacris regilla*) skin in eastern Washington for probiotic screening. We selected an isolate correlated with lower Bd prevalence *in situ* and inhibited zoospore growth *in vitro* to use as a probiotic treatment in 60 frogs. Thirty frogs were exposed to temperatures based on historical data for this region, while 30 frogs were exposed to modeled climate change data 2050–2075. For each climate treatment, 10 frogs were in each of the following treatment groups: Bd only, Bd and probiotic, and control. Frogs were swabbed at multiple timepoints to characterize skin microbiome changes with 16S rRNA Illumina MiSeq sequencing (250 bp) and quantify Bd infection intensity with Taqman qPCR. Initial Bd prevalence of field-collected frogs was 6.67%, despite prevalence as high as 100% in previous years at this site. Prevalence remained low after months in captivity (5%) and exposure to probiotic or sham treatments (6.67%), but increased two weeks (21.67%) and four weeks (18.33%) after Bd exposure. Among treatment groups, there were significant differences in Bd infection prevalence between both pre-exposure and post-exposure to Bd treatment ($P < 0.001$), and pre-exposure and post-exposure groups to probiotic treatment ($P < 0.01$). However, climate treatments did not play a significant role in Bd prevalence. We found that climate treatment and Bd exposure had no effect on Bd infection prevalence, compounded by the life-history of a species which can tolerate generally high infection intensity.

A-1251 (Oral)
Engaging Citizens in Turtle Conservation: The 1 Million Turtles Program

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The Eureka Prize-winning 1 Million Turtles (1MT) program empowers Australian citizen scientists to combat threats to freshwater turtles. Through the user-friendly TurtleSAT app, participants contribute real-time data on sightings, nesting locations, and threats, directly informing research, conservation planning, and policy. 1MT goes beyond data collection by training citizen scientists in nest protection, invasive species surveys, and data analysis, fostering ownership, and transforming them into active partners. The program leverages technology like TurtleSAT, which integrates spatial data and visualization tools to identify turtle mortality hotspots (informing "Turtle-Safe" roads) and is exploring AI for automated road crossing detection. Citizen Science data has significantly impacted conservation, informing endangered turtle species protection (16 EPBC Act Conservation Advice documents), identifying road mortality hotspots (leading to signage and infrastructure improvements), supporting community initiatives like Turtle Islands (safe nesting havens), and fostering positive shifts in public attitudes and behaviors towards turtle conservation. This replicable framework, designed for global adaptation, empowers communities worldwide to become active partners in safeguarding freshwater turtle populations. This talk will demonstrate how the core principles of 1MT—citizen science engagement, capacity building, technological innovation, and a focus on measurable outcomes—can be adapted to local contexts, forming a powerful model for global freshwater turtle monitoring and conservation decision-making.

A-1252 (Oral)
Unified Efforts: The Kerala Model in Mitigating Snake Bites

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India is estimated to have 1.2 million snake bite deaths from the year 2000 to 2019, with many bites being not reported or accounted for. Kerala, being one of the smallest states in the country, with its geographic and climatic abilities, harbours more than 130 species of snakes, including the “big four” causing casualties along with some of the pit vipers responsible for numerous snake bites annually. But, Kerala emerged as a model for other states in tackling these complex issues with a collective approach. The snake rescue guidelines set up by the Kerala Forests and Wildlife Department train rescuers in the safe handling, and rehabilitation of snakes, and oversee a systematic record of rescued and released snakes through a dedicated mobile application, SARPA. Moreover, a participatory approach from researchers, doctors, naturalists and the general public helped to successfully run an information-based mobile application named “Snakepedia” which aims to popularize snakes, aid in rescues, and help identify snakes in case of bites. Additionally, an active Facebook group with more than 15 subject experts assists the general public in identifying snakes and helps medical professionals treat snakebite

cases through WhatsApp communities. A hybrid mode, targeted stakeholder social survey conducted as a part of our study highlighted that these collective approaches significantly increased the understanding of the bite case situations, scientific perspectives on snake handling, and snake identification skills, which were further helpful in reducing snakebite cases. These results emphasise the need for participatory approaches in the long-term conservation of misunderstood taxa like snakes.

A-1253 (Oral)
Two New Species of *Afroedura* (Squamata: Gekkonidae) from the Eastern Cape Province, South Africa

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The gekkonid lizard genus *Afroedura* (Flat Geckos) comprises 34 species of small to medium-sized geckos distributed throughout much of southern Africa. Despite much cryptic diversity being revealed over the last decade, new taxa are still identified at a higher rate relative to other genera within the region. The southern *A. nivaria* group consists of five described species and several putatively new taxa. Two recently documented populations in the Eastern Cape Province, South Africa, outside the known range of their congeners, were investigated. The taxonomy of these populations was addressed using a phylogenetic approach using sequence data of two mitochondrial genes (16S, ND4) and one nuclear gene (RAG1), along with comparisons across different morphological characteristics. We confirm that these two populations represent species-level taxa. These geckos remain poorly known, with the candidate taxon from Mthatha documented from only two localities and that from the Great Kei River region known only from a single locality.

A-1254 (Poster)
Tracking Squamate Extirpations and Recoveries in Singapore

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Over the last two centuries, Singapore has seen the loss of an estimated 37% of its native plant and animal species. This alarming rate of species decline is attributed to the high rates of deforestation and habitat loss caused by the rapid urbanization and industrialization of the island city-state. This estimate, while substantially lower than previous studies suggested, is still concerning. Chisholm et al. (2023) posited that Singapore has transitioned past its extirpation bottleneck and is possibly ready for natural and assisted recolonizations. Singapore has had a number of recorded squamate extirpations. Some species which are likely extirpated are relatively common in neighbouring Peninsular Malaysia – e.g. *Gekko hulk*. An updated checklist of herpetofauna in Singapore, with their occurrence records was recently consolidated

(Figueroa et al. 2023). This monograph details records of all reptile and amphibian species in Singapore over the last 200 years, and provides much higher resolution data than was previously available. This allows for more accurate estimations of known and unknown extirpation rates. Objectives were i) Obtain a more accurate estimate of squamate extinctions in Singapore, ii) Assess extirpated squamates for possible assisted reintroduction potential. In this study, we combine up-to-date species occurrence records with a susceptible-extinct-unknown extant-unknown extinct (SEUX) model and the matrix-of-detections-gives-extinction-estimates (MODGEE) model (Chisholm et al, 2023) to obtain a more accurate estimate of squamate extinctions in Singapore. Much of Singapore's squamate diversity has been lost in the last 200 years. There are periods of data deficiency (e.g., 1930–1960) due to low sampling effort during that time. The use of holistic models like SEUX and MODGEE can enable effective detection of dark extirpations in Singapore. We present a "triage" for possible reptile reintroductions in Singapore's future.

A-1255 (Poster)

On the validity of *Hebius sauteri maximus* (Malnate, 1962) (Squamata, Natricidae), with the Redescription of *H. maximus* comb. nov. and *H. sauteri* (Boulenger, 1909)

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Hebius sauteri (Boulenger, 1909) has been long recognized as a widely distributed species with three subspecies, namely *Hebius sauteri sauteri* from Taiwan Island and southeastern China, *Hebius sauteri bourreti* (Malnate, 1962) from northern Vietnam, and *Hebius sauteri maximus* (Malnate, 1962) from Sichuan, southwestern China. However, the validity of these subspecies of the *H. sauteri* complex has not been evaluated. In the current study, we re-evaluate the taxonomic status of *H. s. maximus* based on morphological and molecular evidence. Molecular phylogenetic results indicate that *H. s. maximus* is a distantly diverged clade with respect to *H. s. sauteri*, and that *H. s. maximus* is morphologically distinguishable from the nominative subspecies. Therefore, our results support the validity of *H. s. maximus* and we elevate it to full species status, namely *Hebius maximus* comb. nov. The distribution range of *H. sauteri* is revised according to our proposed taxonomic change. Furthermore, detailed redescription, natural history, and coloration of both *H. sauteri* and *H. maximus* and comments on the validity of H. s. bourreti are also provided.

A-1256 (Poster)

Microanatomy and Transcriptomics of the Oviduct in a Polymorphic Salamander

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The oviduct is a major feature of female reproductive anatomy. This structure is the passageway of eggs and an important site of egg maturation. In amphibians, the epithelial

component of the oviduct produces secretions and the egg jelly coat. The latter plays an important role in the development and protection of the embryo. The production of the egg jelly coat involves the secretions of a group of active glands located in different parts of the oviduct. The distribution of glands that produce the jelly coat are in three different regions: Pars recta, Pars convoluta, and the Caudal part. In some species glands located in these regions secrete several layers of jelly coat that cover the egg. Several studies show that Pars convoluta may play the most important role in the secretion of egg jelly coat. We used transcriptome sequencing and histology to evaluate the relationship between microanatomy and the gene expression of secretory cells in three oviduct regions of the polymorphic Oklahoma salamander, *Eurycea tynerensis*. Our analysis focused on three different reproductive stages:1) pre-oviposition, 2) post-oviposition, and 3) non-reproductive, as well as in two distinct life cycle modes. The composite of the results shows the up-regulated, and down-regulated genes in each section of the oviduct and the differential expression of genes in the oviducts of three different reproductive stages.

A-1257 (Oral)

A Practical Approach to Antivenom Therapy in Thailand

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Antivenom serves as a crucial treatment for snakebites. In Thailand, the Queen Saovabha Memorial Institute (QSMI) manufactures seven monovalent and two polyvalent antivenoms, all of which are Fab'2, to counteract neurotoxic and hematotoxic snake venoms. Despite their importance, the use of antivenoms is often limited due to unavoidable adverse reactions. Both early and late adverse reactions are theoretically possible, with early adverse reactions (EARs) being more prevalent. The exact mechanisms and factors contributing to these EARs remain unclear, although their clinical manifestations often resemble immunological reactions. However, some studies have challenged this view. Our experience in Thailand has revealed that the incidence of EARs varies across different types of antivenins. The timing of antivenom administration and the rate of infusion also play significant roles. It's important to note that not all snakebites result in clinical toxicity from the venom. To effectively treat snakebite patients within these constraints, we propose a practical approach guided by the principles of "Do no harm" and "Risk and benefit". Clinicians are encouraged to make decisions based on the best available evidence, striking a balance between the benefits of antivenom therapy and patient safety. Consequently, different types of venomous snakebites require different approaches. We will discuss the evidence pertaining to this issue. In the current time, if a patient shows indications for antivenom, the drug should be administered as promptly as possible. The rate of infusion warrants careful consideration. In high-risk scenarios, measures should be in place to manage severe reactions. Close monitoring of the patient is essential during and after the infusion.

A-1258 (Oral)

Effectiveness of a Meadow Viper (*Vipera ursinii*) Detection Dog Unit: Promising Results but Further Development Needed

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Within the HUNVIPHAB LIFE project, a detection dog has been trained and pilot-tested since 2020 for the detection of Hungarian meadow viper (*Vipera ursinii rakosiensis*). Due to the difficulty of locating individual vipers based on the dog's signals alone, we aimed to determine the performance indicators of the viper detection dog unit. In the first trial, viper shed skins were placed in a grassland area where the species is not known to occur, some of the plots were empty. In the second trial, we compared the detections of the visual surveys and the dog unit at viper habitats. In the third trial, the dog unit was deployed to locations where vipers had been visually detected within 24 hours. In the first trial, the dog unit located 67% of the shed skins. In the second trial, the success rate for determining viper presence at the quadrat level was 100%, however, we had signal in sampling plots without visual detections too. In the third trial. in the case of leads to fresh detections, the dog always accurately signalled viper scent within 50 cm. In addition to the controlled trials, the dog unit has successfully detected 2 dead viper individuals, 21 live individuals, and 8 shed skins based on scent cues. The dog unit has also indicated the presence of viper scent at 320 locations without visual observation of the individuals. In the case of visual search, it took an average of 11 surveys per quadrat to detect the presence of vipers by visual surveys, whereas the dog unit detected presence in 1-4 surveys. The viper detection dog unit is a promising tool for conservation monitoring and research. Further development is needed to optimize search strategies and improve the dog's ability to locate individual vipers based on scent cues.

A-1259 (Oral)
Wildfire Impacts to Populations of a California Endemic Newt

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Megadroughts and rising temperatures aggravated by climate change have increased the frequency and intensity of California (USA) wildfires in recent years. In light of clearly observable disturbances to terrestrial ecosystems, episodic wildfires also negatively impact aquatic ecosystems. In the streams of the Santa Monica Mountains (Los Angeles, USA) the occurrence of a wildfire in 2018 destabilized riparian corridors causing landscape erosion which, in turn, led to increased sedimentation in streams and nutrient inputs. Such effects can cascade throughout the ecosystem, causing a loss of suitable habitat and altering food availability. To understand the extent of such immediate environmental changes and potential impacts on foraging behavior and food resource availability, we evaluated body condition data of local populations of an endemic, long-lived species, the California newt (*Taricha torosa*) before and after the 2018 wildfire. We hypothesized that after the wildfire, fire-affected sites would contain, on average, individuals with a decreased body condition compared to sites that were not affected. Our results suggest that amphibian and wildfire interactions are possibly site-specific and may not be acute and immediate. Instead, *T. torosa* may experience lag effects where physiological responses are not immediately observable. Our results bring to light

important mechanisms in the long-term survival of *T. torosa* considering changing wildfire return intervals and other extreme weather events such as drought coupled with heatwaves.

A-1260 (Oral)
Assessing the Efficacy of Habitat Restoration for the Hungarian Meadow Viper (*Vipera ursinii rakosiensis*) in the Kiskunság National Park

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This study evaluates the preliminary outcomes of habitat restoration efforts implemented within the Hungarian Meadow Viper (*Vipera ursinii rakosiensis*) Conservation Project (HUNVIPHAB LIFE) in Kiskunság National Park. Conservation efforts have been ongoing for over two decades, but the long-term survival of the subspecies is still threatened by small population size, limited habitat availability and degradation. To address these threats, we implemented a multifaceted restoration strategy encompassing more than 200 hectares. This strategy included: (i) Forest-grassland conversion (23 ha): This intervention aimed to create corridors for previously isolated viper populations, facilitating movement and gene flow. (ii) Ploughfield-grassland conversion (35 ha): This technique expanded habitat suitable for the vipers by converting former agricultural land. (iii) Floral diversification (180 ha): Abandoned, spontaneously revegetated ploughfields were enriched with native plant seeds to increase habitat suitability. (iv) Wet meadow and pond restoration (23 ha and 22 ponds): This intervention aimed to recreate vital water sources and breeding grounds for amphibians, a key food source for the vipers. The effectiveness of these interventions was evaluated using a stratified random sampling design, incorporating control, baseline, and target state areas. Viper occupancy was intensively monitored through surveys conducted in 50x50 meter squares over a four-year period. Overall viper occupancy rate increased significantly. While long-term monitoring is essential to ensure complete population recovery, all implemented interventions, except for wetland restoration, demonstrated a significant positive short-term impact on viper occupancy rates. Notably, floral diversification on abandoned plough fields displayed a substantial increase in occupancy, reaching target state reference levels within three years and exceeding control areas. These findings suggest that the implemented restoration strategies have the potential to benefit the Kiskunság meadow viper population. The combined effects of these interventions are expected to play a crucial role in the long-term persistence and recovery of this threatened subspecies.

A-1261 (Oral)
Testing the Pace-of-Life Syndrome Hypothesis in a Skink with Intraspecific Variation in Reproductive Mode

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The Pace-of-Life Syndrome (POLS) hypothesis posits that different ecological conditions select for covariation between behavioural, physiological and life-history traits along a

continuum of 'slow' to 'fast'. Under the POLS hypothesis, 'slow' organisms display more conservative behaviours, lower metabolic rates, and life-history traits such as slower growth or greater investment in offspring, compared to 'fast' organisms. We use one of Australia's most fascinating skinks, the South-eastern slider (*Lerista bougainvillii*) to test the POLS hypothesis. *L. bougainvillii* is one of several vertebrates that varies in reproductive mode, with oviparous and viviparous populations, as well as 'transitional' populations displaying an intermediate reproductive form. Using offspring raised in a common-garden design from three populations of *L. bougainvillii* representing each of the parity modes, we measured growth rates, behaviour (activity, boldness, exploration), thermal preferences, and physiological performance (metabolic rate, burrowing speed, sprint speed). We investigated population level differences in these traits, correlations between traits, and repeatability of behavioural traits (animal personality) to determine if the POLS explains the phenotypic variation seen in *L. bougainvillii*. Our main hypothesis was that populations would be spread along the 'slow'-'fast' continuum with viviparous having the slowest pace, oviparous having the fastest, and the transitional parity mode being intermediate, because of the greater parental investment occurring in viviparous and transitional populations. We found population-level and sex-based differences in growth, thermal preference, and physiological traits. Behavioural traits were generally not repeatable, but differences did occur between populations. Most correlations between traits were weak and did not clearly indicate the occurrence of POLS. Thus, our study overall provides weak support for the POLS hypothesis in this species.

A-1262 (Oral)
Estuarine Crocodiles Promote Primary Productivity and Vegetation Growth

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Large predators are crucial for maintaining the health and balance of ecosystems through various top-down and bottom-up processes. However, despite their ecological importance, large predators have been extirpated from much of the globe, leading to large-scale environmental changes. Across northern Australia, Estuarine crocodiles (*Crocodylus porosus*) were almost driven to extinction during the mid-20th century. Since the species protection in 1971, the population has increased from a few thousand to over 100,000 non-hatchling individuals. Over this period, estuarine crocodiles have also shifted from a primarily marine-based diet to a more terrestrial-based diet and, therefore, may act as a critical nutrient link between terrestrial and aquatic ecosystems. In our study, we took a multidisciplinary approach integrating population surveys, remote sensing and bioenergetic modelling to examine the impact of crocodile density on instream primary productivity and riparian vegetation along the Mary River, Northern Territory (NT), Australia. We found that areas with higher crocodile biomass displayed greater primary productivity. In contrast, there was no correlation between the distribution of crocodile biomass and vegetation vigour or percentage of green vegetation. However, when analysed over time, crocodile biomass was significantly correlated with an increase in riparian vegetation vigour and percentage of green vegetation, but not primary productivity. Supporting this observation, bioenergetic modelling revealed a 10-fold increase in nitrogen and a 7-fold increase in phosphorus excretion from crocodiles into the aquatic environment over the last 50 years. We argue that by redistributing nutrients and suppressing large terrestrial herbivores from the water's edge, estuarine crocodiles have increased primary productivity spatially, along with enriching riparian vegetation vigour and the percentage of

green vegetation temporally. These findings highlight the crucial role of Estuarine crocodiles in nutrient translocation and ecosystem linkages in the short and long term.

A-1263 (Oral)
An Overview of Ophidian Fauna of Pakistan with Notes on Future Avenues in Research and Conservation

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We have presented an overview of the diversity, endemism and threatened ophidian fauna through a systematic literature review. Over 80 snake species belonging to eight families have been reported from Pakistan. The family Colubridae, with 43 known species, dominates the ophidian fauna of the country, followed by the family Hydrophiidae (14), family Viperidae (eight), family Elapidae (five), family Typhlopidae and Boidae (four) species each, family Leptotyphlopidae (two), while the family Crotalidae is represented by a single species. Of these, at least eight species are endemic to Pakistan. *Python molurus* and *Naja oxiana* are listed as Near Threatened, while *Telescopus rhinopoma, Hydrophis mamillaris* and *Hydrophis cantoris* are listed as Data Deficient in the IUCN Red List of Threatened Species. We found that loss of habitat, use of pesticides, hunting for medicine, accidental catch, road kills, persecution out of hatred and fear, and collection from the wild by snake charmers are the major threats to snakes of Pakistan. Vipers and elapids are collected for venom extraction; boids and colubrids for snake-mongoose fight; boids and colubrids are also susceptible to pesticide contamination while sea snakes are caught accidentally during fishing. We suggest carrying out robust and systematic field surveys to develop country's ophidian data base. We recommend research on various aspects of natural history, molecular taxonomy, and population estimation of snake species in Pakistan particularly of species found in the northern and south and south-western regions of the country. There is a dire need of changing public perception about the snakes to reduce human-snake conflict by regular round ups and organization of awareness programs. Captive breeding programs for vipers, elapids, sea snakes and the python species should be initiated. Federal as well as provincial wildlife acts should be updated by including threatened, data deficient and endemic species in the list of protected species.

A-1265 (Oral)
Evaluating the Efficacy of Swabbing Protocols to Study Frog Skin Microbiome

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The amphibian skin microbiome has been identified to play a critical role in immune health and pathogen defence. For example, in some species the skin microbiome hosts bacteria that inhibit the fungi *Batrachochytrium dendrobatidis*, which is a significant contributor to global amphibian decline. Understanding the skin microbiome offers insight into the susceptibility of populations to infection and increasing habitat disturbance. Though increasing research has been devoted to understanding the role played by the amphibian skin microbiome, swabbing protocol varies widely in the published literature, including rinsing duration, swab type,

number of strokes, location of sample collection, and the region of the body swabbed. These variances in swabbing protocol may have implications regarding the microbial community composition and relative abundance sampled. Thus, it is critical to understand if the differences in swabbing protocols has an effect on the skin microbiome data. This project seeks to assess the effect of 1) swabbing protocol (A = dorsal, ventral, hind legs, feet; B = ventral, hind legs, feet), and 2) the sampling environment (*in-situ* and in-laboratory) on the quality of frog skin microbiome data. We performed metagenomic sequencing of the 16s region V3/V4 of two species *Incilius mazatlanensis* (n = 40) and *Smilisca fodiens* (n = 10). For both protocols (A and B), half of the *I. mazatlanensis* microbiome samples were collected *in-situ*. All other samples were collected in-laboratory. These results will provide information to help researchers to implement standardized protocols that offer the most accurate evaluations of skin microbiomes, contributing to insights into amphibian health and defence offered by skin microbiome in the context of global amphibian decline.

A-1266 (Oral)
Conservation (of Amphibians and Reptiles): Do We Speak the Same "Language"?

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Biodiversity decline is a major issue globally and conservation actions are urgently needed before it is too late, including for amphibians and reptiles. Strong collaboration among stakeholders is negligible to achieve conservation goals. Unfortunately, there have been evidence that conservation actions were suboptimal in various regions. Communication clash has been identified as one of the factors hindering a success of conservation actions. In this talk, I would like to discuss various challenges and opportunities in navigating communication with stakeholders to successfully achieve conservation goals. Additionally, I would also like to share my thoughts on the important of communication using accessible language that resonates with people's interest and values regarding conservation, which is usually influenced by culture.

A-1267 (Oral)
Developmental Programming and the Mechanisms of Life-History Trade-offs in Juvenile Skinks

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Stress and the environment in which an individual experiences it early in development can have persistent phenotypic and fitness consequences throughout their lifetime. The importance and ubiquity of this syndrome – deemed "developmental programming" – are clear; the specifics and timing of how and when programmatic effects manifest in an individual are, to put it mildly, less clear. Understanding mechanisms by which developmental stress programs phenotypes would help to resolve this clarity. An often proposed mechanism is that "stress" alters physiological pathways involved in growth and metabolism. We tested the joint effects

of developmental stress and environment on growth both organismal and cellular metabolism in two congeneric skinks – the delicate skink and the garden skink – that diverge in life-history strategy. Skink eggs were treated with either corticosterone (a "stress hormone") or a sham control, then incubated at either a "cold" or "hot" thermal regime. We measured the growth of hatchlings throughout their first major growth phase, at the end of which we measured whole-organism metabolism, mitochondrial function, and oxidative cellular damage. At the end of the first major growth phase, corticosterone-treated delicate skinks were smaller, had a depressed metabolism, and produced higher concentrations of reactive oxygen species than control animals, and this was regardless of incubation regime. For garden skinks, there was a complex interaction between developmental stress treatment and the incubation temperature that generally suggests corticosterone-treatment increases physiological function, but its interaction with high temperatures results in adopting an alternative physiological and life-history strategy as a small, metabolically efficient, potentially long-lived skink. These results, part of a longitudinal life-history study on this cohort of skinks, suggest that developmental stress do indeed reprogram physiological pathways, and elucidates how this programming changes across environmental and species contexts in the juvenile phase of development.

A-1268 (Oral)
Investigating the Acoustic Ecology and Taxonomy of Australia's Banjo Frogs Using Citizen Science

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Banjo frogs – or "pobblebonks" - are large-bodied burrowing frogs widely distributed throughout eastern and south-western Australia. With a combined distribution of over 1.7 million km² and inhabiting a wide range of habitats, collecting sufficient representative advertisement call data to examine the acoustic ecology and taxonomic diversity of Banjo frogs has previously been challenging. As a result, despite their conspicuous "bonk" calls being a common feature of Australian frog soundscapes, our understanding of the ecology and taxonomy of Australia's Banjo frogs remains incomplete. By using expert-validated occurrence data from the Australian Museum's FrogID citizen science project, we analysed the advertisement calls of nearly 700 individual Banjo frogs throughout their range, enabling us to examine their taxonomic and acoustic diversity, ecology, distribution, and factors driving their acoustic evolution. By integrating our analyses of advertisement call variation with genetic and morphological data, we revised the taxonomy of the northern Banjo frogs, resulting in the recognition of two additional species. Further exploration of FrogID records enabled us to revise and refine their distribution maps and revealed new insight into their habitat use. While we found considerable geographic variation in Banjo frog advertisement calls and a correlation between advertisement call frequency and habitat density, we found no evidence to suggest that habitat structure is a primary factor driving the evolution of Banjo frog acoustic signals. By examining citizen science data on a continental scale, we have revealed unique insight into the ecology and taxonomy of Australia's iconic Banjo frogs.

A-1269 (Oral)
SNP-Based Analyses Reveal Phylogenetic Relationships and Ecomorph Evolution in Rapidly Radiating *Hydrophis* Sea Snakes

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Phylogenetic analyses of recent, rapid radiations are often confounded by incomplete lineage sorting and past introgression of genetic markers. Within snakes, the fully marine Hydrophis clade is conspicuous in having anomalously high speciation rates, with ~47 species sharing a common ancestor dated at only 5-8 million years ago. *Hydrophis* are also ecologically very diverse, exhibiting great body size and shape variation associated with dietary specialisation. However, lack of phylogenetic resolution, especially along a backbone of short internal branches, has hindered the many previous studies of *Hydrophis* diversification. To address this limitation, genome-wide SNPs were generated using reduced-representation genome sequencing of ~70% of recognised *Hydrophis* species. These data and a mitochondrial alignment were analysed to infer phylogeny, detect cases of mito-nuclear discordance, and identify putative signatures of past introgression. The SNP trees provided substantially higher resolution of *Hydrophis* phylogeny compared to previous analyses of mitochondrial and low-variation nuclear markers. There were several conflicts between strongly supported nodes in the nuclear versus mitochondrial trees, and significant signals of past introgression were detected in four pairs of lineages. This included geographically overlapping species that formed shallow, unresolved clades in the mitochondrial analyses but were well-resolved by the SNP data. Finally, dietary data and three traits related to body size and shape were used to identify broad ecomorph categories and reconstruct ancestral patterns of ecomorphological diversification using the new SNP phylogeny. These analyses extended previous studies by defining five distinct ecomorphs and identifying eel-specialists as the ancestral ecomorphs within Hydrophis, followed by a more recent and replicate origins of generalist ecomorphs.

A-1271 (Oral)
The Emergence of Disease in Wild Populations of California Newts

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In recent decades, amphibians have experienced widespread population declines. While factors including contaminants, climate change, and disease have all been implicated in this biodiversity loss, it is likely a combination of stressors that contribute to such population reductions. The California newt, *Taricha torosa*, is a Species of Special Concern that naturally occurs in the world's largest urban park, Santa Monica Mountains National Recreation Area. While historically, the streams of the Santa Monica Mountains have avoided the devastating declines in amphibian populations and health seen elsewhere, in 2015 we first observed populations presenting disease symptoms and then in 2020, high frequency of disease was noted at a focal stream for the first time in three decades of monitoring. Here, we set out to characterize these declines in newt health and examine the stressors that may have contributed to disease susceptibility. At our focal site, the number of newts found in the stream increased dramatically between 2019 and 2020, along with this disease spike. The most frequently exhibited disease symptoms were necrotic tails and cloudy eyes, and newts expressing fewer

disease symptoms were more common than those expressing multiple abnormalities. The mass and body condition of newts decreased with increasing numbers of symptoms expressed, the body condition of diseased newts was lower than those of healthy newts at the same stream, and the body condition of newts at our focal site was lower than those at all other sites surveyed during the same period. Based on what we have documented and determined with this system, we propose a novel framework that could help assess disease susceptibility and reduce disease risk in wild populations. Ultimately, we expect our insights to inform amphibian conservation strategies by providing adaptable solutions to overcome emergent diseases.

A-1273 (Oral)

Quantification of Habitat Fragmentation and its Implications for Amphibians in Himalayan Foothills, Pakistan

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Remote sensing and GIS tools are essential for understanding environmental dynamics and fostering sustainable urban development for biodiversity conservation. This study employed landsat satellite imagery of the year 2005 and 2022, a 17-year interval, alongside a CA-ANN approach within the MOLUSCE plugin of QGIS, to model spatiotemporal land use and land cover (LULC) changes in District Rawalpindi (Punjab Province) and Islamabad Capital Territory, Pakistan. The results showed that the urban area and with road network have increased from 2015 to 2022. This resulted in the fragmentation at many areas particularly in areas providing refuge to endemic anurans: Nanorana vicina and Allopaa hazarensis. The study identified five sites hosting endemic, uncommon, and common anuran species, showing that road network has expanded significantly from 543 km^2 (58%) in 2005 to 1111 km^2 (67%) in 2022 due to the establishment of housing colonies, infrastructure, and industrial development projects. This expansion has led to severe fragmentation among all five sites, adversely affecting the habitats of anurans. Using CA-ANN, future LULC for 2030 was also predicted, showing a decrease in barren land and increases in water, vegetation, and urban land. The projection for the year 2030 highlighted further expansion in the road network (up to 1852 km^2), exacerbating habitat fragmentation and posing a significant threat to local amphibian populations. This study highlights the role of remote sensing and GIS in monitoring and predicting environmental changes, crucial for urban planning and biodiversity conservation. Urgent sustainable development strategies are needed to mitigate habitat fragmentation and protect biodiversity in rapidly urbanizing areas like District Rawalpindi and Islamabad Capital Territory, Pakistan.

A-1274 (Oral)

Female Vocalization and Communal Oviposition: Novel Insights into the Breeding Behaviour of Indian Purple Frog, *Nasikabatrachus sahyadrensis* (Amphibia: Nasikabatrachidae)

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Among vertebrates, amphibians are unique for the diversity of behavioural modes by which they reproduce. Knowledge of such behavioural diversity, along with data on temporal and spatial distributions, is essential to understanding anuran community organization. Despite this, there is a dearth of descriptive information and quantitative data on anuran reproductive strategies and habitat usage. Vocalization and choice of oviposition site are important pre-amplectic and post-amplectic factors respectively, that have major impacts on the breeding success and offspring survival of any anuran species. Vocalization is mostly an attribute of the males, but on rare occasions females have also been observed to emit calls. On the other hand, choice of oviposition site is an important maternal attribute wherein females choose egg laying sites which fulfill optimum temperature and moisture requirements as well as offer safety to eggs and developing hatchlings from potential predators. In this study that was conducted from 2015-2021 for gaining more insights into the breeding behaviour of Nasikabatrachus sahyadrensis, we report the occurrence of female vocalization and communal oviposition, both of which are understudied aspects of anuran reproductive behavior. We describe the characteristics of female call, thus adding to the knowledge of vocal communication in this species. We also report communal egg laying in one population, a behavioural adaptation that has been previously reported among few winter breeding frogs ovipositing in ponds, but rarely in tropical stream breeding anurans. Further, we also present data on some physical characteristics of the oviposition sites and make an attempt to determine if any of these characteristics plays a significant role in making a particular site preferrable for communal egg laying. The study augments our limited knowledge about the reproductive behavior of this elusive fossorial species and provides important data that can contribute to its conservation management plan.

A-1275 (Oral)
Heavy Metal and Micronutrient Analysis of Harvested Northern Long-Necked Turtles at the Proposed Arafura Swamp Indigenous Protected Area

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The Northern Long-necked Turtle (*Chelodina rugosa*, Chelidae) is an important seasonal food for indigenous people in Northern Australia. This species is micronutrient dense, with high concentrations of iron and zinc in both muscle and liver. However, heavy metal contamination could have severe unintended consequences to human health. We tested the levels of heavy metals and micronutrients in the tissues from *C. rugosa* individuals within the proposed Arafura Swamp Indigenous Protected Area, (Northern Territory, Australia). The sampled population was found to be safe for consumption, with metal limits falling within comparative

safe exposure and consumption guidelines. However, the sampled locations showed clear sign of buffalo and pig disturbance. This study confirmed high Iron levels and variability in *C. rugosa* tissues. Iron levels in *C. rugosa* tissues sampled were high and extremely variable between individual samples, with an average and standard deviation of Iron levels of 210.30 ± 167.04 ppm for individual raw muscle samples (n = 17). Across all samples, raw liver Iron levels were extremely high 2,945.30 ± 2,082.68 ppm (n = 10). Spearman's Rank Correlation Coefficient Test results showed no relationship between Iron levels in raw and cooked muscle (Rho = 0.5, n = 5, p = 0.39). A positive relationship between Iron levels in raw *C. rugosa* muscle and raw liver (Rho = 0.75; n = 9; $p < 0.05$) was observed. Mixed effect linear regressions using site as random effect, indicated that animal size and soil iron were good predictors of levels of Iron in the raw meat. Anemia is major health concern amongst Indigenous people. There is potential to use *C. rugosa* to improve health locally. The availability of uncontaminated *C. rugosa* to the local indigenous community has important links to their health and well-being.

A-1276 (Oral)

Evolutionary Genomics of Reinforcement in the Green-eyed Treefrog Species Complex

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The origin of species has been a central focus of biology since Darwin. Yet, despite the amount of work describing speciation at the phenotypic level, our understanding of its genomic basis remains limited. This is especially true for complex speciation pathways that have been difficult to detect in nature. One such case is speciation via reinforcement, whereby selection against maladaptive hybridization at secondary contact zones leads to the evolution of reproductive character displacement and eventually reproductive isolation. The validity of this speciation pathway has been long debated and, while it is now recognised as a speciation mechanism, few natural examples have been identified with even fewer studied from a genomic perspective. The Kuranda Treefrog (*Litoria myola*) represents one of the first clear examples of speciation via reinforcement detected in nature. Endemic to rainforests in north-east Australia, it evolved from the Green-eyed Treefrog (*L. serrata*) as a result of past cycles of rainforest contraction and expansion. Currently, two contact zones exist at different stages of speciation and with differing levels of introgression. At both contact zones, the two species show significant divergence in their mating trait — male mating call — but little ecological divergence. As a result, this system presents an excellent natural experiment to investigate the genomics of speciation via reinforcement. We produced a draft genome assembly, as well as high-density linkage maps and low-coverage whole genome resequencing for all three lineages within this system. Using this data, we provide the first genomic assessment of population genetic structure and gene flow in this system, estimate the species' past demographic history, and investigate the genomic signal of speciation. Together, these results provide the first characterisation of the genomic architecture of speciation via reinforcement in the Kuranda Treefrog.

A-1277 (Oral)

How Many Hilitai? Estimating Population Parameters of a Varanid Lizard using Spatial Capture Recapture

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The Mariana monitor lizard (*Varanus tsukamotoi*, né indicus; Chamorro name: hilitai) is the largest terrestrial reptile and predator native to the Mariana archipelago. On Guam, they live alongside the only self-sustaining population of the critically endangered Guam rail (*Hypotaenidia owstonii*; Chamorro name: ko'ko') on a small, 33-ha islet called Islan Dano. They have been implicated as a potential nest predator and have thus been subjected to a lethal removal program since 2009, but despite this, little is known about their population parameters. In this study, we estimated the abundance and density of Mariana monitors on Islan Dano using a spatial capture recapture modeling framework. We incorporated data from multiple sources, including hand captures and GPS telemetry, to generate these estimates. Additional analysis incorporating individuals identified from trail cameras will follow. Knowing the density of Mariana monitor lizards across different parts of the island will allow managers to evaluate the efficacy of ongoing control efforts and inform future management actions. We estimate 17.5 individual lizards per hectare, providing one of the highest recorded density estimates of a varanid species, and is more than twice as high as a previous estimate at this site made using a line-transect methodology. Furthermore, using downwards-facing trail cameras along with drift fences has also proved to be effective at detecting smaller species of lizards and amphibians, as well as Guam rail, suggesting this method could be effective at monitoring multiple species in a community.

A-1278 (Oral)
Using High-throughput Micro-CT Scanning to Quantify Multiple Senses Simultaneously in Ecologically Diverse Snakes

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Snakes are an excellent group for understanding patterns and mechanisms of adaptive evolution due to their extreme ecological and sensory diversity. Studies in sensory adaptation, however, tend to focus on one or two sensory systems due to the constraints in quantifying such complex systems. Animal senses must operate in harmony as they are linked by integrated neurological pathways in the central nervous system. To overcome the challenge of quantifying these complex systems, we are using a high-throughput method of diffusible iodine contrast enhanced microCT scanning (diceCT) in museum specimens of snakes. We scanned 73 species representing approximately 12 independent transitions to arboreal, aquatic, fossorial or terrestrial habits across the phylogeny of snakes. Our results include over 1000 individual segmentations (digital dissections) of central nervous system (brain regions, cranial nerves) and peripheral sense organs (e.g., retinae, lens, ear canals, etc.). This talk will focus on how functional regions of the brain, which receive and integrate inputs from four major senses

(vision, olfaction, audition, vestibular), have changed across the spectacular radiation of snakes.

A-1280 (Oral)
Combining Science and Local Collaborations for Conservation in Cloud Forests

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Chytridiomycosis, the amphibian-killing disease caused by the fungal pathogen *Batrachchytrium dendrobatidis* (Bd), poses the greatest threat to biodiversity ever recorded by a pathogen. This threat is largest in the tropics, where biodiversity is exceptionally high, and other threats, such as deforestation, exacerbate the risk of extinctions. This study aims to evaluate, communicate, and combat the extinction risks of three (Critically) Endangered Honduran hylids following sharp population declines. Cusuco National Park (CNP), Honduras, is a biodiversity-rich cloud forest, heavily impacted by both Bd and deforestation. CNP has been identified as one of the top 25 most irreplaceable sites for amphibian conservation, yet its amphibian species remain largely understudied. Efforts have been made by the Honduran Amphibian and Reptile Conservation Center (HARCC) to initiate head-starting, captive breeding, and/or sperm bank programs, but further research is still needed to do so effectively. Swabbing combined with qPCR will be used to conduct a large-scale survey of Bd across the park. Buccal swabs will be taken from three target species (shared by both this project and HARCC) and sequenced to examine current patterns and levels of genetic diversity, a proxy for adaptive potential in the face of ongoing threats. In conjunction with CMR and habitat surveys, vital areas for frog persistence will be identified in the park and recommended for further protection. All results will be communicated with HARCC and the Instituto de Conservacion Forestal (ICF), the Honduran government agency responsible for managing national parks. Through collaboration, the results of this study will result in direct management action.

A-1281 (Oral)
Tales from the Trail: Inspiring Herpetological Curiosity with Guided Walks

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Reptiles, especially snakes are often villainized and portrayed in a negative light in the media. Consequently, many people have misconceptions about them and an antagonistic relationship with them that can end in acts of violence against these animals. The Herpetological Society of Singapore was founded in 2015 with the goal of dispelling these misconceptions through public engagement and outreach programmes. In the past 9 years, we have engaged the public by organising guided walks, talks and workshops to hundreds of participants. We have since fostered a strong community of like minded individuals dedicated to and the study of herpetofauna in Singapore. This presentation shall discuss the efficacy and limitations of such outreach methods providing insights to our efforts to promote reptile conservation in Singapore.

A-1282 (Poster)
Awareness to Action: Strategies for Mitigating Human-Snake Conflict in Rural India

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The Madras Crocodile Bank Trust has been at the forefront of addressing the complex issue of Human-Snake Conflict (HSC) for over three decades. Over the past eight years, our efforts have expanded extensively across India, particularly in rural areas where HSC is prevalent and deeply impactful. With over 70% of incidents occurring in these regions, India faces alarming rates of snakebite incidents, resulting in approximately 58,000 deaths annually, earning the nation the unfortunate title of the world's snakebite capital. Our initiative recognizes that mitigating HSC is essential not only for human safety but also for environmental stability, as snakes play a crucial role in ecosystem balance by regulating rodent populations. Through targeted outreach and education programs, we have reached over 1.6 million individuals, focusing on raising awareness and implementing replicable prevention models. Collaborating with experts from diverse fields, including herpetologists, educators, and healthcare providers, we are developing enhanced prevention strategies tailored to regional needs. By prioritizing data-driven approaches and establishing specialized registries such as the one in Tamil Nadu, we are making significant strides in mitigating HSC incidents. Our efforts are recognized by the Indian government, particularly the Ministry of Health and Family Welfare, which acknowledges our contribution to drafting the National Action Plan for Snakebite Envenomation, emphasizing the importance of addressing HSC comprehensively. Ultimately, our goal is to create a safe environment where both humans and snakes can coexist harmoniously, fostering mutual respect and understanding between communities and wildlife while significantly reducing the incidence of HSC.

A-1283 (Oral)

Diversification Patterns in Snakes on the Sky Islands of India's Western Ghats

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Sky islands within the Western Ghats refer to stunted evergreen (shola) forests situated at high altitudes between 1,000-2,600 m, often separated by deep valleys and/or different habitat types. Historical climate fluctuations have periodically linked and separated these forests. Connections likely facilitated dispersals and gene flow, and disconnections likely promoted vicariance. The resulting pattern is of shola forest assemblages comprised of taxa whose closest relatives typically also occur in shola rather than the intervening habitats. Investigating sky island taxa offers insights into their evolutionary and biogeographic history, and their contribution to biodiversity hotspots, the influence of environmental changes on biodiversity. Approximately 30 species of snakes are restricted to these sky islands. Previous research on

biotic diversification in the sky islands of the Western Ghats has primarily focused on birds, exploring how biogeographic barriers shaped their evolutionary trajectories. In this study, we examined snakes and one lizard genus (*Salea*), to identify biogeographic patterns and infer dispersal, vicariance, and extinction events across the region. Utilizing molecular data for lineages with sky island representatives, we constructed time-calibrated phylogenies and conducted diversification analyses. Our findings reveal a pattern of multiple independent dispersal events among reptiles across sky islands, with the earliest occurring between 34 and 20 million years ago for *Ahaetulla* spp. and most recently for *Xylophis* spp. between 12 and 8 mya. We propose an independent evolutionary origin without phylogenetic sister for specific species within different landscapes, such as *Ahaetulla perotetti* and *Craspedocephalus strigatus* in the Nilgiris, and *A. dispar* and *C. macrolepis* in the Anamalais. Other species including *Salea anamalayana* + *S. horsfieldii* and *Xylophis perotetti* + *X. mosaicus*, have evolved due to vicariance. Overall, our results suggest multiple connections among sky islands in the past, with paleoclimatic oscillations within the Western Ghats playing a crucial role in shaping the biodiversity in this hotspot.

A-1284 (Oral)
Thermal Tolerance of Anurans in a Rapidly Expanding Urbanscape in India

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Urbanization is an ongoing process and green spaces within urban areas are fragmented, sub-optimal habitats. Increased density of buildings and road surfaces also increases heat retention which can have a cascading effect on ectotherms such as anurans. Anurans may face extreme temperatures and may not be able to seek refuge or thermoregulate due to this reduced diversity of habitats. The city of Bangalore in South India once home to nearly 16 species of anurans has doubled in area and little is known about where and how anurans persist in this landscape. Using high-resolution remotely sensed imagery, we categorized the extent of urbanization in the city of Bangalore and sampled for anurans to determine the assemblage and distribution. Subsequently, we determined, for the first time, the thermal tolerance of anurans by measuring the critical thermal minimum (CTMin), and maximum (CTMax) of adult anurans. We expected thermal tolerance to vary with urbanization, body size, ontogenetic stage, and sex. We encountered over a dozen species in varying levels of abundance and distribution. The thermal tolerance of species was significantly different among the assemblage but did not differ between levels of urbanization, and sexes. While we did not detect differences in heat tolerance (CTMax) across body size, the larger individuals had a significantly higher cold tolerance (Lower CTMin). In one species, the thermal tolerance of tadpoles and juveniles was significantly different than the adults. Anurans that persist in the city are largely found in areas that likely mimic natural spaces. Ongoing processes such as urbanization, habitat degradation, and climate extremes may have synergistic effects. Information about thermal tolerance can help determine the vulnerability of these organisms and identify ways to mitigate threats from rapidly changing environments.

A-1285 (Poster)
Rapid Learning of Aposematic Signals by an Agamid Lizard

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In natural environments, predators often avoid attacking unpalatable prey by recognizing their aposematic signals. While this ability is crucial for predator fitness, the efficiency of learning can significantly enhance predator fitness. Although many studies focus on avian responses to aposematic signals and Batesian mimicry, the capacity of reptiles to learn and avoid aposematic prey and their mimics remains less explored. Here, we investigate whether Swinhoe's tree lizard (*Diploderma swinhonis*) can rapidly learn to recognize and avoid attacking aposematic prey, specifically the unpalatable weevil, *Pachyrhynchus nobilis*, and subsequently avoid similar-looking but palatable longhorn beetles (*Doliops similis*) which is regarded as Batesian mimics of the former. Sympatric populations of this tree lizard has shown their avoidance to the weevil due to their long-term co-occurrence, we therefore conducted experiments using lizards from an allopatric population where both the weevils and long-horn beetles are absent and hence unfamiliar to the lizards. Following an initial encounter with distasteful weevils, the lizards were presented with longhorn beetles and crickets. Our results show that after encountering distasteful weevils, a significant proportion of lizards avoided attacking similarly colored longhorn beetles. This study not only demonstrates the effectiveness of the mimetic relationship between the long-horn beetle and the weevil, but also shows the rapid learning ability of Swinhoe's tree lizard to associate and avoid aposematic signals after a single encounter, indicating a sophisticated capacity for prey recognition in reptiles.

A-1286 (Oral)
Navigating the Funding Landscape: Learning How to Build and Maintain Donor Relationships

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Synchronicity Earth is a charitable organisation based in London, UK. Synchronicity Earth works to champion effective approaches and increase funding for Earth's overlooked species and ecosystems, and the communities working to protect them. Synchronicity Earth is both a funder of species and ecosystem conservation work, and a fundraiser working to increase global philanthropic support for environmental issues. Building and maintaining long-lasting donor relationships is critical to sustaining any conservation project. To do this, conservationists must be able to identify the type of funders that are most aligned to their capacity and vision; manage an introduction to those donors; demonstrate the alignment of goals to a donor; and finally maintain that relationship to increase the chances of securing a long-term funding partnership. This process must be carefully balanced with the other time-commitments of building a successful conservation project. In this talk, I will discuss the different types of donors which typically fund herpetofauna conservation, their different priorities, the different ways in which they usually seek to form a funding partnership, and how a conservation organisation can consider which opportunities are worth investing limited time and resources into pursuing. I will also discuss the key elements of maintaining a long-term donor relationship, including reflecting on monitoring, evaluation, and learning requirements that are common among different funders, with a particular focus on individual givers, and Trusts and Foundations.

A-1287 (Oral)
Subspecies Differences of Rote Island Snake-necked Turtle (*Chelodina mccordi*)

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The Rote Island Snake-necked Turtle (*Chelodina mccordi*) comprises three subspecies: C. m. mccordi, *C. m. roteensis*, and *C. m. timorensis*. Currently, two subspecies, *C. m. mccordi* and *C. m. roteensis*, are housed in captivity in Kupang. Research findings indicate several differences between *C. m. mccordi* and *C. m. roteensis*: (1) The egg size of *C. m. mccordi*, at 10.08 gm, is larger than that of *C. m. roteensis*, at 6.39 gm, although *C. m. roteensis* produces a greater number of eggs; (2) The hatching weight of *C. m. mccordi*, at 6.08 gm, is larger than that of *C. m. roteensis*, at 3.60 gm; (3) The incubation period for *C. m. roteensis* is longer, ranging from 88 to 118 days, compared to 77 to 88 days for *C. m. mccordi*; (4) The hatching interval between eggs for *C. m. roteensis* is 7-14 days, while for *C. m. mccordi* it is only 3-5 days; (5) Several months post-hatching, *C. m. roteensis* juveniles tend to exhibit a dark black coloration, whereas *C. m. mccordi* juveniles are gray; (6) The adult body size of *C. m. mccordi* is larger compared to the smaller *C. m. roteensis*; and (7) *C. m. mccordi* displays a brick red coloration, while *C. m. roteensis* has a black-gray coloration. Understanding these differences between the two subspecies of *Chelodina mccordi* is valuable for future management efforts.

A-1288 (Oral)

High-elevation Adaptation: Insights from Amphibians and Reptiles on the Qinghai-Xizang Plateau

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The Qinghai-Xizang Plateau (QXP) is known as the Roof of the World, with an average altitude of 4,000 meters. Compared with low-elevation taxa, those species occurring on such high elevation experience extreme environmental conditions such as hypoxia, low temperatures and strong ultraviolet (UV) radiation. How these organisms adapt to the extreme environment of QTP has received great interests worldwide. Herein, we show that how the frogs (Amphibia, Dicroglossidae, *Nanorana*) and lizards (Reptilia, Agamidae, *Phrynocephalus*) have evolved a series of phenotypic, physiological and behavioral adaptations to counter the harsh condition on the QTP, i.e., the transition from oviparity to viviparity along the altitudes rises and the UV defense. By integrating omics data with functional validation research, we discovered genes related to UV defense and a corresponding temporal expression pattern in *N. parkeri*. Multiple defense genes (i.e., TYR for melanogenesis) exhibit positive selection with function-enhancing substitutions. By comparing differences in gene expression and regulation during the reproductive cycle, we revealed that the genetic basis of the evolution in reproductive behavior from oviparity to viviparity involved temporal and spatial changes in expression of appropriate genes (i.e., ESR1, PTGS2) that account for eggshell reduction or degeneration, placental development, delayed oviposition. Our work offers an improved understanding of evolution of organisms on the Roof of the world.

A-1289 (Oral)

Tales of Geckos in the Andaman and Nicobar Archipelago: A Chronicle of Colonization

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The Andaman and Nicobar Islands of India comprise 572 islands, spread over 800 km^2, and sustain many endemic species of herpetofauna. The two island groups are separated by the 150 km wide ten-degree latitudinal channel which likely functions as a barrier to dispersal of terrestrial species between the two archipelagos. Several taxa such as birds and mammals found on the Andaman Islands are thought to have an Indo-Burma origin and those in Nicobar have an Indo-Sumatran origin. It remains unclear how smaller, less vagile organisms such as geckos have dispersed and colonized the island archipelago. Most research on lizards so far has relied on morphology to infer relationships and discern patterns of colonization. We sampled the archipelago extensively to identify the position of geckos from this archipelago within the larger phylogeny of geckos and identify cryptic lineages. We created a multi-locus data set comprising three mitochondrial and two nuclear markers with ~60 samples of 12 known species belonging to five genera of geckos—*Cyrtodactylus, Cnemaspis, Gekko, Gehyra*, and *Hemidactylus*. We found that the species of geckos found here are nested within the larger phylogeny of lizards found in South and Southeast Asia. While our findings broadly support the observed pattern of Andaman and Nicobar Islands having distinct biogeographic origins, members of two genera, *Cyrtodactylus* and *Cnemaspis*, found in the Nicobar Islands had an Indo-Burmese origin. Furthermore, we found high levels of genetic variation among members of *Cyrtodactylus* and *Gekko* both within and between islands using comparative phylogeography. This study thus shows how gecko populations within these islands are connected, and offers a detailed picture of the origins of geckos in the Andaman and Nicobar Islands.

A-1290 (Oral)
Understanding Amphibian Habitat Connectivity through Mapping Forested Freshwater Streams in Western Himalayan Region

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Habitat destruction and fragmentation are reported as major threats to amphibian populations in the world. Owing to the higher rate at which natural habitats are being fragmented, studies on habitat connectivity help generate data for a long term species conservation planning. We conducted this study to produce digital maps of the streams of Murree Tehsil, District Rawalpindi, and to examine connectivity among the habitats of endemic Hazara Torrent Frog (*Allopaa hazarensis*) and Murree Hills Frog (*Nanorana vicina*). We used a digital elevation model (12.5 m resolution) to delineate strahler stream order of the study area using flow direction and flow accumulation tools in ArcMap 10.8. We used satellite image (Sentinel 2)

for land use land cover classification. We then performed the least cost path analysis to examine connectivity among these streams. We also gathered data regarding stream hydroperiod (permanent or temporary), frog species presence and breeding evidence of *N. vicina* and *A. hazarensis* by surveying 56 streams (nocturnal stream searches). We delineated a total 390 streams (79, 534 m) of the study area. These were categorized into Strahler stream order: 213 are first order streams, 101 second order, 74 third orders, and remaining two as fourth order streams. We found presence of the studied frog species from 15 of the 56 streams surveyed while found breeding evidence from at least nine streams. We found that the habitat of *N. vicina* and *A. hazarensis* comprises of the streams at elevation >1,100 m. We mapped five connected stream networks important for the studied frog species. The analysis of connectivity establishes pathways linking all stream networks comprising shortest paths between pairs of nodes within these networks which may facilitate amphibian movements.

A-1291 (Oral)

Snakes of China: Underestimated Diversity and Future Perspectives

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Being one of the few countries that harbour multiple global biodiversity hotspots, China has a rich and unique diversity of snakes, and understanding China's serpentes diversity and their distribution is not only crucial for taxonomic, phylogenetic, and evolutionary researches, but also for effective conservation actions. Utilizing the most comprehensive samples across China collected between 2000 and 2020, covering 80.6% of recognized taxa, we attempt to establish a DNA barcoding library for Chinese snakes and estimate the total diversity of snakes in China. Our results showed that despite recent progress in taxonomic studies, the snake diversity in China is still severely underestimated and understudied: apparent issues exist on the current taxonomy of Chinese snakes, with some species being paraphyletic, while others being lumped or further split by species delimitation analyses; and the total number of detected unnamed operational taxonomic units (OTUs) account for 30% of the currently recognized diversity. The speed of taxonomic descriptions/changes for Chinese snakes are rapidly increasing in recent years, with 119 species added as of the end of 2023 comparing to the national checklist published in 1998; and the geographical distribution of the type localities for newly added taxa is not even across China, with southern and southwestern China having the highest number of new species discovered (namely Yunnan, Xizang, Guangxi, Sichuan, and Guangdong Provinces as the top five). Lastly, to facilitate future taxonomic research and promote scientific outreach on Chinese snakes to the public, we have established a publicly available, online database on the snake diversity of China (SnakeChina, http://www.snakechina.cn).

A-1292 (Oral)

Conservation Challenges and Opportunities - Genomic Study of Chinese Giant Salamanders (*Andrias davidianus* Complex)

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Consisting of seven species, Chinese giant salamanders (*Andrias davidianus* complex) remain critically endangered in nature while overstocked in farms, and face the problem of genetic homogenization by artificial breeding. However, their huge genome sizes have hindered understanding of their evolution history, assessments of their population status, and the implementation of conservation efforts. Here, we present the chromosome-level assembly of *Andrias jiangxiensis*. We got an assembly of 33 chromosomes, with lengths ranging from 58.5 Mb to 7.3 Gb, and only 2.6% small unplaced scaffolds. The final length of the assembly is 45 Gb, with an N50 of 5.0 Gb. We uncover 92% transposable elements (TEs) constituting the most repetitive animal genome that ever reported. The *Andrias* genome had experienced several rounds of TE proliferation since 120Ma, and with 3Gb-TEs continuously active in recent 10 million years. About 1.1Gb LIR-RTs in giant salamander are still active within two million years, which might be a trace left by the divergence among different species of *Andrias*. Besides, the assessments of demographic histories indicate five *Andrias* species had lost over 99% individuals in recent 15K years. Our results provide insights and key resources for understanding the evolution history and genetic assessments for the critically endangered *Andrias* species.

A-1293 (Oral)

Climate Driven Abundance and Life History Evolution Among Terrestrial Salamanders (Genus *Plethodon*) in the Southern Appalachian Mountains, U.S.A.

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Concern over climate change is motivating research to predict the potential consequences to biodiversity, particularly within montane landscapes. For montane Plethodontid salamanders, initial research predicting declines or extinctions has been tempered by recent studies demonstrating behavioral or physiological adaptations that might counter the effects of rising temperatures or reduced rainfall. This has and changed the rhetoric about the potential risks of climate change to plethodontid populations. We used two long-term or spatially extensive data sets composed of more than 20,000 captures of individual large *Plethodon* species from 56 sites across north Georgia, western North Carolina, and eastern Tennessee to demonstrate that mean daily vapor pressure deficit (VPD) has a strong negative effect on salamander abundance despite behavioral or physiological counter adaptations. We also demonstrate that minimum size at first reproduction increases with mean daily VPD, likely because body size is a key adaptation to reduce evaporative water loss. Larger minimum size at maturation at the driest sites likely requires a delay in maturation of 2-4 years compared to the wettest sites. We propose that delaying maturity to achieve a larger body size is a key mechanism by which Plethodon - and perhaps other amphibians - evolve to persist at sites with drier climates. This life history change constrains population growth resulting in lower abundance. If future climates are warmer or drier at occupied sites, *Plethodon* abundance is expected to decline with little potential for adaptation to offset those effects.

A-1294 (Poster)
Are there any Chemical Restrictions on the Compounds that *Rhabdophis tigrinus* can Use?

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Many toxic animals sequester toxins from environmental sources such as diet. Recent studies revealed that some of these species have shifted toxin sources. Because such a shift in sources is usually observed among diet that have chemically similar toxins, there may be restrictions in the chemical properties of toxins that a given animals can sequester. However, it is unclear how flexible they are in utilizing new compounds. Thus, it is difficult to discuss the specific evolutionary pathways of shifting toxin sources. Perhaps they were able to utilize a variety of toxin sources from the beginning, or adaptive evolutions might occur that allowed them to utilize new toxin sources. Snakes of *Rhabdophis* are widely distributed in Asia. Some of them sequester cardiotonic steroids known as bufadienolides from toads consumed as prey and store them in unique organs called nuchal glands. In this study, we examined the flexibility of the ability in sequestering compounds in a Japanese natricine snake, *Rhabdophis tigrinus*. We administered cardiotonic steroids, that are not utilized under natural conditions to the snake and examined its sequestered and excreted substances. The results showed that chemical constraints exist in metabolic system and transportation into the nuchal glands. In other words, *R. tigrinus* may have chemical specificity in the compounds that can be sequestered. A derived clade of *Rhabdophis*, the *R. nuchalis* group, has shifted toxin sources from toads to lampyrine fireflies. Although toads and fireflies have toxins classified into the same category, bufadienolides, those have different chemical structures. In the future research we will focus on the *R. nuchalis* group which has shifted their toxin sources, to determine the evolutionary mechanisms that led them to utilize compounds of new chemical structures.

A-1295 (Poster)
Diversity of the Blood Parasite Genus *Hepatozoon* (Apicomplexa: Adeleorina: Hepatozoidae) in Snakes of South Africa: A Parasite of Concern or Nothing to Worry About?

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Southern Africa is host to an estimated 168 snake species. With this diversity, little is known about the diversity of parasites infecting these hosts, particularly haemoprotozoa such as the genus *Hepatozoon* (Apicomplexa: Adeleorina: Hepatozoidae). *Hepatozoon* is a frequently recorded haemoprotozoan parasite of snakes with over 120 reported from snakes worldwide. It has been suggested that *Hepatozoon* species of snakes follow a three-host life cycle, including an invertebrate vector (arthropod), a primary intermediate host (mammal, reptile, amphibian), and a secondary intermediate host (the snake). Of those species of *Hepatozoon* formally reported and described worldwide, only four have been described from snakes of

South Africa, two of these essentially a century ago and the other two in 2018. In the present study, a total of 154 snakes from five genera and seven species from three provinces within South Africa were screened for the presence of *Hepatozoon*. Thin blood smears were prepared from each host, with these subsequently screened via the aid of light microscopy to identify the presence, as well as morphology, of blood stages. A small volume of blood was also collected for further molecular analyses. PCR was performed targeting the 18S rRNA gene of the parasites. Of the snakes screened, 49/154 (31.8%) were found to be infected with species of *Hepatozoon*. Molecular and phylogenetic analyses suggested the presence of three species of *Hepatozoon*, each with a different route of infection, potentially dependent on dietary preference or range of diet. Routes included potential infection via an intermediate host or associated vector from mammalian, reptilian, or amphibian hosts. Furthermore, it would appear that snake species with a more diverse diet were parasitised by a higher diversity of *Hepatozoon* species. Overall, it would strongly suggest that species of *Hepatozoon* infecting snakes are not species-specific, and require attention, particularly in regard to translocation.

A-1296 (Oral)
The Role of Australian Marine Parks in Protecting the Biological and Cultural Values of Sea Snakes

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The north-west coast of Australia is home to a diversity of sea snake species, including two Critically Endangered (*Aipysurus apraefrontalis, A. foliosquama*) and one endangered (*A. fuscus*) under the local Environmental Protection Act. Unexplained population declines within Ashmore Marine Park and subsequent rediscovery in coastal habitats underscore the need for a scientific framework to understand protected areas' roles in conserving sea snake populations. The Australian Marine Parks (AMPs) network, established to preserve marine ecosystems and biodiversity, includes varied habitats like coral reefs and deep-sea environments, yet its effectiveness in conserving sea snakes remains uncertain. Additionally, sea snakes hold significant cultural value for Indigenous Australians, such as the Murujuga people's connection to the Barrimirndi, a Rainbow Sea Serpent. However, these cultural values have not been thoroughly explored in relation to sea snake conservation. This presentation introduces a project aimed at filling critical knowledge gaps in sea snake conservation within AMPs and better characterising Indigenous cultural knowledge. We conducted a comprehensive investigation into sea snake distributions, population connectivity, and seascape ecology across the North-west AMP network using a multi-method approach: i) environmental DNA (eDNA) surveys to map species assemblages and distributions, ii) population genomics to assess genetic connectivity and diversity, and iii) acoustic telemetry to track individual movements between protected and unprotected areas. These methods clarified the role of AMPs in safeguarding sea snake populations, identified critical habitats and connectivity pathways, and pinpointed key Traditional Owner groups with cultural ties to sea snakes. The next phase will involve collaborating with Traditional Owner groups to document their cultural knowledge of sea snakes and develop Indigenous Ranger-led monitoring of sea snake populations within key AMPs.

A-1297 (Oral)
Impacts of Climate Change on Herpetofauna Diversity in the Qinghai-Tibetan Plateau

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Although numerous studies on the impacts of climate change on biodiversity have been published, only a handful are focused on the intraspecific level or consider population-level models. We endeavored to fill this knowledge gap relative to the Qinghai-Tibetan plateau (QTP) by combining species distribution modeling (SDMs) with population genetics and phylogenetic methods. We applied our models to 11 endemic and widely distributed herpetofauna species inhabiting high elevations in the QTP. We aimed to determine the influence of environmental heterogeneity on species' responses to climate change, the magnitude of climate-change impacts on intraspecific diversity, and the relationship between species range loss and intraspecific diversity losses under 2 shared socioeconomic pathways (SSP245 and SSP585) and 3 future periods (2050s, 2070s, and 2090s). The effects of global climatic change were more pronounced at the intraspecific level (22% of haplotypes lost and 36% of populations lost) than the morphospecies level in the SSP585 climate change scenario. Maintenance of genetic diversity was in general determined by a combination of factors including range changes, species genetic structure, and the part of the range predicted to be lost. This is because the loss and survival of populations were observed in species irrespective of the predicted range changes. In the southeast (mountainous regions), climate change had less of an effect on range size than in central and northern QTP-plateau regions. This may be attributed to environmental heterogeneity, which provided pockets of suitable climates in the southeast, whereas ecosystems in the north and central regions were homogeneous. Generally, our results imply that mountainous regions with high environmental heterogeneity and high genetic diversity, may buffer the adverse impacts of climate change on species distribution and intraspecific diversity. Therefore, genetic structure and characteristics of the ecosystem may be crucial for conservation under climate change.

A-1298 (Oral)
Comparative Analysis of Psammobiotic Reptile Communities in Iranian Deserts: Illustration of Zoogeographic Trends

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In the era of computer modelling, genomic research and artificial intelligence, classical zoological methods are losing popularity. However, any computer model or hypothesis must be tested and verified on nature environment on real communities, populations and species to acquire scientific significance. This study we provide actual data of diversity, distribution and population density assessment of Iranian psammobiotic reptiles communities in different habitats across the country, based on data collected over a decade. We found that the uniqueness the isolated sand massifs' has led to a high level of endemism and diversification among psammobiont reptile species in Iran. The long-term dynamics of quantitative ratio of dominant species in the community is a rather stable characteristic and despite significant fluctuations of density in different years, the position of the dominant species in the communities has remained stable. Population densities of specialized psammobiont species usually higher than of eurybiont species. The structure of reptile communities in sandy deserts is significantly influence by the historical factor of habitat formation and zoogeographical background. In Central Iran's deserts, species diversity decreases from east to west, as well as population density. The proportion of Turanian species is decreasing and autochthonous species are increasing in this direction, and the density of psammobiont mostly decreases. In southern Iran, the sandy massif in the northwest of Ahvaz (Khuzestan) have the highest diversity of psammobiont species with approximately equal densities on both diurnal and nocturnal species. The diversity and density of psammobiont populations decreased from west to east along the sea coast. Present data can serve as the foundation for modelling, long-term monitoring, and evaluating changes at the community level. In the context of global climate change and expanding desert areas, having reference points to monitor potential changes is crucial.

A-1299 (Oral)
Phylogeny and Biogeography of the Genus *Gekko* (*Japonigekko*) (Reptilia: Squamata) in East and Southeast Asia

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The genus *Gekko* is a representative group of the family Gekkonidae, and six subgenera are currently recognized within it. One subgenus, *Japonigekko*, is the most diverse group

distributed in the northern part of the entire range of the genus *Gekko* including northeastern part of Southeast Asia to East Asia, and contains some 30 species. More than one third of the species have been described in the recent years and several unnamed species are waiting to be described. In this study we conducted a comprehensive phylogenetic analysis for the members of this infrageneric group based on nearly complete mitochondrial DNA (mtDNA) sequences and long sequences of two nuclear genes. We determined sequences for 24 species and additional four possibly undescribed species. Combining published sequences of partial mtDNA for other 7 species, we depicted phylogenetic trees based on the supermatrix data. Tree topology based on the mtDNA and that on the nuclear genes largely agreed with each other, and seven clades were recognized within this subgenus. Three clades near the basal position consisted of species from the southern part of the group's range including Laos, Vietnam, and southern China, and most species in the central and northern parts of the range were placed at derived positions in the tree. These results suggest that this group originated in somewhere from southern China to Vietnam and diversified with the range expansion northeastward, and this scenario was supported by the ancestral range reconstruction analysis. A phylogenetic analysis using Bayesian inference indicated that the initial divergence in this group occurred around 40 million years ago, and subsequent divergences leading major subclades in the northern part were inferred to have occurred around 25–15 Mya. The phylogenetic information provides the basis for further evolutionary researches on this group of geckos.

A-1300 (Oral)

No Place Like Home: Relocated 'Nuisance' Pythons Move Further and Die Earlier

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Snakes have a particularly unpopular reputation, and frequently relocated away from human habitation in a bid to enhance human well-being and for the safety of the snake. To investigate the impact relocation has on urban snakes, 10 'nuisance' urban carpet pythons (*Morelia spilota*) were sourced from professional relocators and released into bushland within 26 km of their capture sites, consistent with standard relocation practices. Radio-tracking occurred intensively for the first 21 days and up to fortnightly for the following year using implanted VHF radio-transmitters. Comparative data were gathered from 11 resident pythons that were not relocated but monitored under similar conditions, including up to a year prior to the release of the relocated pythons. Results showed that relocated pythons experienced higher mortality rates, greater displacement, and larger area of occupancy compared to resident pythons. Within 26-70 days, four female relocated pythons perished due to human-caused mortality. Homing behaviour was not observed, and all relocated pythons left bushland to visit human habitats. Although relocated pythons spent more time in bushland, their erratic movement patterns suggest this is not their preferred environment. Relocated male pythons were observed more frequently in ambush posture and exhibited disturbance responses to human approach. Surviving relocated females had higher temperature differences between body temperature and ambient temperature. These results suggest long distance relocation has a detrimental effect on urban carpet pythons and raises questions about suitability of current management practices.

A-1301 (Oral)

Genetic Structure of the Chytrid Fungus *Batrachochytrium dendrobatidis* from China

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The chytridiomycosis caused by *Batrachochytrium dendrobatidis* (Bd) has emerged as an emerging infectious disease that poses a considerable threat to amphibians. Although China hosts a rich and diverse range of amphibian species, there are still insufficient studies to assess the impact of Bd on these species. The current state of Bd infection among Chinese amphibians remains unclear, with less than 10% of species having been screened to date. Furthermore, previous studies on the Bd lineages in China have been restricted to only four amphibian species in Yunnan and Guizhou, lacking representativeness and potentially concealing additional unknown lineages. In this study, we have sampled 5,683 samples (toes and swaps) from 29 provinces, which include 62 genera across 13 families in China. Nested PCR and qPCR were used to detect if they were infected. Further, we designed probes set to enrich libraries for a set of 886 target exons of Bd for each positive sample. Presently, our results showed that 163 samples from 31 genera and 8 families were identified as positive, which are distributed across 10 different provinces in mainland China. The ecological factors that affect the distribution of Bd in China are analyzing. Genetic diversity and structures of Bd are analyzing based on the exon capture data set. These results will advance our understanding of the ecology and evolutionary origins of Bd, and contribute to the genetic monitoring of this pathogen in China.

A-1302 (Oral)
Unveiling the Hidden Diversity of Snakes in Northeast India

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Situated at the junction of Himalayan and Indo-Burma biodiversity hotspots, the northeastern part of India is a treasure trove of herpetofaunal diversity. However, this biodiversity is grossly underestimated, evident from the fact that many new squamate reptiles were discovered in the region adding significantly to the region's endemic biodiversity. In the last two decades, we carried out herpetological exploration in over 150 localities including 30 protected areas. Our exploratory research spanned all the main physiographic formations and helped us document 105 species of snakes. Our integrative taxonomic approach resulted in taxonomic revision and phylogenetic status of snakes species in various genera (*Herpetoreas, Lycodon, Trachischium, Boiga, Blythia, Smithophis, Rhabdophis*) from the region and helped describe new species within *Rhabdophis, Stoliczkia, Smithophis*. We also rediscovered and redescribed lost species such as *Herpetoreas pealli* and *Oligodon malaneus* after more than a century. A large-scale phylogenetic database on natricine, colubrid (*Boiga, Oligodon*) and viperid (*Trimeresurus*) snakes from this region is being used to understand the complex biogeographic patterns of this understudied part of Asia. Our integrated taxonomic approach is also helping in determining

species distribution crucial for conservation assessment and also identifying critical habitats for conservation priority.

A-1303 (Oral)
Monsters in the Park: Potential Disease Transfer from Captive Individuals to Free-ranging Snakes

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Throughout the world there are many diseases found in captive reptile collections, raising concerns about transfers to wild populations. One potential pathway of exposure to wild populations may occur through escaped infected individuals. Within Australian zoological and private collections, confirmed fatal diseases include Sunshinevirus, Nidovirus and Bornavirus, however infected individuals may be asymptomatic. Increased encounters in the wild with non-endemic reptile species, either as escaped or released pets, is occurring and highlights a transmission risk to local snake populations. To investigate disease status of free-ranging pythons, mouth/cloacal swabs were collected from 46 free-ranging urban carpet pythons (Morelia spilota) and four non-endemic (escaped pet) pythons encountered in 26 Brisbane suburbs. Findings included a positive test for Nidovirus in one non-endemic carpet python, a 'morph' commonly found in the pet industry and potential false positives for Sunshinevirus in nine pythons. Although no pythons tested positive for Bornavirus, a low presence of a strain of Chlamydia, was detected in eight pythons, as a collaboration with the 'Molecular Chlamydia' research team. The positive Nidovirus individual was encountered in a public park by a snake relocator. The presence of an infected individual in areas where free-ranging snakes may occur, highlights potential of transmission of captive reptile disease to wild populations. Urban wildlife management practitioners need to develop awareness and protocols for this potential emerging threat.

A-1304 (Oral)
Skin Microbiome Disturbance Linked to Drought-associated Amphibian Disease

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The onset of global climate change has led to abnormal rainfall patterns, disrupting associations between wildlife and their symbiotic microorganisms. We monitored a population of pumpkin toadlets and their skin bacteria in the Brazilian Atlantic Forest during a drought. Given the recognized ability of some amphibian skin bacteria to inhibit the widespread fungal pathogen *Batrachochytrium dendrobatidis* (Bd), we investigated links between skin microbiome health, susceptibility to Bd and host mortality during a die-off event. We found that rainfall deficit was an indirect predictor of Bd loads through microbiome disruption, while its direct effect on Bd was weak. The microbiome was characterized by fewer putative Bd-inhibitory bacteria following the drought, which points to a one-month lagged effect of drought on the microbiome that may have increased toadlet susceptibility to Bd. Our study underscores the capacity of rainfall variability to disturb complex host–microbiome interactions and alter wildlife disease dynamics.

A-1305 (Oral)

Disrupting Stream-front Views? Investigating the Impact of Mining on Neighbourhood Frogs

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Frog communities play essential roles in the functioning of balanced ecosystems. However, frogs are very susceptible to habitat disturbance and are among the first taxa to react to environmental stressors. Longwall mining represents a previously understudied mode of habitat disturbance where, prior to ongoing monitoring and research, the influence of this disturbance on stream-breeding fauna was largely unknown. Longwall mining involves the removal of coal via construction of underground tunnels, which can initiate cracking of the surrounding rock strata and subsequent loss of surface water. Multi-species occupancy modelling presents an invaluable opportunity to assess the potential for longwall mining to impact frog occupancy across a mined landscape. We sampled anuran communities across 73 sites situated in south-eastern New South Wales, Australia. We compared habitat occupancy between mined and non-mined streams, where occupancy was quantified at both the frog community and individual species levels. Our study investiagted the impact of longwall mining on frogs' occupancy of habitats, with 11 out of 12 frog species responding negatively across mined habitats. Our research also identified a community-wide response to longwall mining among frogs. Overall, our study demonstrated the capacity for longwall mining to affect frogs at the community level, and emphasised the role habitat restoration is likely to play in buffering frogs against the landscape-scale impact mining can pose to the broader environment.

A-1306 (Poster)

Geographic Variation in Reproductive Strategy of Maternal Allocation for Offspring in *Fejervarya kawamurai*

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All parents face the fundamental life-history decision of how much to invest their energy in the offspring produced. The frequency and timing of reproduction can influence maternal

allocation and ultimately reproductive success. We investigated geographic differences in maternal investment, clutch size, and egg size between the temperate and subtropical populations in *Fejervarya kawamurai* to understand the effects of breeding season length on maternal investments. We collected the samples from Okayama, mainland Japan, and Okinawa, Ryukyu Islands. Our findings revealed that the body size in both females and males did not differ between the populations. Also, there were no differences in their mature size. However, the relationship of maternal investment with body size varied between the populations. Both total egg mass and clutch size indicated a positive correlation with the maternal body size in the temperate population, but not in the subtropical population. The females from the latter population invested less, regardless of the body size. We discuss the plasticity of maternal strategies for reproductive allocation in the frog.

A-1308 (Poster)

Food Web Dynamics Using Ecological Niche Modelling for the Japanese Giant Salamander (*Andrias japonicus*) in the Nawa River Basin, Tottori, Japan

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Understanding food web dynamics aids in prioritising habitat conservation and developing ecosystem-based strategies for the conservation of species. Here, we assessed food availability within the Nawa River Basin, Tottori, Japan, for the Japanese giant salamander (*Andrias japonicus*), an opportunistic predator foraging on aquatic and terrestrial species. Based on the primary terrestrial prey species in Hiroshima, Japan, we identified the top seven species likely to significantly contribute to the diet of the species: two crabs species, Eriocheir japonica and Geothelpusa dehaani, and five frog species *Dryophytes japonicus, Fejervarya kawamurai, Rana japonica, Rana tagoi*, and *Zhangixalus schlegelii*. To analyse overlap and prey abundance, we collected occurrence data for all species and built ecological niche models using 19 bioclimatic and two topographic variables in Maxent. Next, we measured the niche overlap between *A. japonicus* and each prey species. Our results revealed that: (1) the most important factor influencing *A. japonicus* population distribution and prey species were temperature annual range followed by precipitation of coldest quarter and annual precipitation, with a total contribution of 93.10%. (2) The niche overlap was maximum between *A. japonicus* and *Z. schlegelii* (100%), followed by *R. tagoi* (98%), *R. japonicus* (96%), and equal for *G. dehaani* and *E. japonica* (95%). The overlap was comparatively lower with *D. japonicus* (87.9%) and *F. kawamurai* (83.8%), and especially at higher elevations suggesting geographic clustering of species at lower elevations. High niche overlap with *Z. schlegelii* and *R. tagoi* suggests a possible significant contribution to the diet of *A. japonicus*. The high niche overlap observed among most prey species is likely due to their abundant availability within the habitat of *A. japonicus* and could result into prey saturation, leading to selective feeding behaviour in *A. japonicus*. Consequently, the threat to these species might not arise from prey scarcity, when focused on terrestrial species.

A-1309 (Oral)

Engaging Local Villagers in Saving the Painted Terrapin in the District of Aceh Tamiang, Sumatra, Indonesia

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The Painted Terrapin (*Batagur borneoensis*) is a Critically Endangered species that has been protected in Indonesia since 2018. According to recent survey data, the remaining wild populations in Indonesia are restricted to the provinces of Aceh, North Sumatra, and East Kalimantan. The sharp decline of the wild population is largely attributed to the substantial poaching of adults, particularly in the 1990s, coupled with the unsustainable harvesting of eggs by villagers. The threat of illegal harvesting still persists within some fishing communities. Since 2010, the Satucita Foundation and its partners have enacted Painted Terrapin conservation efforts in Aceh. One of the principal annual activities is the daily patrolling for nests during the breeding season of December through February to collect eggs for translocation to a protected hatchery at our Painted Terrapin Information Centre. For first 12 years of the nest patrolling initiative, a team canvassed 2-3 km of island beaches every night for the three-month nesting season. The beaches are only accessible by boat, and when combined with the duration of the nesting season and daily labor-intensive patrols, the endeavor is financially costly. To make it more cost-effective and efficient, during the 2021-2022 nesting season we altered our method for nest detection and egg retrieval. Now, we engage local fishermen in nest detection. As an incentive, we pay for their gasoline, which significantly reduces their daily overhead fishing expenditures. We ask them to help locate nests, collect the eggs, and deliver them for incubation at the hatchery in Pusung Kapal, roughly 6 km from the nesting beaches. Through this initiative, returns have increased in respective areas from 20 to 100 percent, and, during the last two years, our costs have decreased by more than 50 percent. This method looks promising, and we will continue to evaluate and streamline operating protocols.

A-1310 (Oral)
Preventing Reptile Extinctions on Islands by Eradicating Invasive Alien Animals

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Over 80% of reptile extinctions have occurred on islands and invasive alien species are implicated in more than 85% of cases. During the past 30 years, conservationists in the Caribbean have endeavoured to control or eradicate rats, mongooses and other harmful alien animals from more than 40 islands. This has resulted in significant improvements in the status of dozens of species of snakes and lizards such as the Antiguan racer (*Alsophis antiguae*) in Antigua, White Cay Iguana (*Cyclura rileyi cristata*) in the Bahamas, St. Croix ground lizard (*Pholidoscelis polops*) in the US Virgin Islands, and Saint Lucia whiptail (*Cnemidophorus vanzoi*) in Saint Lucia. On the island of Redonda, the density of Critically Endangered endemic lizards *Anolis nubilus* and *Pholidoscelis atratus* increased by more than four-fold and ten-fold respectively after invasive alien ship rats (*Rattus rattus*) and goats were eradicated in 2017. With the fast-rising spread of invasive alien reptiles, such as the common green iguana (*Iguana iguana*) and Peters' rock agama (*Agama picticauda*), however, herpetologists are struggling to find ways to defend Caribbean reptiles from competition, disease transmission and even hybridization. This paper provides an overview of the methods used, lessons learned, and the prospects for saving more species at risk of extinction.

A-1311 (Poster)
Introduction of *Diploderma polygonatum polygonatum* (Agamidae, Squamata, Reptilia) into the Main Islands of Japan

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Diploderma polygonatum is widely distributed in the subtropical region of the East Asian islands except for Northern Ryukyus: *D. p. polygonatum* in the Central Ryukyus, *D. p. ishigakiense* in the Southern Ryukyus (exclusive of Yonagunijima Island), *D. p. donan* in Yonagunijima Island of the Southern Ryukyus, and *D. p. xanthostomum* in Taiwan. Of these, the nominotypical subspecies has been introduced to the mainland of Japan across islands of the Northern Ryukyus. Populations of Nichinan and Ibusuki, located in the temperate area of southern Kyushu, were found in 1998 and 2005, respectively. A colony on Yakushima, a subtropical island off the southern Kyushu, was also found in 2012. In these three areas, it was thought that breeding populations were already established. More recently, specimens of this subspecies were collected in Matsuura in northern Kyushu and Hamamatsu in central Honshu. In the present study, we conducted various surveys on the Nichinan, Ibusuki and Yakushima populations. Our long-term field observations, verifying survival of the breeding colonies in each area, revealed that *D. p. polygonatum* was still active in March, which is colder than its native region. Our analyses of mitochondrial DNA sequences suggested some individuals were introduced from Okinawajima Island of the Central Ryukyus. Morphological analyses also revealed significant differences between native and introduced populations.

A-1312 (Poster)
The Effect of Artificial Lights at Night on Food Intake and Body Condition of Japanese Tree Frog (*Dryophytes japonicus*)

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Artificial lights at night (ALAN) are known to attract invertebrates, which are food resources for some nocturnal predators such as frogs. Previous studies conducting field enclosure experiments have shown that the food intake of a toad species (*Rhinella marina*) increases in the presence of ALAN. Although such previous studies have focused on short-term increase in food intake of nocturnal predators, most ALAN is present for long periods in the field, and ALAN can provide abundant food resources for these nocturnal predators continuously. Abundant foods may improve body condition and reproductive investment of nocturnal

predators around ALAN, increasing their fitness. Here, to verify this assumption, we compared the amount of food intake, site fidelity, and body condition between frogs nearby ALAN and those away from ALAN. *Dryophytes japonicus*, which is known to forage around ALAN, was used as the study species. Field surveys were conducted in July, August, and September at four areas in Aomori Prefecture, Japan. In each area, four study sites were established at different distances from ALAN respectively. The amount of food intake of *D. japonicus* was evaluated using the weight of stomach contents. The site fidelity was evaluated using the recapture rate about one month after the mark and recapture of the individuals at each site. The body condition was evaluated using BMI (body mass/SVL^2), which was found to correlate with clutch size in our preliminary surveys. Comparison of the above indices across study sites at different distances from ALAN found that all indices were higher at the sites nearby ALAN than those at the sites away from ALAN. These results imply that *D. japonicus* around ALAN improves their body condition through a continuous increase in the amount of food intake. Furthermore, the improved body condition may also contribute to the increase in clutch size.

A-1313 (Oral)

Dermal Armour in Lizards: Far more Common than Presumed

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Osteoderms, also known as dermal armour, are bone plates in the skin. They occur widely but inconsistently across the tetrapod tree of life. The greatest diversity in osteoderm shape, distribution, and expression is found in squamate reptiles, i.e., lizards and snakes. Despite the suggestive name, it remains poorly understood if dermal armour serves protection. An array of other functions in ecology and life history is part of ongoing discussions in the literature. However, most of these have not been systematically studied. The lack of a consistent and comprehensive catalogue of osteoderm expression has rendered this difficult. We present here the first qualitative investigation of osteoderm expression in squamate reptiles as whole on a low taxonomic level. To this end, we examined 1,540 micro-computed tomography (µCT) scans representing specimens from 65 scientific collections. We complemented this with 551 literature reports from the past 170 years. Our samples cover 525 extant lizard genera, in 42 % of which we found osteoderms. In monitor lizards alone, we found previously unreported osteoderms in 29 species. We show that osteoderms are ~2/3 more common among lizards than prior literature suggests. With our dataset, we also reconstructed that squamate osteoderm expression is a result of repeated independent acquisitions. It is the first time that this long-discussed hypothesis is substantiated with an ancestral character state reconstruction of this robustness. Our findings provide the groundwork for future systematic investigations into osteoderm functions, thus potentially inspiring biomimetics and providing novel insight into evolutionary trajectories and constraints that shaped present day biodiversity.

A-1314 (Oral)

Using Genomics to Understand and Potentially Mitigate Impacts of Habitat Loss and Fragmentation on Species at Risk Snakes in Ontario

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Habitat loss, degradation, and fragmentation are leading causes of biodiversity loss worldwide. While the perception of Canada is that of a country with expansive, pristine wilderness, this notion is illusory and wrong. For example, while globally ~19% of reptile species are at risk of extinction, in Canada about two-thirds of all reptile species are at risk – because most reptiles lie at their northern range peripheries in Canada and occur within a few hundreds of kilometers of the US border, where urbanization, agriculture and road development have caused past and ongoing habitat loss and fragmentation. Seeking to mitigate or reverse such loss requires that we better understand the impacts of these threats on connectivity of wild species. We assess population structure of four broadly co-occurring snakes of conservation concern across their Canadian ranges (Eastern hog-nosed snake, *Heterodon platirhinos*; Foxsnake, *Pantherophis vulpinus*; Massasauga rattlesnake, *Sistrurus catenatus*; Butler's gartersnake, *Thamnophis butleri*) using suites of markers including mtDNA sequences, DNA microsatellites and genome-wide panels of Single Nucleotide Polymorphic markers (SNPs). We find evidence of marked genetic population structure and isolation for all species driven by a combination of postglacial colonization dynamics and profound human-caused habitat alteration modulated by life history. Based on our findings we explore options for conservation including options for altered landscape management practices, habitat restoration, and *ex situ* conservation.

A-1315 (Poster)
A First Report of Complete Albinism in the Wild Adult *Ichthyophis kohtaoensis* from Peninsular Thailand (Amphibia: Gymnophiona: Ichthyophiidae)

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Albinism, a condition characterized by the absence of pigmentation, is a rare phenomenon in amphibians and is poorly understood, particularly in Southeast Asia. Here, we present the first documented case of albino caecilian in Southeast Asia, specifically identified as *Ichthyophis kohtaoensis*. The specimen was discovered in a rubber plantation, formerly a paddy field, exhibiting complete albinism with red eyes. Using molecular techniques, we confirmed its species identity through cytochrome b sequencing, revealing a close genetic relationship to I. *kohtaoensis*. Unlike typical caecilians, the lack of pigmentation in this albino specimen allowed for the observation of dermal scales, a feature typically concealed by dark coloration. Morphometric measurements indicated normal anatomical proportions without any malformations. This discovery contributes to our understanding of amphibian albinism and underscores the importance of further research in elucidating its genetic and ecological implications. The survival of albino caecilians in subterranean environments suggests potential adaptations to light-independent lifestyles.

A-1316 (Poster)
Ecological Niche Modelling and Spatial Distribution of the Pitvipers in Mindanao, Philippines

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Ecological niche models are essential for predicting the distribution of venomous snakes, offering insights into their spatial patterns and habitat preferences. Pit viper is one of the venomous snakes in Mindanao, Philippines, whose niche and spatial distribution are less studied. This study aims to model the ecological niche and distribution of pit vipers namely *Tropidolaemus subannulatus, T. philippensis*, and *Trimeresurus flavomaculatus* in Mindanao, Philippines, a region known for its rich biodiversity but lacking comprehensive data on these venomous snakes. We employed an ensemble of ecological niche models, including Generalized Linear Model, Random Forest, and Maxent, to predict the potential distribution of pit vipers across the island. Our results indicate that pit vipers predominantly inhabit forested and intact habitats, highlighting the importance of undisturbed environments for their survival. The models also identified key environmental variables influencing their distribution, such as temperature, precipitation, and vegetation cover. Areas with dense forest cover and minimal human disturbance were found to be the most suitable habitats for pitvipers. These findings underscore the critical need for habitat preservation and the establishment of protected areas to safeguard pit viper populations. The implications of our results are significant for conservation planning, as they provide a scientific basis for prioritizing areas for conservation action. By integrating ecological niche models into conservation frameworks, we can better ensure the long-term survival of pit vipers in Mindanao.

A-1318 (Oral)
Combating Illegal Turtle Trade: Utilizing Blood Parasite Prevalence as an Indicator for Distinguishing Wild and Captive Freshwater Turtles in Hong Kong

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Poaching and illegal trading are some of the biggest threats faced by freshwater turtles worldwide, including the native species found in Hong Kong. All five species of native freshwater turtles are at a high risk of extinction in the wild. They are listed as Vulnerable (VU), Critically Endangered (CR) and Endangered (EN) on the IUCN Red List. However, law enforcement and prosecution in illegal procession and trading of turtles is challenging due to the difficulties in differentiating wild and captive-bred individuals. In this study, we aimed to evaluate utilizing of blood parasite prevalence as an indicator to distinguish wild and captive turtle. Blood parasite in turtles adopt an indirect lifecycle and are less likely to complete in captive environment due lack of definite host. For the first time in Hong Kong, we obtained baseline blood parasite prevalence of both wild and captive freshwater turtle population. Blood samples were collected from turtles and a combination of molecular and microscopy methods was employed to detect blood parasite. The result reveals a significant difference in blood parasite detection rates between captive and wild turtle. Decrease in blood parasite prevalence for turtles with longer duration in captivity was also observed. These findings consistent with the indirect lifecycle of haemogregarines that rely on intermediate hosts typically found only in natural habitats. Our findings highlight the potential utility of blood parasite screening as an additional factor in distinguishing between in distinguishing wild-caught and captive-bred individuals in illegal trading. We hope this finding can enhance law enforcement efforts in illegal trading and contribute to the conservation of endangered freshwater turtle in Hong Kong.

A-1319 (Oral)

Incubation Temperature Impacts Brain Anatomy and Learning in a Lizard

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Thermal environment (i.e., incubation temperature) plays a critical role in reptile development. Variation in incubation temperature induces changes in phenotypes that can persist throughout life. These changes can affect cognitive processes that are crucial for survival. In this study, we manipulated egg incubation temperature in a lizard, the delicate skink (*Lampropholis delicata*), by splitting eggs into two treatments: 'warm' (29°C) and 'cool' (23°C). We quantified learning ability using an association-based foraging task and quantified behavioural flexibility by reversing the previously learnt contingency. We quantified neuroanatomical differences by using magnetic resonance imaging (MRI) followed by nonlinear registration to compare regional volumetric differences across the brain. There was no difference between temperature treatments in the number of lizards that were able to learn the association and reversal tasks. However, warm-incubated lizards learnt the association task significantly faster than cool-incubated lizards, and cool-incubated lizards passed the learning threshold for the reversal tasks after fewer trials than the warm-incubated lizards. Neuroanatomically, overall brain size did not differ between the two groups, however some brain regions, including those involved in learning and memory, were smaller in the warm-incubated lizards compared to the cool-incubated lizards. Other brain regions, principally those important for visual processing, were larger in the warm-incubated lizards. We demonstrate the potential for changes in climate

to directly impact brain development, resulting in altered cognitive abilities that are likely to impact an individual's ability to survive.

A-1320 (Oral)
There and Back Again – Direct Development and the Re-evolution of Aquatic Larvae

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Amphibians show a great diversity of reproductive strategies that range from completely aquatic to complete terrestrial forms of reproduction. Some of these have evolved several times independently within each of the three major clades of modern amphibians. One particularly widespread strategy is direct development in which the entire development takes place within a terrestrially deposited egg, leading to a fully formed hatchling that corresponds to a postmetamorphic stage of species with a larval stage. Direct development is characterized by heterochronic shifts and large scale ontogenetic repatterning of development that lead to a reduction or loss of most larval characters. The degree of this loss is not universal in all lineages that develop directly and an initial focus on just one species, *Eleutherodactylus coqui*, led to some distortions of our understanding of direct development and its evolutionary consequences. Broader, comparative research shows that different direct-developing taxa differ in the degree in which larval characters are reduced during ontogeny. This provides an explanation for how a biphasic life history can re-evolve from a direct-developing ancestor, as has been repeatedly proposed based on phylogenetic evidence. Larval characters that are still transitorily expressed during the ontogeny of direct developers can be elaborated again, leading to a regain of a free-living larva. However, while some studies support such a scenario, there is no evidence that this is generally the case in all instances of a proposed larval re-evolution.

A-1321 (Oral)
Novelties and Convergences in African Tadpoles

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African anurans, like frogs and toads worldwide, evolved a broad diversity of reproductive strategies, from fully aquatic to fully terrestrial forms of reproduction, including viviparity. This diversity is reflected in a range of morphological specialisations seen in African tadpoles that evolved in adaptation to living in a number of different habitat types. These include several independent instances of adaptation to a stream dwelling lifestyle, adaptations for a semiterrestrial life, life in micro water bodies low in oxygen, and modifications of the tadpole morphology in connection with the evolution of viviparity. Some of these modifications show remarkable degrees of convergence with unrelated taxa from South America and Asia. In my talk, I will highlight some of these, and briefly discuss tadpoles of African anurans within the global context.

A-1322 (Oral)
Successful Recovery of *Gonatodes daudini*, a Gecko Endangered by Illegal Wildlife Trade

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A study by Cambridge University and Fauna and Flora in 2017 discovered that the Critically Endangered Union Island gecko (*Gonatodes daudini*), also known as the Grenadines clawed gecko, had become the most frequently trafficked reptile from the Eastern Caribbean. This small but strikingly colourful sphaerodactylid is endemic to a small area of mature dry forest on Union Island in St Vincent and the Grenadines (SVG). Its wild population crashed by 80% between 2011 and 2018, putatively due to illegal trade for international collectors. In collaboration with the SVG Forestry Department, Union Island Environmental Alliance and other stakeholders, an urgent conservation action plan was developed that included deploying community wardens to patrol the forest, installing cameras with artificial intelligence to detect intruders, community outreach, training of police, border control officials and other enforcement personnel, and listing the gecko on CITES Appendix I. This combination of measures appears to have been highly effective, resulting in a sharp fall in records of wild caught G. daudini for sale. A survey in 2022 found the wild population is recovering quickly, with an 80% increase in density since 2018.

A-1323 (Oral)
Age Truncation Due to Disease Shrinks Metapopulation Viability for Amphibians

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Metapopulations often exist in a fragile balance between local extinctions and (re)colonisations, in which case emerging threats that alter species vital rates may drastically increase metapopulation extinction risk. We combined empirical data with metapopulation simulations to examine how demographic shifts associated with amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, Bd) have altered metapopulation viability for two threatened amphibian species in Australia. Comparing the ages of museum specimens collected before Bd emerged in eastern Australia with individuals from geographically matched remnant populations revealed significant truncation of age structures post-Bd, with a halving of annual adult survival probabilities. Spatially realistic metapopulation modelling demonstrated that reduced adult survival led to major reductions in the parameter space over which persistence was possible for the focal species, with contractions to landscapes with higher patch connectivity, lower environmental stochasticity, and considerably higher recruitment rates. Interactions between recruitment rate, environmental stochasticity and landscape connectivity were also increasingly important for metapopulation persistence post-Bd. Higher recruitment was required to mitigate the impacts of environmental stochasticity, and higher landscape connectivity was required to mitigate the impacts of environmental stochasticity and low recruitment. Our study demonstrates that emerging threats that alter species vital rates can

drastically reduce the capacity of certain environments to support metapopulations. For our focal species, decreased adult survival rates due to Bd produced major reductions in the environmental conditions under which persistence was possible, providing mechanistic insights into the processes underpinning observed range and niche contractions of amphibians impacted by this pathogen. More broadly, our study illustrates how environmentally-mediated host resilience can enable persistence following the emergence of novel pathogens.

A-1324 (Oral)
History of Herpetofauna Studies in Uzbekistan, Current Problems of Land Development and Possible Solutions (Key Herpetological Areas)

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The history of the study of amphibians and reptiles of Uzbekistan and other vertebrates of Central Asia began with the expedition of E. A. Eversmann and C. Pander (October 1820 - April 1821). The most important contributions were made by E. Eversmann, A. Kaznakov, A. Fedchenko, A. Nikolsky, V. Lazdin, N. Zarudny, O. Bogdanov and many others. There are 64 species of reptiles in Uzbekistan, 27 of which are endemic to Uzbekistan and the surrounding countries. These species are of particular value for the conservation of global biodiversity. As a modern country, Uzbekistan has followed the way of accelerated development and modernisation in all fields of activity. This is obviously to the benefit of the country's population, but huge natural areas are being allocated for the construction of wind and solar power plants, new factories, mining and much more. Sometimes these development areas coincide with the habitat of endemic reptile species. This raises controversial issues where reptile conservation often loses out. One of the ways to solve this problem could be the introduction of a tool for reptile conservation as Key Herpetological Areas (KHA), following the example of IBA, KBA, IPA. The criteria of existing Key Biological Areas as well as the EBRD Project Implementation Requirement (PR6) could serve as a basis for the establishment of such areas. For Uzbekistan, for example, such areas could be 1. CHA Akkum - Fergana Valley, 13 reptile species, including five species in the national Red Data Book, three species in the IUCN RL with status above VU and three endemics of the Fergana Valley; 2. CHA Kattakum - South Uzbekistan, 27 reptile species, including eight species in the national Red Data Book, two species in the IUCN RL with status above VU and four endemics of southern Central Asia.

A-1325 (Oral)
Current Status of the Norfolk Island Lizard Fauna

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The Norfolk Island group lies on the Norfolk Ridge between Australia, New Zealand and New Caledonia. Norfolk Island and the surrounding islets are the eroded remnants of a much larger island formed by volcanic activity approximately 2.5 million years ago. The high levels of endemism, restoration of the Phillip Island ecosystem, and biogeographical relationships to the

Zealandia region have made it a research focus. The only two endemic lizard species from Norfolk Island are a skink (*Oligosoma lichenigerum*) and a gecko (*Christinus guentheri*). Whilst both species have been extirpated from the main Norfolk Island due to historical introductions of invasive mammals, populations remain on outlying offshore islets. Phillip Island, six kilometres south of Norfolk, supports the only skink population and the largest population of geckos. Phillip Island has undergone large scale restoration efforts since the final eradication of rabbits, pigs and goats in 1988, resulting in the ongoing recovery of many species. The Australian Museum has a strong history of herpetological research on Norfolk and its offshore islands with surveys conducted in 1978 and 2005. In 2022, a joint survey of the terrestrial fauna of Norfolk Island was conducted by staff from the Australian Museum Research Institute and Auckland Museum. The herpetology team surveyed Phillip Island to examine the current status of the two species and further investigate their biology and ecology.

A-1327 (Oral)

Basking and Cuddling in Non-related Females of Gravid Viviparous Lizards, *Zootoca vivipara*

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Many reptiles form permanent or temporary aggregations, which may be driver of increasing complexity of social behaviour (Gardner et al., 2016). Therefore, studying the origin of such behavior in reptiles may shed light on the factors that trigger social behavior evolution. We observed individually-marked Viviparous lizards, *Zootoca vivipara* from the single colony in Tver region (Russia) during three years. Study site was established at the edge of a mixed coniferous forest. In the middle of this clearing was a pile of rotted logs. We collected behavioural, spatial and genetic data from 74 adult individuals. Lizards emerged from hibernation in mid-April, with males preceding females by approximately a week. In spring, females had non-overlapping home ranges (95% kernel, $S = 3.76 \pm 0.799$ m^2, $n = 16$) and did not interact with each other. Females started to interact with each other during gestation period in July 2020. They aggregated into groups comprising 2–4 individuals, layed on each other and basked in a close physical contact (affiliative behaviour). The composition of these groups was stable and regular, however, after giving birth all the females no longer gathered together. Once we noted aggressive behaviour, when one female chased the alien female away from the basking group. Though kin recognition ability has been confirmed for Z. vivipara (Léna and Fraipont, 1998), we did not find any genetic relationship between females in aggregations. In *Crotalus horridus* kin-biased cooperation of gravid females increase effectiveness of eggs heating and avoiding of predators (Clark, 2004). Our data suggests that the advantages of grouping females may be a good evolutionary strategy for unrelated females as well partly supporting group theory selection.

A-1328 (Poster)

Measure Twice, Cut Once: Age Estimation in Lizards by Keratin and Bone Structures

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Despite sceletochronological method (Kleinenberg and Smirina, 1969) is commonly used intravital method of age estimation in reptiles and amphibians, it still has number of problems. One of them is a mistake in counting of registration of lines of arrested growth (LASs) due to slow growth in old individuals (Tsellarius and Tsellarius, 2009) or presence of intermediate layers (Castanet and Smirina, 1990). Hence, additional reference data are obviously required to support the results obtained by a skeletochronological method. We have noticed that dermal structures on the dorsal part of the claw sheath are multilayered and these layers might be useful for age estimation. For the present study we used phalanges of 43 individuals of three rock lizard species (*Darevskia arribasi*, 1997) from Armenia. Rock lizards hibernate during the winter period (Darevsky, 1978). We used double-blind scoring method to count LAGs in tubular bones and claw sheath from the same phalanx. As a result, we found strong correlation between the number of keratin and bone LAGs. The proposed method allows to double-check the number of growth lines on the same finger phalanx belonging to the same individual. We hope, our method facilitates age estimation in poikilothermic animals and makes the results more accurate.

A-1329 (Poster)

Predation on the Endangered Hungarian Meadow Viper in Pastures and Hayfields: Insights From Plasticine Models

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Management of grasslands for agriculture and other land uses is a critical issue for the conservation of grassland animals, both due to direct effects on mortality, as well as indirect effects such as altered predation regimes. In this study, we investigated the effect of mowing on the predation pressure by birds on an endangered snake, the Hungarian meadow viper (*Vipera ursinii rakosiensis*), using plasticine snake models. We placed 200 snake models each in mowed hayfields and grazed pastures (as controls) in two study periods, before and after mowing on hayfields, in 2021 and 2022. We found no strong negative effects of mowing on attack rates by birds in our study. Attack rates on snake models were higher before mowing than after mowing, and in general lower in the second year of the study than in 2021. However, in 2021 attack rates on snake models in pastures were higher than on hayfields, but this pattern reversed in 2022, when attacks were more frequent on hayfields than pastures. Our study highlights the importance of considering potential factors influencing predation pressure and predator-prey dynamics in grassland habitats, as well as the need for further research to provide

reliable datasets for evidence-based conservation management strategies to mitigate population declines and local extinction risk.

A-1330 (Oral)
Differential Dispersal Capability Between Sexes Drives Genetic Structure Across the Genome of a Broadly Distributed Snake

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Sand snakes of the genus *Psammophis* are swift and agile diurnal snakes that occur throughout Africa and West Asia. The species with the broadest distribution, P. *schokari*, inhabits the extremely arid regions of northern Africa, Arabia and southwestern Asia. With samples covering densely the entire distribution of the species, we set to investigate its phylogeographic history and identify major dispersal corridors that enabled the species to colonize its vast range in such harsh environmental conditions. Preliminary genetic evidence based on mitochondrial data pointed to a pronounced genetic differentiation within the species and even its potential paraphyly. However, the nuclear markers did not support these findings and instead indicated admixture of mitochondrial clades. The discrepancy between the genetic structure of the maternally inherited mitochondrial DNA and bi-parentally inherited nuclear DNA may be a result of differential dispersal capabilities of males and females. The psammophiids possess the ZZ/ZW sex determination system where males are the homogametic sex (ZZ), and females are heterogametic (ZW). We employed whole genome sequencing to test whether the genetic structure of the maternal W-linked genes matches that of the mitochondrial DNA and, if so, to ascertain whether it differs from the paternally inherited genomic regions. Should the female-specific genomic regions (W, mtDNA) bear similar signal that would differ from the male-specific parts of the genome, this would imply that the genetic structure within the species is determined by the differences in dispersal capability between the sexes and would suggest significant dispersal of males and philopatry of females.

A-1331 (Poster)
The Potential of Legend of the White Snake in Conveying Ecofeminism

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The Legend of the White Snake (LWS) is considered as one of China's four great folktales and has been readapted in more than 80 works through several mediums. The romance between a female snake spirit, Bai Suzhen and a young man, Xu Xian, creates basis for ecofeminist

interpretation highlighting the link between the oppression of women and the exploitation of nature which may also play a role in constructing local conservation program of snakes. A targeted literature search was conducted in Google Scholar. Initially, the search was limited to peer-reviewed articles published in the past five years but due to limited publications, the restrictions were removed. A review of 13 publications identified the following points to support the interpretation of LWS through ecofemisim: 1. Yin-yang concept in Daoism, an ancient Chinese philosophy reflecting the harmony of human society and the nature; 2. Sisterhood of the white snake and the green snake strengthening the ecofemisim message of the story; 3. More recent versions of LWS humanising Bai Suzen has her transcend nature and human society; 4. Multifaceted symbol of water (e.g., fertility, destruction, and transformation) facilitating to convey the ecofeminism narrative. Despite these perspectives, the study identified another dominant Chinese philosophy, Confucianism, which is centered on the workings of human society, potentially influencing LWS to prioritize human struggles and diminishing the intrinsic value of nature in ecofeminist thought. Overall, LWS offers some opportunities for ecofeminist interpretation. However, it is important to acknowledge the limitations of the narrative and consider how it can be reinterpreted or expanded upon to fully embrace ecofeminist ideals.

A-1332 (Poster)

Monitoring of Climate Change-Sensitive Philippine Anurans in Mimbilisan Protected Landscape, Philippines

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The Mimbilisan Protected Landscape (MPL) is located between the Municipalities of Balingoan and Talisayan in Misamis Oriental, Philippines. The protected area connects the coastal zone to the Central Mindanao biodiversity corridor that extends from Mt. Balatukan to Mt. Apo Range encompassing Mt. Kaluayan-Kinabalian, Mt. Tago, and other inter-connected forested mountain ranges. The study primarily aimed to monitor the anuran species at the Mimbilisan Protected Landscape and determine its impact on anuran diversity and population. Night treks were conducted from 1800 to 0100 hours using standard illuminating device along the established monitoring trail. All observed anurans were collected using standard scoop net to avoid injuries and to minimize animal escape. Biometric measurements including pictures of the anurans were taken. A total of 94 individuals were recorded belonging to 12 species, 11 genera in six families. The 2017 survey documented only eight species, seven genera in four families. Family Rhacophoridae which is predominantly composed of arboreal tree frogs had the highest number of genus and species both in the previous survey (2017) and the present (2023) survey. The present survey documented nine endemic species consisting of five Greater Mindanao Island species and four Philippine endemic species. showing an increase from the 2017 survey with only five endemic species. No invasive alien species was found during both surveys. Only one threatened species, the Mindanao fanged frog, *Limnonectes magnus*, which suffered a continuing decrease in population due to over-exploitation and from other direct and indirect anthropogenic factors, was recorded. The presence of higher number of species especially endemic species in this monitoring survey indicates that well-managed protected areas like the Mimbilisan Protected Landscape improves animal welfare by providing refuge

these climate-sensitive anurans which calls for the strengthened conservation and protection of MPL.

A-1333 (Oral)
Thermal Tolerance Mismatch Explains Patterns of Pathogen Prevalence Within and Among Frog Species

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Emerging infectious diseases threaten many wildlife populations, yet there is considerable variation in pathogen impacts both within and among species. Understanding this variability is key to identifying where and when pathogens will have substantial effects. Here we use data on prevalence of the invasive pathogen *Batrachochytrium dendrobatidis* (Bd) in Australian frogs to test two predictions derived from the hypothesis that mismatches in host-pathogen thermal tolerances can explain prevalence patterns. We show that: 1) the slope of the relationship between Bd prevalence and temperature within host species transitions predictably from positive to increasingly negative as the host species' thermal optima increases; and 2) among host species, mean Bd prevalence increases, peaks, and declines as the host species' thermal optima increase. Both results align with theoretical expectations and suggest that mismatches in environmental tolerance between hosts and pathogens can explain much of the variation in pathogen impacts observed within and among species.

A-1334 (Oral)
Genetic Diversity of the *Polypedates megacephalus* in Southern China, Phylogeography and Climate Correlates

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Understanding the intricate genetic makeup and dynamics of a population is paramount for interpreting complex evolutionary trajectories and facilitating biodiversity conservation. This study delves into the genetic and environmental determinants influencing the dispersal patterns of *Polypedates megacephalus*, a native foam-nesting tree frog species in southern China. Employing a multifaceted approach encompassing multilocus genomic analyses utilizing RAD-seq loci, alongside investigations into population structure, demography, species distribution modeling, and phylogeography, we scrutinized the genetic structure of P. megacephalus populations across the region. Tissue samples from 77 individuals across 18

localities underwent Rad-sequencing and SNP-based phylogenetic analyses, yielding a comprehensive dataset comprising 135,385 nucleotide sites across 921 loci and 7775 SNPs. Our analyses unveiled a nuanced yet significant genetic structure within *P. megacephalus* populations, hinting at an origin around the Tibetan Plateau during the late Pliocene epoch. Subsequent diversification led to the emergence of six genetically distinct populations (k=6 model; i.e., Guangxi (G), Sichuan (S), Xizang (X), Yunnan (Y), Guangxi+Yunnan (GY) and Fujian+Guangdong+Guangxi (FGG)) within southern China, demarcated by four river basins. Notably, despite geographic barriers, certain populations exhibited limited gene flow (X to GGF, X to GY, and S to G), hinting at potential historical genetic admixture events. Furthermore, our findings shed light on three notable population bottleneck events (decline in effective population sizes), coinciding with global cooling periods, underscoring the species' resilience amidst climatic fluctuations. The stable climate conditions in some regions in southern China since the Last Glacial Maximum (LGM) seem to have acted as refuges, fostering population isolation. Our results show the influence of geographic distance, karstic landscape and historical climate oscillations on gene flow dynamics between isolated populations. The knowledge generated informs strategies to conserve vulnerable tree frog populations.

A-1335 (Oral)

Steroidogenesis and Expression of Sex Steroid Receptors during Gonadal Development of the Snail-eating Turtle, *Malayemys macrocephala*

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Prior studies on *Malayemys macrocephala* showed that the incubation temperature influenced somatic and gonadal development and suggested the existence of temperature-dependent sex determination in this tropical freshwater turtle species. This study aimed to examine the onset of steroidogenesis and expression of steroid receptors during gonadal development of M. macrocephala. Embryos at the sexually undifferentiated gonad stages (Yntema stages 14–16), differentiating gonad stages (Yntema stages 17–22), and differentiated gonad stages (Yntema stages 23–25) reared at the male- and female-producing temperatures (26 °C and 32 °C, respectively) were examined. Gonads were processed for immunofluorescence staining for detection of steroidogenic potential, using antibodies against 3β-hydroxysteroid dehydrogenase (3β-HSD), 17β-hydroxysteroid dehydrogenase (17β-HSD), and P450 aromatase (P450arom), as well as the presence of the androgen receptor (AR) and estrogen receptor-α (ER-α). In males, expression of steroidogenic enzymes and steroid receptors were found as follows: 3β-HSD at stages 14–22, 17β-HSD at stages 14–25, and AR at stages 17–25. In females, the expression was as follows: 3β-HSD and 17β-HSD at stages 14–22, P450arom at stages 19–25, and ER-α at stages 19–25. These results suggest that 3β-HSD plays a role as a key enzyme in biosynthesis of sex steroids in gonadal development of *M. macrocephala*. 17β-HSD and the AR play roles in testis development, and P450arom and the ER-α play roles in ovary development. Furthermore, it is of importance to note that previous studies in other

freshwater turtle species showed that these steroidogenic enzymes were not observed in genital ridge/gonad of developing embryos at any stage. It is, therefore, possible that the immunofluorescence technique used in this study in more sensitive, enabling a better demonstration of the presence/absence of protein expression of steroidogenic enzymes.

A-1336 (Oral)
Habitat Use and Activity Patterns of Puff Adders (*Bitis arietans*) in the Kalahari, South Africa

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Activity patterns and habitat use of animals can provide insight into aspects of their ecology. Thermoregulation in animals is impacted by environmental heat load, which may result in microhabitat selection, influencing space use. Ambush-foraging species such as Puff adders (*Bitis arietans*) spend long periods of time on the surface waiting for prey, and thus temperature increases due to climate change could significantly impact their choice of ambush sites and movement ecology. We evaluated space use of Puff adders in the Kalahari, South Africa by assessing how environmental conditions influenced microhabitat selection, home range size, daily and monthly displacement, and periods of activity. Utilizing a standard radiotelemetry approach, we implanted transmitters in 22 snakes, and collected data on their location, behaviour and microhabitat choice approximately every three days. These data allow the assessment of how extreme temperatures in the Kalahari affect Puff adder behaviour and predict how other populations may respond to extreme conditions expected during climate change. Preliminary analysis revealed that Puff adders are inactive during the winter season and spend the entire season in rodent burrows between the months of June and August. Puff adders in the Kalahari have relatively small yearly ranges of approximately 0.34 km^2 (± 0.09). Ongoing analyses of movement frequency and microhabitat selection will provide further insight to the home range characteristics and how Puff adders adjust their behaviour to cope with the extreme environmental conditions in the Kalahari. This research contributes valuable insights into the potential responses of puff adders and similar ambush-foraging reptiles to climate change. By elucidating the complex relationship between environmental factors and snake behaviour, our study highlights which microhabitats are important for Puff adder survival in an extreme environment and inform conservation strategies for reptiles in the face of ongoing environmental shifts.

A-1337 (Oral)
Coping Through Diversity: Quantifying Variation in Behavioural Thermal Tolerance of Grassland Vipers (*Vipera* Spp.) on Individual and Population Level

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Thermal constraints on ectotherms emerge from the substantial impact of temperature on their physiology, which subsequently influences their behaviour and distribution, and ultimately, determines their long-term survival. These constraints become more and more pronounced in range-restricted, rare species, that persist in small population densities and are confined to specific habitats. Populations of the grassland vipers in the Acridophaga subgenus are particularly vulnerable to overheating and associated threats due to their small size and exposure in open landscapes. Understanding the variability in physiological and behavioural thermal tolerance, at both the individual and the population level is therefore crucial for predicting the susceptibility of these snakes to changing temperature. Here, we studied behavioural thermal tolerance in nine taxa (three steppe and six alpine) of the *Vipera ursinii* species complex. Our results show that irrespective of steppe-alpine habitat divergence, vipers showed substantial individual differences in both average (i.e., behavioural type), and behavioural predictability of voluntary thermal maximum (VTmax), indicating the presence of individual thermoregulatory strategies. Both steppe and alpine vipers were highly consistent in their VTmax, indicating the presence of 'animal personality' in this trait. While we found alpine vipers exhibiting higher mean VTmax, behavioural predictability was not influenced by the steppe vs. alpine divergence. We found no sign of environmental impact on mean VTmax or behavioural predictability. On the other hand, males expressed higher mean VTmax than females. Our findings highlight the importance of considering both among and within-individual variation when studying thermal tolerance and responses to climate change in ectotherms, as diverse conclusions may emerge.

A-1338 (Poster)
Sexual Size Dimorphism in Mature Snail-eating Turtles, *Malayemys macrocephala*, in Captivity

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Sexual dimorphism, a phenomenon that different sexes of the same species exhibit distinct morphological traits including size, is common in reptiles. Patterns of sexual size dimorphism

usually correlate with habitat type, mating strategy, fecundity, and intersexual competition. Despite its prevalence in reptiles, studying sexual dimorphism in wild reptiles faces challenges due to limited sample availability. Most studies focus on the wild caught populations where age and size could be constrained with trapping method. As a result, sexual characteristics were mainly measured and compared in relation to the standard length. Furthermore, research on sexual dimorphic traits in turtles, particularly tropical species, is limited. In this study, sexual size dimorphism was examined in the Snail-eating turtle, *Malayemys macrocephala*, a freshwater turtle native to Thailand and Southeast Asia. Fully matured turtles aged 17 years old (3 males, 10 females) were used as subjects. Since these turtles were from incubated eggs, and reared in captivity since 2007, it is certain that this cohort has a similar age and captive condition. We measured 18 morphological characteristics of the head, carapace, plastron, and tail, and used parametric or non-parametric statistical analyses to compare between sexes. It was found that 16 of these characteristics are significantly different ($p < 0.05$) between sexes. Female turtles exhibited significantly larger head size, body size, and some shell features (such as nuchal scute) compared to males, which could be due to enhanced fecundity and minimizing intersexual competition. Male turtles exhibited larger tail width and length than females, especially, a significantly larger pre-cloacal length, a location where male intromittent organ was kept. These findings deepen our understanding of sexual dimorphism in this species and complement prior studies conducted on wild populations. These offer valuable insights that can be utilized for further research on adaptive strategies for reproductive success.

A-1339 (Oral)

Home and Away: The Core Gut Microbiome of *Xenopus laevis* is Modified by its Environment

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The vertebrate gut microbiome is a community largely composed of bacterial, fungal and viral components, whose molecular component equal that of the host. The influence of the microbiome is known to be significant both on an individual basis, and also on population scales in a wide range of host organisms. The gut microbiome is known to be involved with key attributes of animal health, including assimilation of nutrients, immuno-defensive functions and host behavior. In this study, we used bacterial 16S rRNA amplicon-based sequencing for metataxonomic classification of the gut microbiome of individuals from eight populations of *Xenopus laevis*. These populations were selected to represent an altitudinal gradient in the native range of the host species (0 to 3,000 m asl). From the 16S rRNA community profiles, we determine the components of the core microbiome of *X. laevis* , and ask whether deviations from the core are associated with the environmental context in which they live. In addition, we sampled four European invasive populations and a laboratory population from the European Xenopus Resource Centre (EXRC) in the UK, to determine what aspects of the core microbiome are retained by non-native populations. This represents the first time that the microbiome of *X. laevis* has been assessed across such diverse conditions, and

provides data that will help understand the role played by the environment and inform monitoring of health within this model organism.

A-1340 (Poster)
A Field Record of Parental Care Behavior of Hundred-Pacer in Taiwan

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Vipers are known for their parental care during egg-hatching period. However, most previous observations focused on hatching behavior or conducted in controlled environment. This research includes complete record of *Deinagkistrodon acutus* hatching process, from egg-laying, guarding, hatching, nurturing, to juvenile leaving, in a wild habitat using both camera trapping and radio telemetry tracking method. Our result shows that female viper rarely leave the cave after laying eggs. When they do leave, it usually happened between 11:00 and 16:00 and the frequency is positively related to incubating period. The eggs hatched after about five weeks and the hatching process took about 10 hours. It took about 37 hours for all 20 eggs to hatch. After hatching, the timing and frequency of female viper leaving the cave became irregular, and the peak activities hours changed to midnight (22:00 to 00:00 h). After hatching, It took about 10 days for the juvenile to leave the cave and molt for first time. Our telemetry tracking data show that the juvenile did not make long distance movement at the beginning, and mostly hid under rock cracks or under forested ground layers. The juvenile's peak activity hour is in the morning (05:00 to 07:00 h) and dusk (17:00 to 21:00 h). This research presents a rare complete field observation of entire viper hatching process and detail behavior record of both female and juvenile vipers. It also shows that camera trapping and radio telemetry tracking are suitable to be used for such researches and can provide activity records in fine scale.

A-1341 (Oral)
A Museum and a Cradle: The Western Ghats Escarpment as a Hotspot for the Diversification of Herpetofauna

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Mountains have been considered as centres of diversity and biodiversity hotspots across the globe. However, the fundamental drivers of diversity, diversification and dispersal remain poorly explored in many regions. We studied diversification in multiple clades of frogs, lizards and snakes in the Western Ghats Escarpment and peninsular India using a combination of molecular, morphological, geographical and ecological data. Using multi-criteria approaches and biogeographical approaches to sampling, we uncovered over 100 new lineages (~50 species) of herpetofauna. An analysis of diversification across multiple frog families reveals that a climatically stable WG may have supported the persistence of lineages, supporting the museum hypothesis. Furthermore, across frogs and reptiles, many ancient lineages were found to be distributed in the southern Western Ghats, which may have served as a refugium during glaciations. On the other hand, both adaptive and non-adaptive radiations contribute to recent diversification in many clades, with the Palghat gap acting as a major biogeographical barrier. This suggests that the Western Ghats also serves a major cradle for lineage and clade diversification. Finally, many clades show a signature of both *in-situ* diversification and dispersal from other biogeographic regions. Thus, a combination of past climate, geography and geological history make this escarpment a hotspot of diversification for herpetofauna in peninsular India.

A-1342 (Oral)
Unlocking Vertebrate Complexity: Eco-Evo-Devo of Craniofacial Tissues in Squamate Reptiles

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The craniofacial complex, encompassing the head and face, stands as a pinnacle of sophistication and diversity among vertebrates. Both skeletal and soft tissue components are finely tuned to meet functional and ecological demands with tremendous precision. Yet, the role of development in shaping and constraining macroevolutionary patterns remains poorly understood. Understanding the molecular and morphogenetic processes controlling the remarkable variation in vertebrate morphological features requires the integration of form, function, ecology and development. Furthermore, the inclusion of underexplored animal models with substantial craniofacial variation offers a promising avenue to address these gaps. Here, we exploit the extensive phylogenetic diversity and remarkable ecomorphological diversity of squamate reptiles (lizards and snakes) to assess the major developmental drivers and tissue interactions shaping craniofacial phenotypic diversification with respect to various ecological factors. Integrating a multidisciplinary approach including geometric morphometrics, high-definition 3D imaging, histology, molecular biology, and mathematical modeling, our data from various craniofacial tissues not only elucidate strong connections and shared evolutionary changes, but also reveal the critical importance of developmental changes and innovations underlying craniofacial complexity in vertebrates. This study underscores the importance of an integrative approach in eco-evo-devo studies and highlights the role of multiple different developmental changes behind the emergence of craniofacial phenotypes.

A-1343 (Oral)
Uncover the Underground: Taxonomic Status of Blind Snakes in Hong Kong

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Fossorial fauna, animals that live underground, are among the most understudied vertebrate groups locally and globally. Their ecological importance in shaping the subterranean habitat may be invisible, yet indispensable to nature. In Hong Kong, the taxonomic status of two blind snake species, the Hong Kong Blind Snake (*Indotyphlops lazelli*) and the White-headed Blind Snake (*I. albiceps*) is questionable given the rarity of specimens and lack of genetic studies. In this study, we conducted a phylogenetic analysis to determine if the population referred to as *I. albiceps* is a new species and *I. lazelli* is a valid species. Regular fieldwork of different sampling methods has been conducted in their distributed sites, the collected specimens were then examined and analysed. We found that there is a significant genetic difference between the populations of *I. albiceps* in Hong Kong and Southeast Asia. This result suggests that the Hong Kong population represent a new, cryptic species. *Indotyphlops lazelli* also showed a significant disparity between other congeners, confirming *I. lazelli* as a valid species. The research outcome shed light on the taxonomic and conservation status of the threatened fossorial reptiles; it can be a leverage, benchmarking an up-to-date conservation strategy for fossorial reptiles against future developments in Hong Kong. Without a referable ecological baseline, they could be particularly vulnerable to ongoing urbanisation and are possibly on the brink of extinction.

A-1345 (Oral)
Surface Activity and Circadian Rhythm in Caecilians (Amphibia: Gymnophiona): New Experimental Data on Animals in Captivity

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Circadian rhythm is a ubiquitous phenomenon controlled by endogenous molecular oscillators entrained to an environmental cue, the zeitgeber. One prominent zeitgeber is the natural photoperiod. Biological rhythms in animals exposed to little or no light is a topic of broad research interest. Terrestrial (largely soil-dwelling) caecilians are minimally exposed to natural light and have evolved various adaptations for this mode of life, including significantly reduced vision with eyes covered by skin or bone, retinas that contain only rod cells, compact and heavily ossified skulls, and a pair of sensory tentacles. The degree to which burrowing, soil-dwelling caecilians spend time on the surface is little studied, and circadian rhythm has been investigated in only one species of this order. We studied the surface-activity rhythm of the Indian caecilians, *Ichthyophis* cf. *longicephalus* and *Uraeotyphlus* cf. *oxyurus* (Ichthyophiidae) and *Gegeneophis tejaswini* (Grandisoniidae), under 12h light/12h dark, constant dark and 12h dark/12h light cycles. We examined daily surface activity and the role of light-dark cycles as a zeitgeber. All three species were strictly nocturnal and *G. tejaswini* displayed the least surface activity. Four out of thirteen individuals displayed a more or less distinct surface-activity rhythm in all three cycles, and for the nine other animals clear activity patterns were not evident. An approximately 24 h free-run period (the time required for the circadian rhythm to occur in constant conditions) was observed in the three species. When the light-dark cycle was inverted, surface activity in the three species shifted to the dark phase. The findings of this study suggest that caecilians have a weak circadian surface-activity rhythm and that the absence of light can act as a prominent zeitgeber in these animals.

A-1346 (Oral)
Planning Fynbos Frog Reintroductions

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The Western Cape Province of South Africa has very high amphibian endemism with 60% of frog species endemic to the province. One of the reasons for this is the presence of the unique Fynbos biome with its many habitat types and very rough and dissected topography that have evolved over a very long time. CapeNature has instituted long-term monitoring of fynbos frog populations at 5 sites and is currently setting up another. Monitoring at these sites has shown that fires is a main driver of population trends in Protected Areas although there are weak climatic effects implicated too. Another big driver, particularly in conjunction with fire, is the presence of invasive alien trees. Outside of Protected Areas the main driver of populations has been, and continues to be, habitat loss. Conservation action for the species occurring in the areas affected by habitat loss that are the subject of this presentation. To mitigate the historical and ongoing habitat loses it is argued that there are good opportunities for reintroductions for several Threatened species. The species targeted here are those that have experienced local population reductions or extinctions as a result of habitat loss and land use change. The species recommended for reintroduction are the following: Western Leopard Toad (*Sclerophrys pantherinus*), Micro Frog (*Microbatrachella capensis*), Cape Platanna (*Xenopus gilli*), Cape Caco (*Cacosternum capense*) and the Kogelberg Moss Frog (*Arthroleptella kogelbergensis*). Species that are currently not considered threatened but have experienced significant habitat loss are suggested as a second tier for consideration for reintroductions such as the Arum Lily Frog (*Hyperolius horstocki*). The research and monitoring required for designing and assessing reintroduction pans for these species is discussed.

A-1347 (Oral)
Restriction Times on the Rise: Mechanistic Modelling of Activity Time of Grassland Vipers (*Vipera* Spp.) in the Face of Climate Change

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Climate change poses a significant threat to species adapted to cool alpine environments, particularly ectotherms like grassland vipers. Their small size and open habitat make them vulnerable to overheating and dehydration. We modelled the activity restriction time (hours vipers cannot be active) for 20 grassland viper taxa to assess the impact of climate change. We used the voluntary thermal maxima values measured or predicted to all known populations of grassland vipers and mechanistic modelling of operative temperatures across the distribution of these vipers for current and future weather conditions. Our model predicts a substantial increase in yearly restriction hours (mean increase of 38%) by 2100. All taxa will be affected, with the most significant increases expected for *Vipera graeca, V. renardi renardi, V. ursinii moldavica, V. anatolica, V. r. altaica, V. dinniki*, and *V. ursinii rakosiensis*. These findings highlight the urgent need for conservation strategies that mitigate the negative effects of climate change on grassland vipers, particularly the most vulnerable species.

A-1348 (Oral)

A Review of the Complex of *Calamaria linnaei* (Boie, 1827) (Colubridae: Calamariinae) from Java, Indonesia

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The reed snake of the genus *Calamaria* (Colubridae: Calamariinae) on the island of Java currently has nine extant species but is rarely to be as subject of systematic research. One of these snakes is *Calamaria linnaei*, which is a species with high intraspecific variation besides having conservative morphology characters. Herein, we performed a comparison of morphological characters on 97 well-preserved *C. linnaei* specimens from the Museum Zoologicum Bogoriense (MZB). Morphological analysis of 34 *C. linnaei* characters shows that at least three taxa within this cryptic species differ at the species level and are currently still confounded under differences in scale and pattern variation. We also compared all *C. linnaei* specimens with the type specimens of *C. maculosa, C. multipunctata*, and *C. reticulosa*, resulting in distinct characters. The high morphological variation has revealed distinguishing diagnostic characters that are recommended as separate species within the species complex.

A-1349 (Poster)

Patterns of Elevational Variation in the Distribution of Caecilians (Amphibia: Gymnophiona): A Study From a Northern Kerala Part of the Western Ghats of Peninsular India

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Over 10% of the global caecilian diversity occurs in the Western Ghats Biodiversity Hotspot on the west coast of peninsular India. Caecilians here occur at all elevations, except perhaps the highest peaks, and they belong to two families. Ichthyophiidae (the South and Southeast Asian caecilians) and Grandisoniidae (Indo-Seychellean caecilians) and four genera *Ichthyophis*, *Uraeotyphlus, Gegeneophis* and *Indotyphlus* comprising 26 currently

recognised species. Current knowledge on the spatial distribution of Western Ghats' caecilians is patchy, even though such knowledge is important for ongoing assessments of taxonomy, biogeography and conservation. We conducted an extensive field study in the Kasaragod district of Kerala, part of the Western Ghats comprising mosaics of agrosystems and natural habitats with an elevational range of 10–710 m asl. The study area was divided into 30 grids (10 km^2), and we undertook randomised sampling using timed digging. We recorded soil parameters from the sampling sites. All three caecilian genera known from the southern Western Ghats (*Gegeneophis, Ichthyophis* and *Uraeotyphlus*), were recorded. Differences in the elevational distribution of these genera is significant ($p < 0.05$). The Western Ghats-endemic genus *Uraeotyphlus* occurs mostly along the western lower elevations (0–200 m amsl), *Gegeneophis* in the medium elevations (200–400 m amsl) and *Ichthyophis* in the medium to high eastern elevations (260–700 m amsl) though elevational ranges overlap. We found no significant correlation between any measured environmental parameters and genus distribution, except for elevation. This extensive study on the elevational gradient in caecilian distribution is the first of its kind in India, and we believe it can contribute substantially to improved conservation and knowledge of caecilians in the Western Ghats.

A-1350 (Oral)

Integrating the Gut Microbiota into our Understanding of Amphibian Responses to Salinity and Pathogen Stress

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Host-associated microbial communities are increasingly recognized as an important factor influencing stress-mediated disease outcomes. In particular, gut microbiota could affect susceptibility to infectious disease through direct interactions with pathogens, by increasing resources available for host immune function, and by regulating the neuroendocrine response to infection. Assembly of the gut microbiota, however, depends upon environmental conditions, and its function may therefore vary based on host exposure to pollutants or diet. We investigated how increasing salinization of freshwaters and associated increases in growth of nutritional algae influenced gut bacterial assembly, host physiology, and responses to ranavirus exposure in Wood frogs (*Rana sylvatica*). Ranaviruses cause die-offs of wood frog larvae in the northeastern USA. Die-offs are more likely for ponds impacted by the application of road de-icing salts, as elevated salinity exacerbates a maladaptive stress response to infection. However, we found that supplementing the diet with algae reversed the effects of elevated salinity on the stress response—that is, larvae that were fed algae did not exhibit elevated kidney corticosterone levels, accelerated development, or weight loss post-infection, whereas larvae fed a basic diet did. Salt pollution and algae supplementation had unique and interactive effects on the gut microbiota that were consistent with the way in which hosts responded to infection across treatments. Elevated salinity led to the proliferation of Proteobacteria that have been associated with disrupted metabolic function and disease. By contrast, algal supplementation selected for bacteria (Firmicutes) that may have diminished the stress response to infection by producing short chain fatty acids that influence host metabolism and endocrine function. Effects of algal supplementation on the gut microbiota were observed even under high salt conditions. This study highlights how early-life exposure to pollutants and resource availability can influence the gut microbiota, which are integrators of host and pathogen responses to infection on multiple fronts.

A-1351 (Oral)

Successes and Challenges in Restoring Cambodia's National Reptile, the Southern River Terrapin (*Batagur affinis*), and the Asian Giant Softshell Turtle (*Pelochelys cantorii*) in Cambodia

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The Cantor's Giant Softshell Turtle (*Pelochelys cantorii*) is listed as Critically Endangered on the IUCN Red List. The Critically Endangered Southern River Terrapin (*Batagur affinis*) is Cambodia's National Reptile and one of the world's 25 most endangered chelonians. Targeted hunting and incidental capture in fishing gear, illegal fishing activities, and destruction of its nesting habitat through sand mining and illegal riparian logging for commercial purposes, and exploitation for food and traditional medicines continue to threaten the remaining *B. affinis* and *P. cantorii* in Cambodia. A long-term partnership between Wildlife Conservation Society (WCS), Cambodian Fisheries Administration, and Turtle Survival Alliance has worked to conserve and restore the populations *P. cantorii* and *B. affinis* in Cambodia. To address such challenges, WCS has implemented the following conservation interventions: 1) nest and habitat protection; 2) head start and release; 3) post-release monitoring; 4) law enforcement by SMART (Spatial Monitoring And Reporting Tool) Patrol; 5) education and awareness programs; and 6) livelihood alternatives. As a result, since 2002, 49 B. affinis nests have been secured and 477 hatchlings produced. From eggs collected on a nest bank on the Sre Ambel River, since 2015, we have released 182 headstarted subadult B. affinis into the Sre Ambel River system. In 2021, we witnessed the first captive reproduction of headstarted, and now mature, B. affinis at the Koh Kong Reptile Conservation Centre (KKRCC). In 2024, headstarted female B. affinis deposited 22 nests totalling 222 eggs at Koh Kong Reptile Conservation Centre. While the nearly two-decades long project for B. affinis is seeing a boost in recruitment, our recent nest monitoring data strongly suggests a sharp decline in the Asian Giant Softshell Turtle population in the Mekong River. The number of nests found along the Mekong River dramatically decreased from 65 in 2022 to 10 in 2023.

A-1352 (Oral)
Venomous Resistance: Unveiling Bacterial Challenges in Snake Oral Cavities and Venom

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The rapid rise in microbial resistance to various medications has raised concerns, pushing the hunt for viable alternative treatments, especially when dealing with multidrug-resistant infections. This resistance has been associated with morbidity and mortality in both humans and animals, with overuse and misuse of antibiotics being identified as the primary source of bacterial resistance emergence. Few investigations have demonstrated the relationship between bacteria and ophidian venom. Our aim was to detect and characterize bacteria from the oral cavities and venom of selected snake species from South Africa (including Black mamba, Puffadder, Boomslang and Rinkhals), and to test for antibiotic resistance. We used Next-Generation Sequencing to determine the bacterial diversity, species richness, as well as

establish if differences exist among snake species, and between oral and venom bacterial communities. Bacterial isolates from venom samples were subjected to full length 16srRNA PCR and Sanger sequencing. The susceptibility of each isolate was determined for 12 antibiotics using the Kirby-Bauer method. Of the 26 isolates only three did not display any antibiotic resistance; all other isolates displayed resistance to at least one of the antibiotics, but multiple drug resistance was uncommon. If a snake develops a bacterial infection that is resistant to commonly used antibiotics, it can pose challenges for veterinary treatment. Furthermore, antibiotic-resistant bacteria in snake venom could potentially be transmitted to humans or other animals through bites or contact with oral secretions. This could contribute to the spread of antibiotic resistance in broader ecosystems.

A-1353 (Oral)
Influence of Habitat Characteristics on Wetland Occupancy and Movement Patterns of Western Chicken Turtles in Southeastern Oklahoma

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Western Chicken Turtles (*Deirochelys reticularia miaria*) are an endemic species of the southern United States that are of conservation concern in nearly every state where they occur and have only begun to receive serious research attention in the last 15 years. They inhabit shallow wetlands and move among these regularly, but the specific environmental factors that drive wetland occupancy and patterns of interwetland movement are not well understood. In order to better create and manage suitable habitat for this species, we used a multi-species occupancy modeling approach in a Bayesian framework using the R package spOccupancy to examine Chicken Turtle wetland use patterns and evaluate factors that may affect detection and occupancy probability of Chicken Turtles and ten other co-occurring freshwater turtle species (five of which are also of local conservation concern) that comprise the local turtle community. These models were informed with extensive sampling of a set of wetlands surrounding the only two known extant Western Chicken Turtle populations in the US state of Oklahoma. Between 2020 and 2024, we performed effort-standardized occupancy surveys at 52 wetlands spanning gradients of depth, area, degree of isolation, aquatic vegetation coverage, and surrounding upland land use by humans. Here, we report our preliminary findings on the impacts of these factors in determining Western Chicken Turtle wetland usage and movement patterns in Oklahoma, US.

A-1354 (Oral)
Testing Brillat-Savarin's Tenet in Lizards: Evolutionary and Macro-ecological Patterns in the Feeding Habits of Lacertids

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In the past seven decades, herpetologists have collected a wealth of data on the dietary habits of lacertid lizards. Much of this information has lain scattered in papers and reports on individual species in disparate journals and languages, making it difficult to test macro-ecological and evolutionary hypotheses on how and why diet varies in space and time. For this presentation, we have collated the data from 288 studies on 318 populations representing 84

species of lacertid lizards. Drawing on the inspection of more than 15,000 stomachs and fecal pellets, and the identification of over 150,000 prey items, we examine the flexibility of the lacertid diet within and among species. We test the putative effects of biotic and abiotic environmental conditions (latitude, climate, competition, insularity, prey availability) on realized niche breadth and on the taxonomic and functional diversity of the prey community. We also explore whether changes in dietary habits are reflected in morphological changes (in particular in total body size and relative dimensions of the head), and whether sexual size and shape dimorphism produces dietary niche divergence between males and females. We ran all our analyses in an explicit phylogenetic frame to assess the evolutionary flexibility of diet breadth composition in lacertids, and to examine the role of phylogenetic inertia in shaping relationships between diet, environment and morphology.

A-1355 (Poster)
Human Impact on Milan Freshwaters' Biodiversity and Functionality

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Freshwaters are biodiversity hotspots and yet have suffered a dreadful decline, especially in urban landscapes. We're investigating the human impact in Milan's metropolitan area, by assessing freshwaters' biodiversity and their functionality along an urbanization gradient. The sampling sites are natural and artificial lentic waterbodies (pools, ponds, small lakes), as well as slow-flowing channels, backwaters and fountains. Biodiversity is profiled through environmental DNA amplification, targeting bacteria, insects, amphibians and teleost fishes. Abiotic measures of each water body (length/width, substrate, water T, pH, conductivity..) and C/N/P cycling assessment in the lab will ensure the characterization of multiple ecosystem functions. Each site is sampled twice (April, June) to assess changes in the functional traits of the whole community. Evaluation of eDNA accuracy will be performed on amphibians, by comparing water filtering results with visual encounter surveys (Feb-June). The investigation results will reveal how different human landscapes impact multitrophic biodiversity and ecosystem functioning along the urbanization gradient, while changes in food-webs and cross-taxon patterns will provide a measure of the ecosystem's stability and robustness.

A-1356 (Oral)
Fire in the Near-East? Phylogeography of the Near-Eastern Fire Salamander, *Salamandra infraimmaculata*

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The evolutionary history of the Near-Eastern fire salamander, *Salamandra infraimmaculata*, is for the first time studied using phylogenetic and clustering analyses of ddRAD genomic data

with samples from all corners of its large distribution range in Turkey, Syria, Lebanon, Israel, Iraq, and Iran. It is the oldest lineage within the genus *Salamandra* and its current distribution seems highly fragmented. With this study, we dive deeper into the phylogeography of the currently known diverged lineages and try to resolve their taxonomic validity.

A-1358 (Oral)
The Philippine Toad, *Ingerophrynus philippinicus* (Boulenger, 1887) and its Skin Secretions

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Ingerophrynus philippinicus, locally known as Philippine toad is an endemic species that produces skin secretions containing bioactive compounds that could have potential medicinal uses. To evaluate the pharmacological potential, the analgesic, insecticidal, antibacterial, antifungal and toxicity activities of the skin secretions were assessed. Skin of the toads were subjected to solvent extractions using different solvents. The aqueous and ether extracts were tested for analgesic and insecticidal activities. Analgesic properties were tested using the tail flick with 500C water and the acetic acid induced abdominal writhing mouse models. Insecticidal assays were conducted against Aedes aegypti, specifically: larvicidal assay against 3rd star instar larvae and noted the LC50; percent oviposition deterrent activity using pairs of male and female in Mylar film cages; and ovicidal assay with 2-day old eggs for LC50 determination. Meanwhile, the action of crude and ethanolic extracts against *Escherichia coli*, *Staphylococcus aureus* and *Aspergillus niger* was conducted using agar well diffusion assay. In addition, the median lethality concentration of these extracts using brine shrimp toxicity assay was established. Results showed weak analgesic properties of the aqueous extract only. The larvicidal LC50 for aqueous and ether extracts were 92.73 ppm and 3.96ppm, respectively, while ovicidal LC50 were 185.37 ppm and 12.52 ppm for aqueous and ether extracts, respectively. Both fractions showed 100% deterrent of oviposition. Finally, crude and ethanolic extracts showed no antibacterial and antifungal activities. However, LC50 of crude and ethanolic extracts were calculated at 1 ppm and 3.94 x 108 ppm, respectively. The data presents opportunities for possible applications of the skin secretions of the Philippine toad, increasing the value of this endemic species. Hence, understanding its biology and conservation is an urgent concern to ensure the continuous population of *Ingerophrynus philippinicus*.

A-1359 (Poster)
Testicular Ovarian Follicles in Male Rice Frog *Fejervarya limnocharis* (Anura: Dicroglossidae)

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The Rice frog, *Fejervarya limnocharis*, a common anuran species living in rice field throughout Southeast Asia, is a good candidate of sentinel species in assessing effects of environmental stressors. For monitoring adverse effects on frogs in agricultural areas, reproductive system is one of target organ system due to long-term and intensive utilization of endocrine disrupting chemicals at agricultural fields. The study of normal gonadal structure is thus fundamental. Male *F. limnocharis* (n = 63) were collected from a natural habitat at Chulalongkorn University Forest and Research Station, Saraburi Province, Thailand, where there is no herbicide or pesticide utilization in this area. After euthanasia, morphometric and gravimetric data (snout to vent length, body weight, testis weight) were recorded. Testes were fixed and processed through paraffin method, sectioned and stained with hematoxylin and eosin for histological observation of testicular ovarian follicles (TOFs). Results showed that condition factor and gonadosomatic index of *F. limnocharis* in this area are comparable to those of the frogs in reference areas of previous study. Incidences of TOFs in adult, subadult and juvenile frogs are 46/50 (92%), 7/7 (100%) and 6/6 (100%), respectively. Presence of TOFs in the male Rice frog living in natural habitat with no history of herbicide utilization could be further used to evaluate the proper utilization of the TOFs as a biomarker of effect and susceptibility for herbicide contamination in this frog species. High incidences of TOFs in subadult and juvenile frogs suggested further study about process of gonad differentiation in this species. It is therefore crucial to clarify that TOFs may normally be present in testis during gonad development in this species.

A-1360 (Poster)

Philippine Snakebite Initiative; Bridging the Gap on Snakebite Response

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Snakebite envenomation is a significant cause of morbidity and mortality in Philippines. However, there is no comprehensive study on the actual number of incidents, despite the presence of three allopatric species of Naja listed under WHO Category 1 and the monotypic King Cobra listed as a Category 2 medically important venomous snake. Like many other countries, snakebite incidents in the Philippines primarily occur in rural areas. As an archipelago, responding to snakebites is particularly challenging and demographic data is lacking. With only one recognized government-produced isotonic antivenom, the Purified Cobra Antivenom (PCAV) derived from *Naja philippinensis* has also been used for critical cases of snakebites from hetero-specific *Naja* species and other snakebite incidents. As herpetology continues to evolve, the importance of accurate snake identification in the clinical diagnosis of snakebites has increased. Philippines is home to at least 146 snake species, including over 30 venomous species, making accurate identification a matter of paramount importance in medical society. One of the primary challenges in managing snakebites is the sheer diversity of snake species, which often leads to incorrect identification of culprit species by medical doctors and toxicologists. The Philippine Snakebite Initiative addresses this gap by involving local herpetologists in the identification process. This collaboration aims to improve the accuracy of snakebite diagnoses and enhance treatment outcomes.

A-1361 (Poster)

Bony-Tailed Tadpoles: Genomic Insights into the Development of Supernumerary Caudal Vertebrae in Megophrid Toads (Anura)

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Vertebrate tails exhibit a diverse array of morphologies and functions. Most tadpoles of Anura possess a tail with only 2-4 rudimentary neural arches in their tails, which significantly reduces the burden of tail resorption during the late stages of metamorphosis. Interestingly, species within the Megophryinae and Leptolalaginae (Megophryidae) evolved supernumerary caudal vertebrae (SCV) during larval development, which may be a key trait to adapt to swift mountain streams. Due to the paraphyletic relationship, whether SCV originated independently twice or arose once in their ancestors remains contentious. The SCV begins to develop shortly after tadpole hatching (around stages 25-26), undergoes a rapid proliferation phase, reaches stability around stages 35, and eventually undergoes dissolution and disappearance towards the end of metamorphic development. There are two developmental modes: one involves the formation of ossification centers at the dorsal and ventral lateral corners of the notochord, which then extend to form vertebrae; the other entails the simultaneous formation of cartilaginous spools circumscribing the notochord, followed by ossification. However, the molecular underpinnings underlying the development of supernumerary caudal vertebrae remain unclear. Thus, we performed histomorphological, genomic, and transcriptomic investigations to explore the genetic basis of supernumerary caudal vertebrae. Through these studies, we aim to elucidate the evolutionary developmental mechanisms of the supernumerary caudal vertebrae, which would provide new insights into the evolution of the caudal vertebrae.

A-1362 (Poster)
Shell Morphometry of Hermann's Tortoise in Calabria Region (Southern Italy)

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Testudo hermanni is a circummediterranean and thermophilus species; in Italy it occurs both with the subspecies *T. h. boettgeri* (north-eastern Italy) and with the nominal subspecies, distributed from Tuscany southwards, including the islands. The Hermann's tortoise prefers coastal and hilly habitats of Mediterranean scrub, although it rarely reaches mountain altitudes (Basilicata, Calabria and Sicily); it also occurs in habitat partially altered by humans (e.g., traditional agricultural areas). The high conservation value of the Calabrian populations of *T. hermanni* has recently been discovered. In fact, the Region is a genetic diversity hotspot, hosting the populations with the highest heterozygosity and allelic richness. The populations are distributed discontinuously in the Calabria region: most of them occur in the central-northern part, whereas a smaller and isolated nucleus is in the southern part, on the Aspromonte

massif. Since 2015 the Calabrian populations of *T. hermanni* have been studied to define their morphological features and verify a possible morphological divergence both at inter-regional and intra-regional levels, considering that the tortoises from Aspromonte massif, geographically isolated, show unique genetic. The preliminary results of the study, which is still in progress, are then presented.

A-1363 (Oral)
Phylogenetic Systematics of Ground Agamas (*Agama*) in Southern Africa

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The genus *Agama* is a group of conspicuous diurnal, insectivorous lizards with nearly ubiquitous distribution throughout Africa. A high degree of morphological conservatism, incomplete taxon sampling, and inadequate geographic coverage has resulted in uncertainties with respect to species boundaries and the validity of certain taxa. Existing work on southern African ground agamas has historically emphasized patterns within South Africa, but the ranges of two highly widespread taxa (*A. anchietae, A. aculeata*) extend well beyond its borders. *Agama atra knobeli* is recognized by some as a northern member of the complex either endemic to Namibia or to Namibia and part of the Northern Cape Province of South Africa. In this study, we utilize more representative geographic coverage across their ranges (chiefly by the inclusion of specimens from Angola and Namibia) and increased gene sampling to generate robust molecular phylogenies in maximum likelihood and Bayesian frameworks using a combination of two mitochondrial genes (ND4, 16s) and three nuclear genes (PDKREJC, PNN, SETX). We uncover reciprocally monophyletic, previously undescribed deep divergences within *A. aculeata* and *A. anchietae*. Our nuclear and mitochondrial phylogenies do not support the existence of a monophyletic northern clade of *A. atra*, so elevation *A. knobeli*, would render *A. atra* paraphyletic. This work will contribute to a broader integrative taxonomic assessment of all members of the southern African ground agama radiation using additional nuclear markers, increased sampling coverage, and species distribution modeling to resolve problematic species boundaries within this striking group of lizards.

A-1365 (Oral)
Hang'in There! Toward Stabilising Phylogeny of Asian Ranids with Gastromyzophorous Tadpoles

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The systematics and phylogenetic relationships of Asian ranid frogs of the genus *Huia* has been unstable for decades and has not been convincingly resolved. Prior to my study, five species (*H. cavitympanum, H. masonii, H. sumatrana, Huia modigliani*, and *H. melasma*) were recognized under the genus. However, none of available studies suggested that *Huia* is a monophyletic group and provided adequate systematics solutions, leaving the genus to languish in classification that is evolutionary incoherent. In my study, I generated the most comprehensive taxon sampling of *Huia* via extensive fieldwork and museum loan and applied integrative taxonomy approaches. In this talks I will present the latest progress of my long term research project on the Asian ranids with gastromyzophorous tadpoles. My analysis (of molecular and morphological data of adults and larvae) thus far, revealed that *Huia* is a

paraphyletic group, which corroborates the previous hypothesis. However, (i) disclose multiple highly divergent, undescribed lineages of ranids with gastromyzophorous tadpoles in Sumatra and Java, (ii) provide evidence to justify the retention of the genus *Huia* and to erect a new genus to accommodate the remaining members, (iii) provide evidence that the mainland population of these group possesses gastromyzophorous tadpoles. My study highlights the importance of having thorough geographic sampling and adding tadpole morphology to diagnose lineages that are otherwise hard to differentiate as adults.

A-1366 (Oral)
Checklist of Lizards and Amphisbaenians of Argentina

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We present an annotated and updated checklist of the lizards and amphisbaenians of Argentina. It includes species missing in the most recent checklist of reptiles and several previously cited species are synonymized with others, thus we removed them from the country's list. Also, several new species have been described since the last published checklist. We also include comments highlighting where more study is needed. We provide authors, dates, and original spellings of higher-level taxonomy of all taxa covered. We include information about general biogeographic distribution and a proposal of conservation status for recently described species. A total of 302 species (290 lizards and 12 amphisbaenians) are now known from the country with 220 species being Argentinean endemics

A-1367 (Oral)
Threat-based Mitigation and Species-focused Conservation Actions to Promote Recovery of Herpetofauna in British Columbia, Canada

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British Columbia (BC) is the fourth largest province/territory (~945,000 km^2) in Canada and is located at mid (48°N) to northerly (60°N) latitudes. As a result of its glacial history and varied physiography and climate, BC supports diverse aquatic (marine, freshwater) and terrestrial environments including alpine, forest, riparian, wetland and grassland ecosystems. A total of 14 native species of reptiles and 20 native species of amphibians can be found throughout these ecosystem types; four species of sea turtles can be found on occasion off the BC coast. Four additional species of invasive amphibians (n = 2) and reptiles (n = 2) occur in the province. In BC, amphibians and reptiles are the most at risk species assemblages with more than 50% of species in each group listed provincially and/or federally as of conservation concern. Leading threats include habitat loss and fragmentation and road mortality. Chytridiomycosis is widespread throughout the province and ranavirus has been detected in specific locations. Invasive species (e.g., American Bullfrog and Red-eared Slider) are of concern for several species. Changing climate and extreme weather events (e.g., flooding and wildfires) have been observed with increasing frequency and severity. The overall cumulative impact of these threats is concerning and not well understood. Actions for threat mitigation and recovery of listed species are identified in provincial recovery and management plans. Diverse

recovery teams of government agencies, academic researchers, breeding/research facilities, independent consultants, land conservation organizations, Indigenous partners and stewardship groups plan and carry out actions. Active recovery work is underway for various species in the province; in this talk, I will highlight threat-based mitigation efforts benefitting multiple amphibian and reptile species and describe species-based recovery work (i.e., increasing knowledge, reducing targeted threats and recovering populations) as it pertains to Sharp-tailed Snake (*Contia tenuis*) and Northern Leopard Frog (*Lithobates pipiens*).

A-1368 (Poster)
Molecular Biomarker and Reproductive Examination of Sea Snake in Thailand

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Coastal areas of Thailand are well known as an importantly water resources as well as a recreational area for human activities. Environmental changes are affecting to the coral reefs where is an exhibition of marine creatures especially sea snakes. Yellow-lipped Sea Krait, *Laticauda* sp. is common species living along the coral reef and their population is disturbed by these factors. Information of sea snake diversity in Thailand is limited and uncovered of reproduction. To examine whether the sea snake could be diversified, and reproductive system could be observed, the muscle tissue and gonadal tissue of *L.* sp. collected from sample kept in the museum during 2022-2023 A.D. and subjected to analysis for molecular biomarker and histological techniques. Since *L.* sp. is also known to be higher level predator position of food web, it is thus important to clarify and examine this species. The results on diversity will be presented by genetic biomarker and the results of relationship with relative species will be showed by phylogenetic tree. Association between results from molecular technique and histological technique will be discussed. The information from this study could be used as an alternative way to understand the water resources along coastal environment and the potential link to other managements for the sustainability in the future.

A-1369 (Poster)
LLP: Ladder-like Pattern in Phylogenomic Analysis, a Potential Sign of Gene Flow

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During an empirical study focusing on the phylogeography of montane puddle frogs (*Phrynobatrachus steindachneri* species complex) from the Cameroon Highlands in Central Africa, we analysed a phylogenomic dataset generated using anchored hybrid enrichment (AHE). Maximum likelihood analysis of this phylogenetically shallow dataset yielded an unusual tree where several individuals were placed with high support between two 'main' clades, forming a ladder-like pattern (LLP). Empirical testing based on the removal of these 'intermediate' individuals, in which their geographic origin was also evaluated, yielded a 'clean', typically structured phylogenetic tree, and we hypothesized that the 'intermediate'

individuals might represent hybrids. We tested this hypothesis using 19,883 single nucleotide polymorphisms (SNPs) called from the AHE dataset and analysed the population structure. Next, based on theoretical assumptions such as biogeographic rationale (multiple-lineage sympatry) and phylogenetic rationale ('in-ladder' phylogenetic position, inferred population structure), we tested whether hybrids were present in our system by analysing several different sets of SNPs to calculate maximum likelihood estimates of hybrid indices. In addition, phasing to gametic haplotypes in an experimental subset of 20 loci was performed using a Bayesian coalescent-based algorithm to test whether the gametic haplotypes of putative hybrid individuals segregate in different parental lineages. All these approaches supported our hypothesis that the 'intermediate' individuals formed in the ladder-like phylogeny (LLP) represented hybrid individuals. Finally, morphometric analysis also supported this hypothesis, as the phylogenetically 'intermediate' individuals were placed between expected parental populations/species. In conclusion, the Ladder-Like Pattern (LLP) in phylogenomic (or high-multilocus) analysis indicates the presence of gene flow, that is, hybridization. By analogy, we obtained artefactual branches between parental taxa when analysing chimeric concatenated sequences, which can be a common problem in meta-analyses of taxonomically misidentified GenBank data.

A-1370 (Oral)
Status, Trends, and Implementing Conservation Initiatives for Asian and Australasian Tortoises and Freshwater Turtles

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At present, 476 recognized extant taxa, representing 353 recognized extant species of chelonian inhabit Earth. Of those, 469 taxa are considered non-marine. The IUCN Red List officially recognizes 171 species of chelonian as Threatened (Vulnerable, Endangered, Critically Endangered), and, of those, 113 species as Endangered or Critically Endangered. The regions of East, South, and Southeast Asia, and Australasia, are of particular importance to the preservation of global chelonian species richness and endemism, as these regions encompass six of the top ten countries exhibiting the greatest diversity of species richness of tortoise and freshwater turtle, including India, Indonesia, China, Vietnam, Australia, and Myanmar. These regions additionally encompass five of the top ten countries exhibiting extant taxa endemism, including Australia, China, India, Indonesia, and Myanmar. However, these regions also exhibit the greatest cumulative global decline in tortoise and freshwater turtle populations, with 74 regarded as Threatened by the IUCN Red List of Threatened Species. The most pervasive threats to tortoises and freshwater turtles in these regions include unsustainable collection for food, pet, and traditional medicine trades, and subsistence consumption, habitat destruction, degradation, and alteration, and incidental capture and mortality in fishing gear. Thus, strategic and persistent conservation efforts in these regions are principal to preserving and restoring populations of imperiled terrestrial and freshwater chelonians.

A-1371 (Poster)
Common Frog Tadpoles Show Adaptive Behavioral Response to the Presence of Minnows

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Freshwater ecosystems have suffered the most dramatic decline compared to marine or terrestrial ones, since the 1970s. Among the drivers contributing to this decline, fish stocking of naturally fishless ecosystems, like alpine lakes, was a common practice in Europe in the 1960s. *Rana temporaria* (the Common Frog) is a widespread species in Europe and one of the few amphibians capable of breeding in alpine lakes. *Phoxinus phoxinus* (the minnow) was a common fish species used as bait for fishing in alpine lakes where trout was introduced. The minnow persisted in many alpine lakes, even after the disappearance of the trout. We investigated the changes induced by the presence of minnows during the early developmental stages of the Common Frog, using a mesocosm experimental setup (Retezat National Park, Romania, 2023). We quantified the: (1) growth rate and activity patterns (i.e., distance covered and velocity) during the aquatic stages (i.e., tadpoles G26-40), and (2) size, body condition and endurance (i.e., distance covered and inactivity to external stimuli) at metamorphosis. We found that the growth rate was not affected, but tadpoles raised in the presence of minnows were on average significantly faster and more active compared to those raised in the absence of fish. Size, body condition and endurance were similar in all metamorphs. These results suggest that an increased activity during the aquatic stage could act as a behavioural coping mechanism to overcome the stress induced by the presence of fish and avoid trade-offs in size and fitness at metamorphosis. This study highlights the intricate interactions between amphibians and fish.

A-1372 (Oral)
Potential Misuse of the CITES Zoo Code: Case Studies from the Philippines

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This study examines the potential exploitation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Zoo (Z) code in the Philippines. The Z code allows zoos to import and export wildlife for conservation breeding and education, but not primarily for commercial purposes. Four case studies involving endangered Philippine species were analyzed: I. Philippine Crocodile *Crocodylus mindorensis* is one of the most critically endangered crocodilians in the world and has been listed in Appendix I since 1975. Between 2006 and 2011, 31 individuals were exported to Europe and some individuals or offspring were eventually offered for sale; II. Fourteen Southern Luzon Forest Monitor Lizards Varanus olivaceus with dubious sources were exported by a now defunct private zoo to a US zoo in 2006; III. Between 26 (importer-reported) and 76 (exporter-reported) Philippine Forest Turtles *Siebenrockiella leytensis* were exported from 2011-2014 but most individuals were suspected to be laundered based on dubious captive breeding reports. An attempt to export 30 F2 individuals to a commercial farm in 2017 was denied by the Philippine CITES Management Authority when the proponent failed to authenticate its captive breeding claim; and IV. 240 Philippine Box Turtles *Cuora philippinensis* (junior syn. *C. amboinensis*) were exported by a private zoo in the Philippines to a commercial turtle breeding farm in the US between 2012 and 2018. These cases suggest the Z code might have been misused to facilitate commercial trade disguised as conservation efforts. CITES Management Authorities should scrutinize the import and export permits under the Z code to prevent abuses by commercial traders.

A-1373 (Oral)

Recent Progress and Scopes in Taxonomic Studies of Indian Snakes

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Snakes are an interesting group of reptiles from evolutionary, ecological and sociocultural points of view. Despite their relatively recent emergence in reptilian evolution, they contribute significantly, constituting 33.8% of extant reptilian diversity globally. India is home to nearly 800 species of reptiles, including 355 species of snakes that constitute 8.6% of the 4108 recorded species worldwide. The taxonomic exploration of reptiles in India has reached its zenith, marked by the continuous discovery of new species that enrich the checklist annually. A better understanding of evolutionary history and systematic exploration using molecular tools have been employed in Indian snake taxonomy since the last decade. At the beginning of the 21st century, 41 out of 50 species discovered are described using both molecular and morphological characters. Significantly, recent descriptions are increasingly reliant on anatomical features like skull structure and hemipenis morphology, offering profound insights into the evolutionary trajectories of these species. However, snake taxonomy confronts unique challenges, including the elusive nature of snakes in natural habitats, errors or vague type locality information, accessibility to museum specimens and legal constraints on specimen collection imposed by the Indian Wild Life (Protection) Amendment Act, 2022. It becomes more challenging while dealing with cryptic and polymorphic species and those having complex nomenclature issues. Other than taxonomic studies, citizen science initiatives and an increasing number of snake rescuers in India comprising enthusiasts and armatures add substantial information on natural history observations. There is vast potential in studying reptilian systematics in India because of the varied landscape hosting several endemic species. Furthermore, using a comprehensive suite of morphological, anatomical, and molecular traits in species descriptions and revisions ensures a robust foundation for future research in understanding past and present diversity.

A-1374 (Oral)
Taxonomy and Conservation Challenges in Indian Reptiles

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India, renowned as one of the world's megadiverse nations, is home to numerous biodiversity, concentrated within the Himalayas and Western Ghats regions. The scenario of Indian reptiles seems largely unexplored, evident from the consistent pace of new species discoveries, especially in the past decade. Underscoring the ongoing exploration and revelation of the nation's reptilian diversity, 208 species (26%) have been identified within the last decade, out of close to 800 extant species documented till now. With diversity comes the weighty responsibility of safeguarding biodiversity, and India is no exception. The Indian Wild Life (Protection) Amendment Act, 2022 accords the highest legal protection to 68 reptile species under Schedule-I and 312 in Schedule-II. A notable addition to the revised act is the inclusion of all species listed in Appendices I-III of CITES within Schedule-IV of the Act, irrespective of their country of origin, with penalties outlined for unlawful possession. According to the IUCN Red List Assessment, 17% of Indian reptiles face extinction risks primarily due to habitat loss, urban development, and trade/poaching. Furthermore, 19.7% of Indian reptile

species are classified as Data Deficient, indicating limited knowledge on their distribution, ecology and threats. India has initiated processes for a national Red List Assessment to obtain a scientific consensus for biodiversity protection, aimed at periodically evaluating species status to facilitate future amendments to the Protection Act. Presently, India grapples with the challenge of managing exotic reptile pets and threats of illegal exploitation of endemic species, notably geckos, highly sought after in the international pet market. Reptile experts play a pivotal role in advocating for the conservation of rare and threatened reptiles, engaging with forest managers, local communities, and policymakers to ensure their protection. Without such concerted efforts, the risk of extinction, both locally and regionally, will persist alongside the discovery of new species.

A-1375 (Oral)

Lessons, Challenges and Pitfalls of Wildlife Detection Dogs for Amphibian Monitoring: Situational Training and Cognition Inform the Development of Effective Training Protocols Tailored to Individual WDDs

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Wildlife Detection Dogs (WDDs) play a pivotal role in biodiversity research, utilising their exceptional olfactory abilities to locate and monitor wildlife. Understanding WDD behaviour, team performance, training methodologies, and project suitability becomes increasingly crucial, especially when dealing with rare species. Therefore, assessing WDD capacity and accuracy before and after deployment requires a comprehensive approach, often validated by stringent and standardised methodologies conducted in both artificial and field-relevant conditions. As insights into cognitive research and canine olfaction grow, along with an understanding of human-dog team dynamics, tailored training protocols should guide more effective deployment strategies. Determining the adaptability of WDDs to their search environment is key to understanding their performance, search patterns, speed, and memory capabilities. In line-up and closed field trials, we observed an influence of temperament, task-oriented learning, decision-making, and memory on the speed and accuracy of their searches. However, we propose that these factors alone are not reflective of a team's readiness for field operation. Instead, we highlight that while standardised methodologies can be incorporated into initial training, a multi-step approach leading up to deployment is necessary. Transitioning from sterile environments where the target odour is easily detectable to the field, where target odours are part of a complex scent picture, must be included in this process. Training should focus on dog-human team communication, progressive enhancement of odour and task understanding, and species-specific search strategies in complex environments, which cannot be adequately reflected by standardised methods alone. Depending on temperament, standardised methods might positively impact cognitive abilities such as confidence, determination, and experience enhancement, but they can also negatively influence motivation and engagement. In conclusion, we emphasise the uniqueness of each WDD and the dynamics of the team, advocating for the refinement of training methodologies tailored to individuals, considering their strengths, styles, cognitive abilities, experience, and project requirements.

A-1376 (Oral)
Cold Frogs and Damp Logs: Training Detection Dogs to Locate the Critically Endangered Baw Baw Frog

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Since the 1980s, Baw Baw frogs (*Philoria frosti*) have experienced a 98% decline in abundance. Current survey efforts are restricted to the one-two month long breeding season during which time mature males can be detected through calls. Zoos Victoria began training two Wildlife Detection Dog-handler teams to search for this cryptic species *in-situ* with the aim of monitoring known Baw Baw frog populations and surveying likely habitat with the hope of finding new populations. Fortunately, successful captive breeding and release programs have increased the number of frogs in the wild, while also allowing dog-handler teams to train on captive-bred frogs during releases. The 2023 season involved training dogs on numerous frogs during and after release to re-familiarise them with the frog odour and practise successful detection in the wild. Dog-handler teams then conducted a total of 33 blind searches of 25m2 plots at captive release sites, into which 0-3 frogs were released between 1-3 hours before searching. Teams also completed a further six searches for frogs released > 48 hours before searching. Teams successfully located 34 of 36 frogs released after 1-3 hours. While dogs performed four confident alerts at or near to release sites of six frogs > 48 hours after release, no alerts could be confirmed. The protracted survey season, challenging environmental conditions and the difficulty of confirming dogs' alerts to frogs concealed in tree roots and wet soil all contribute to the overall challenge of this project. Detection dog training is ongoing and we anticipate that frog detection experience will increase dogs' confidence and efficacy over coming seasons. As with many critically endangered species, we are hopeful that a combined survey approach including auditory surveys, ongoing detection dog training during frog releases and detection dog surveys could represent the best hope for detecting this species in the wild.

A-1377 (Oral)
Viper-Raptor Dynamics in Hungary: Geometric Morphometric Identification of Snake Vertebrae and Habitat Preference of an Avian Predator

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The Hungarian meadow viper (*Vipera ursinii rakosiensis*) is an endangered subspecies of *Vipera ursinii*, which faces high predation pressure, partially due to avian species. To create a systematic method for estimating the measure of pressure, we developed a geometric morphometric approach to identify both undamaged and damaged vertebrae of snake species found in viper habitats from raptor feeding remains. We used linear discriminant analysis with a reference material of vertebrae from identified snake species as training data and tested its efficiency by predicting the identification results of different simulation levels based on completeness. We practiced this method on vertebrae of unknown species of snakes obtained from nests and pellets of Common buzzards (*Buteo buteo*, n = 14). We also placed radio telemetry devices on buzzards (n = 6) captured in viper habitats and recorded their movement patterns to study their habitat preference. The vertebrae identification approach showed high accuracy (above 90%), even in the case of missing landmarks to some extent. We identified vertebrae remnants of *Natrix natrix* (86%) and *V. u. rakosiensis* (14%), therefore the common buzzard was proved to prey on vipers, which is in agreement with its generalist lifestyle. Based on radio telemetry, the most preferred habitat of buzzards were alfalfa plough fields and treeless wetlands, whereas the less preferred ones were open sand steppes, intensive plough fields and mesotrophic wet meadows. This suggests a preference for habitats with high prey diversity and abundance. Diverse habitats are most likely to be occupied by the Hungarian meadow viper, where the predation pressure is higher compared to low-quality hayfields or pastures. Our approach of identification is applicable for other studies and taxa as well, therefore can be a practical tool for classification of incomplete vertebrae and for the estimation of predation pressure on endangered snake species.

A-1378 (Oral)
Should You Doo-Doo Dragon Scat Detection with Dog Teams?

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The Victorian grassland earless dragon (*Tympanocryptis pinguicolla*; VGED) has been identified as the most at-risk reptile species in Australia. Since the VGED rediscovery in 2023, significant investment has gone into expanding our knowledge and conserving this species. Whilst wildlife detection dog-handler teams (WDDT) have been a successful method for a multitude of invasive and endangered species, research into WDDT for reptile species is a new, evolving field. Our study aimed to determine whether WDDT could reliably discriminate between VGED and non-target reptile scat, and whether VGED scat could effectively be located in search areas by WDDT. Two detection dogs were initially trained on frozen captive VGED scat, then fresh captive scat and finally wild scat. Assessments occurred before progressing onto the next sample type. Assessments were comprised of six line up trials - five trials utilising the familiar sample type and one generalisation trial to the new sample type (e.g. wild scat). Each trial was comprised of one target and five non-targets. Assessments across 25 search areas (5 x 5 m outdoor areas) were also completed to measure search sensitivity, precision and effort. During frozen captive scat assessments both dogs achieved a sensitivity and precision of 100%, and successfully generalised to fresh captive scats. Again, both dogs

achieved 100% sensitivity and precision in fresh captive trials, however, failed to generalise to the wild VGED scat. Additional training was therefore required to improve the dogs' performance on wild VGED scat when samples were available. Whilst search area assessments are currently ongoing, preliminary data demonstrates that both dogs are able to successfully detect VGED scat, however, this typically requires a high level of search effort. Our research demonstrates that WDDT can successfully be trained to discriminate between VGED and other reptile scat, and successfully detect these scats within search areas.

A-1379 (Oral)
Island Fragmentation by Sea Level Rise and Global Warming Drive Prehistoric Extinctions in Mediterranean Island Reptiles

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We assess how reptile population extinctions on Mediterranean islands since the Last Glacial Maximum (LGM) have been influenced by the interacting effects of physiology, island area, duration of isolation, changing climate, and topography. Using geophysical models of sea level rise, we construct island fragmentation trees showing the sequence and timing by which 80 present-day islands and 52 paleoislands in the Aegean and Ionian Seas were progressively separated from paleolandmasses. These trees are used to reconstruct the progressive sequence of local reptile population extinctions. The data show that extinctions are non-random but are closely related to species life history characteristics. We also found that population extinctions increase linearly with duration of isolation and that extinctions are negatively correlated with (paleo)island area. In addition, extinctions are positively associated with higher summer temperatures, implying heat stress, and with higher island topographic roughness, which may indicate reduced resource availability. These conclusions have implications for understanding, predicting, and ultimately preventing future species extinctions due to climate change.

A-1380 (Poster)
Phylogenetic Relationship and Morphological Revision of Grandison's Forest Skink *Sphenomorphus grandisonae* Taylor, 1962

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Grandison's forest skink *Sphenomorphus grandisonae* Taylor, 1962 is a diminutive skink living in montane forest in northern Thailand. In addition, only few morphological characters has assigned for identification. Moreover, there were not enough specimens to be examined leading to confusion with other closely related species. However, several Grandison's skinks have been found at highland of Doi Phu Ka National Park and adjacent areas in Northern Thailand, leading to an opportunity to examine it in detail. Therefore, this study aims to examine phylogenetic relationships and revisit morphological characteristics of the skink. The field surveys have been conducted from 2020-2022 in highland areas of northern Thailand. The phylogenetic relationship using mitochondria (16S rRNA and ND2) and nucleus (R35 and NGFB) genes present that Grandison's forest skink has its own clade and it is not grouped with other species of the same genus. In addition, the Grandison forest skink can be divided into two populations including Nan province populations and Uttaradit-Phrae provinces population. The morphological study showed that Grandison's forest skink has characteristics that are

different from other skinks including adpressed forelimb and hindlimb do not meet, lateral occipital scales are small and blackish scales under the chin. This study shed light on hidden diversity of reptile in montane areas of Thailand and further Taxonomic study of this species is required.

A-1381 (Oral)
Effects of Malarial Infection on Body Condition and Locomotory Performance in Lizards

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Presence and impacts of pathogen infections in wildlife are known to be determined by a hierarchical set of factors including host, habitat, and general environment characteristics. While an increased number of studies have been documenting host-parasite interactions in natural systems, little is known about these impacts in island populations. To elucidate the impacts of infection, we investigated the effects of *Hepatazoon* (an apicomplexan hemoparasite) Wall lizard (*Podarcis erhardii*) populations from 17 Cycladic islands (Aegean Sea, Greece). Specifically, we evaluated the effects of infection on multiple aspects of lizard life history from lizards from these islands. We found significant declines of condition in infected populations, though stronger in male lizards, suggesting a sex-specific response to infection. These results indicate variability in the impacts of malarial infection across populations of *P. erhardii*.

A-1382 (Oral)
Evolutionary History and Diversity of the Colubrid Genus *Platyceps*

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The colubrid racers of the genus *Platyceps* are slender, medium-length snakes inhabiting a vast area that spans from southern Europe, northern Africa, Arabia, western and central Asia to India. The genus´s phylogeny has not been satisfactorily resolved yet. Even though it has been part of many phylogenetic studies, they usually contained only a fraction of species, leading to misinterpretation of the relationships within the genus. In our study, we sequenced two

mitochondrial and four nuclear markers for 136 specimens from 19 of the 30 currently recognized species, some sequenced for the first time. The results divide the genus in four main clades. One contains two Indian species (*P. plinii* and *P. josephi*) and stands as a sister clade to the rest of the species. The second clade, which also occurs in India and surrounding countries, contains five species - *P. ventromaculatus, P. bholanathi, P. gracilis, P. ladacensis* and an undescribed species from Central Asia. This group is sister to the remaining species, which form two sister clades - *karelini* and *florulentus* clades. The *karelini* clade contains four species (*P. karelini, P. saharicus, P. rogersi* and *P. rhodorachis*) that occur from Central Asia through the Arabian Peninsula to North Africa. The last clade includes Arabian species (*P. variabilis, P. sinai, P. manseri, P. elegantissimus*), two strictly African species (P. florulentus and *P. taylori*), and two West Asian and European species (*P. najadum* and *P. collaris*). The crown diversification of the genus took place most likely in southern Asia approximately 19 Mya. The genus dispersed to the west in two independent colonization events. The first wave resulted in the colonization of Arabia, eastern Africa, and southern Europe. The second wave followed a similar route and resulted in the colonization of northern Arabia, Mesopotamia, and northeastern Africa by species of the *karelini* clade.

A-1383 (Oral)
Spa toads: Asynchronous Winter Toad Breeding Activity at Liard Hot Springs, Canada

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The Western Toad (*Anaxyrus boreas*) ranges from Baja, California to Alaska and lives in a wide range of habitats in British Columbia, Canada. It has one of the most northly distributions of anurans in western North America. In northern British Columbia, this species normally breeds in late May. Here we provide natural history notes on a Western Toad population that breeds starting in early March in the geothermally heated waterways within Liard River Hot Springs Provincial Park. In April 2021, we observed toads in all stages of their life cycle (amplexus, egg strings, variously sized tadpoles, metamorphs, and juveniles) within the thermal waterways of the Park. The water temperature in the streams and pools varies from 15-38°C, depending on proximity to the source and distance from the edge of the pools, side channels and streams. Snow still covered most of the surrounding landscape. Observation in June 2023 indicated that by June all the toads had metamorphosed and left the hot spring. Winter breeding has also been observed at warm springs near Atlin, B.C., and in Utah. The observation of hot spring breeding toads raises many questions such as: What triggers breeding in the hot springs? Do toads arrive in the fall and remain active in the hot springs habitat until breeding time or are they hibernating under tufa? And most importantly, is the winter breeding in thermally heated water a plastic behavioral trait or is there genetic divergence between winter and spring breeding toads as the breeding activity between the two populations is temporally segregated.

A-1385 (Oral)
Conserving a Little-Known Threatened Amphibian Through a Crowdfunded Art Exhibition

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Funding for conservation research is limited and often biased towards charismatic and highly threatened megafauna. Funding agencies are less likely to support research projects focusing solely on herpetofauna that are relatively unknown to the public. Roadkill is a serious threat to the Hong Kong newt (*Paramesotriton hongkongensis*), which is named after the city where it was first discovered but remained relatively unknown to its seven million human inhabitants. To raise awareness about this species and raise funds for its conservation, we organized a crowd-funded, single-species art exhibition that showcased various aspects of the Hong Kong newt through high-quality arts in various formats, including photography, videography, scientific illustration, and installation art. In a relatively short time, we managed to crowdsource the funds (> US$40,000) needed to host the exhibition and conduct systematic research on the roadkill issue threatening this species. In this presentation, we will share the lessons learned in crowdfunding the exhibition, present findings from the roadkill survey led by citizen scientists, and reflect on the impact of this project on the conservation of a lesser-known but nonetheless important local fauna.

A-1386 (Oral)
Herpetofauna Trade Through Social Media and E-Commerce

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Today's wildlife trade has grown in line with the increasing use of inteet media. The trade trend that has shifted from conventional trading to online media (in the network) following the developments of this era allows for an increase in the activity of trading through online media. The purpose of this research is to find out the trade in herpetofauna on the platforms of Shopee, Tokopedia, and Facebook using observation methods. The results of this study revealed 97 herpetofauna species from 32 families and 20 types of herpetofauna animal treatments marketed. The most widely offered product category is living animals. There are two species that are included in the protected species according to the Ministry of Environment and Forest No.106 from 2018, namely *Python bivittatus* and *Morelia viridis*. All the sellers are from Indonesia.

A-1387 (Oral)
Progress Amidst Crisis: Counter Wildlife Trafficking Efforts in Vietnam

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Vietnam is a source state, consumer state, and transit state for the trafficking of tonnes of native and non-native reptiles each year. Wild populations of many reptile species, particularly tortoises and freshwater turtles have declined sharply over the past thirty years as a result hunting and trade to meet demand from consumers in China. In the late 1990s, Vietnamese traffickers expended their reach into neighboring Laos and Cambodia to meet demand. By the early 2000s, as the standard of living increased in Vietnam, there was a coinciding increase in

demand for wildlife from Vietnamese consumers. Consumption of reptiles including monitor lizards, a wide array of snakes, softshell turtles, and other species became common in specialty restaurants throughout the country. At about the same time, commercial farming of wildlife including Siamese crocodiles, pythons, softshell turtles, and a long list of tortoises and freshwater turtles presented additional pressure on wild populations as newly licensed wildlife farmers established captive populations from illegally sourced animals, or operated commercial farms as a cover to launder wild-caught animals into the legal trade. While laws and enforcement continued to improve addressing these illegal activities, the use of social media to establish online markets starting in 2015 presented yet another challenge for CWT efforts, this newly emerging crisis compounded by growing demand in both Vietnam and China for exotic reptiles as pets starting in about 2017. ENV has been actively engaged in CWT in Vietnam for almost 25 years, utilizing a unique and integrated strategy to achieve meaningful impacts on behalf of wildlife. While substantial obstacles lie ahead, measurable results of these efforts suggests that there are brighter days ahead for some of Vietnam's most endangered reptiles.

A-1388 (Oral)

Conservation Status and Future of *Vipera ursinii rakosiensis* in Romania

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Listed as Endangered on the IUCN Red List, *Vipera ursinii rakosiensis* is considered one of the most endangered vertebrate species in the Council of Europe area. The only available assessments and conservation action plans on the species are outdated, and recent discoveries of populations in Romania highlight the need for updated information. Moreover, questions arise regarding the reported Favourable conservation status for *V. u. rakosiensis* in the latest Natura2000 Species assessments, as the data and decision-making process behind this remain unknown. In Romania, it is threatened by conversion of its grassland habitats into arable land, overgrazing, burning, and mechanised mowing. Yet the impact of these threats and their more accurate spatial extent remains largely unknown. Usually, when assessing a conservation status, criteria including population size and geographic distribution area are also considered. Here, we introduce new data concerning the distribution and density of Romanian populations. In 2022, we surveyed a total of 780 ha across five habitats in Romania and included data from two Hungarian populations and the Danube Delta (*Vipera u. moldavica*) for comparison. At each habitat, we conducted surveys in at least four sampling units (100 × 100 m) on 15 occasions during spring. For estimating abundance, Bayesian n-mixture models were utilised. In Romania, the average density of *V. u. rakosiensis* ranged from 1.29 to 2.63 individuals per hectare, whereas in Hungary, it varied from 1.45 to 1.91 individuals per hectare. In comparison, *Vipera u. moldavica* showed an average density of 4.68 individuals per hectare. The density estimates indicate higher abundances of *V. u. rakosiensis* at certain sites in Romania compared to Hungarian populations. These findings underscore the importance of transparent and up-to-

date assessments for effective conservation measures and highlight the significance of continued monitoring and conservation efforts in both country to ensure the persistence of *V. u. rakosiensis* populations.

A-1389 (Oral)
Spatial Analysis of Reintroduced Hungarian Meadow Vipers' (*Vipera ursinii rakosiensis*) Seasonal Movements

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The Hungarian meadow viper (*Vipera ursinii rakosiensis*) conservation program started captive breeding of the species in 2004. Over the past two decades altogether 4,900 vipers were bo in the Hungarian Meadow Viper Conservation Centre. Reintroduction of the species to reconstructed grasslands was started in 2010 and over 940 vipers were released to 13 habitats in Kiskunság and Fertő-Hanság National Parks in Hungary. Artificial burrows, used in the outdoor terraria of the breeding centre, served as medium for release, providing known retreat for the released individuals. During regular monitoring, visual encounter surveys and burrow checks by pipe camera, we observed 15% of the released vipers at least once again and the longest period between release and last observation was 1,575 days. Recapture rate varied between locations and between years. Timing of release was set for end of winter, but after evaluation of results, late-spring to mid-summer releases were preferred. In order to learn more about the fate of the vipers, generally five snakes were implanted with radiotelemetry tags within each released group, resulting 55 tagged snakes. Snakes usually moved by making a circular path, returning to the release location, probably investigating the new territory. Snake movement range varied between 0.5-1.2 hectares, generally males moving more. In 21 cases the snakes were killed by predation, half of them by avian predators like Common buzzards or Harriers and the other half by mammals, like Red fox and Badger.

A-1391 (Oral)
Snake Diversity and Recent Progress in Herpetological Studies in Bhutan

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Bhutan, nestled in the Eastern Himalayas, boasts a rich biodiversity that extends to its reptilian inhabitants, particularly snakes. Despite this richness, progress in herpetological studies in Bhutan has been hindered by significant challenges, including a lack of human resources and prevalent cultural beliefs associated with snakes. This presentation will provide an overview of snake diversity in Bhutan and discuss the recent progress and challenges in herpetological research. The country's diverse topography provides an ideal habitat for a wide array of snake species, yet research efforts have been slow to progress due to limited funding, expertise, and infrastructure. The scarcity of trained herpetologists and research institutions dedicated to wildlife studies has impeded comprehensive surveys and data collection on snake diversity and

ecology. Moreover, cultural perceptions and superstitions surrounding snakes have further hindered research and conservation efforts. In Bhutanese society, snakes are often associated with myths, folklore, and religious beliefs, leading to a reluctance to engage with these creatures or support scientific investigations into their biology and conservation needs. Nevertheless, despite these challenges, there have been some notable advancements in herpetological research in Bhutan in recent years. A small but dedicated group of researchers and conservationists have worked tirelessly to overcome barriers and raise awareness about the importance of snake conservation. This presentation aims to shed light on the complexities of snake research in Bhutan, highlighting the urgent need for increased support and investment in herpetological studies. By addressing the barriers to research and fostering a greater understanding of snakes within Bhutanese society, we can work towards the conservation of these fascinating and often misunderstood creatures.

A-1392 (Oral)
Practical Tools to Minimise Disturbance in Snake Monitoring

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The Hungarian meadow viper (*Vipera ursinii rakosiensis*) conservation program started captive breeding of the species in 2004. Over the past two decades altogether 4900 vipers were bo in the Hungarian Meadow Viper Conservation Centre. Vipers are individually identified by their unique head scalation, using photographic identification and scale-counting, replacing marking or tagging. A self-developed MySQL database, Viper 1.7.7 is enabling the project team to catalogue the vipers and related events. Reintroduction of the species to reconstructed grasslands was started in 2010 and over 940 vipers were released to 13 habitats in Kiskunság and Fertő-Hanság National Parks in Hungary. During regular monitoring, visual encounter surveys and burrow checks by pipe camera, we observed and identified 15% of the released vipers. In 2023 we installed three sets of drift-fence.

A-1393 (Oral)
Fungal Diseases of Amphibians

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Over the past 15 years there have been huge gains in the knowledge of chytridiomycosis, and a few studies on other fungal diseases including saprolegniasis and mucormycosis. Significant results on chytridiomycosis include fungal genetics showing east Asia as the origin, improved understanding of hosts' resistance with indications of acquired immunity, and strong evidence of recovery of populations in some anurans. Research has informed trials of diverse interventions including some proven to be successful for local management. In Australia's Wet Tropics, recovery of some rainforest frogs has involved recolonisation of former upland sites, but physical barriers likely limit their expansion. Australian alpine species declined at a slower rate, but may become extinct without interventions, such as improving hosts' resistance. Here we review recent progress with proven or potential outcomes for conservation.

A-1394 (Oral)
Historical Museum Specimens and Recent Multidimensional Evidence Revealed the True *Leptobrachella oshanensis* (Liu, 1950) and its New Congener from Mt. Emei, China

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The Asian leaf litter toads of the genus *Leptobrachella* Smith, 1925 (Anura, Megophryidae Bonaparte, 1850) are a group of morphologically conserved but genetically diverse small toads. They are found on the forest floor and along rocky streams in hilly evergreen forests, and are widely distributed from southern China and Myanmar, through mainland Indochina to peninsular Malaysia and the island of Borneo. For a long time, the species *L. oshanensis* (Liu, 1950) was once thought to be widespread in southern China. However, recent researches have shown that its distribution is restricted to a small area on the southwestern edge of the Sichuan Basin in southwest China. Our research, based on data from the holotype and newly collected topotypes, showed that the name *L. oshanensis* should only be applied to some *Leptobrachella* from its type locality, the Mt. Emei. Our analysis revealed another *Leptobrachella* species, *L. yeae* Shi, Hou, Song, Jiang and Wang, 2021 from Mt. Emei, which differs from *L. oshanensis* in morphology, phylogenetics, and apparently acoustics. The two species share the same breeding season and could be isolated from each other by different advertisement calls. We also report the first known sexually dimorphic skin glands in Megophryidae, which was found on males of some *Leptobrachella* species.

A-1395 (Poster)
Parasitic Helminths and WBC Count in Three Calabrian Common Wall Lizard Populations *Podarcis siculus* (Rafinesque-Schmaltz, 1810)

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Being in close contact with terrestrial microhabitats, often in conditions of high anthropic pressure, results in reptiles particularly subject to parasitosis by numerous helminth species. *Podarcis siculus* is perhaps one of the best experimental models that can be used in Italy and Calabria precisely because of its marked synanthropy. This work aims to analyze the endoparasitic communities that characterize the species in three different Calabrian study areas, trying to give an interpretation to any differences and causes that may have generated them. An analysis was also carried out of the results obtained from the count of three leukocyte categories, subsequently compared with the number of parasitic helminths collected in order to define whether the Italian wall lizard in Calabria can really be considered a good bioindicator in habitats with different level of anthropization. The site that is least affected by anthropic pressures was not only the one to present exclusively nematodes, but also the least parasitized in general. For what concerns leukocytes, however, while for the populations relating to the "less anthropized" sites the number of leukocyte categories remains fairly constant (relatively low and relatively high respectively), this is not the case for the site with greater anthropic pressures and pollution, in fact basophilic leukocytes are particularly low. It is possible that in the exclusive presence of a specific category of parasites not only are the eosinophils more

effective (much greater in number) but that the increase in basophils could act (also thanks to future studies) as an indicator of a multispecific parasitosis.

A-1396 (Poster)
Decoding the Complex Vocal Repertoire of *Polypedates leucomystax* from Flores Island, Indonesia

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Acoustic signalling is the primary mode of communication in amphibians, especially anurans. Male frogs usually produce stereotyped calls but certain species of anurans have been known to possess multiple call types. *Polypedates leucomystax* is a species complex, with a wide distribution ranging from Indian subcontinent to South East Asia. Also, *P. leucomystax* is one of those species distributed on both sides of the Wallace line, probably facilitated by accidental human-mediated dispersal between the oceanic islands. In this study, we have analysed 70 calls of two individuals of *P. leucomystax* from Flores island, Indonesia. Flores is a Wallacean island and is isolated from both the Asian and the Australian continental shelves due to lack of land bridges, making it a host to several endemic fauna. Existing studies on *P. leucomystax* has only described vocalization of individuals from the Asian region necessitating bioacoustics study in the Australo-asian region, where Flores island is located. We conducted a Principal Component Analysis using the 17 analysed temporal and spectral call properties. Based on our analysis, the species *P. leucomystax* showed a complex vocal repertoire and the calls were categorised into five distinct call types. Females of some species have been known to prefer complex calls. Such variations are thus, important for understanding sexual selection as well as evolution of acoustic signals due to geographical divergence. Future comparative studies with other *P. leucomystax* populations across its distribution range can help in understanding phylogenetic relations between populations across the Wallace line as well contribute towards conservation efforts for this poorly studied species.

A-1398 (Oral)
Diversity and Ecology of Amphibians and Reptiles along Karst Habitat Gradients in Dinagat Islands, Philippines, and its Implications for Island-wide Conservation

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Conservation of highly significant biological habitats relies on practical field-based information acquired through expeditions and field investigations. In the Philippines, karst habitats are among the most threatened environments, but they are still relatively less explored in terms of biodiversity. Here, we performed multiple comprehensive herpetological fieldwork on the west side of Dinagat Islands in September 2019, and January to March 2020. We used the standard sampling method and employed a 48 10 by 100 meter transects in four identified habitat gradients in Dinagat and Unib Island. A combination of visual encounter survey, microhabitat searches, and opportunistic catching was done in surveying herpetofauna. We documented a total of 60 species (13 frogs, 27 lizards, 19 snakes, and one turtle) in more than 48,000 square meters of karst landscape across a disturbance gradient (e.g., approximately 3,220 person-hours spent), providing extensive information on the herpetological diversity in the island. Our records included 36 Philippine-endemic species, 17 species with new distribution records, two threatened species, and four possible novel species. High species diversity was recorded in mature secondary forest (H = 2.656) and found least in old growth forest (H = 2.299). The information we generated allowed us to identify priority areas for conservation (i.e., municipalities), where future conservation measures, awareness campaigns, and policies for protecting these ecologically significant habitats can be made. With this, we provisionally recommend the immediate protection of the karst habitat within Basilisa municipality in Dinagat, due to the high species diversity, the rare amphibian and reptile endemics, and the possible novel taxa it harbors.

A-1399 (Oral)
Conserving Amphibians in a Multi-use Landscape: A Case Study from Western Ghats, India

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Our project is anchored to the biodiversity hotspot of Western Ghats in India, in the Munnar Landscape. It is a lush green multi-use mosaic landscape, harbouring 47 species of frogs, including 45 Western Ghats endemics and several threatened species. Although the habitats of most of these species are shrinking because of human activities, such as changes in land use and urban development, there are significant gaps in our understanding of the population and distribution status of most species. We aim to protect and restore habitats and assess the conservation requirements of five endangered endemic species: *Beddomixalus bijui, Rhacophorus pseudomalabaricus, Raorchestes resplendens, Nyctibatrachus deccanensis*, and *Nyctibatrachus poocha*. Since 2020, we are implementing a multifaceted strategy, partnering with government and non-government stakeholders for amphibian conservation. Through our collaborations with plantation estates, we have secured five water bodies to boost breeding grounds. We are also advocating for frog-friendly practises in plantations, aiming to minimise habitat deterioration. From 118 man-hours of surveys, we recorded 886 individuals of 35 species, including six Endangered species. *N. poocha* was the most abundant with an encounter rate of 127 individuals/100 man-hours, while *B. bijui* and *R. pseudomalabaricus* were rare (2 and 7 individuals/100 man-hours respectively). Forest fragments and swamps spread among plantations were critical habitats for several of these species. This increases the vulnerability of these population, indicating a need for management interventions in plantations to enable

habitat and population recovery. The secured water bodies were used by thirteen species with *N. poocha* colonising all secured waterbodies. *R. pseudomalabaricus* breed in one of these water bodies, showing two seasonal breeding peaks associated with southwest and northeast monsoons. Conservation interventions have the potential to improve habitat quality and aid in the population recovery of threatened amphibians in the Munnar landscape.

A-1400 (Oral)

Butterfly Lizards (Reptilia: Agamidae: Leiolepidinae) - As a Model Group for Studying Reticulate Evolution Processes

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Butterfly lizard (*Leiolepis*) represent a distinct group of agamid lizards comprising 10 species to date, four of which are asexual species, believed, based on available data, to be the product of hybridization between two parental species, *L. guttata* and *L. reevesii* (*L. rubritaeniata*). It is precisely this group of lizards that we have chosen for the study of reticulate evolution processes, which have resulted, in part, in the emergence of asexual species. In total, 135 lizards were collected, belonging to four sexual species (*L. belliana, L. guttata, L. reevesii, L. rubritaeniata*), and four asexual species (*L. guentherpetersii, L. ngovantrii, L. boehmei and L. triploida*). Species identification was determined through examination of external morphology, as well as by analyzing the mitochondrial gene CytB, nuclear gene C-mos, and RAD seq. To refine the species identification of asexual species, as well as specimens with intermediate morphological features, we employed cytogenetic methods, including determination of chromosome numbers and comparative genomic hybridisation (CGH). The following results were obtained: 1) the ranges of the studied species were refined. In particular, zones of syntopic occurrence were found for *L. guentherpetersii* with both parental species (*L. guttata* and *L. reevesii*) and hermaphroditic species with each other; 2) mosaic distribution of two asexual species was identified in Thailand (*L. boehmei* and L. triploida), requiring a redefinition of previously collected collections; 3) models of potential species distribution (SDM) have been created for three Vietnamese species: *L. guttata, L. reevesii*, and *L. guentherpetersii*, demonstrating the intermediate position of the habitat of asexual species relative to the parental species; 4) a tetraploid hybrid between *L. guttata* and *L. guentherpetersi* was found, confirming ongoing hybridization processes and gene exchange in areas of cohabitation. The research was funded by grant No. 22-14-00227 from the Russian Science Foundation (RSF).

A-1401 (Oral)
Acetylcholinesterase Inhibitor Use in Neurotoxic Snake Envenomation: Philippine Experience

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The Philippines belong to the ASEAN region with one the highest number of medically important Category 1 snakes, meaning snakes with the most common venomous species responsible for the highest morbidity and mortality (WHO, 2016). It is estimated that there are 160+ species of snakes described, 70% are endemic to the country, and 33 are believed to be venomous. By far, the most important local snake is the endemic Philippine cobras (Naja philippinensis and Naja samarensis) belonging to the family Elapidae, which comprises of majority of deaths locally due to its neurotoxic envenomation (Cortes-Maramba et al., 2011). Treatment includes prehospital application of pressure bandage immobilization, administration of purified cobra antivenom (PCAV), a monovalent antivenom derived from N. philippinensis, and supportive wound care (RITM, 2019). Recently, some hospitals experience difficulty in acquiring PCAV. Thus, if PCAV is not readily available, anticholinesterase inhibitors like neostigmine or edrophonium (IV), and pyridostigmine (per NGT) may be given for the reversal of the neurotoxic signs (Cortes-Maramba et al., 2011). This intervention has shown benefit in several retrospective reviews and clinical trials (Belleza et al., 2016; Sugiarto et al., 2001, Tindungan and Espinosa, 1998), including the landmark trial by Watt and colleagues (Watt et al., 1986; Watt et al., 1989). The lecture will share and highlight the use of anticholinesterase inhibitors with the scarcity of antivenom in our country.

A-1403 (Oral)
New Insights into the Natural History of Western Ghats Caecilians

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India's Western Ghats region is a hotspot of caecilian amphibian diversity. Most studies of the natural history of Western Ghats' caecilians have been on taxonomic diversity, based on relatively few specimens from few localities. Few studies have been conducted thus far of Indian caecilian ecology and behaviour, for multiple reasons including lack of dedicated or appropriate fieldwork, challenges in studying soil-dwelling taxa, few local experts, and the lack of facilities for studies in captivity. However, some Indian caecilian species can be locally abundant, and India is one of the few countries having both caecilians and caecilian biologists, so there is potential for progress in discovering other aspects of their diversity and natural history. We have conducted systematic, extensive, multi-year, multi-season fieldwork in a selected region of the southern Western Ghats, aiming to better document taxonomic diversity but also to discover distributions and other aspects of ecology. We have identified patterns of spatial distribution of the three caecilian genera found here, and documented soil parameters

of their microhabitats. We employed multiple sampling methods to test their efficacy. Digging remains the most effective method of locating caecilians, though employing multiple methods provides opportunities to discover aspects of ecology. Bringing animals into temporary captivity in a new facility enabled us to conduct experiments on circadian rhythm and surface activity. The three species studied were all strictly nocturnal, with a weak circadian rhythm. Variation in the extent of surface activity among the study species partly matches predictions from interpretations of morphology and from qualitative and anecdotal field observations, as well as our new quantitative field data. Many of our investigations and findings are firsts for Indian caecilians. A multidisciplinary approach including fieldwork, static (eco)morphology, and studies in captivity can yield new insights into the natural history of these generally poorly known animals.

A-1404 (Oral)
Herpetofauna Surveys in the Gold Mining Region of Western Ethiopia

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A series of biodiversity field surveys was conducted by Flora Fauna and Man, Ecological Services (FFMES) during the period 2015 to 2022, to serve as baseline assessments for the prospective gold mining projects at Dish Mountain and Ashashire in western Ethiopia. Prior to these surveys, the herpetofauna of this region had been relatively poorly explored. The FFMES studies recorded a combined total of 1935 herpetofauna observations for the two study areas, including several new country (Ethiopian) and new regional state (Benishangul-Gumuz) records, as well as instances of species that were previously known from only a few (< 5) records from Ethiopia. Some of these records are of taxonomic interest, including taxa that are currently undescribed. A substantial limitation encountered during these baseline assessments was the bureaucratic difficulties experienced in obtaining export permits for voucher specimens and tissue samples for post-fieldwork analyses. This situation hampered morphological examinations and prohibited genetic analyses, thereby reducing the potential for producing scientific publications. The usefulness and shortcomings of using online biodiversity 'virtual museum' platforms (e.g., iNaturalist.org) as an alternative to depositing voucher/tissue material in classical museum holdings is discussed in the context of producing interim publications of the survey results.

A-1405 (Oral)
The Effects of Livestock Grazing on Populations of Two Endangered Lacertids, *Phoenicolacerta kulzeri* and *Parvilacerta fraasii* in Lebanese Mountains

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Two endangered Lebanese lacertid lizards *Phoencilacerta kulzeri* and *Parvilacerta fraasii* are found at high altitudes in Lebanese mountains and are sympatric at altitudes between 1900 and 2100m asl, together with a skink species, *Heremites vittatus* which is more widely distributed in Lebanon at all elevations. Field studies were conducted on their habitat structure and preferences The results show habitat differences between the three species in terms of physical structure and types of vegetation associated with these habitats. The species were studied in protected and unprotected areas and both lacertid species are not more abundant in protected areas. The main "disturbance" in the unprotected areas is livestock grazing which affects the vegetation composition and physiognomic structure but leads to increased abundance of the two lacertid species.

A-1406 (Oral)
The Global Women in Herpetology Project: Putting a Spotlight on the Diversity of Women Working with Amphibians and Reptiles

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Gender equality remains a major issue globally. Though it has been improving in some areas during the last decades, women in many professions, including herpetology, are still underrepresented as a whole. The number of women is lower than men at all career stages. We will present data showing that representation decreases as the career stage increases. Societal structures, cultures, norms, and traditions have been identified as factors contributing to gender inequality. However, the exposure to diverse role models and broader representation within STEM has a positive effect in the recruitment and retention of students and early career biologists, especially from underrepresented groups in STEM. To increase the visibility of women in herpetology across disciplines, regions, and cultural backgrounds, we are working on a collaborative project with female herpetologists worldwide. This project, titled "Global Women in Herpetology" consists of three main parts: (1) a book, (2) a network directory and (3) a scholarship. The book is a compilation of short stories where 50 female herpetologists from 50 countries (representing one quarter of the countries in the world) share a personal narrative that intersects their gender, cultural background, and professional journey. The profits of this book were used to establish a conference scholarship for female students in underrepresented regions around the world to attend the World Congress of Herpetology X in Malaysia. The network directory provides a searching tool to promote collaborations with and among women. Through this initiative, our aim is to collectively place a spotlight on the diversity of women in our field and encourage more young generations to enter the field of herpetology.

A-1407 (Oral)
Antimicrobial Defenses of Reptilian Eggs

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How do reptilian eggs avoid microbial infection? These eggs contain both an embryo and yolk that are potentially rich food sources for bacteria, and have less of the albumen that provides water to avian eggs. Thus, reptile eggs must import external water for the developing embryo, potentially allowing influx of bacteria. Here, we show evidence for two potential mechanisms of antimicrobial defense in reptilian eggs. First, protein analyses and antimicrobial tests indicated the presence of potent antimicrobial proteins in reptilian yolks, with the strongest in soft-shelled eggs. Such proteins, typically found in the albumen of bird eggs, may provide a last line of defense against infection once bacteria have passed through the shell. Furthermore, experimental tests and microscopy indicate that the fibrillar matrix of eggshells selectively filters bacteria from water that crosses through it. Thus, eggs contain multiple defensive layers that collectively lower the risk of infection and therefore hatching failure. The precise mechanisms and evolution of these defenses will be rich areas for future research.

A-1408 (Poster)

Herp Havens in the Metropolis: A Snapshot of Amphibian and Reptile Communities within Urban Green Spaces in the Philippines

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Urban green spaces have since become important refugia for herpetofauna. The presence of freshwater habitats in these civilized green spaces creates safe havens for amphibians and reptiles by providing both food and shelter. However, rapid urbanization and changes in land use and land cover have greatly impacted the integrity of these important habitats. We conducted biodiversity surveys within three urban sites in the Philippines, namely: San Jose Del Monte City, Bulacan; Municipality of Nasugbu, Batangas; and Davao City, Davao. The findings reveal a surprising diversity of herpetofauna with a cumulative total of 46 species (17 frogs, 19 lizards, and 10 snakes) and an endemism rate of 57% (27 Philippine endemics): 25 species in Bulacan (40% endemism), 15 species in Batangas (53% endemism), and 26 species in Davao (46% endemism). Threats from habitat degradation faced by these urban herpetofauna were compounded by competition against invasive alien species, including *Rhinella marina, Hylarana erythraea, Kaloula pulchra*, and *Hoplobatrachus rugulosus*. Maintaining and protecting these herpetofaunal communities requires concerted efforts to support their survival requirements. Our findings reveal that these urban green spaces are still capable of sustaining favorable microhabitat conditions including sufficient water security, canopy cover, and ground litter that provide shelter to these species. Enhancing public awareness and conservation initiatives that foster a sense of ownership and responsibility for native wildlife will be crucial for safeguarding these species. We also believe that the incorporation of green architecture and wildlife corridors in urban planning will be crucial steps in achieving coexistence with wildlife and supporting urban biodiversity.

A-1409 (Oral)

Evaluating the Long-Term Effect of Successful Translocation on the Genetic Diversity of Romer's Tree Frog (*Liuixalus romeri*) in Hong Kong: Small Steps Lead to Giant Leaps

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The Hong Kong International Airport was built by reclaiming land from the ocean and flattening Chek Lap Kok Island. Among the species inhabiting the island was the endangered *Liuixalus*. Due to imminent airport construction, this population was translocated to eight sites where the species was not previously found in Hong Kong. Subsequent population monitoring found that three were unsuccessful, and five are were successful. Our study aims to 1) provide a detailed translocation history of *L. romeri* , 2) evaluate the long-term effect that translocation had on *L. romeri* genetic diversity and 3) identify the environmental variables that promoted translocation success. We performed double digestion RAD sequencing for 61 individuals from 16 localities (8 native, 8 translocation). We found that each native island represents a genetically independent cluster, and the translocation sites are not significantly different from each other. We extracted environmental data (NDVI, slope and bioclimatic variables) from the localities of successful and unsuccessful translocation sites, and all Hong Kong sites with *L. romeri* records in four 5-year time intervals. Only the slope was significantly different between successful and unsuccessful translocation sites, and that the precipitation and the temperature were significantly different between sites and across the four 5-year time intervals. By estimating the genetic diversity of *L. romeri* post-translocation and accounting for the environment suitability, we provide information to help manage the conservation efforts for this species, as well as contribute to the general understanding of the impact of translocations.

A-1410 (Poster)
Unveiling Cryptic Species Diversity of Ranidae of the Western Ghats

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The tropical rainforests of the Western Ghats have been identified as one of the significant regions for amphibian diversity, supporting several endemic and cryptic species. Cryptic species are morphologically similar but genetically distinct which may arise due to recent divergence in populations. When genetic differences accumulate without corresponding morphological changes in lineages, their identification and delineation becomes difficult. Thus, distinguishing cryptic taxa requires the integration of multiple lines of evidence such as geographic, genetic, and morphological data. The current study focuses on the frogs of the family Ranidae of the Western Ghats, including two genera, *Clinotarsus* and *Hylarana*. Despite extensive measurements of 32 morphological characters, grouping populations with similar characters proved insufficient to distinguish cryptic species within the genus. Therefore, we aimed to identify cryptic lineages by reconstructing phylogenies, analysing geographic distance and building haplotype networks. The ranid frogs of the Western Ghats are a complex of multiple cryptic lineages with geographical separation between them. Five of these lineages also showed high levels of genetic divergence. By integrating multiple lines of evidence, we examine cryptic species within this group, contributing to a broader understanding of the significance of the Western Ghats as a habitat for species diversification.

A-1411 (Oral)
Taxonomic Reassessment of Flying Frog (Amphibia: Rhacophoridae) from Sangihe Island, Indonesia

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Sangihe, a remote island of Indonesia situated at the tectonic junction between the Sulu and Indonesian Archipelagos, represents the easternmost distribution limit of the tree-frog family Rhacophoridae, alongside Mindanao Island in the Philippines. *Rhacophorus pardalis* was once considered a widespread species distributed in the Philippines, Borneo, Sumatra, and Sulawesi until the Sulawesi population (from Sangihe) was reclassified as a subspecies, *R. p. rhyssocephalus*. During a field expedition to Sangihe Island in 2023, we collected two specimens of this subspecies and examined their morphology in comparison with the nominotypical subspecies from Borneo. Subsequent molecular studies (12S and 16S rRNA) between the Borneo and Sangihe populations revealed that the subspecies *R. p. rhyssocephalus* is actually nested within the *R. georgii* clade in Sulawesi, and not within the widespread *R. pardalis* clade. Furthermore, *R. pardalis* and *R. p. rhyssocephalus* exhibit a high genetic distance of 14-15%. Our morphological comparison also showed unique differences between the two subspecies, such as a prominent U-shaped ridge present in the Sangihe population (vs. absent in Borneo). Therefore, the population from Sangihe is distinct from *R. pardalis* and should no longer be considered a subspecies of *R. pardalis*, warranting an integrative taxonomic reassessment. Moreover, the Sangihe subspecies should be elevated to species level, supported by the comprehensive phylogenetic tree we have constructed. By examining the taxonomic complexities and significant discoveries on this remote island, this study will enhance our understanding of insular evolutionary processes in this intercontinental archipelago region, which has not been fully explored.

A-1412 (Oral)
Amphibian Species as Indicators of Habitat Quality in Mount Mantalingahan Protected Landscape, Palawan, Philippines

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Indicator species act as an effective early warning system for environmental health. Although amphibians are often used as ecological indicators, the vast majority of species populations are threatened by rapid environmental changes. This study aims to provide information on the state and condition of forest habitats and aid in developing mitigation strategies for threats to biodiversity. We surveyed amphibians along 29 two-kilometer transect lines across habitat and

elevational gradients within the Mount Mantalingahan Protected Landscape from February to May 2023. We recorded 23 anuran species, including nine (9) threatened species and 14 (61%) Philippine endemics. Various multivariate ecological analyses were used to define forest habitat conditions and indicator species. Two species showed to be indicators of high elevation forests (*Pelophryne albotaeniata*) and mixed vegetation habitats (*Philautus longicrus*). Both species can be used separately for evaluating habitat conditions. *P. albotaeniata* is an indicator of good quality forests, while the remarkable tolerance of *P. longicrus* to habitat change demonstrates that mixed vegetation habitats may serve as intermediary microhabitats. We then examined their survival envelopes based on their respective spatial distribution ranges to gain a deeper understanding of their ecology and habitat relationships. The predicted suitable habitats were found along areas with sufficient vegetation, across various elevational gradients, and in close proximity to streams or rivers. Predictive modeling showed suitable habitats were highly influenced by land cover, elevation, and topographic wetness index, which suggests that environmental covariates play a vital role in shaping these preferred habitats. Indicator species produce prioritization measures by highlighting areas of high conservation value. A multi-indicator species approach using a combination of species from different taxonomic groups can provide more robust data on habitat conditions. This data will aid area managers in safeguarding conservation success when used in science-based decision making.

A-1413 (Oral)
Systematics of Caecilians of the Seychelles

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The Seychelles harbours an ancient radiation of caecilian amphibians (eight species in two genera) of a family, Grandisoniidae, with representatives in Africa and India. I review the history of the taxonomy and systematics of these caecilians and present recent findings on their phylogenetic relationships based on genome scale data.

A-1414 (Oral)
With Knowledge Comes Hopefully Fewer Bites: A Systematic Review, of Published Case Studies and Case Reports of Snakebite In Africa

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The incidence and mortality of snakebites in Africa are most often estimated from medical and scientific literature, many times this lacks key ecological and behavioral information on the culprit species, and also the situation that led to the bite. In many reported snake bite incidents, the species is neither seen nor identified. The annual range of deaths caused by snakebites in Africa highly fluctuates with estimates ranging from 7,000 to 20,000. We believed it necessary to thoroughly investigate snakebite literature from an ecological perspective and also to examine for any trends in causation. We conducted a systematic literature search on snakebite research in Africa over time up until 2024 using the Web of Science™ and Scopus search engines on 28th February and 18th February 2024, respectively. The search strings used for this review identified internationally peer-reviewed publications and conference proceedings

of snakebite research across all African countries, and also work done outside the continent but on African species venom. To obtain these publications, we used the search terms, snake, snakebite, Africa, case report, and case study, to ensure all relevant research was gathered. The results for each publication were recorded in a Microsoft Excel spreadsheet. The search string used was not limited to publication date, ensuring all snakebite publications conducted in Africa were included. In both Excel files each publication that was provided by Web of Science and Scopus we added our additional criteria which were; Country, Patient, snake species, area type, tried to catch or kill the snake, Indoors/outdoors, patient outcome, and finally was the snake killed. Each publication is being manually cross-examined for this information and is being added for analysis. To date, 1,596 publications have been cross-examined and removed for not fitting our criteria. This is ongoing research with the detailed results prepared for presentation.

A-1415 (Poster)

Contrasting the Evolutionary Dynamics of the PRDM9 Gene in Two Genera of Lizards, the Wall Lizard (*Podarcis* Sp.) and Green Anole (*Anolis* Sp.)

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PRDM9 plays a crucial role in controlling meiotic recombination across most metazoans, specifying the sites and facilitating the repair of meiotic double-strand breaks. Furthermore, the gene encoding PRDM9 is the only known speciation gene in vertebrates. It contains a zinc finger domain that exhibits considerable variability, particularly in its rapidly evolving minisatellite region determining the DNA binding position. Although the PRDM9 gene holds significant importance, there have been numerous losses in the tree of life. Squamata, in particular, are fascinating because there have been documented instances of gene loss in certain species of lizards like *Anolis carolinensis*, as well as redundancy in some species of snakes, such as rattlesnakes. Our research involves examining PRDM9 pseudogene presence in various species within the *Anolis* genus. Including studying the gene's variability in the ZNF array, comparing its evolutionary dynamics in two lizard genera (*Podarcis* and *Anolis*), and exploring the evolution of PRDM9 and coevolving genes across Squamates. We amplified the ZNF arrays across all *Podarcis* species, revealing no apparent losses and variability in *Podarcis*. Contrary to previous literature, they were amplified even in certain *Anolis* species, indicating unconfirmed losses. The absence of the gene in certain lineages may suggest recent losses. Considering the crucial role of PRDM9 in recombination pathways, this absence implies a potential alternative mechanism adapted by Squamates.

A-1416 (Oral)

Amphibians and Reptiles of Dryland Island, Timor Island, East Nusa Tenggara

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The study of amphibians and reptiles in the East Nusa Tenggara region is very different from the study of amphibians and reptiles in the Lesser Sunda region. The study of amphibians and reptiles of East Nusa Tenggara has not yet received attention despite the fact that the East Nusa

Tenggara region has unique species of not only reptiles, but also amphibians. The East Nusa Tenggara region is divided into islands, making it possible for species on one island to be different from other islands. Therefore, this study is a long-term research to record amphibian and reptile species in East Nusa Tenggara. On this term, the location was divided into Timor Island for the first step, on the campus of the University of Nusa Cendana (UNDANA) campus, Kupang City, Kupang Regency, South Central Timor Regency and North Central Timor Regency in November 2022, and January until December 2023. This study aim to identification the diversity of amphibians and reptiles from Timor Island using Visual Encounter Survey combined with Time search with a time limit of two hours of observation. Data collection was carried out at night in terrestrial and aquatic locations and recorded total 16 species (seven species amphibians and nine species reptiles) that were identified to the species level. Herpetofauna was recorded at the built area and natural habitat with minimum disturbance. Then we found that the highest altitude to find amphibians in Timor Island around 1,700 masl from Mutis Timau Nature Reserve, *Litoria everetti*.

A-1417 (Oral)
Citizen Conservation – Joining Efforts to Prevent Species Extinctions

Björn Encke[1,2], Johannes Penner[1,2], Heiko Werning[1,2], Tina Nagorzanski[1,2], Vanessa Dubberke[1,2] and Mark-Oliver Rödel[1,2,3]
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The ongoing decline of biodiversity is well documented. However, efforts are currently not sufficient to effectively to stop it or even reverse it. This has been recently also shown by the latest Global Amphibian Assessment. Despite numerous existing *in situ* and *ex situ* conservation efforts, additional endeavours are thus necessary. An important resource is the voluntary commitment of civil society. There are a large number of people who are willing and able to actively participate in efforts to combat the current biodiversity crisis and this resource should be activated. This might be especially true for *ex situ* conservation strategies where professional institutions, but also a large number of private persons, have already saved many species from extinction. We believe that joining institutional efforts with amateur knowledge, together contributing to *ex situ* programmes for selected species, has a huge potential. However, such effort needs coordination. Citizen Conservation is an NGO under whose umbrella zoological institutions and private enthusiasts meet and in a joint effort, keep and breed endangered species of selected animal groups, currently amphibians, fish and reptiles, following evidence based management guidelines. We illustrate the framework of Citizen Conservation, the coordination guidelines of our programmes, that we have significantly increased *ex situ* capacities and display our road for the future.

A-1418 (Oral)
Uncover the Hitherto Overlooked Cryptic Diversity of Blind Snakes in Bangladesh

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When compared to neighboring countries, Bangladesh's understanding of its herpetofauna is inadequate. The number of snake species present in this country remains uncertain. Only three to four species of blind snakes, namely *Indotyphlops braminus, Typhlops diardii, T. jerdoni,* and *T. porrectus*, are believed to exist in Bangladesh. Our current study, conducted from January 2018 to December 2019, utilized mtDNA and morphological methods to confirm the presence of at least five blind snakes in Bangladesh. The blunt heads, cylindrical bodies, and short, pointed tails distinguish these organisms. The animals are fossorial, meaning they dig underground. They mostly consume termites, ants, soft-bodied insects, and their eggs. Its global dispersion was achieved by colonizing the soil in potted plants and reproducing through parthenogenesis. The specimens from Lawachara National Park (BS-28) were genetically different from a closely related species (*Argyrophis muelleri*) (5.45% in the Cytb gene [Cytb]). This genetic difference, along with the observed physical characteristics, supports the classification of these specimens as a new species. A different group of specimens (BS-7, 8, 13, 15, 27, 28, 29, 30, 33, and 34) from different parts of the country had a clear genetic difference of 19.0–25.5% Cytb compared to other known blind snake species. This suggests that these individuals may represent cryptic species or potentially new species. The current discovery will serve as a fundamental dataset that could be useful for future research and conservation efforts on the herpetofauna in Bangladesh. These findings suggest a lack of thorough investigation into the extent of blind snake species diversity in Bangladesh, necessitating further research to fully understand the genetic diversity of blind snakes in the country.

A-1419 (Oral)

Biologically Tailored Distribution Models Reveal Widely Divergent Potential Climate Change Trajectories Among Four Co-occurring Specialist Amphibians

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Whether or not "indicator species" are viable for representing entire guilds or communities under climate change is a critical factor affecting the amount of effort needed to identify overarching climate-smart conservation strategies. As amphibians are commonly labeled as indicator species, we assessed the viability of this concept using four specialist amphibians (*Ascaphus montanus, Dicamptodon copei, Plethodon idahoensis*, and *Plethodon vandykei*) belonging to the same groundwater-dependent guild in the Pacific Northwest, USA. We used boosted regression trees to construct species distribution models (SDMs) for each species, then projected future suitable areas under different climate change scenarios. We hypothesized that our study species would share broadly similar projected climate change trajectories (e.g., northward shifts in suitable areas and modest reductions in overall suitability) given their overlapping environmental preferences. Contrary to our expectations, projected climate change trajectories were highly idiosyncratic among species, suggesting risks of treating individual species as indicators of broader (e.g., guild-wide) climate change impacts. Notably, *A. montanus* was the only species meeting our combined expectation of northward-shifting suitability and a modest overall reduction in suitable areas by 2071-2100 under a moderate-to-severe climate change scenario (SSP370), whereas projected suitability for *D. copei* either shrank or grew in place depending on region. Surprisingly, the extent of highly suitable areas projected for *P. idahoensis* expanded four-fold by 2071-2100 under moderate-to-severe climate change, whereas, in stark contrast, its sister species *P. vandykei* was projected

to experience a three-fold loss in highly suitable areas under the same scenario, disproportionately impacting Cascades populations. Moreover, model performance (AUC scores) increased in all cases when using species-specific predictor variables (e.g., seep-specific variables for seep-associated species) to construct SDMs. Overall, our findings suggest that climate change "indicator species" are conceptually questionable within our study system, underscoring the need for climate-smart conservation plans to consider subtle biological differences among species.

A-1420 (Oral)
DNA Barcoding of Sea Snakes in Bangladesh

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Snakes are renowned for their significant role in maintaining ecological balance and promoting the overall well-being of an ecosystem. Sea snakes, which are reptiles belonging to the Squamata order and Elapidae family, have effectively adapted to the saltwater environment. Among the 102 snakes documented in Bangladesh, only 12–16 species have been found in the water (specifically the Bay of Bengal) within Bangladesh's boundaries. The Bay of Bengal encompasses the entire southern region of the country and stretches downstream, providing habitat for a wide variety of fauna. Based on this information, it is easy to infer the existence of a substantial reptile sanctuary over a vast geographical area. However, it is unfortunate that there has been minimal focus on snakes since Bangladesh achieved independence in 1971. The sea snake is classified in the genera *Hydrophis* and *Laticauda*, which include the sea kraits. The IUCN 2015 (Bangladesh Chapter) report lists the following sea snakes: *Hydrophis cantoris, H. cyanocinctus, H. caerulescens, H. curtus, H. fasciatus, H. gracilis, H. nigrocinctus, H. lapemoides, H. ornatus, H. obscures, H. platurus, H. schistosus, H. stokesii,* and *H. stricticollis*. The report also includes two species of Sea Kraits: Laticauda colubrine and L. laticaudata. Yellow-lipped Sea Kraits (*Laticaudata colubrina*) and Black banded Sea Kraits (*L. laticaudata*) inhabit the waters surrounding St. Martin Island in the Bay of Bengal. From January 2024 to the present, our morphological and genomic analysis has revealed the list's incompleteness and numerous inaccuracies. Our collected the Teknaf and Kuakata specimens showed significant divergence (based on the COI gene) from the nominal species. As a result, our current discoveries can serve as fundamental data for conservation and local herpetologists. Additional research is required to thoroughly investigate all aspects of sea snakes in this underdeveloped country.

A-1421 (Oral)
Habitat Quality Modelling of *Chelodina mccordi* in Rote Island

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The Rote Island Snake-necked Turtle (*Chelodina mccordi*) is an endemic species found only on Rote Island in East Nusa Tenggara, Indonesia. Since 2018, the IUCN has categorized it as a critically endangered species. In 2022, successful captive breeding facilitated the transfer of 13 *C. mccordi* from Singapore to Indonesia. These individuals are currently held at Kupang and will be released into Rote Island's lakes, their natural home. The purpose of this study is to analyze the habitat quality of *C. mccordi* and will be undertaken in two stages. The first stage involves a study to model land cover changes, specifically water body changes, in 29 lakes across Rote Island from January to April 2024. This study will focus on lakes on lakes other than Peto, Ledulu, and Lendeoen which have been previously studied. We aim to detect and evaluate changes in water body size through spatial analysis spanning 30 years. This habitat quality study aims to provide a comprehensive analysis of the habitat suitability. The habitat of *C. mccordi* is typically characterized by permanent water bodies with relatively low water temperatures. Previous studies have reported that the water quality conditions in existing lakes on Rote Island adequately meet the habitat requirements of *C. mccordi* based on their habitat characteristics. However, these studies focused only on the three main lakes, while spatial modeling indicated that they cover less than 10% of the water bodies on Rote Island. For the second stage, we will continue our fieldwork on the 29 lakes identified in the first stage of the study to verify the models generated through spatial analysis on June-July 2024.

A-1422 (Oral)

Living in Paradise: Comparative Phylogeography of Seychelles Caecilian Amphibians Reveals Differing Evolutionary Histories

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Our understanding of the genetic patterns of intraspecific variation among Seychelles organisms is relatively lacking in comparison to other major island groups. Studies of comparative phylogeography on the Seychelles would provide insight into the processes that have affected the archipelago's biota. In this presentation, we report investigations of the phylogeography of the partly co-distributed caecilians of the Seychelles. The Seychelles caecilians provide an interesting opportunity to study patterns of comparative intraspecific variation because they are an ancient, morphologically distinct radiation with different life-history strategies and which occur across multiple of the granitic islands. Data were generated for one mitochondrial and four nuclear loci in 244 caecilian specimens. Contrasting patterns of intraspecific geographic variation were observed among the species: no geographic variation (*Hypogeophis sechellensis* (in mtDNA) and Praslinia cooperi), a basal northern- vs southern-island split (*Hypogeophis rostratus*), a geographic split between specimens from the western island of Silhouette and elsewhere (*H. alternans* and *H. larvatus*), and one species showing independence of each island population (*H. sechellensis* (in nuDNA). Based on our current knowledge of the ecologies and life histories of the Seychelles caecilians it is unlikely that the observed genetic patterns of geographic variation are the result of a single causal factor.

A-1423 (Oral)
Asia's Herp Route: Understanding Herpetofauna Trafficking in Asia through Analysis of Seizures

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Asia is an important source, transit, and consumer of a wide array of wildlife species that are acquired both legally and illegally. Reptiles and amphibians feature prominently, prevalent in the illicit trade network. Here we present insights gleaned from seizures recorded by TRAFFIC, spanning 2000 to 2023 across Asia. Our data shows that more than a million reptiles and amphibians have been seized across 31 countries and territories during this period, predominantly involving live specimens. Additionally, over 200 tonnes of reptile and amphibian meat and body parts were intercepted. Confiscations involved species that are either banned from trade or those for which trade is permitted and subjected to legal trade regulations, encompassing over 400 species; Testudines accounted for over half of the incidents. Records involving amphibians however was notably scarce, representing only 2% of overall incidents. Over the 24-year period, more than 3,000 people were detained or arrested, revealing diverse trafficking trends and patterns across species and nations. A multi-faceted approach throughout the entire trade chain, from source to market, is imperative. Strengthening trade regulations and investment in investigative efforts are crucial to curbing illegal and unsustainable trade and disrupting criminal trade networks. Targeted initiatives to reduce demand and influence consumption patterns are also essential in addressing this issue effectively.

A-1424 (Oral)
Aesthetics, Education and Conservation – Telling Amphibian Stories to a Broad Public

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A basic problem of exhibiting amphibians for educational purposes is that many species lack a critical amount of extroversion. This characteristic has left zoos and other institutions neglecting amphibians in their collections in the past. However, with more than 700 million annual visitors, the scientifically led WAZA-zoos around the globe play a key role in educating people about biodiversity and the threat its loss poses for mankind. Consequently, the critical situation amphibians face takes place almost totally outside of general public awareness. In 2014 the non-for-profit organization Frogs & Friends was founded by scientists and media experts to act as a PR-agency for amphibian conservation, searching for new ways of storytelling, online and offline. Frogs & Friends was approached in 2021 by Hanover zoo and asked to develop a concept for an amphibian exhibition in a space of approximately 250 square meters. After successful planning and construction the so called “Amphibium” was opened in May 2024 to the public. The presentation will give a short overview of the approach we chose to attract visitor’s attention to the fascinating life of amphibians on the one hand, while on the other hand placing a spotlight on the need of coordinated breeding programs to fight the biodiversity crisis. The main quest was to find a balance between light musings of storytelling and hard necessities of amphibian conservation, held together by a modern exhibition design.

A-1425 (Oral)

Local Adaptation and Vulnerability to Climate Change in a Forest Lizard in the Amazon

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Genetic variation among current taxa reflects a history of diversification and adaptive mechanisms to cope with changing climates, contributing to the rich biodiversity seen today. Understanding how species respond to global climate change is crucial for informing conservation strategies. In our study, we focused on the widespread and forest-dwelling Amazonian lizard, *Gonatodes humeralis* to explore its adaptive potential and vulnerability to climate change. Through genome-environmental analysis and vulnerability/genomic offset, we identified 56 single nucleotide polymorphism (SNP) under local climatic selection in *G. humeralis*. These adaptive/candidate SNPs exhibited allele frequencies that followed an east-west gradient across the Amazon, indicating significant differences across geographic space. We found that allele frequencies were most strongly associated with low precipitation in the hottest months and high precipitation seasonality. Predictions of vulnerability to climate changes revealed contrasting patterns, with the central-western Amazon showing high vulnerability and the southern and eastern portions exhibiting low to moderate vulnerability. Our findings underscore the importance of understanding genome-environment relationships and evolutionary potential in locally adapted lizard populations. The adaptive landscape index we employed provides valuable insights into the underlying evolutionary processes along Amazonian climatic gradients. Populations demonstrating genuine local climatic adaptation may have enhanced resilience to environmental change through mechanisms such as natural selection and genetic rescue. This study emphasizes the necessity of considering spatial contexts and ensuring broad sample coverage to comprehensively understand the role of environmental gradients in shaping patterns of local climate adaptation and vulnerability in lizards and Amazonian landscapes.

A-1426 (Oral)
Adding or subtracting? Biogeography and species limits of the Australo-Papuan death adders (*Acanthophis*)

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The systematics of the death adders (genus *Acanthophis*) in the Australo-Papuan region have remained shrouded in controversy and confusion for many decades due in part to limited

sampling and taxonomic instability caused by unethical practices. Here, we present results derived from three mitochondrial and three nuclear loci for 165 individuals, alongside morphological data to evaluate phylogenetic relationships, species limits and the biogeographic history of the genus. Delimitation methods support a 15-lineage model, confirming putative species and previously unrecognised lineages. We also update species boundaries, especially within Australia, where a lack of previous genetic data impeded confirmation of the range of some lineages. Within New Guinea, lineages of the smooth-scaled death adders (*A. laevis* complex) are broadly concordant with tectonic plate history and the relatively recent formation of New Guinea in its current form.

A-1428 (Oral)
Are Cardiovascular and Pulmonary Systems of Caecilians Impacted by Burrowing?

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Caecilians display morphological substantial variation in their hearts, aortic arches, major veins and lungs, ranging from massive elaboration to complete reduction, and including many asymmetries. I survey our knowledge of this variation, consider the extent to which it may provide useful evidence of phylogenetic relationships and ask whether the variation is explicable in terms of the adoption of burrowing in this lineage of amphibians.

A-1430 (Oral)
Community Perception on Snakes and Trainings on Snakebite Management in the Philippines

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Snakebite as a tropical neglected disease has become both an occupational hazard and a health issue in the Philippines. Community perceptions on snakes and local snakebite management significantly affect the outcomes of both the victims and snakes. Traditional methods predominantly remain to influence the health-seeking behavior of the victims of snakebites. Through proper educational information/dissemination and advocacy trainings, these perceptions on snakes and improper first aid and management of snakebites will be corrected and promote good outcomes of patient and snake preservation.

A-1431 (Oral)
Evolution of Vomerolfaction in Snakes

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Tongue-flicking is a characteristic behaviour of all snakes and is shared by some 'lizards'. The forked snake tongue samples chemical cues in the environment and delivers these to paired vomeronasal (Jacobson's) organs via the roof of the mouth. Numerous studies of snake behaviour have shown that vomerolfaction plays a key role in mediating feeding, mating and predator-avoidance; however, very few studies have attempted to connect vomeronasal

genotypes to phenotypes and the environment during the evolution of snakes. This is largely because squamate vomerolfaction has a complex genetic basis that is underpinned by hundreds of genes in the poorly characterised type-2 vomeronasal receptor (V2R) superfamily. We hope to support future studies by building a genome-wide map of V2R architecture and selection history using chromosome-scale snake genomes. We identify several large clusters of V2Rs that show substantial syntenic and phylogenetic divergence at broad phylogenetic scales. At a fine scale, genome scans of closely related sea snakes suggest an important role for balancing selection in the evolution of V2Rs, and lineage-specific divergence versus retention of V2R polymorphisms provides preliminary clues to their biological activities.

A-1432 (Oral)
A Brief Introduction to the Diversity of Subterranean Amphibians and Reptiles

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Subterranean habitats are usually lightless, hypoxic and hypercapnic inhospitable environments with scarce food resources that lead to strong evolutionary constraints for organisms inhabiting them. Nevertheless, several amphibians and reptiles i.e., caecilian amphibians, fossorial anurans, amphisbaenians, scolecophidian snakes and many more independently evolved a subterranean lifestyle accompanied with diverse adaptations including elongated bodies, robust skulls, stronger forearms, limb reduction, reproductive modes or even a complete loss of the eyesight. However, due to the inaccessibility of the habitat and a lack of sampling methods the knowledge on the biology of burrowing herpetofauna has lacked far behind. The last symposium dedicated to the biology of subterranean herpetofauna i.e, "Quantifying the ecology of burrowing herpetofauna" held at the WCH5 in Stellenbosch, South Africa dates to 2005. Within nearly two decades much information on several aspects of the biology of fossorial amphibians and reptiles has accumulated. The symposium aims to summarise some of these diverse progresses but will also shine a light on the new developments of the research field.

A-1433 (Oral)
Amphibian Conservation in the Anthropocene: Adaptive Traits of Frog Species from South Africa in the Face of Climate Change

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As the most threatened vertebrate class on earth, amphibians are at the bleeding edge of the biodiversity crisis. With 41.5% of species globally considered to be at risk of extinction, these extraordinary and diverse creatures are experiencing the worst population declines and highest extinction risk of any vertebrate group. Amphibians are vulnerable to a wide array of threats, with habitat loss the leading cause of declines. Amphibians are also the casualty of two ongoing global amphibian-specific pandemics. Climate change is identified as a significant emerging threat, impacting 29% of species globally. Assessing the potential impacts of climate change scenarios is difficult, especially so for amphibians which are generally very site-specific and

tend to have relatively short generation lengths. Reproduction, movement, and metabolism of amphibians is strongly influences by temperature, seasonality, and moisture availability, and these activities are likely to be impacted by local climate shifts, potentially affecting survival. South Africa hosts high amphibian diversity and the landscapes in which these species occur are predicted to be increasingly threatened by climate change. Most frog species exhibit attributes that heighten their sensitivity to climate change and are also reliant on environmental cues predicted to be disrupted by climate change. These impacts are exacerbated by limited dispersal ability of most species. Micro-habitat specialists are especially constrained in their ability to adapt to climate change. Future climate scenarios (2050s) modelled for South Africa's threatened frog species predict a wide range of distributional impacts, which will be exacerbated by ongoing land-use change. 35% of threatened species are likely to be highly impacted by future climate change scenarios. Emerging research and conservation priorities identified to overcome these challenges include improved understanding of the effects of climate change, community-level (rather than single species-level) drivers of declines, methodological improvements for research and monitoring, and effects of land-use change.

A-1434 (Oral)
Anuran Ecosystem Health Indicator (AEHI)

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Borneo, a known biodiversity hotspot, its acknowledged for its high levels of diversity and endemism, as well as a high level of threats. These make conservation a priority for biodiversity protection. Within Sarawak (in Malaysian Borneo), deforestation is often the effect of habitat conversion and land clearance activities, which disrupt gene flow among frog populations. It is critical for organisms to maintain heterozygosity so that the population can adapt to changing environments with high fitness. Thus, researchers need to assess a species' current status in its natural habitat (ecosystem health) and determine the area of conservation priority. A database management system is developed for the purposes of a management database of anuran amphibian diversity, habitat utilisation, geographical distribution, genetic connectivity, physical tolerances (temperature, pH, dissolved oxygen, etc.), as well as biotic interactions, and to develop indicator scores by categorising species importance based on previous studies and integrating them. Through the ecosystem and environmental sustainability of amphibians, we presented a virtual indicator for assessing ecosystem health.

A-1435 (Oral)
Basics and Updates About the Medical Significance of Non-front-fanged Snakes

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Non-front-fanged snakes (NFFS) comprise approximately 80% of extant snake species and include several taxa now known to cause lethal or life-threatening envenoming in humans. Although the medical risks of bites by a relative handful of species have been well-documented, a growing number of NFFS are implicated in medically significant bites. Many of these (not all) have a low-pressure venom gland, Duvernoy's venom gland, and variably enlarged, often deeply grooved teeth that are often located in the posterior or mid-maxilla. Expanded awareness of the need for formal documentation has added momentum to an accumulating database of medically significant NFFS bites. Recently documented case reports have included mild/moderate local envenoming inflicted by several less-known NFFS taxa including *Polemon acanthias, Platyceps saharicus* and *Platyceps ventromaculatus*. These bites featured mild-moderate local edema and pain, erythema, and in the former case, local blistering. Although a few previously documented bites by more familiar species such as *Crotaphopeltis hotamboeia, Psammophylax rhombeatus* and *Leptodeira* spp. have reported mainly insignificant local effects, recently detailed bites by the former two species included local edema, arthralgia and persistent joint stiffness; moderate local envenoming by *Leptodeira frenata* resembled that from a crotaline viperid. Two victims reported weeks to months for asymptomatic/functional recovery. Some accumulating mixed quality evidence has also suggested that some bites by *Chlorosoma* (*Philodryas*) *viridissimum* may cause moderate ecchymoses. Documentation supported or suggested recognition of rare systemic envenoming inflicted by three species (*Phalotris lemniscatus* [coagulopathy, weak evidence], *Rhabdophis ceylonensis* [coagulopathy, moderate evidence], *Heterodon nasicus* [isolated thrombocytopenia, moderate evidence]), previously associated only with mild- or moderate local envenoming. Recommended management of envenomed patients includes antivenom for life-threatening envenoming inflicted by *Dispholidus typus* and three species of *Rhabdophis*; others in this subset without commercially available antivenoms are treated with replacement therapy and supportive care. Recommended management for some rare systemic envenoming by several species may include use of acetylcholinesterase inhibitors, airway protection and meticulous wound care. Species capable of inflicting local envenoming with uncommon local progression comprise a larger group; bites commonly produce significant local effects only, often associated with a protracted bite. Management is restricted to wound care. Most of those surveyed evidenced insignificant minor effects of bites from a variety of diverse taxa. This ongoing study has produced a comprehensive evidence-based listing of NFFS tabulated against medical significance of bites, together with best-practice management recommendations. Accurate, formal documentation of bites by verified species of NFFS is required to increase the evidence base and establish the best medical management approach for each species.

A-1436 (Poster)

The Impact of Fish Stocking on Amphibian Communities from Mountain Lakes

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Amphibians inhabit a variety of aquatic ecosystems, from sea level to the alpine regions. During the past decades, a substantial part of these, including fishless mountain lakes, have been stocked with fish. Recent studies have shown that fish have a negative effect on water quality, ecosystem functioning and biodiversity in general. We conducted a systematic literature review to assess how fish interact with amphibian communities inhabiting mountain lakes. We found 90 studies conducted between 1978 and 2019, mostly in Europe and North America, in lakes with depths ranging from 0.9 to 70 m, located at altitudes up to 3,583 m asl.

The reviewed studies addressed the interactions of 34 fish species (including 3 hybrids) on 54 amphibian species (33 anurans, 21 urodela). We constructed a biotic interactions network to visualize and better understand how introduced fish interact with amphibians in mountain lakes. Most reports (75%) document the impact of introduced fish on amphibian population structure and density. Fish had both a direct and indirect impact. The direct impact resulted from predation, while the indirect impact was caused by changes in habitat structure and impoverishment of aquatic communities. For newts and salamanders, fish act as both predators and competitors for food. Tadpoles often respond with changes in the time and/or size to metamorphosis, with potential carry-over effects that could affect population survival. The rest of the reported interactions (25%) only referred to the co-occurrence of fish and amphibians, without mentioning any type of impact.

A-1437 (Oral)
Monitoring Frog Meat Harvesting and Population Estimation as a Key Step to Sustainable Wildlife Utilisation in Ghana

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In many parts of the world, demand for frog meat is on the rise, yet the few available studies on frog meat focus mainly on trade dynamics and volumes. Few studies have attempted to establish the linkages between socio-economic factors and frog meat demand. Furthermore, in West Africa where frog exploitation is widely reported, there have not been any attempts to study the impacts exploitation is having on hunted species, hence, there is no information on the sustainability of the practice. Using a combination of citizen science, semi-structured questionnaires, and visual encounter surveys to monitor harvested species within three sites (two collection sites and another with no collection), the study aimed to: assess the socio-economic drivers influencing the demand for frog meat in northern Ghana; and estimate the relative abundance of harvested species within collection sites as a predictor of their long-term survival. We established that frog meat is an important protein in the diet of the Builsa tribe found in the Upper East Region of Ghana. Many frog consumers, 82% (n = 216) earn less than $150/month. We also documented for the first time, the consumption of toads in Ghana by the Badomsa community in Builsa South District. Within this semi-arid area of Ghana, the frog species *Hoplobatrachus occipitalis, Pyxicephalus edulis*, and *Ptychadena trinodis* are heavily exploited. The abundance of *H. occipitalis*, the most harvested species, was highest at the non-harvested site. There was a significant difference ($H(2) = 9.9988$, $p = 0.006742$) in abundance between the three study sites. By documenting these disparities in abundance, we have provided the first evidence of the potential impacts of excessive collection of frogs for consumption on species population. This calls for long-term monitoring protocols to initiate the first steps towards the establishment of harvest regulations in West Africa.

A-1438 (Oral)
***Cnemaspis kendallii* and The Mysterious Mr. Kendall**

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The namesake for *Cnemaspis kendallii* Gray (1845) had remained unknown, being unspecified in the original description or in subsequent publications. The types were described as collected/donated by Captain Edward Belcher, in command of H.M.S. Samarang. The species is known from lowlands of western Sarawak. The Samarang made collections of zoological specimens for the British Museum, the reptiles enumerated in Gray et al. (1850), and did not include the aforementioned species. It is argued here that the species is named for Lieutenant Edward Nicholas Kendall (1800–1845), of the Royal Navy, also, a hydrographer and polar explorer, who died the year *Heteronota kendalli* was described. Kendall joined the Royal Navy in 1814, and appointed Lieutenant in 1827. He served in expeditions to the Arctic and Antarctic, including to the Polar Sea in 1825–1827, where he was the companion of the zoologist-naturalist, John Richardson (1787–1865), when they delineated the north coast of America, between the Mackenzie and Coppermine Rivers. The connection between Kendall and Gray cannot be determined but Gray was in contact with Richardson, who contributed material from the New World, West Asia and Australasia, and was active in the British Museum at the time. The association between Richardson and Gray was long and significant, with the latter naming several reptiles in Richardson's honour, as well as providing a foreword to his ichthyological catalogue. We hypothesize that Richardson convinced Gray to name the Bornean lizard after his former assistant during his explorations of boreal America, particularly on account of both his presumed disappointment at Kendall's misfortune not to be recognized for his scientific contributions and his death at the time Gray's lizard catalogue was going to press.

A-1439 (Oral)
The 100th Tadpole. Description of the Larva of the Bornean Endemic *Pelobatrachus edwardinae* (Inger, 1989) (Amphibia: Anura: Megophryidae)

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The recently published 'Tadpoles of Borneo' describes 99 species of tadpoles known from Borneo. The tadpoles of the rare Bornean megophryid frog, *Pelobatrachus edwardinae* are described as the 100th species to that list, based on larvae hatched in captivity from *ex situ* breeding of a pair of adults collected at Ulu Baleh, Sarawak, Malaysia (Borneo) on 21 July 2022. The habitat comprised a perennial stream in hill dipterocarp forest, flowing over sandstone substratum, edged with riparian vegetation. Frogs were maintained in a landscaped terrarium at temperature range 22–25°C, and with running water, and maintained on a diet of the roach, *Blaptica dubia*. A clutch of eggs were observed on 25 July 2022. Eggs were removed and larval stages permitted to develop to Gosner's Stage 20, when they were euthanised, preserved and studied under a dissecting microscope. The larvae of *Pelobatrachis edwardinae*

correspond to the Megophryini type, and are characterised by an enlarged and umbelliform oral disc, assumed to be an adaptation to surface feeding.

A-1440 (Oral)
Around the World in 111 Million Years: New Insights about the Biogeography of Worm Lizards (Squamata: Amphisbaenia)

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Extant Amphisbaenia (202 valid species) are currently distributed over Africa, the Americas, the Middle East, and Mediterranean regions. Due to their fossorial habits and low dispersal capacity, amphisbaenian biogeography has been historically explained by vicariance. However, recent studies based on DNA sequence data highlighted the role of transoceanic dispersal. In this presentation I provide the first comprehensive large-scale phylogenomic assessment of Amphisbaenia based on extensive taxon sampling, including an expanded sampling of the South American and African radiation and 390 loci generated by sequence capture sequencing (Anchored Phylogenomic methods). Additionally, I provide the first densely sampled estimation of the divergence time of the main cladogenic events within Amphisbaenia, enabling the implementation of model-based analyses of distinct biogeographic scenarios. Considering the biogeographic history, Amphisbaenia originated during the Early Cretaceous, and Rhineuridae—a North American group—evolved in isolation and currently represents an ancient branch with a long ghost-lineage. Additionally, biogeographic results support at least two transatlantic long-distance dispersal events, one from the Mediterranean to the Caribbean and the other from Africa to South America and the Caribbean. Furthermore, according to the biogeographic analyses, African and South American lineages initially diversified in forested areas, supporting the Pan-African and Pan-South American rainforest hypotheses.

A-1442 (Oral)
Recent Anatomical Studies of *Rhabdophis* and their Significance for the Defensive Sequestration of Bufadienolide Toxins

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Most members of the Asian natricine genus *Rhabdophis* possess integumentary structures known as nuchal or nucho-dorsal glands. Those structures release fluid rich in bufadienolide toxins in response to a predatory attack. Experiments have demonstrated that the toxins are sequestered by the snakes from dietary sources, either toads (Bufonidae), larval fireflies (Lampyridae), or both. Although the glands were first described almost 90 years ago and have been the subject of intensive study for about 30 years, significant aspects of their morphology remain poorly understood, including the blood supply to the glands. Previous studies have shown that the nuchal and nucho-dorsal glands are richly vascularized, and the vasculature presumably is directly involved in transport of sequestered toxins to the glands. The use of Microfil, a vascular casting medium, made it possible to see the blood vessels in chemically cleared skins and bodies of the snakes, revealing that the glands contain dense capillary beds and are surrounded by larger, circumferential vessels. However, such preparations previously required separation of the skin from the body to observe the glands on the underside of the skin. Even with chemical clearing of the soft tissues, such dissection disrupted the vessels,

rendering it difficult to trace their passage. In addition, a number of important vessels travel deep within the axial musculature or through the vertebral column, making it difficult to trace the vessels supplying and draining the nuchal glands without extensive destruction of the surrounding tissues. However, the recent application of microCT scanning to vascular cast specimens has overcome the constraints presented by dissection and chemical clearing, revealing the path of blood flow to and from the nuchal glands. In species with nucho-dorsal glands, the anterior and posterior series of glands exhibit differences in their vascular supply.

A-1443 (Oral)
Climate-driven Range Expansion Depletes Genetic Diversity and Creates New Opportunities for Gene Flow for the Marbled Four-Eyed Frog (*Pleurodema marmoratum*)

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Given that climate-driven range shifts have become a widespread phenomenon, illuminating how their evolutionary consequences play out in real, contemporary systems is of critical importance for biodiversity management under rapid global change. We used low-coverage, whole-genome resequencing to study Marbled four-eyed frogs (*Pleurodema marmoratum*) in the Cordillera Vilcanota, Peru, where they were previously recorded to have expanded their upslope elevational range limit by hundreds of vertical meters to become the highest living amphibians globally. Specifically, these frogs expanded upslope into a long, deglaciating mountain pass, Osjollo, which now forms a continuous passage across the otherwise heavily glaciated Vilcanota mountains. In Osjollo Pass, we see clear genetic hallmarks of frogs' recent, rapid expansion: site pairwise differentiation (Fst) is elevated relative to what can be observed downslope, and travelling inwards from the southern and northern mouths of Osjollo Pass, frogs are characterized by an increasing inbreeding statistic (F) and mutation load, while heterozygosity (He) declines. However, reaching the region of Osjollo Pass where glacial ice most recently melted and where frogs expanding from north and south would have presumably first had contact, we see evidence for new admixture between these populations: there is a steep cline in ancestry components centered around that region, and the inbreeding statistic and mutation load drop, while individual-level heterozygosity recovers. With association mapping and redundancy analysis, we identified candidate genes for high elevation adaptation, including outliers with established roles in alveolar gas exchange, angiogenesis, and high elevation adaptation in other systems. Our candidates are generally minor alleles that increase in frequency with increasing elevation then drop out within the zone of recent, rapid elevational expansion, but further work will be required to demonstrate if this drop-out was a result of the strong genetic drift implicit with range expansion.

A-1444 (Oral)
Homing Pythons? Do Coastal Carpet Pythons (*Morelia spilota mcdowelli*) Return to their Place of Capture?

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The carpet python, *Morelia spilota*, is a large constricting snake found throughout much of Australia. It occupies an array of habitats and is a generalist, feeding on a variety of animals (Anderson 2019). Owing to its size (up to four metres) and proclivity to inhabit urban environments, the carpet python is possibly one of Australia's most well-known reptiles. At times it is also the subject of human-wildlife conflict. In Australia, human-wildlife conflict is often mitigated by authorised snake relocators. Of interest, are the ecological implications of wildlife relocation. This naturally begs the question, is relocating 'problem' reptiles always the solution? Little is known about the ecology of coastal carpet pythons (*Morelia spilota mcdowelli*) after having been translocated, particularly in the Mackay region (Queensland, Australia). Carpet pythons are a commonly relocated species in urban environments in Australia. Between December 2020 and August 2021 this study used radio-telemetry to investigate the spatial movements of 11 coastal carpet pythons following translocation within the Mackay region. Snakes were captured during routine call-outs by a licensed snake relocator, and were subsequently relocated between 0.37 km and 2.72 km away from their original capture site into a suitable habitat. The findings of this study suggest that the translocation of snakes from residences is not always an effective tool in reducing human-wildlife conflict. The relocation of unwanted reptiles is a common practice worldwide, thus the study has implications for translocation practices for both carpet pythons and other commonly relocated snakes.

A-1445 (Oral)
Pancreatic Islets Formation during Pancreas Morphogenesis of Different Squamate Clades

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Little is known about the embryonic pancreas of lizards with regard to the differentiation of endocrine compartments. Therefore, the aim of this study was to focus on the formation of pancreatic islets in different lizard species: leopard gecko (*Eublepharis macularius*), mourning gecko (*Lepidodactylus lugubris*), brown anole (*Anolis sagrei*) and sand lizard (*Lacerta agilis*). Analysis of serial paraffin sections and 3D reconstructions of pancreatic endocrine tissue showed that the spatial arrangement and volume of the islets changed as the gland grew. The first endocrine islets of the gekkotan species were found in the dorsal pancreatic bud as small cell clusters. They formed a few smaller pancreatic islets of different sizes. The endocrine tissue then accumulates in the splenic lobe, especially in the part adjacent to the spleen. In addition, small pancreatic islets between the ducts are also present in the lower lobe in both gekkotan species studied. The first endocrine islets of the brown anole and sand lizard pancreas were found as small cell clusters in the dorsal pancreatic bud. During embryogenesis, endocrine tissue accumulates in the juxtasplenic body located in the splenic lobe of the lizard pancreas. The results of this study indicate that the first pancreatic islets of all species studied differentiate within the splenic lobe, but their size and shape are species-specific. In addition, the brown

anole and sand lizard lacked endocrine islets within the lower lobe of the pancreas during development. This study was supported by NCN grant (OPUS) - 2019/35/B/NZ4/00905.

A-1446 (Oral)
Conservation of Mexican Vipers, the Most Diverse Viper Fauna in the World

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With 74 species of vipers (Serpentes: Viperidae) of the more than 380 recognized globally, Mexico is the country with the largest number of species. Also, more than half of the vipers present in Mexico are endemic, and this makes the country a paradise for viper enthusiasts. The 74 species of Mexican vipers are in 10 genera: three of Nearctic origin, which are *Agkistrodon* (with 4 species present in Mexico), *Crotalus* (44 species) and *Sistrurus* (2); and seven genera of Neotropical origin, that are represented by *Bothriechis* (with 4 species in Mexico), *Bothrops* (1), *Cerrophidion* (3), *Metlapilcoatlus* (5), *Mixcoatlus* (3), *Ophryacus* (3) and *Porthidium* (5). Despite this striking diversity, there are many voids in the knowledge of natural history and basic biology for many species. During this talk we will discuss the viper diversity in Mexico and the main lines of research to fill these knowledge voids, we will highlight selected species with peculiar biology, morphology or distribution that could be of interest to the audience in the World Congress of Herpetology, we will also highlight projects to conserve the viper fauna in Mexico, and will close with the strategies that the IUCN's Vipers Specialist Group has proposed to contribute to support viper research and conservation globally.

A-1447 (Oral)
Evolution of the Egg Tooth in Squamata

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The egg tooth of squamate reptiles is a large premaxillary tooth that allows them to break through the eggshell during hatching. Most squamates have only a single egg tooth, whereas gekkotans are characterized by two egg teeth. Depending on the phylogenetic framework, the presence of the two egg teeth may be considered as a plesiomorphic (molecular data; i.e., Gekkota as sister to other squamates, called Unidentata) or a paedomorphic character (morphological data; i.e., Gekkota nested within squamates). Indeed, some studies have shown that two egg tooth germs are present in Unidentata embryos, and it has been suggested that they may fuse to form a single, enlarged egg tooth. Unfortunately, discriminating between these

two scenarios is problematic since the 'egg tooth' of tuatara (*Sphenodon punctatus*), the sister taxon of squamates, is only a keratinized structure, known as caruncle, and not any premaxillary tooth, which precludes definition of character polarity. Consequently, the evolution of the egg tooth and the remaining premaxillary dentition remains unclear. Here, we used light microscopy and X-ray microtomography to analyze the development of the egg tooth and remaining premaxillary dentition in Lepidosauria, primarily focusing on five squamate species (*Lacerta agilis*, *Anolis sagrei*, *Natrix natrix*, *Eublepharis macularius*, and *Lepidodactylus lugubris*) and the tuatara. The results of our study suggest that the large size of a single squamate egg tooth may be caused by a retardation of the regular premaxillary teeth development. In addition, the early fusion of the premaxillary bones could have been an important 'preadaptation' for the ancestor of Unidentata.

A-1448 (Oral)

Frogging in Acronyms and Corporate Waters through Environmental Social Governance (ESG), Monitoring Reporting and Verification (MRV), Mandated Sustainability Reporting, Net Positive Impacts (NPI) and the Biodiversity Plan

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Funding and interest in conservation and field research has traditionally tended towards the charismatic and iconic species which were seen as an umbrella species protecting all the lesser-known species, including herpetofauna. There is mixed reaction to the utility of these icons as an umbrella species in conserving and protecting smaller wildlife. 6th Extinction, Climate Change, Environmental Social Governance (ESG), Monitoring Reporting and Verification (MRV), mandated Sustainability Reporting, Net Positive Impacts (NPIs) and The Biodiversity Plan presents an opportunity to set monitoring targets or Key Performance Indicators (KPIs) for lesser-known species including frogs. This is especially so when corporate entities understand the importance of the lesser-known species the ecosystem and how they are the foundation stones to nature and to humans. Case examples from Sarawak, Malaysia are highlighted.

A-1449 (Oral)

Amphibian Survival in Extreme Hyper-Arid Climates: A Case-Study from the United Arab Emirates

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The United Arab Emirates (UAE) has two regional endemic toad species namely the Dhofar toad (*Duttaphrynus dhufarensis*) and Arabian toad (*Sclerophrys arabica*). The UAE lies in the northeast corner of the Arabian Peninsula and experiences an hyper-arid climate with summers temperatures rising to 45–50°C and an average rainfall of 140–200 mm with some mountainous areas experiencing a slightly higher amount. This hyper-arid climate poses a challenge to amphibian survival and the two toad species have unique characteristics that enable them to

survive in this arid climate. The UAE has a land area of approximately 83,000 km^2 and the majority of the country is comprised of desert ecosystems with the Hajar Mountain range crossing in the north-eastern part in a north-south direction. It is in these mountainous areas with wadis (seasonal rivers) where the toad populations are concentrated. From our field research we have found the Arabian toad is more reliant on seasonal and permanent running water in the wadis. Dhofar toads on the other hand can also be found within the wadis and also far from any permanent and/or seasonal water sources. Arabian toads will usually breed in the wadis and other large water bodies like artificial dams. Dhofar toads have also been observed in such habitats but are also specialized in breeding in temporary rain pools which can also be far from seasonal/permanent water sources. They are adapted to breed rapidly when such water sources become available, such as after a rainfall event. There are some introduced populations of Dhofar toads outside the expected distribution in some city parks and also in areas at their extreme range of distribution have been found to persist in urbanized areas such as zoo grounds, date farms and other urban green spaces. An introduced population of the Asian common toad (*Duttaphrynus melanostictus*) was also recorded and mitigation measures were taken to control and eradicate this population before it could become established.

A-1450 (Oral)
Answering the Call: Evaluating Amphibian Declines to Reveal Feasible Conservation Solutions despite Chytrid Impacts

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A mystery emerged during the first world herpetology congress about declining and disappearing amphibian populations. But at that time, herpetologists lacked the data to determine if the observed amphibian population changes were problematic declines due to anthropogenic causes or simply natural population fluctuations. To help resolve this, we established a multifaceted project to investigate the issue in two sympatric frog species with differing conservation statuses, one listed threatened and the other non-threatened. The research project included a longitudinal occupancy study across the threatened species entire distribution spanning 50 years, an intensive mark-recapture study spanning 30 years, disease surveillance spanning 20 years, as well as genetic monitoring, and targeted experiments. Our results reveal clear evidence of concerning declines in the size, number, and genetic diversity of the threatened species populations as well as unexpected responses of both species to multiple threatening processes. While chytridiomycosis affected both species, other factors that influence species recruitment dictate their population trajectories. Through this research we have uncovered and started to implement feasible solutions to recover the declining frog populations despite chytrid impacts. Our research provides an amphibian decline case study with a lens of hope. We highlight the value of long-term and targeted ecological research plus some of the social and technical challenges that must be overcome to achieve threatened species conservation when amphibians face multiple complex threats.

A-1451 (Oral)
Recent Changes in the Frog Fauna of the New England Tablelands Region of Eastern Australia

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The decline of frog species is well documented world-wide. Historical records provide invaluable baselines to frog populations' site occupancy for future monitoring endeavours. However, historical records often involve mostly intermittent, opportunistic collecting, with very few repeat surveys of individual sites which cannot be modelled using conventional occupancy methods. Historical records of the presence of frogs have been collected over the period of 1966-1975 from some 898 sites in the New England Tablelands. The aim of this research was to use single-visit occupancy estimation as a method to model the historical occupancy of frog species in the New England Tablelands, and to compare these occupancies with those obtained from more recent surveys. Two hundred of the 898 historical sites were surveyed for frog species presence during the period of 2017-2019. The sites were clustered into three groups to be sampled four times during the period extending from early summer (December) through to mid-autumn (May) over the three years. Overall, only 18 of the 35 previously identified species in the region were observed in the more recent survey. Of these, only three species had maintained or increased their occupancy in the region. Further, a number of previously common species were not detected at all during the contemporary surveys. The patterns of occupancy observed in the New England Tablelands are unlikely to be exclusive to the region. Similar comparisons should be made in other localities where extensive historical records exist in order to help understand changes in occupancy and build a foundation for future monitoring efforts.

A-1452 (Oral)
The Herpetofauna of AlUla County (Kingdom of Saudi Arabia): Preliminary Results from an Uncharted Territory

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The biodiversity of the herpetofauna in the Arabian Peninsula is significantly under-documented, with new and cryptic species described regularly. Despite AlUla county's ecological significance, this region has never been rigorously surveyed for its herpetofauna. The Royal Commission for AlUla (RCU) and BIOPOLIS/CIBIO carried out a county-wide faunistic survey during 2022-2023. A total of 542 sites were sampled, 2,381 reptile and 78 amphibian observations were made. From these observations, 2,166 (91%) reptiles and 72 (92.3%) amphibian specimens were identified to the species level, which resulted in 57 reptiles and four amphibian species documented in the region. Ten (6.1% of the observed herpetofauna)

species were new to the region and two (3.3%) were new to the Kingdom of Saudi Arabia, as well as one (1.6%) snake species turned out to be new to science. One (1.6%) exotic species have been found during this survey. Among the reptile species occurring in the AlUla region, 15 (26.3%) species are regionally considered Data Deficient, and additional data are needed to define their regional conservation status. For reptiles, the areas accumulating the most species are located in Sharaan, Wadi Nakhlah, parts of Harrat Uwayrid, Harrat AlZabin, and AlGharameel. For amphibians, the areas predicted as accumulating high species richness are almost all located outside the conservation areas of AlUla. The new snake species (*Rhynchocalamus hejazicus* sp. nov.), discovered in AlUla county, exemplifies the richness of the region's biodiversity and the significant gaps in our current understanding. Fieldwork-based knowledge is crucial to understand the distribution of biodiversity and assure informed conservation decisions in under-documented areas. RCU remains committed to the conservation and sustainable management of the natural resources of AlUla county, in synergy with the preservation of the cultural, historical and natural treasures.

A-1453 (Poster)
Oil Palm Plantation Landscape As Habitat for Herpetofauna in Peninsular Malaysia

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Palm oil is an important economic commodity in Malaysia. Although oil palm plantations (OPP) have been associated with land use changes in Malaysia, sustainable practices within OPP landscapes often provide suitable habitat for biodiversity and promote coexistence between planters and biodiversity. This assessment aims to identify and determine the conservation status of amphibian and reptile species inhabiting OPP, with a focus on landscape structure, which includes OPP: with no forest, with forest patches, and next to forest reserves. Two field techniques were used- direct observations and drift fence-associated pitfall traps. A preliminary study in FGV Setiu, Terengganu, recorded eight reptile and 12 amphibian species. The Endangered turtle, *Heosemys spinosa*, was found in OPP next to a forest reserve. This indicates that forest is an important component of landscape structure in oil palm plantations to buffer against biodiversity loss and provide refuge for these organisms. Therefore, a strategic action to reserve green patches within OPP landscapes need to be considered, to ensure sustainable plantation practices.

A-1454 (Oral)
Nature's Remedy: The Wound Healing Wonders of Frog Skin

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This keynote lecture explores the remarkable regenerative properties of frog skin, elucidating its potential applications in modern medicine. Drawing on a wealth of biological research, it reveals how compounds found in frog skin can accelerate wound healing, reduce inflammation, and combat infection. These natural peptides, with their broad-spectrum antimicrobial activity, present a promising alternative to traditional antibiotics and synthetic treatments. The talk delves into the molecular mechanisms underlying these effects, demonstrating how frog skin's unique biochemical environment fosters rapid tissue repair and regeneration. This lecture not

only highlights the therapeutic potential of these natural compounds but also underscores the importance of biodiversity in discovering novel medical treatments.

A-1455 (Oral)

Diverging Morphological Effects of Invasion and Aquaculture in a Globally Introduced Anuran

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Increased dispersal ability and changes in response to dietary differences are frequently observed in rapidly evolving invasive species. Similarly, captive-bred animals undergoing domestication also frequently demonstrate phenotypic changes on short timescales. The interaction of these processes, and the influence of domestication histories on invasive species, remain understudied. Here we examined the American bullfrog (*Rana* [*Lithobates*] *catesbeiana*), a prolifically invasive species native to eastern North America with established feral populations in western North America, South America, Europe, and Asia. These introduced populations threaten native species through competition, disease transmission, and direct predation. Many of these introductions were fueled by the widespread cultivation of frogs for meat. Thus, this species represents both a conservation concern and an economic resource for numerous countries. We collected morphometric data from 1,205 American bullfrogs in Canada, the U.S.A., Brazil, China, and South Korea. These represent native, introduced, and captive populations. We used linear model selection and model averaging to investigate the effect of native, introduced, or captive origin on head and limb allometry as well as body mass. Our analyses indicated phenotypic differences among the three groups, most prominently with the increased body mass and shorter hindlimbs of captive bullfrog adults. Further analyses could elucidate the heritability of these phenotypic differences as well as potential fitness consequences for escaping captive individuals. Increasing understanding of the evolutionary interplay of invasiveness and cultivation could aid in management decisions addressing invasive bullfrog control, the frog farming industry, and importation of live farmed bullfrogs.

A-1456 (Oral)

Snaking our Way Towards Successful Conflict-Driven Translocation: Does Brown Snake Personality Influence Post-Release Movement Behaviour and Survival?

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Human-wildlife conflict is increasing on a global scale with repercussions for both human health and wildlife conservation. In 2017, the World Health Organisation recognised snakebite as a major public health issue and assigned Australia's Eastern brown snake (*Pseudonaja textilis*) the "highest medical importance" due its venom toxicity and common occurrence in populated areas. Brown snakes are a prime example of human-wildlife conflict caused by habitat modification and human encroachment into natural areas. Recent research has shown that society's typical response to snakes in human-occupied spaces – translocation – often has detrimental impacts on the welfare of individual snakes and unknown repercussions for snake populations in general. Our aim is to investigate how translocation affects brown snake health and movement behavior by tracking individuals implanted with radiotransmitters and temperature loggers. Specifically, our research will examine differences in 1) space use and movement behaviour, and 2) thermoregulatory efficiency between translocated and resident (non-translocated) brown snakes in Canberra. To account for consistent individual differences in behaviour among individuals, I will 3) measure variation in personality and plasticity using repeated behavioural tests, and 4) investigate the degree to which personality influences the movement and survival of translocated snakes. Growing awareness of personality in animals has revealed personality traits can also influence an individual's spatial movements and even affect the survival of translocated individuals, but few researchers have studied the link between venomous snake personality and movement in the field. Our results will further our understanding of venomous snake behaviour and the potential role personality plays in snake movement patterns, with implications for reducing human-snake conflict.

A-1458 (Oral)
Chytridiomycosis in Asian Amphibians: The Lessons Learnt and the Way Forward

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Until 2018 there were in all three reports of Chytridiomycosis in Indian anurans. The work done so far has revealed that *Batrachochytrium dendrobatidis* (Bd) involved in the infection evades detection in Taqman qPCR. We designed a one-step SYBR green-based quantitative polymerase chain reaction for robust detection of Bd. It amplifies an 82 base-pairs between the 5.8S rRNA and ITS2 of the Bd genome. The primer pair was tested *in-silico* on known Bd lineages. Using skin swab samples of wild amphibians and cultured zoospores from Australia and Panama, we compared the clinical specificity and sensitivity of the newly described primers to the existing TaqMan-based qPCR assay. From India, we used samples which were tested with Nested PCR to validate the new primer pairs. The new primer pair was tested on swab samples from Anura, Caudata and Gymnophiona from India. We report widespread chytridiomycosis with varying infection loads on them. The new assay showed comparable efficiency to the TaqMan-based qPCR assay. This diagnostic assay can facilitate widespread screening of chytridiomycosis in Asia. We now know that it is widespread and prevalent in

anurans, salamanders and caecilians in India. The prevalence in anuran populations ranges between 50-70%, in a wide range of species. With no clinical signs on frogs recorded so far, we hypothesize that the frogs might have enzootic strains of Bd caused by host-pathogen coevolution. To test this, we monitored stream anurans in ephemeral streams in the Western Ghats, attempted culturing the pathogen and screened historical anuran specimens archived in museums. Our attempts to culture Bd have not been successful so far, after performing experiments with 920 toe clips over the past 6 years. Sub-clinical impacts of Bd on anurans have been investigated, but the range of implications for their movement, reproduction and survival have not been fully explored. As anurans continue to show a declining trend in Asian tropics, investigation on the impacts of sub-clinical Bd infections in anurans needs impetus.

A-1459 (Oral)
Interactive Effects of Temperature and Hydration on the Behavioral Performance of Anuran Amphibians

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Temperature and water availability profoundly affect the ecology, physiology, and behavioral ecology of anuran amphibians while climate variability exposes them to considerable changes in the thermal and hydric configuration of the environment on a geographic and temporal scale. Indeed, anurans have their behavioral performance highly impacted by changes in temperature and hydration state, which can lead to deleterious consequences to fitness, local population extirpations, and, ultimately, species extinction. Thus, successful habitat occupancy and the maintenance of viable populations are inextricably linked to physiological tolerance and attributes related to the regulation of water balance and body temperature. These two central aspects of organismal functioning, however, are complexly intertwined with each other and are often required to be dynamically adjusted in response to changes in environmental drivers and/or physiological state. Herein, I will approach the thermo-hydro regulation processes of anuran amphibians in order to advance our understanding on the functional compromises and determinants involving the interactive effects of changes in temperature and hydration state, as well as their regulation and respective eco-physiological consequences.

A-1460 (Oral)
Variation in Envenomation from *Calloselasma rhodostoma* Bites in Kalimantan and Java

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Calloselasma rhodostoma is a medically important snake species that is known from western Indonesia. Examination of hemotoxin reveals significant differences between bite cases in Kalimantan and those in Java, especially from Lebak Banten. This study provides an analytical picture of cases recorded medically in the form of physical and laboratory examinations from these areas. The differences in systemic conditions can be attributed to their geographic locations, diet and other factors. Further research on these differences in systemic cases of *C. rhodostoma* bites can provide interesting data on venomic composition of proteins and enzymes.

A-1461 (Oral)
Species Delimitation, Phylogenetic Relationships and Biogeography of *Hemiphyllodactylus* (Reptilia: Gekkonidae) in Yunnan Karsts

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Hemiphyllodactylus geckos show high levels of endemism in karst areas. Geckos collected from 15 sites in karsts areas across Yunnan were investigated through the integrative taxonomy approach using molecular (mitochondrial ND2 gene) and morphological data. Ten potential new species were identified, three of which were described: *H. yanshanensis, H. zhutangxiangensis*, and *H. simaoensis*. The investigation also indicated that *H. yunnanensis* sequences from GenBank were actually not a single species, but a group of as-yet undescribed species. *Hemiphyllodactylus* phylogenetic relationships were also observed and indicating that Yunnan Province has been colonised by four lineages: the East, Central, Northwest and Southwest Indochina lineages. *H. yanshanensis* is reported in this study to be the first evidence of Yunnan colonisation from the East lineage, which never been reported before. A time-calibrated tree analysis indicated that most of *Hemiphyllodactylus* diversification happened during the Miocene. The estimated time was used together with geological and paleo-climatic events to explain the colonisation history of *Hemiphyllodactylus*. In Yunnan, the combination of the surface elevation process in the Eocene–Miocene and the Red River incision in the Pliocene, which resulted in a deep valley seems to be an important barrier in shaping current *Hemiphyllodactylus* biogeography in the region. The overall results suggest that Yunnan karsts are likely to have more hidden species of *Hemiphyllodactylus* and highlights the importance of karsts as arcs of gekkonid endemic species.

A-1462 (Oral)
Socioeconomic Evidence for an Industry-led Healthy Trade Certification Program in the USA

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Wildlife trade can contribute to the global dissemination of pathogens that are harmful to pets and biodiversity. International and domestic movement of chytrid fungi (Bd, Bsal) and ranaviruses have been documented in amphibian trade and contribute annually to millions of dollars loss in revenues to US businesses. Spillover of pathogens from captivity to the wild also can have negative impacts on native species. In 2021, we performed a socioeconomic survey of US pet amphibian businesses and consumers to assess their awareness of pathogen threats to amphibians and gauge interest in purchasing pathogen-free amphibians. Most US businesses and consumers were aware of the threats that Bd, Bsal and ranaviruses pose to industry and biodiversity, and they were very interested in a program that could facilitate healthy (clean) trade. US consumers were willing to pay 77% more for an amphibian that was negative for Bd, Bsal and ranavirus. Using an average price per amphibian of $50 reported by US consumers, US businesses could increase profit margins by at least 26% if they incorporate pathogen testing and other biosecurity practices into their operations. Our results provide evidence that a market-driven healthy trade certification program is feasible for pet amphibians in the US.

A-1463 (Oral)
Modulation of Neuropeptides in the Tadpole Brain of the Indian Skipper Frog, *Euphlyctis cyanophlyctis* Exposed to Natural Pond Drying

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Anuran development is profoundly intricate process, wherein tadpoles (larval stages) confront a diverse range of environmental factors and must adapt to their changing surroundings to ensure survival. In India, particularly during the post-monsoon period (October to December), intermittent dry spells occur, leading to pond desiccation. This exposes tadpoles to survival risks due to factors such as hypoxia, increased salinity, and decreased food availability, thereby disrupting homeostasis. Consequently, there is a transient acceleration in the rate of metamorphosis to cope with the environmental stressors to restore equilibrium. This behavior of anuran tadpoles is regulated by the interplay between various neuroendocrine modulators present in the brain. While in the mammalian system, several neuronal signaling molecules such as CART, NPY, and CRF-like peptide are known to help cope with environmental stressors, their roles in amphibians are less understood. Therefore, the current study aims to investigate and analyze the involvement of neuronal signaling molecules (CART, NPY, and CRF-like peptide) in aiding anuran tadpoles during harsh environmental conditions caused by the drying up of ponds. For the experimentation, the tadpoles were collected from a desiccating puddle in the field, and the distribution of neuropeptides was examined using immunohistochemistry and fluorescence immunolabelling. In tadpoles exposed to natural chronic overcrowding, cells with strong CART, NPY, and CRF-like peptide immunoreactivity were observed in the preoptic area (POA) and entopeduncular nucleus (EN) of the diencephalon compared to the control group. Moderate CART and NPY immunoreactive cells

were noted in the septal and hypothalamic areas (dorsal and ventral hypothalamus) in the control groups, with increased cell count and intensity of immunoreactivity in the overcrowding group. The highest immunoreactivity for the three peptides was noted in the Edinger Westphal nucleus (EW) of the overcrowding group compared to the normal group. Additionally, elevated levels of CRF like peptide were observed in the median eminence. The upregulation of CART and NPY, along with CRF like peptide, in the stress and anxiety regulating centers suggests their potential role in reinstating homeostasis during adverse environmental conditions caused due to pond drying. Furthermore, the varying levels of CRF like peptide in the POA, a homologous region of the PVN, alongside CART and NPY, suggest its potential mediation of CART or NPY release in the brain, as reported in the mammalian system. This study highlights the potential significance of the endogenous neuropeptide system in neural plasticity amid adverse environmental conditions during anuran development.

A-1464 (Oral)
Milk Provisioning in Oviparous Caecilian Amphibians

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Among vertebrates, yolk is commonly the only form of nutritional investment offered by the female to the embryo. Some species, however, have developed parental care behaviours which may be associated with specialized food provisioning essential for offspring survival, such as lipidic-rich parental milk in mammals. Among amphibians, peculiar parental food provisioning modes have been previously documented in caecilians. These amphibians, members of the Order Gymnophiona, are elongate, limbless, snake- or worm-like, living primarily in tropical regions. They are considered one of the least-known vertebrate groups related to their primarily fossorial habits. Recently, we discovered that females of the egg-laying amphibian caecilian *Siphonops annulatus* provide similarly lipid-rich milk to altricial hatchlings during parental care. We observed that for two months, the babies ingested milk released through the maternal vent, seemingly stimulated by tactile and acoustic signals. The morphological analysis of the internal organs in *S. annulatus* indicated that the milk originates from the oviductal glands that hypertrophy during parental care. The milk mainly comprises carbohydrates and lipids, especially long-chain fatty acids, which are also present in bovine milk. Our data suggest lactation in this non-mammalian oviparous species, demonstrating how integrative approaches can contribute to overcoming the challenges related to the knowledge of fossorial animals.

A-1465 (Oral)
Folklore and Science from the East Coast of India: Patrick Russell's Contribution to Indian Ophiology

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The Scottish physician and natural scientist and Fellow of the Royal Society of London, Patrick Russell (1727-1805), is regarded as one of the pioneers of research into the plant, fish and especially snake species native to the east coast of the Indian subcontinent. On behalf of the English East Indian Company, stationed in a hospital in 'Vizagapatam' (now Visakhapatnam, NE Andhra Pradesh), Russell systematically studied the snakes found in the region from 1782 onwards, documenting their anatomy and experimenting with their venom effects. He published his research on snakes in a monumental two-volume work of text and plates, which was published between 1796 and 1810 (partly posthumously) in a total of six sections and was lavishly illustrated by unknown Indian artists. While the first volume (1796) mainly deals with the species found on the Coromandel Coast, the second (1801–1810) also includes snakes from Sri Lanka and the Sunda region. As a physician, confronted with accidents caused by snake bites, his aim was to identify poisonous snakes and distinguish them from harmless ones, as documented in his experiments and writings. Russell used almost exclusively local vernacular names to denote the snakes but negated the Linnaean binomial system. Nevertheless, his work formed the basis for a number of new descriptions of Asian snake species by other authors. Some of the specimens illustrated in his plates were later misidentified, causing long-lasting taxonomic confusion and subsequently leading to reclassifications. Russel's descriptions also contain elements of traditional folklore from the east coast of India that have been passed down to the present day and are recited by local people when identifying snakes. Our presentation will provide an overview of Russell's contributions to Indian ophiology, based largely on the published literature and some of our collaborative work on the taxonomy of snakes from the east coast of India.

A-1466 (Poster)
Habitat Use of the Critically Endangered Wonder Gecko (*Teratoscincus keyserlingii*) in Abu Dhabi Emirate

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The Wonder Gecko (*Teratoscincus keyserlingii*), which also known as the Desert Skink Gecko is listed as Critically Endangered in the IUCN Abu Dhabi Red List. This species is found in Central Asia, and in the UAE, are only found within a narrow coastal strip stretching from Abu Dhabi, Dubai, Sharjah and northern Emirates. They live in burrows and only emerging at night to feed on invertebrates which form their main prey. They are a sensitive species and can be easily impacted by anthropogenic activities and development projects. The populations are very localized and mainly inhabit the coastal sand dunes but in some other Emirates they have been found further inland. Our study focusses on the habitat use of the Wonder Gecko based on the Terrestrial and Habitat map of Abu Dhabi Emirate based on satellite analysis in 2020. A recent genetic study showed that the populations within the UAE are not different so this allows more flexible management of the species when it comes to translocation of populations that may be impacted by development activities.

A-1467 (Oral)
Conservation Status Updates for the Amphibians of Malaysia and Singapore

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We review significant conservation issues affecting the amphibian fauna of Malaysia and Singapore, since the publication of the relevant chapter in the Amphibian Biology series in 2014. These continue to be habitat loss and fragmentation, mineral extraction, especially from areas of karst limestone and collection for the pet trade. Current and future threats to habitats also include activities related to the expansion of forest-based industries and in the case of Singapore, an ambitious project to link the northern portion of the island to the south, via an underground rail link. Positive developments in the past decade include the establishment of new protected areas, particularly in the State of Sarawak, increased conservation awareness, and more amphibian-related content in the media.

A-1468 (Poster)

A Reference Genome for the Endangered Hungarian Meadow Viper *Vipera ursinii rakosiensis* (Méhely, 1893) and Genomic Insights into the *V. ursinii* Species Complex

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The Meadow viper, *Vipera ursinii* (Bonaparte, 1835) is considered as one of the most threatened snake species in Europe. Its range comprises highly scattered populations associated to open meadows across Southern, Eastern and Central Europe, divided into different subspecies (*V. u. ursinii, V. u. rakosiensis, V. u. macrops, V. u. moldavica*). We sequenced and assembled a reference genome from one female *Vipera ursinii rakosiensis* collected from Hungary, as part of the European Reference Genome Atlas (ERGA) Pilot Project, using PacBio HiFi reads at 28x coverage and Hi-C for chromosome-level scaffolding. The final assembly, of 1.625 Gb, comprises 383 scaffolds and yielded a scaffold N50 of 212.8 Mb. Most (99.31%) of the assembly sequence was assigned to 19 chromosome-level scaffolds, representing 17 autosomes and the W and Z sex chromosomes. In addition, we generated whole-genome sequencing data from 19 individuals, representing all *V. ursinii* subspecies as well as related Western Palearctic vipers: *V. renardi*, *V.graeca*, *V. anatolica* and *V. berus*. The phylogenomic analysis showed that *V. ursinii* complex is differentiated into two clades: a Western clade comprising the nominotypical subspecies *V. ursinii ursinii* and *V. u. macrops*, and an Eastern clade including *V. u. rakosiensis, V. u. moldavica*, and a population from Bistra Mts. located in North Macedonia splitting from *V. u. rakosiensis*. Our dataset also shed light on introgression events causing mito-nuclear discordances. Finally, we underscore the importance of genomic insights to guide conservation efforts on this endangered snake species.

A-1469 (Oral)
Why Are There So Many Bent-toed Geckos?

L. Lee Grismer[1], Chan Kin Onn[2], Minh Le Duc[3], Vinh Quang Luu[4], Sean B. Riley[5], Anchalee Aowphol[6], Attapol Rujirawan[7], Jimmy A. McGuire[8], Jesse L. Grismer[9] and Evan S. H. Quah[10]

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Hyperdiverse lineages can result from an adaptive radiation of an ancestor invading a previously unoccupied ecological landscape, an ancestor acquiring a novel trait allowing it to

radiate in an existing ecological landscape, or both. Bent-toed Geckos (genus *Cyrtodactylus*) comprise the third largest vertebrate genus on the planet with well over 400 species. We explore the possible reasons for this diversity using a multi-pronged approach based on phylogeny, biogeography, the evolution of habitat preference, ecomorphology, and shifts in diversification rates across the phylogeny. The consilience of these data suggest that following *Cyrtodactylus* dispersal out of its ancestral range in the Himalayas into the heterogeneous landscape of Indochina, it began to rapidly diversify. This was in a large part due its ability to traverse mountain ranges, rivers, seaways, and other typical biogeographical barriers across its range from South Asia to Melanesia, followed by *in situ* radiations and habitat specialization. The majority of habitat specialization happened in karst landscapes where 30% of the genus currently occurs—many of which are site-specific endemics. Only habitat generalists constitute a larger percentage of the genus (34%). This would seem to suggest that rates of diversification should increase in karst-adapted lineages, but this is not supported by the data. The high percentage of karst-adapted species is associated with the vast amount of fragmented karstic habitats across the landscapes of Indochina and Southeast Asia where multiple, smaller convergent radiations happened simultaneously but not at an increased rate of diversification.

A-1470 (Oral)
Amphibian Updates from Bangladesh: Present Status, Conservation and Research Trend

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Several new country records have come out in Bangladesh after the national red list assessment in 2015. In this study, we updated the checklist of amphibians of Bangladesh along with their conservation status based on several well-accepted parameters. Our study confirms the presence of 59 amphibian species in Bangladesh belonging to two orders, eight families and 34 genera. Among the recorded species, two were Critically Endangered (CR), three Endangered (EN) and five Vulnerable (VU). About 80% amphibians were found in protected areas while 20% were found in non-protected areas. Fifty species are found in forest areas including 32 species are strictly forest dwellers. We conducted a literature survey to understand the current research trend in amphibian research in Bangladesh. Our study reveals that most of the amphibian research in the country focused on status and distribution (43%), followed by molecular taxonomy (28%), habitat and ecology (11%), morphometry and conservation (7% each), food and feeding (3%), bioacoustics (1%). The country was divided into 4 regions to understand where most of the amphibian research projects have been conducted. Our findings noted that research sites are mostly located in the northeast (22%) and southeast (17%), followed by central (13%) and northern (12%) part of Bangladesh.

A-1471 (Oral)
How Landscape of Fear (LOF) and Hunters' Horizon (HuHo) Mediate Foraging Activity of Salamanders in Spring Habitats

Raoul Manenti, Elizabeth Brophy, Matilde Parozzi, Davide Piacenza, Alessandro Pinna, Gentile Francesco Ficetola, Benedetta Barzaghi and Andrea Melotto
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Predators encountering patches with variable food abundance/quality and different risk conditions should forage in a way that equalizes marginal capture rate among patches, i.e. stay in a patch until its advantages in terms of energy intake diminish below the average capture rates and energetic costs/risks of the environment as a whole. Springs are ideal systems to assess foraging behaviour of salamanders. They are ecotones at the boundary between groundwater and surface water environments that differ for contrasting and distinctive pressures, especially in terms prey availability and predation risk. With this study we assessed how Landscape of Fear (LOF) and the Hunters' Horizon (HuHo, i.e., higher prey availability) affect springs exploitation by two salamanders, one typically subterranean, such as the olm *Proteus anguinus* and the other typical of surface freshwaters like the fire salamander (*Salamandra salamandra*). We surveyed 69 springs near Trieste to assess occurrence of *P. anguinus* and we combined field and laboratory observations of *S. salamandra* larvae belonging to springs between the Lecco and Como districts (northern Italy). We assessed if *P. anguinus* occurrence and abundance of fire salamander larvae varied depending on the LOF and HuHo conditions and how were them related to ecotones' extension. We observed that *P. anguinus* occurrence was negatively related to increased LOF and positively to springs subject to flooding. The abundance of fire salamander larvae was positively related to HuHo and external sides in laboratory conditions. From a side, while *P. anguinus* is generally considered as a strict subterranean species, the use of surface patches bordering groundwater gives important evidence of opportunistic exploitation of an unexpected habitat prompting an investigation of its determinants. From the other side *S. salamandra* larvae can be excellent models to map the interactive dynamics of HuHo and LOF shaping temporal and spatial variation of ecotone communities.

A-1472 (Oral)
Cooperative Breeding of *Theloderma asperum*

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Despite many theoretical models of the prisoner's dilemma, there are few observed evidences of the tragedy of the commons in nature, probably because of the difficulty in finding different strategy sets for comparison, quantifying payoff and investment, and defining cooperation and defection empirically. Parents of the Pied wart frog *Theloderma asperum* lay eggs on the inner wall of a phytotelma centimeters above water, and splash water by hind legs onto the eggs as parental care, potentially a material of cooperative breeding to test the model. This research combined behavioral experiments and field investigation on this frog species to study its game relationship. The behavioral experiments were conducted in a glass terrarium with a water-filled plastic box and two wood chips for breeding. I measured investment and payoff by splash frequency and egg hatching rate respectively, taking biparental care as a control, to explore whether the parents' investment and payoff under multi-parental care decreased. The behavioral experiments showed that compared with the biparent control (FM) group, egg clutches in multi-parent groups (two females and one male (FFM) group, one female and two males (FMM) group) received less investment and payoff both in total and of each parent (except for male investment in the FFM group). Field investigation suggested that clutch overlapping and density peak of adult frogs mainly occurred in the driest season (March to May), possibly because habitat saturation forced them to involve into competitive social interaction. Therefore, the game relationship between the parents of *T. asperum* in multi-

parental care was competition (tragedy of the commons), due to the intense conflict of interests in alloparental care. This study provides a new case of the prisoner's dilemma, extrapolates sexual conflict in cooperative breeding to conflict between multiple parents, and provides a perspective for the initial formation mechanism of social evolution.

A-1473 (Oral)
The Amphibian Biology Series: History, New Perspectives, and Future Outlook

Harold Heatwole
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The first volume of the series *Amphibian Biology* was published in 1995. The series initially was published by Surrey Beatty and Sons, a small family press in Sydney, Australia. The owner Ivor Beatty was extremely interested in the venture, and published volumes 1-8, and 10, each on a different aspect of Amphibian Biology, and sold them virtually at almost no profit for his company. The death of both Ivor and his son precipitated a crisis, and further volumes were delayed and some authors withdrew their papers. Until other presses could be found some chapters were published as individual monographs in a journal. Volumes 9 (Eastern Hemisphere) and 11 (Western Hemisphere) were devoted to a country-by-country account of the status of the decline and conservation of amphibians. Each of these two volumes consisted of a number of "Parts" some of which were full-length, hard-bound volumes in their own right. The papers of this symposium and issues either in progress or in press will complete the coverage with every country in the world represented. At present, the series has involved 650 authors and co-editors, accounting for a total of 6,148 published pages to date, not counting the issues in press, in preparation, and pending. During the World Congress, there will be discussions with volunteers for the continuation of the series following a capstone volume on the status of decline and conservation.

A-1474 (Oral)
Connecting the Dots Between Micro- and Macroevolution in Amphibians: The Eco-Evo-Devo Thread

Ivan Gomez-Mestre and H. Christoph Liedtke
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Evolutionary innovations refer to the emergence of major shifts in the traits of organisms, particularly as a consequence of sudden changes in environmental conditions. They can include the development of new morphological structures, functions, behaviors or other aspects of organisms. These innovations are the result of mutations, genetic recombination, or changes in gene regulation that occur over successive generations. Understanding how evolutionary novelties arise continues to be an interesting challenge in evolutionary biology. Morphological structures, functions, development, behaviors or other aspects of organismal biology often represent discontinuities across extant evolutionary lineages. Some evolutionary innovations in amphibians, at times highly complex traits, have evolved repeatedly in phylogenetically distant groups (e.g., direct development, limblessness or miniaturization). This convergence of evolutionary solutions to common environmental challenges, allows for the investigation into whether shared alternative developmental pathways have deviated in a predictable and repeatable manner. The expression of some such alternative forms may be plastic in origin, and therefore the evolutionary rate of innovations, their recurrence and their reversibility may depend on the nature of the genomic regulation of the trait, its environmental sensitivity, and

the selective pressure acting on the trait. Eco-evo-devo research often combines genomic analyses with experimental work to explore the dual role of the environment as both a selective sieve and a phenotypic inducer. It considers the possibility that environmentally-induced changes in the genomic regulation of traits during development may later evolve under selection into accommodated differences among taxa. These approaches may help us bridge the apparent gap between micro-and macro-evolutionary processes in amphibians.

A-1475 (Oral)
Amphibians of Afghanistan: Research and Conservation

Daniel Jablonski
Department of Zoology, Comenius University in Bratislava, Slovakia

Afghanistan is one of the least explored countries in terms of herpetology. Despite world museum collections in Europe and the US containing many specimens, comprehensive exploration of the country is lacking. Scientific research has mostly been limited to parts of Afghanistan accessible to scientists during the thirty years of the second half 20th century. Although the amphibian fauna of Afghanistan is not rich, it is crucial for understanding the biogeography and evolution of Asian herpetofauna. Currently, Afghanistan's amphibian fauna consists of four families: Bufonidae, Dicroglossidae, Ranidae, and Hynobiidae, which include both Palearctic and Oriental members. Overall, there are ten species of amphibians (although the genus *Bufotes* requires further genetic investigation) across seven genera. Two Palearctic genera (*Bufotes* and *Pelophylax*) are distributed throughout Afghanistan, while Oriental members (*Euphlyctis* and *Hoplobatrachus*) are confined to the southern provinces where a subtropical climate prevails. Two (sub)endemic genera, *Chrysopaa* and *Paradactylodon*, are found in the Hindu Kush area and represent ancient divergences that evolved in these mountains. While the genus *Chrysopaa* is also known from Balochistan in Pakistan, the genus *Paradactylodon* is currently known only from several central Afghan provinces. Recent genetic research efforts in Afghanistan (and Pakistan) have investigated several populations of local amphibians (*Bufotes*, *Chrysopaa*), enhancing our understanding of amphibian evolution between major zoogeographical realms and between Central and South Asia. However, other species and their populations remain unexplored and should be investigated through direct fieldwork or museogenomics. From a conservation perspective, special attention should be given to the endemic species *Paradactylodon mustersi*, whose current species and conservation status is largely unevaluated. Current data suggest that its distribution could be larger than previously expected, necessitating the application of conservation genetics to accurately assess its threats. Given the improved security situation in Afghanistan compared to the past twenty years, direct field research, though still challenging, may now be possible.

A-1476 (Oral)
Energy-related secondary salinization of wetlands: Coordinated experiments and field surveys to identify mechanistic links with amphibian abundance

Blake R. Hossack[1,2], Kelly L. Smalling[3] and Brian J. Tornabene[1]
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[2]Wildlife Biology Program, W. A. Franke College of Forestry & Conservation, University of Montana, Missoula, Montana, USA
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Growing demand for energy and advances in drilling techniques have resulted in a rapid increase in oil and gas extraction globally. Highly saline wastewaters that are commonly co-produced with oil and gas extraction can cause persistent contamination of soils and surface waters. In some areas, such as North America's Prairie Pothole Region, historical disposal practices and modern spills related to energy extraction have altered water quality of wetlands. Despite the potential threat of wastewaters to aquatic habitats, there has been surprisingly little research into its ecological effects on aquatic vertebrates. Through a series of experiments and field surveys in North Dakota and Montana, USA, we measured the sub-lethal (e.g., development, growth) and lethal (e.g., embryo survival) effects of salinization on amphibians and used N-mixture models to estimate how those effects abundance of larvae across a gradient of brine contamination in 33 wetlands. Pairing experiments and field surveys provided greater insight into mechanisms and how they translate to population abundance. For example, salinity levels linked with reduced amphibian abundance in wetlands much lower than those that caused decreased survival in laboratory experiments. Further, our field surveys suggested historical brine management practices were the primary driver of contamination and reduced amphibian abundance, reflecting multi-decadal ecological effects. Collectively, these results underscore the critical need for tools to protect and restore landscapes contaminated by brines and other sources of salinity.

A-1477 (Oral)
Studying Sea Snakes through Citizen Science

Claire Goiran
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Université de la Nouvelle Calédonie - BP R4 98851 Nouméa Cedex, New Caledonia

The contribution of citizen scientists to herpetology programs has been increasing during the last few years, thanks to digital technologies. In New Caledonia, a program involving grandmothers to study sea snakes was launched in 2017. Since then, it has been very successful, allowing us to collect valuable data on sea snake populations and spatial ecology. As for many other citizen science programs, data collecting is not the only outcome of this program. Due to its unusual combination of grandmothers and venomous snakes, our program attracted strong media's interest. This mediatization in turn raised public and stakeholder's awareness about sea snakes and their importance in New Caledonia's marine ecosystems. It gives us opportunities to educate public and positively change attitude and behaviour towards sea snakes.

A-1478 (Oral)
Steep Environmental Gradients are Sinks for Neotropical Lizard Species

Pedro Tourinho Dantas[1] and Guarino Rinaldi Colli[2]

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Ecotones have a crucial role in the flow of species, genes and nutrients between adjacent areas. They not only separate, but also connect neighboring areas, acting as filters of varying

permeability. The structure of biological communities change with proximity to ecotones, and species richness in ecotones can be higher than, lower than, or similar to adjacent areas. We investigate how an extensive forest-savanna ecotone between two Neotropical biomes, Amazonia and Cerrado, affects the structure of lizard communities. Based on field and literature data, we performed correlation analyses between diversity indices and the distance of each sampling point to the ecotone and to the biome centroids. To investigate the processes responsible for the observed patterns along the gradient, we conducted a canonical correspondence analysis (CCA) relating species incidences in communities and environmental variables. Our results demonstrate that proximity to the Cerrado-Amazonia ecotone negatively affects lizard diversity. The ordination by the CCA was able to clearly distinguish two groups of species (from open and from forest habitats), and associate them to potential vegetation, soil moisture and mean diurnal range of temperature. Despite the low diversity indices for lizards, the Cerrado-Amazonia ecotone can harbor genetically diverse populations resistant to environmental change and able to persist in unstable environments. In the face of the predicted global climate changes, transition zones could prove to be an important genetic repository.

A-1479 (Oral)
Using the Past to Predict the Future: What Museum Specimens Tell Us about Organismal Responses to Climate Change

Jennifer Sheridan
Carnegie Museum of Natural History, USA

Museum specimen collections date back more than 150 years and can illustrate how organisms respond to long-term environmental changes, in ways that are not feasible with long-term field data. Museum and herbarium specimens have been critical in demonstrating phenological changes and range shifts in response to climate change, and more recently how body size has changed with climate. However, many existing studies focus on temperate species, despite the fact that the majority of life exists in the tropics, and the fact that the effects of climate change are expected to be stronger in the tropics than temperate regions. Further, ectotherms are less studied than endotherms, despite theoretical evidence that ectotherms are more sensitive to changes in temperature and precipitation than endotherms. This talk highlights a recent study using more than 100 years of Borneo anuran body size and climate data to show how temperature and precipitation interact to influence body size, and next steps in this field of research.

A-1480 (Poster)
Herpetofauna Diversity of the Disturbed and Isolated Bukit Maras in Terengganu, Peninsular Malaysia

Muhamad Fatihah Syafiq[1], Baizul Hafsyam Badli-Sham[1], Farah Hazirah Amir[2], Nur Nadhirah Sapri[2], Nurziattul Farhana Nordin[2], Mohamad Aqmal-Naser[1], Muhammad Shahril-Ridhwan[2], Joehan Azzimin[2], Tng Kel Li[2], Ng Shu Xin[2] and Amirrudin B. Ahmad[1]
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We documented the first herpetofauna checklist of Bukit Maras based on surveys conducted from 2019 to 2023. The collection methods used were Visual Encounter Survey (VES) and

drift-fenced pitfall traps. A total of 55 herpetofauna species comprises of 23 amphibians and 32 reptiles were recorded at Bukit Maras to date. *Manouria emys* is listed as "Critically Endangered" in IUCN Red List of Threatened Species was found here. Non-asymptotic of SAC indicated that additional records could be discovered with subsequent sampling efforts. Species-habitat network analysis displayed differences species composition among habitat types. Habitat-wise, secondary forest had higher herpetofauna diversity compared to the agricultural area. Thus, preserving the remaining secondary forest in Bukit Maras is paramount to conserving the herpetofauna and mitigating the anthropogenic impact in this disturbed and isolated area.

A-1481 (Oral)
The Status of Conservation and Decline of Amphibians in Taiwan

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Taiwan is a subtropical island located in Southeast Asia with only 36,000 square kilometers. The island is located in the subtropical region and earthquake zone which provides warm climate and diverse terrains. Five caudata species and 38 anuran species were described. Including 19 endemic species, 12 protected species, and 6 invasive species. Five caudata species were all classified in Hynobiidae which were all critically endangered, and endemic species. Low temperature and stream environmental requirements limit the species to thrive in high-elevation mountains. Global warming and the increase of high mountain tourism decrease the suitable habitats for the hynobiids to survive. Anuran species were classified into 7 families including Bufonidae, Hylidae, Eleutherodactylidae, Dicroglossidae, Microhylidae, Ranidae, and Rhacophoridae. Six invasive species were introduced through aquatic plant import, aquaculture, and pet trade. Main threats from the invasive species included predation, competition, and poison to the native anurans and other native fauna as well. For the native protected species, main problems included habitat destruction due to urban development and habitat degradation due to conventional agriculture. Cooperation between the governments and the local farmers has been established to create pesticide-free environments for the native anurans. Species restoration accompanied by the establishment of eco-friendly agriculture products has been carried out in anuran species conservation while enhancing the profit from the local farmers. In addition, the Society for Taiwan Amphibian Conservation has been conducting citizen scientists for nearly two decades. Over 80 volunteer survey groups and 700 volunteers have joined and collected over 400 thousand pieces of anuran data. The society provided extensive study sites over Taiwan to provide long-term surveillance data for conservation purposes. Moreover, environmental education and events of removing invasive species have been held from time to time to raise conservation awareness of the Taiwan amphibians.

A-1482 (Oral)
Where the Baseline Never Sets: Insights into Amphibian Dynamics and Conservation in Fluctuating Environments

Miguel de Felipe[1], Carlos Melián[2,3], Margarita Florencio[4], Mamen Ramírez-Soto[1] and Carmen Díaz Paniagua[1]

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Habitat loss and climate change stand as some of the main threats to amphibians worldwide. And yet, the mechanisms governing the emergence and maintenance of biodiversity remain one of the central questions in ecology and biogeography. By using an amphibian diversity hotspot (the Doñana National Park, SW Spain) as a case study, we provide insights into the long-term population trends of an amphibian community, its drivers in this protected area, and a Bayesian Markov Chain Modelling (BMCM) framework to understand the role of fluctuating landscapes in maintaining gamma diversity, and where future climate change and habitat loss projections can be implemented. We found a profound decline in Doñana's amphibian abundance and alpha diversity over the past two decades associated with habitat loss. Moreover, our results highlight BMCM as a useful tool to study the mechanisms by which species and diversity persist in dynamic landscapes. This flexible approach can be applied to current, prospective, and simulated environmental scenarios. Which might represent a useful tool in conservation planning and management of protected areas to ensure the long-term viability of amphibian populations.

SPECIAL PRESENTATION

An Introduction to the Herpetofauna of Borneo

Chien C. Lee
Institute of Biodiversity and Environmental Conservation
Universiti Malaysia Sarawak, 94300 Kota Samarahan
Sarawak, Malaysia

With its stable ever-wet climate, the immense equatorial island of Borneo is home to some of the most biodiverse tropical rainforests on the planet. Currently, there are an estimated ~500 species of reptiles and amphibians recognized from the island, including a high number of endemic taxa and several genera such as *Lanthanotus* and *Meristogenys*. Although Borneo has a long history of biological exploration, ongoing research indicates that its herpetofauna is still incompletely documented, with many species awaiting formal recognition. Given the island's increasing deforestation, the documentation of Borneo's biodiversity is more imperative than ever.

WORKSHOPS

W-01
What Editors Want:
A Guide Through the Publication Process for Graduate Students

Brian J. Halstead
U.S. Geological Survey, Western Ecological Research Center
Dixon Field Station, 800 Business Park Drive, Suite D,
Dixon, CA 95620-4309, USA

Join us for lunch and a discussion of editors' perspectives on the publication process, including how it works, what strategies increase the likelihood of your paper being sent out for review and being accepted, how to overcome obstacles to publishing your research, and how to be a productive reviewer and collaborator. At the 10th World Congress of Herpetology (7 August 2024 from 10:15 am to 2:00 pm). The workshop aims to provide graduate students and early career herpetologists with insights from editors of herpetological journals about how to successfully write and publish your work.

W-02
Wildlife Acoustic Workshop

Sharon Camm
Wildlife Acoustics, Inc., 3 Mill and Main Place, Suite 110
Maynard, MA 01754-2657, USA

Sound analysis is increasingly becoming a valuable tool for resource management, habitat health assessment, regulatory compliance goals, animal behavior studies and even documenting the effects of climate change. Unattended acoustic recorders provide a non-invasive and cost-effective technique to support these types of projects. This is especially true for herpetology research, where study sites may be difficult to access, and timing and conditions make traditional methods of monitoring challenging. Acoustic recordings can help determine population trends, find unknown populations, and answer other research questions to support conservation efforts. This will be a hands-on workshop (8 August 2024, 10:15am) to teach participants the features and configuration options of the Song Meter Mini 2 acoustic recorders.

SIDE EVENTS

ROUNDTABLE "TAKING THE INVASIVE TOAD TOOLKIT GLOBAL"

Invasive toads are a global problem, and yet many solutions and mitigations are available – particularly as a result of a large investment into cane toad invasions in Australia. But how much of the "invasive toad toolkit" can be exported to other invasions? This round-table event is aimed at stakeholders with an interest in toads and toad invasions to precise what parts of the toad toolkit can be used in toad invasions worldwide.
Date: 9 August 2024
Time: 1:00-2:00 pm
For more information, please contact:
John Measey: jmeasey@sun.ac.za, or
Georgia Ward-Fear: georgia.ward-fear@mq.edu.au
Angelica Crottini: acrottini@fc.up.pt

GLOBAL WOMEN IN HERPETOLOGY (GWH) LUNCHEON

Join us (the organizers, the authors, and the first batch of GWH scholarship holders) for an informal discussion about Women in Herpetology and the book "Women in Herpetology: 50 Stories from around the World" at the 10th World Congress of Herpetology (6 August 2024, at 1:00-2:00pm).
This event aims at facilitating networking among women, especially those early in their career.
For more information, please contact:
HERp Women: womeninherpetology@gmail.com

IUCN SSC AMPHIBIAN SPECIALIST GROUP LUNCH MEETING

The IUCN SSC Amphibian Specialist Group (ASG) is the International Union for Conservation of Nature's (IUCN) global volunteer network of dedicated experts who donate their time and expertise to create a community from where practical amphibian conservation can be advanced based on a solid foundation of science. This network currently consists of over 300 members in over 40 regions, enabling the ASG to act at a global scale. The gathering of numerous amphibian conservation-minded people at the WCH enables the members of the network to meet in person every few years.
Date: 7 August 2024
Time: 1:00pm - 2:00pm
Please contact:
Prof. Amaël Borzée, Ph.D.
Nanjing Forestry University, College of Life Sciences, Lab of Animal Behaviour and Conservation
IUCN SSC Amphibian Specialist Group, Co-chair
Email: aborzee@amphibians.org

AMPHIBIAWEB MEET-UP

AmphibiaWeb (amphibiaweb.org) will host a meet-up for all amphibian enthusiasts, with a special invitation to our new and old contributors. Come meet the AmphibiaWeb team, win amphibian-themed door prizes, learn more about AmphibiaWeb, and play some games to connect with other amphibian enthusiasts. Space will be made available for the first 60 people to arrive.

Date: 9 August 2024
Time: 11:45am
Please contact:
Prof Jimmy A. McGuire (mcguirej@Berkeley.edu) or
Prof Rebecca Tarvin (rdtarvin@berkeley.edu)
Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720-3160, USA

ALL-DAY 'SHOWS' AT VENUE FOYER

Three multimedia shows will be screened daily during the Congress, at the giant LCD screen at the venue foyer, courtesy of Kraig Adler and the Society for the Study of Amphibians and Reptiles.

1. AMPHIBIANS OF THE APPALACHIANS. This program depicts the lives of amphibians over the course of a single year, beginning in the late winter, as photographed in eastern North America from New York to Alabama. The images were taken primarily at night with flash photography, mostly without ever touching the animals. Some pictures were taken up in trees or underwater, wherever the animals were active. The panoramic images show parts of Appalachia that are still relatively wild and only sparsely populated.

2. HERPETOLOGISTS PAST AND PRESENT. This show chronicles the development of herpetology over the centuries by focusing on the leading herpetologists of the world. The program is divided into two parts: the "Past" (organized by Kraig Adler) being herpetologists who are deceased and the "Present" being the rest of us. The images are of portraits of the people and their major works and relevant animals, institutions, and habitats. The background music is classical for our distinguished "Past," but for the "Present" the music shifts abruptly to the Charlie Daniels Band to represent our livelier era.

3. AMPHIBIANS AND REPTILES OF THE AMERICAN SOUTHWEST. This completely revised show just premiered two months ago at the SSAR meeting at The University of Michigan (USA); Kuching (Borneo) is its first showing overseas. This program depicts the herpetofauna, habitats, and panoramas of the North American Grasslands, Colorado Plateau, Great Basin, Sky Islands, and the Chihuahuan, Mojave, and Sonoran deserts of the Southwest. The background music is from Stravinsky's "Firebird" and "Petrushka" ballets, enchanting melodies but having absolutely nothing to do with the American West, of course.

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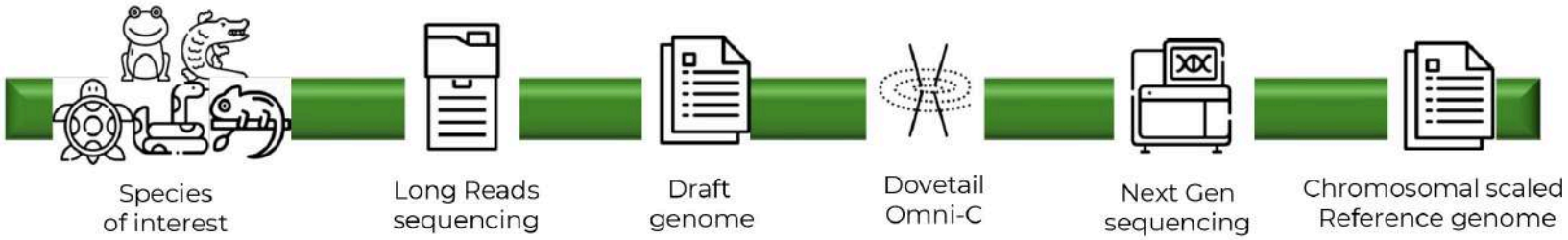

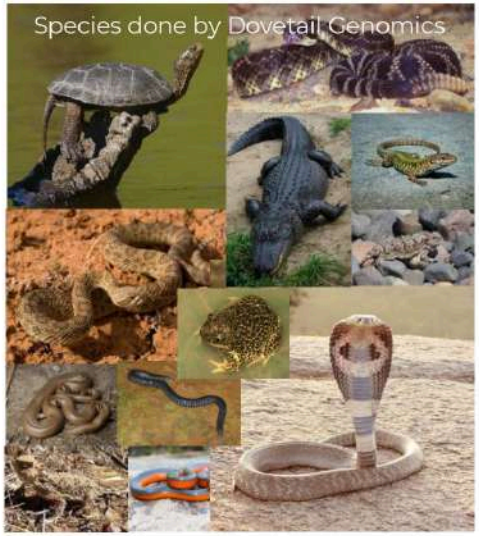

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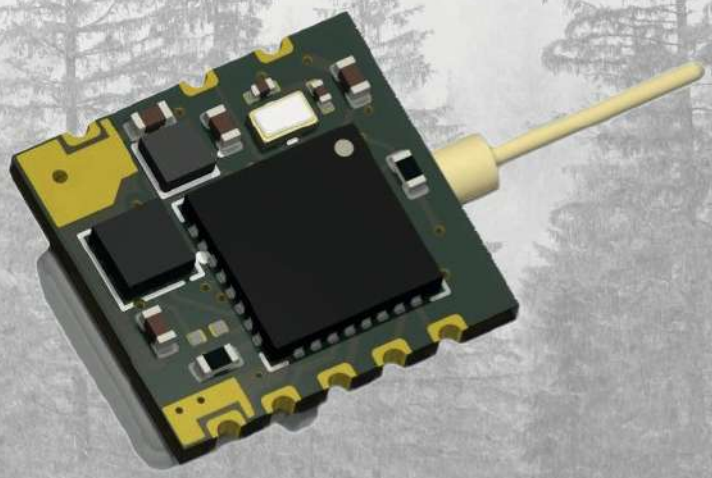

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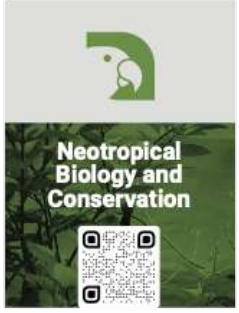

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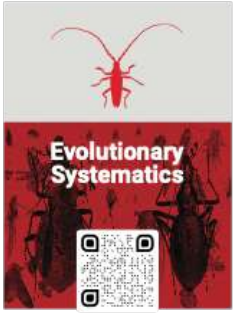

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