

Arboreal behaviour in lizards of the genus *Lacerta*: insights from observations and Citizen Science data

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Arboreal locomotion of reptiles is broadly documented among lizards and snakes. Many species of lizards, including those found in Europe, are completely adapted to an arboreal lifestyle (e.g., *Chamaeleo africanus* and *C. chamaeleon*; Speybroeck et al., 2016), whereas others are dwelling in trees only occasionally (e.g., *Euleptes europaea*, *Hemidactylus turcicus*, *Mediodactylus kotschy*; Salvador, 1981; Schwarz et al., 2016; Salvi et al., 2023). Arboreal behaviour is rarely described from European lacertid lizards (see Arnold, 1987) and, for example, was recently mentioned in the genera *Podarcis* (Ayres, 2020; Ayres and Domínguez-Costas, 2021), *Psammodromus* (Llorca et al., 2023), and *Teira* (Petrovan, 2023). Surprisingly, reports describing this behaviour in the large European lizards of the genus are rare or scattered in the literature (Peters, 1970; Arnold, 1987; Mikátová, 2001; Blanke and Fearnley, 2015). As demonstrated by Vanhooydonck and Van Damme (1999), phylogenetic analyses did not reveal a clear relationship between limb dimensions and habitat use in lacertid lizards, indicating either a lack of adaptation or limitations of the study methods. This suggests that some species may exhibit plasticity in how they use their morphological traits across different habitats. Consequently, this behaviour is either overlooked in the genus *Lacerta* or regarded as “normal” and therefore not given much attention (see Nettmann and Rykena, 1984).

The genus *Lacerta* is distributed mostly in the

Western Palaearctic, where it is represented by ten species (Sindaco and Jeremčenko, 2008; Kornilios et al., 2020). It is widely known as mostly terrestrial or shrub-climbing and often territorial, but surprisingly its potential for arboreal locomotion is rarely explored in the available literature (Darevsky, 1946; Yablokov, 1976). We here present some direct observations of arboreal locomotion in three species of the genus *Lacerta*, particularly in large green lizards, and provide a listing of additional observations found on iNaturalist.

Our first observation was made by TJ and DJ on 2 April 2024 in northern Bulgaria, near the village of Novacene (43.5747°N, 24.9414°E, elevation 91 m; WGS84). Two adult individuals, a male and a female of *Lacerta diplochondrodes dobrogica* Fuhr and Mertens, 1959, were found basking near the edge of a pine forest in a hilly area. As we walked along the forest edge, the lizards retreated to the bark of nearby trees, climbing up to about 5 m above the ground (Fig. 1A). When we approached to photograph them, they remained motionless in a relaxed position near the tree nodes (Fig. 1B, C) and continued to bask. When we moved back to a distance of 3–5 m, we observed the lizards descending after 5–10 min to the lower parts of the tree, though not to the ground. However, as we increased our distance to approximately 10 m, they almost immediately returned to the ground or to ground-level vegetation but remained watchful of our presence. As we moved closer again, the lizards retreated to the tree bark and climbed higher. This singular observation suggests that these lizards actively use trees both as a strategy to escape predators and as a means of thermoregulation, thereby avoiding terrestrial threats. However, together with *Podarcis tauricus* (Pallas, 1814) we also observed this species in other parts of the study area where individuals exhibited more typical terrestrial behaviour.

Our findings are further supported by earlier records. On 13 July 2013, a subadult *L. viridis viridis* (Laurenti, 1768) was observed by MS basking on a *Thuja* tree about 1.5 m above the ground in a garden in Tokaj, Hungary (48.117°N, 21.411°E; WGS84; Fig. 2A).

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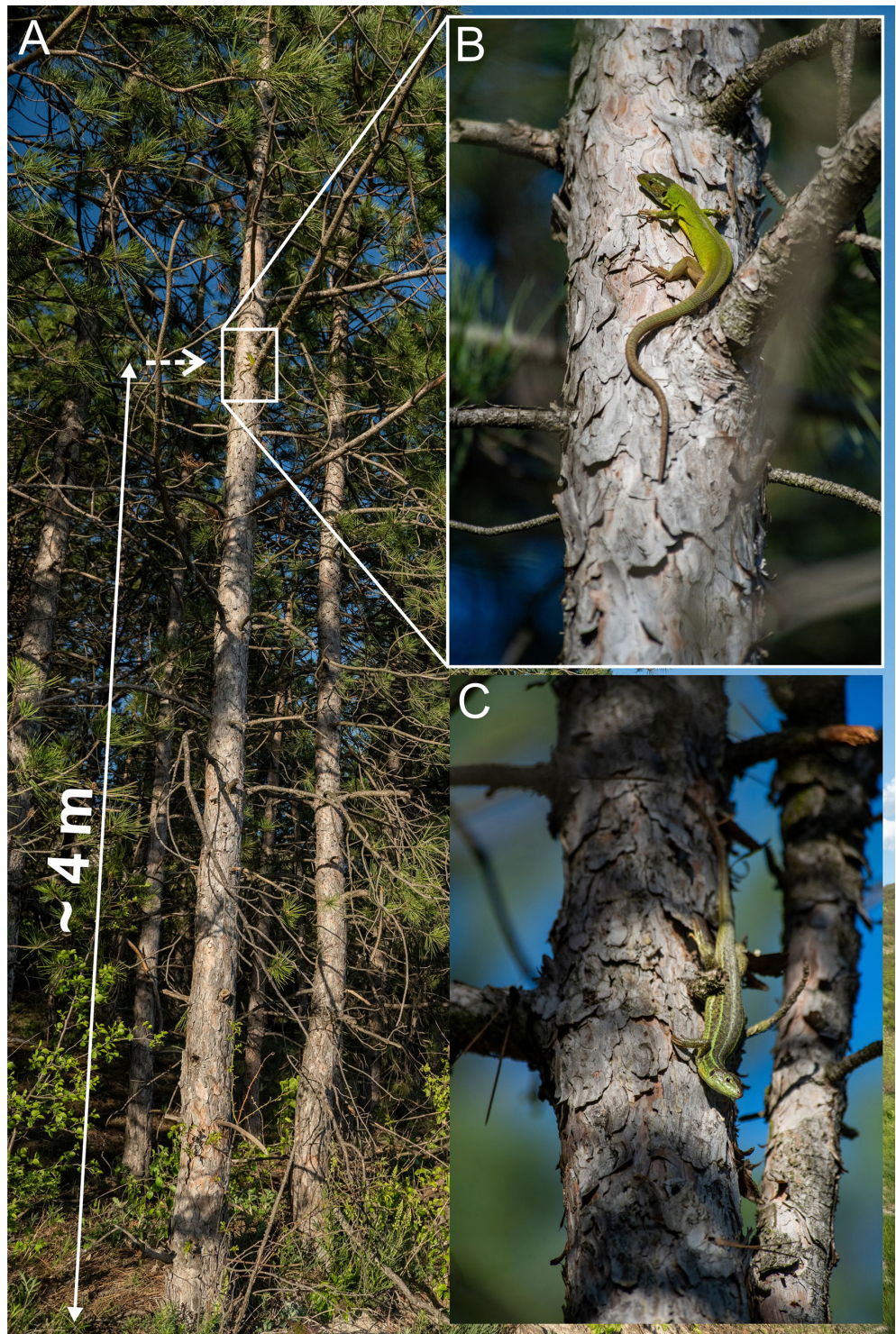


Figure 1. A case of arboreal behaviour observed in *Lacerta diplochondrodes dobrogica* from northern Bulgaria. (A) The forest edge with *Pinus nigra* where an adult male (B) of the species was found nearly 5 m high in a tree. (C) An adult female of the same species observed on a different tree, approximately 4 m high, within a few meters of the previous observation site. Photographs by Daniel Jablonski.

On 25 May 2015, an adult pair of *L. v. viridis* was observed by MS while they were resting on an apple tree (*Malus domestica*), about 1.8 m above the ground in an abandoned orchard in the middle of a hay meadow on Tokaj Hill (48.131°N, 21.386°E; Fig. 2B). As is typical for that period of year, the male probably guarded the female from potential other males, but no other lizards were observed.

On 21 October 2017, in the Stofylia Forest in southern Greece (38.155°N, 21.368°E), ET observed an adult male *L. trilineata trilineata* Bedriaga, 1886 sleeping on a thin branch of an Aleppo Pine (*Pinus halepensis*) approximately 3 m above the ground (Fig. 2C). The lizard was first spotted using a headlamp and was photographed *in situ* without any disturbance from the observers. This nocturnal observation took place in a habitat characterised by extensive dune formations dominated by *P. halepensis* and Mediterranean Juniper (*Juniperus turbinata*), adjacent to a dense pine forest comprising a mix of *P. halepensis* and Stone Pine (*P. pinea*). Although multiple encounters with *L. t. trilineata*

have been documented at this site over the years, they predominantly involved terrestrial behaviour, without any records of the lizards occupying tall trees. Additionally, similar arboreal behaviour was noted in younger, mostly subadult individuals in a nearby location (approximately 2 km southeast in a straight line) covered with Valonia Oaks (*Quercus macrolepis*) and introduced eucalyptus trees. In these cases, a few individuals exhibited arboreal behaviour, but only as a means of avoiding interaction during daylight hours. Although arboreal sleeping is common in other terrestrial lizard groups (e.g., the genus *Laudakia*), our observation likely represents the first documented instance of arboreal sleeping behaviour in this species, highlighting a previously unreported aspect of its ecology.

Lastly, an adult female *L. viridis* was observed basking on a Blackthorn (*Prunus spinosa*), at around 2.5 m height on 2 April 2024 near the village of Gorni Tsibar (43.782°N, 23.625°E) in northern Bulgaria by BW (Fig. 2D).



Figure 2. Subadult female *Lacerta viridis viridis* from Tokaj, Hungary, basking on *Thuja* sp. (A); a pair of *L. v. viridis* from Tokaj, Hungary, basking on *Malus domestica* (B); a sleeping male *Lacerta trilineata trilineata* observed on *Pinus halepensis* in the Stofylia Forest, southern Greece (C); female *L. v. viridis* from Gorni Tsibar, Bulgaria, basking on *Prunus spinosa* (D). Photographs by Márton Szabolcs (A, B), Elias Tzoras (C), and Bálint Wenner (D).

To contextualise our observations and filling the literature gap, we reviewed 45,191 records of the genus *Lacerta* on iNaturalist (as of 27 August 2024; Appendix 1) to identify instances of lizards exhibiting arboreal behaviour, such as climbing or basking on trees and their branches at heights ≥ 1 m. We excluded photos where individuals were in the suspicious position, probably staged and arranged for photography (e.g., Observation 226251455). In total, we identified 311 records (0.7%) that we considered arboreal behaviour, featuring nine species (15 observations of *L. pamphylica* did not include arboreal behaviour). We found 53 arboreal observations for *L. agilis* (0.2% of 22,444 records), 145 for *L. bilineata* (1.2% of 12,163), one for *L. citrovittata* (3% of 33), four for *L. diplochondrodes* (1.7% of 237), five for *L. media* (2% of 248), 12 for *L. schreiberi* (0.6% of 1849), two for *L. strigata* (0.3% of 629), 22 for *L. trilineata* (1.7% of 1292), and 67 for *L. viridis* (1.1% of 6028). Of the 311 observations of arboreal activity, 46.6% involved *L. bilineata*, 21.5% *L. viridis*, and 17.0% *L. agilis*, with the remaining species accounting for less than 10% (Fig. 3; Appendix 1).

Based on the observed data, we can preliminarily report that in certain species the number of arboreal

observations tends to increase with the total number of records. For instance, *L. bilineata* shows more than twice the number of records on iNaturalist (12,163 vs. 6028) with twice the number of arboreal observations (145 vs. 67) than *L. viridis*. These two species are closely related, sometimes only considered different subspecies (Arnold and Ovenden, 2002) but currently recognised as members of a species complex distinct at the species level (Marzahn et al., 2016; Speybroeck et al., 2020). In the sense of habitat selection, *L. viridis* was considered rather terrestrial or shrub-climbing (Vanhooydonck and Van Damme, 1999). However, *L. bilineata* and *L. viridis* are regarded as adept climbers (Peters, 1970; Nettmann and Rykena, 1984). According to the literature, their arboreal activity is typically associated with predator avoidance and foraging behaviour (Arnold, 1987; Mikátová, 2001), which conforms to the observations we present here. Additionally, tree climbing has been considered to play a role in their thermoregulation (Mikátová, 2001; Sound, 2005). Thus, our comparison based on Citizen Science data preliminarily shows that with its high relative share of arboreal records (46.6%) *L. bilineata* has a higher tendency for arboreality compared to other taxa in the genus (Fig. 3).

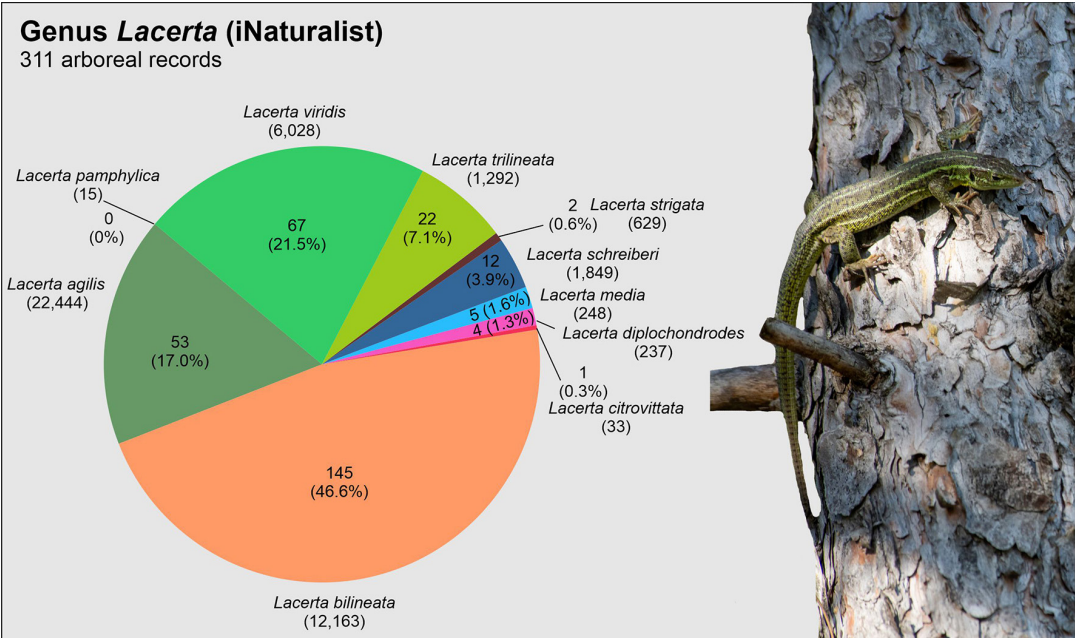


Figure 3. The pie chart illustrates the distribution of arboreal records across different species of the genus *Lacerta* based on iNaturalist data. Each slice represents the proportion of arboreal records for a specific species, labelled with the species name and its total number of records. The total number of arboreal records for each species, along with the percentage values (in parentheses), indicates their relative share of these observations.

As shown in the iNaturalist data, some of observations were from a great height of trees (e.g., Observations 188519627 or 167722800). This may offer a new perspective on behaviour and habitat preferences in these sister species within the *L. viridis* complex and should be further studied, particularly in their contact zone, to assess the possibility of different microhabitat preferences.

Currently, our data are insufficient to draw definitive conclusions regarding the specific conditions under which *Lacerta* species utilise trees for escape, thermoregulation, or nocturnal shelter. However, is it surprising that this phenomenon has not yet been reported with more depth in the literature. For example, in *L. agilis*, a species considered rather terrestrial, we found several cases in the iNaturalist data that suggest possible arboreality, especially in the subspecies *L. a. exigua* Eichwald, 1831 (e.g., Observation 161984780). It was also described by Darevsky (1946), who observed this species basking on the top of a pine tree at the height of about 25 m. However, the literature mentions climbing in this species, with individuals reaching heights of approximately 1.5 m (e.g., Mikátová, 2001; Schwartze, 2010; but see Blanke and Fearnley, 2015).

It is plausible that during the spring or autumn months (periods corresponding to our observations) when vegetation is sparse and low, large lizards of this genus may benefit from utilising tree heights as a shelter strategy (see also *Psammodromus algirus*; Llorca et al., 2023). However, this remains speculative and additional data of field observations will be necessary to support this and other suggestion resulting from arboreal locomotion of the genus *Lacerta*.

Citizen science platforms such as iNaturalist have revolutionized the accessibility and scope of natural history observations. The number of observations now available would have been impossible to obtain or logistically challenging and resource intensive. The ability to tap into a vast pool of observations significantly enhances ecological and behavioral insights, allowing for a more comprehensive understanding of habitat use and activity patterns of organisms (see Spaseni et al., 2024). In the context of arboreality, the aggregation of data enables the detection of broad trends that might otherwise go unnoticed in smaller, researcher-driven studies. However, the reliance on citizen science data also introduces inherent biases that need to be critically considered. One major limitation is observational bias (i.e., what people see and what they report is not always a random sample), which can be influenced by factors

such as visibility, accessibility, personal interest, and preferences for uploading data to online databases or social media platforms. These biases can (i) skew the dataset toward more conspicuous arboreal observations (e.g., a green lizard perched on a contrasting grey tree trunk is far more noticeable to a casual observer than one camouflaged in dense grass), (ii) introduce selection bias (e.g., observers may prefer to upload unusual or striking sightings, such as a lizard high up in a tree.), and (iii) lead to a disproportionate contribution of data from frequently visited locations, potentially overrepresenting particular microhabitats. The issue may arise also due to incorrect species identification in the field, especially between morphologically similar species in their contact zones.

These biases are particularly relevant when interpreting absolute numbers and ratios (Fig. 3). On the other hand, the overall number of available records (> 45,000) carries significant weight. Nevertheless, the observed frequency of arboreal vs. terrestrial sightings may not fully reflect the true ecological distribution and behavior of these lizards but rather the conditions under which they are most readily noticed. While this does not undermine the overall trend observed in the study, it does warrant caution when extrapolating raw frequencies to infer precise behavioral tendencies. Future studies could mitigate these biases by incorporating targeted field surveys, structured sampling methods, or statistical corrections that account for observer effort and detectability.

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References

- Arnold, E.N. (1987): Resource partition among lacertid lizards in southern Europe. *Journal of Zoology* **1**: 739–782.
- Arnold, E.N., Ovenden, D.W. (2002): *Reptiles and Amphibians of Europe*. Oxford, UK, Oxford University Press.
- Ayres, C. (2020): Arboreal behaviour in a coastal population of Bocage's Wall Lizard (*Podarcis bocagei*). *Podarcis* **11**: 59–60.
- Ayres, C., Domínguez-Costas, M. (2021): Arboreal behavior in the Lusitanian Wall Lizard, *Podarcis guadarramae* (Boscá, 1916). *Reptiles & Amphibians* **28**: 13–14.
- Blanke, I., Fearnley, H. (2015): *The Sand Lizard. Between Light and Shadow*. Bielefeld, Germany, Laurenti Verlag.

- Darevsky, I.S. (1946): K biologii prytkoy yashcheritsy [On the biology of the sand lizard]. *Priroda* **9**: 52–54.
- Kornilios, P., Thanou, E., Lymberakis, P., Ilgaz, Ç., Kumlutaş, Y., Leaché, A. (2020): A phylogenomic resolution for the taxonomy of Aegean green lizards. *Zoologica Scripta* **49**: 14–27.
- Llorca, A.B., Tortosa, F.S., Guerrero-Casado, J. (2023): Arboreal behavior of *Psammodromus algirus* (Squamata: Lacertidae) in olive groves. *Herpetological Conservation and Biology* **18**: 155–160.
- Marzahn, E., Mayer, W., Joger, U., Ilgaz, Ç., Jablonski, D., Kindler, C., et al. (2016): Phylogeography of the *Lacerta viridis* complex: mitochondrial and nuclear markers provide taxonomic insights. *Journal of Zoological Systematics and Evolutionary Research* **54**: 85–105.
- Mikátová, B. (2001): Distribution of the green lizard *Lacerta viridis* (Laurenti, 1768) in the Czech Republic. *Mertensiella* **13**: 138–149.
- Nettmann, H.K., Rykena, S. (1984): *Lacerta viridis* (Laurenti, 1768) – Smaragdeidechse. In: *Handbuch der Reptilien und Amphibien Europas*. Band 2/1 Echsen II (*Lacerta*), p. 129–180. Böhme, W., Ed., Wiesbaden, Germany, Aula Verlag.
- Peters, G. (1970): Studien zur Taxonomie, Verbreitung und Ökologie der Smaragdeidechsen. IV. Zur Ökologie und Geschichte der Populationen von *L. v. viridis* (LAUR.) im mitteleuropäischen Flachland. *Veröffentlichungen des Bezirksmuseums Postdam* **21**: 49–119.
- Petrovan, S.O. (2023): The wall (and tree) lizard: surveys and citizen science to improve understanding of arboreal behaviour of Madeiran Wall Lizard *Teira dugesii*. *Herpetology Notes* **16**: 701–709.
- Salvador, A. (1981): *Hemidactylus turcicus* (Linnaeus 1758) – Europäischer Halbfingergecko. In: *Handbuch der Amphibien und Reptilien Europas*. Band I/1, Echsen (Sauria), p. 84–117. Böhme, W., Ed., Wiesbaden, Germany, Aula Verlag.
- Salvi, D., Berrilli, E., Bruni, G., Garzia, M., Gomes, V., Radi, G., Delaugerre, M.J. (2023): The secret life of a rock-dweller: arboreal acrobatics observed in the European leaf-toed gecko *Euleptes europaea*. *Herpetozoa* **36**: 135–141.
- Schwartz, M. (2010): Beobachtungen an einer Population der Zauneidechse (*Lacerta agilis*) auf einem Friedhof im Münsterland (NRW). *Zeitschrift für Feldherpetologie* **17**: 77–88.
- Schwarz, R., Gavrilidi, I.-A., Itescu, Y., Jamison, S., Sagonas, K., Meiri, S., Pafilis, P. (2016): *Mediodactylus kotschy* in the Peloponnese peninsula, Greece: distribution and habitat. *Acta Herpetologica* **11**: 179–187.
- Sindaco, R., Jeremčenko, V.K. (2008): The Reptiles of the Western Palearctic. Volume 1. Annotated Checklist and Distributional Atlas of the Turtles, Crocodiles, Amphisbaenians and Lizards of Europe, North Africa, Middle East and Central Asia. Latina, Italy, Edizioni Belvedere.
- Sound, P. (2005): Räumliche und zeitliche Einbindung einer strukturierten Population der Westlichen Smaragdeidechse (*Lacerta bilineata*, Daudin 1802) im Mittelrheintal. Unpublished PhD thesis, Johannes Gutenberg-Universität Mainz, Mainz, Germany.
- Spaseni, P., Sahlen, T.C., Gherghel, I., Zamfirescu, R.Ş., Petreanu, I.C., Melenciu, R., et al. (2024): *Natrix natrix* after dark: citizen science sheds light on the common grass snake's nightlife. *PeerJ* **12**: e17168.
- Speybroeck, J., Beukema, W., Bok, B., Van Der Voort, J. (2016): *Field Guide to the Amphibians and Reptiles of Britain and Europe*. Bloomsbury, London.
- Speybroeck, J., Beukema, W., Dufresnes, C., Fritz, U., Jablonski, D., Lymberakis, P., et al. (2020): Species list of the European herpetofauna – 2020 update by the Taxonomic Committee of the Societas Europaea Herpetologica. *Amphibia-Reptilia* **41**: 139–189.
- Vanhooydonck, B., Van Damme, R. (1999): Evolutionary relationships between body shape and habitat use in lacertid lizards. *Evolutionary Ecology Research* **1**: 785–805.
- Yablokov, A.V. (1976): *Prytkaya Yashcheritsa. Monograficheskoe Opisanie Vida* [The Sand Lizard. Monographic Description of the Species]. Moscow, Russia, Nauka.

Appendix 1. Arboreality records for species in the genus *Lacerta*, based on Citizen Science data (as of 27 August 2024). The total number of observations (*n*) for each species on iNaturalist is also provided.

***Lacerta agilis* (*n* = 22,444)**

<https://www.inaturalist.org/observations/146498581>
<https://www.inaturalist.org/observations/36252688>
<https://www.inaturalist.org/observations/44973726>
<https://www.inaturalist.org/observations/198647078>
<https://www.inaturalist.org/observations/146491305>
<https://www.inaturalist.org/observations/20220783>
<https://www.inaturalist.org/observations/196107141>
<https://www.inaturalist.org/observations/17819094>
<https://www.inaturalist.org/observations/68911206>
<https://www.inaturalist.org/observations/12460613>
<https://www.inaturalist.org/observations/51296204>
<https://www.inaturalist.org/observations/24985777>
<https://www.inaturalist.org/observations/25314230>
<https://www.inaturalist.org/observations/44757964>
<https://www.inaturalist.org/observations/45245029>
<https://www.inaturalist.org/observations/46734109>
<https://www.inaturalist.org/observations/68698879>
<https://www.inaturalist.org/observations/53727758>

***Lacerta bilineata* (*n* = 12,163)**

<https://www.inaturalist.org/observations/195650045>
<https://www.inaturalist.org/observations/190830444>
<https://www.inaturalist.org/observations/525595>
<https://www.inaturalist.org/observations/196781396>
<https://www.inaturalist.org/observations/197404732>
<https://www.inaturalist.org/observations/9796285>
<https://www.inaturalist.org/observations/204056812>
<https://www.inaturalist.org/observations/197133834>
<https://www.inaturalist.org/observations/15284377>
<https://www.inaturalist.org/observations/205136678>
<https://www.inaturalist.org/observations/71553220>
<https://www.inaturalist.org/observations/47752245>
<https://www.inaturalist.org/observations/69094936>
<https://www.inaturalist.org/observations/149438411>
<https://www.inaturalist.org/observations/21358480>
<https://www.inaturalist.org/observations/18702052>
<https://www.inaturalist.org/observations/148455464>
<https://www.inaturalist.org/observations/5057582>
<https://www.inaturalist.org/observations/4039396>
<https://www.inaturalist.org/observations/106669066>
<https://www.inaturalist.org/observations/5685143>
<https://www.inaturalist.org/observations/5638842>
<https://www.inaturalist.org/observations/6159830>
<https://www.inaturalist.org/observations/7380015>
<https://www.inaturalist.org/observations/6349380>
<https://www.inaturalist.org/observations/6560242>
<https://www.inaturalist.org/observations/6683513>
<https://www.inaturalist.org/observations/13152255>
<https://www.inaturalist.org/observations/105054568>
<https://www.inaturalist.org/observations/7330290>
<https://www.inaturalist.org/observations/19901809>
<https://www.inaturalist.org/observations/17325479>
<https://www.inaturalist.org/observations/8385345>
<https://www.inaturalist.org/observations/11005548>
<https://www.inaturalist.org/observations/11314501>
<https://www.inaturalist.org/observations/12260651>
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<https://www.inaturalist.org/observations/14445806>
<https://www.inaturalist.org/observations/39242326>
<https://www.inaturalist.org/observations/16164061>
<https://www.inaturalist.org/observations/30528515>
<https://www.inaturalist.org/observations/145913037>
<https://www.inaturalist.org/observations/17710586>
<https://www.inaturalist.org/observations/22428429>
<https://www.inaturalist.org/observations/27746254>
<https://www.inaturalist.org/observations/23111264>
<https://www.inaturalist.org/observations/28138298>
<https://www.inaturalist.org/observations/36982251>

***Lacerta citrovittata* (*n* = 33)**

<https://www.inaturalist.org/observations/33611574>

***Lacerta diplochondrodes* (*n* = 237)**

<https://www.inaturalist.org/observations/170425801>
<https://www.inaturalist.org/observations/100676137>

***Lacerta media* (*n* = 248)**

<https://www.inaturalist.org/observations/235549968>
<https://www.inaturalist.org/observations/183152833>

***Lacerta schreiberi* (*n* = 1849)**

<https://www.inaturalist.org/observations/197017077>
<https://www.inaturalist.org/observations/184731408>
<https://www.inaturalist.org/observations/153365204>
<https://www.inaturalist.org/observations/118490066>

<https://www.inaturalist.org/observations/110203301>
<https://www.inaturalist.org/observations/74915109>
<https://www.inaturalist.org/observations/79195559>
<https://www.inaturalist.org/observations/78250818>
<https://www.inaturalist.org/observations/78390186>
<https://www.inaturalist.org/observations/132533169>
<https://www.inaturalist.org/observations/87370571>
<https://www.inaturalist.org/observations/99896166>
<https://www.inaturalist.org/observations/111345258>
<https://www.inaturalist.org/observations/116801394>
<https://www.inaturalist.org/observations/118356171>
<https://www.inaturalist.org/observations/161984780>
<https://www.inaturalist.org/observations/195742619>
<https://www.inaturalist.org/observations/166802231>
<https://www.inaturalist.org/observations/169941810>
<https://www.inaturalist.org/observations/171344894>
<https://www.inaturalist.org/observations/174449979>
<https://www.inaturalist.org/observations/125945120>

<https://www.inaturalist.org/observations/32235178>
<https://www.inaturalist.org/observations/140693612>
<https://www.inaturalist.org/observations/236502599>
<https://www.inaturalist.org/observations/26793395>
<https://www.inaturalist.org/observations/26911054>
<https://www.inaturalist.org/observations/28720244>
<https://www.inaturalist.org/observations/29848666>
<https://www.inaturalist.org/observations/32011949>
<https://www.inaturalist.org/observations/30028059>
<https://www.inaturalist.org/observations/74052192>
<https://www.inaturalist.org/observations/44117549>
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<https://www.inaturalist.org/observations/45279692>
<https://www.inaturalist.org/observations/46074059>
<https://www.inaturalist.org/observations/46241707>
<https://www.inaturalist.org/observations/131793850>
<https://www.inaturalist.org/observations/46479276>
<https://www.inaturalist.org/observations/46834020>
<https://www.inaturalist.org/observations/47711179>
<https://www.inaturalist.org/observations/47949769>
<https://www.inaturalist.org/observations/61681865>
<https://www.inaturalist.org/observations/48703730>
<https://www.inaturalist.org/observations/165194574>
<https://www.inaturalist.org/observations/53643692>
<https://www.inaturalist.org/observations/71205804>
<https://www.inaturalist.org/observations/55152222>
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<https://www.inaturalist.org/observations/45874834>

<https://www.inaturalist.org/observations/66734308>
<https://www.inaturalist.org/observations/63788713>
<https://www.inaturalist.org/observations/16537195>
<https://www.inaturalist.org/observations/10222338>

Appendix 1. cont.

Lacerta strigata (n = 629)

<https://www.inaturalist.org/observations/236933887>

Lacerta trilineata (n = 1292)

<https://www.inaturalist.org/observations/222143360>
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<https://www.inaturalist.org/observations/215761911>
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<https://www.inaturalist.org/observations/209719979>
<https://www.inaturalist.org/observations/209104189>
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<https://www.inaturalist.org/observations/175998884>

Lacerta viridis (n = 6028)

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