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**MALE-MALE COMBAT IN *Pseudopus apodus* (REPTILIA: ANGUIDAE)****Daniel Jablonski<sup>1</sup>***Submitted May 23, 2017*

Despite its interesting diversity, life history and evolution, the family Anguidae is one of the least-explored group of lizards in the world. The same is true for the largest member of the family, *Pseudopus apodus*. Life history data on this species are still very scarce. Here, I present the observation of ritualized male-male combat based on two records from Kyrgyzstan and Greece. Male-male combat is an interesting phenomenon in different aspects of *P. apodus* life history including mating behavior, sexual size dimorphism or intra-sexual competition. Therefore, in this article I present the first description of male-male combat for *P. apodus* and make comparisons with this phenomenon in the closely related genus *Anguis*.

**Keywords:** intra-sexual and intraspecific interactions; competition; ethology; *Anguis*; Sheltopusik; European legless lizard.

**INTRODUCTION**

Family Anguidae represents a mainly small but morphologically and genetically diverse, relatively ancient clade of generally insectivorous reptiles, within which limblesness and viviparity have repeatedly evolved (Macey et al., 1999; Wiens and Slingsluff, 2001). Lizards of this family have disjunct distribution in Americas, Europe, northern Africa, SW and SE Asia (Vitt and Caldwell, 2014). This family includes 11 genera of small tropical members with very limited distribution and cryptic lifestyle (e.g., the genera *Dopasia*, *Mesaspis*) as well as bigger members (*Ophisaurus*, *Pseudopus*) occurring in wide areas of North America and Eurasia. Both morphological and molecular phylogenetic analyses support the monophyly of the three main subclades of anguids (Gauthier et al., 2012; Pyron et al., 2013). However, data on many aspects of anguid ethology, reproduction and life history remain scarce. Only information about parental behavior were studied in detail for this family in the review of Greene et al. (2006). Generally speaking, the reason for the paucity of studies on *P. apodus* is due to its cryptic behavior under natural conditions.

The largest member of the family, *Pseudopus apodus* (Pallas 1775), is a robust legless lizard with a total length

commonly up to 1.2 m (Obst, 1981; Sviridenko and Kukushkin, 2003). The tail is 1.5 – 1.7 times bigger than the body length. The color of adults is generally brown or brown-yellow. Currently, two subspecies are recognized, *P. a. apodus* (Pallas 1775) from Eastern Turkey eastwards, including the Crimean populations and *P. a. thracicus* (Obst, 1978) from the Balkans and Western Anatolia (Obst, 1981). Differences between the two subspecies are primarily in coloration of the body, in the proportion of the head, in some features of pholidosis and also in genetics (Obst, 1978; Jandzik et al., 2018). However, taxonomic status some of populations is still questionable. Moreover, the manuscript was accepted with this order of figures.

Life history data are very scarce for this species with only scattered information (see below; Obst, 1981; Milto, 2010; Kukushkin et al., 2013a, 2013b; and literature therein). In the present contribution, I describe ritualized male-male combat observed in both subspecies of *P. apodus*.

**MATERIAL AND METHODS**

During a field trip in the vicinity of the Jalal-Abad city, Kyrgyzstan (Fergana valley), on May 5, 2015 (hilly grassy habitats in open landscape; 40.93748° N 73.03702° E; 956 m a.s.l.), I encountered two fighting

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Fig. 1. Male-male ritual combat of *Pseudopus apodus* observed near Jalal-Abad city, Kyrgyzstan.

males of *Pseudopus apodus* at 12:30 of the local time. The weather was sunny. Both males were adults with approximate lengths of about one meter. The entire observed course of the male-male ritual combat was captured by camera Nikon D810 in lens with the focal length 400 mm. Observed individuals were located about 15 m from me and did not react to my close presence. Overall, during the two days (May 4 and 5, 2015) I spent in the field near Jalal-Abad city, I found five males and only one female of *P. apodus*.

The second observation was made by the wildlife photographer Jean Bisetti. He sent me pictures showing the male-male combat of *P. a. thracicus* (Fig. 2) which he had taken near Ipsilou Monastery (39.22594° N

25.93854° E; 270 m), western Lesvos Island, and Greece. This observation was recorded on May 8, 2014 between 15:00 and 16:00 (local time) during a sunny day.

## RESULTS

Regarding my observation from Kyrgyzstan, I did not observe the beginning of the combat. However, the slightly larger individual (A) was more active and aggressive throughout the whole observation. It seemed the individual A originated this instance of male-male combat. When I started to watch this combat, both individuals were crawling next to each other and individual A



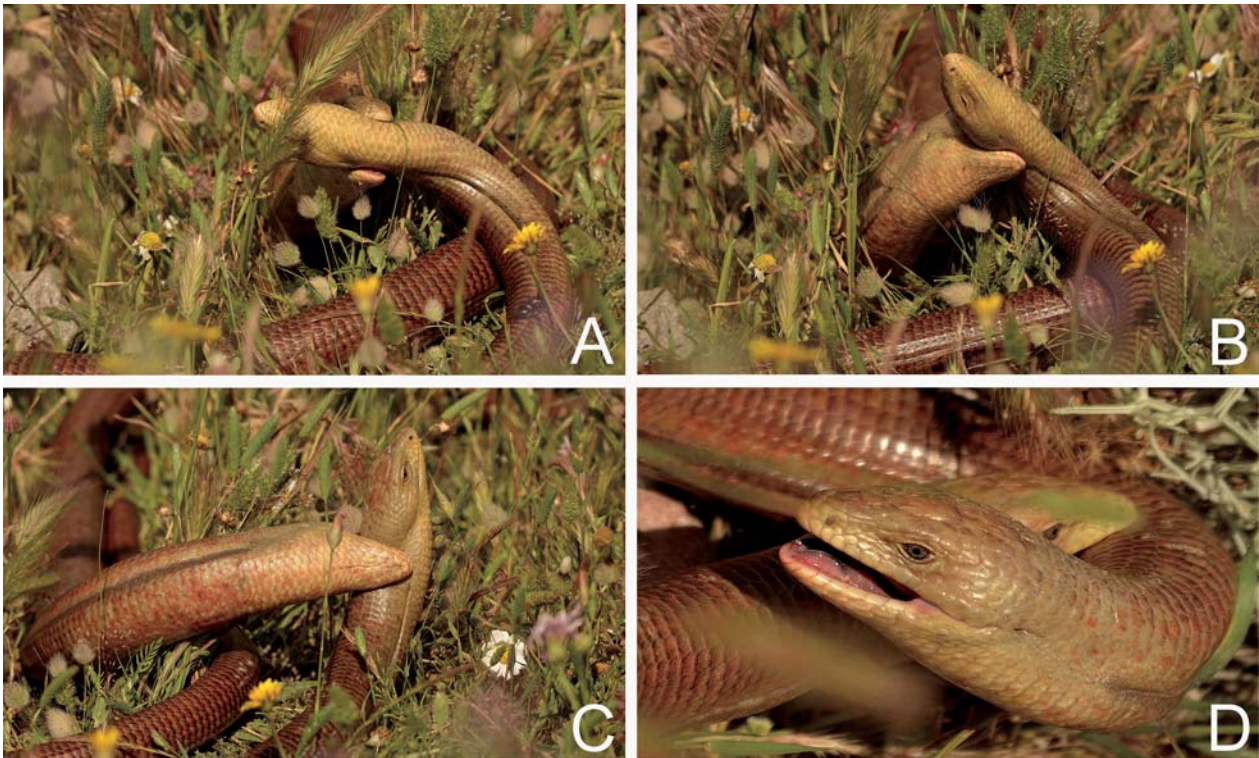


Fig. 2. Male-male combat of *Pseudopus apodus* from Lesvos, Greece. Photos by J. Bisetti.

was just about to bite into the flank of male B (Fig. 1A). However, the bite was not held for a long time and the bitten male (B) turned immediately around and attacked the aggressor (male A) on the left flank, just behind the head again. This ritual continued in both individuals during the next 40 – 50 sec with short breaks when one of the individuals (or both, Fig. 2F) was overturned on its back (Fig. 2C, J, O). A mutual bite (Fig. 2D, N, O) as well as head pushing to the ground was also observed (Fig. 2F, G, H, Q). The very swift procedure of an alternating, mutual biting and attacks with rotation around its axis (very well known as defensive behavior for this species) or with body and tail twisting (Fig. 2K, L, M, N) was repeated several times, until after ca. 3 min (the fight was already ongoing when I started to see it). Then the B individual began to crawl away and the A individual last bit into the body of B (Fig. 2S, T). It violently forced the B individual to jerk sharply with its body and to crawl away more actively. The individual released its bite and the combatants crawled away in different directions. The whole observed combat took six minutes. A female of the species was not observed in the close vicinity of the male combatants. Both males were captured after the end of the combat when they were about 15 m from each other. They showed no signs of aggression and their de-

fenses consisted of rotation around their body axis, defecation and hemipenes eversion.

In the second case, the author (J. Bisetti) observed a trio of *P. apodus* (two males and one female) altogether. The observation was not fully documented, however, combat of both males was conducted, (according to the author), in a similar manner to the previous observation from Kyrgyzstan. Both males attack and bite mutually in the neck region while at the same time twisting their bodies and tails. After that one male suddenly crawled away and the second male returned to mate with the female. Mating was observed for a long time (not measured exactly) and continued when the author left. In both described observations, the losing male closed his eyes as is presented in Fig. 2B.

## DISCUSSION

In general, despite *P. apodus* being a very well known and spectacular species of the family Anguidae, detailed information about its reproduction ethology are not known. We have only fragmented information about mating behavior (males bite females during mating; Bischoff, 1974; Kukushkin et al., 2013a), oviposition and

parental behavior or care regarding the eggs, respectively (Bischoff, 1974; Obst, 1981; Claffey and Johnson, 1983; Milto, 2010; Kukushkin et al., 2013a, b). However, we can assume that life history and reproduction ethology is similar to other anguids (Greene et al., 2006; and references therein for parental behavior).

The observations of combat in *P. apodus* are in good agreement with the previous descriptions in slow worms (*Anguis*; Malkmus, 1995; Capula et al., 1998; Böhme, 2006), the genus phylogenetically close to *Pseudopus* (Pyron et al., 2013). It was suggested that this behavior is probably difficult to observe due to specific conditions during the mating season (e.g. necessity of the sufficient concentration of males in particular locality) and cryptic life of the genus (Böhme, 2006). Based on field data I can presumably distinguish the four characteristic features of the combat in *P. apodus*: (i) detection and evaluation of second male for combat, (ii) one-sided and mutual biting, (iii) body and tail twisting, and (iv) head pushing to the ground which are consistent with published records of *A. fragilis* (sensu lato in this article) male-male combat (Malkmus, 1995; Capula et al., 1998; Böhme, 2006; see below for the details).

Although lizards of the genus *Anguis* are not considered to be a territorial species, it is known that males fight each other. However, there are only few of such observations (Malkmus, 1995; Capula et al., 1998; Böhme, 2006). Considering the cryptic lifestyle of slow worms, the fights mainly take place at obscure places in the thick vegetation and so usually escape our attention (Capula et al., 1998). Male-male combats in this genus likely occur mainly during the springtime in the mating season. However, considering *A. fragilis* population densities or terrain variability, male-male combat can occur in other seasons (Völkl and Alfermann, 2007).

Obst (1981) assumed that particular individuals of *P. apodus* recognize each other by olfaction. During the study of the Spanish population of *A. fragilis*, Gonzalo et al. (2004) found out that males are able to distinguish their own scent from the scent of other males. It may be explained that they naturally tend to explore the place with a scent track of conspecifics. Perhaps, it shows that a scent track carries information which can be used in further intra-sexual social interactions. Cabido et al. (2004) found out that *A. fragilis* was able to detect a predator by olfaction and if needed, escape. According to Obst (1981), optical signals are absent in *P. apodus*. However, observation described above suggests that in male-male combat certain defensive optical signals are probably utilized.

A typical behavior of *P. apodus* after handling is a rotation about the axis of the body, side-pushing, hemipenes everting and defecation (Obst, 1981). For compari-

son, in *A. fragilis* the defecation after catching was recorded in 23% of cases ( $n = 124$ ; Greven et al., 2006). Biting is, however, very rare in both genera. I have caught dozens of individuals of *P. apodus* through its distributional range and I have never recorded biting. However, biting may very rarely occur (one male among about 300 caught individuals of the species; Kukushkin, pers.comm.). Blosat (1997) observed defensive biting in *A. fragilis* in only 2.8% cases. Therefore, the intensity of vigorous biting between males of *P. apodus* (and in the literature at *A. fragilis*) observed during the combats is surprising. The bite can be aimed at various parts of the body. Böhme (2006) and Völkl and Alfermann (2007) also published a photograph where a male of *A. fragilis* is bitten by his rival next to its head. For *A. fragilis*, Malkmus (1995) observed biting to the flank of body shortly before the cloaca whereas Böhme (2006) observed biting to different body parts. However, instances of biting were directed to the neck region, not to the tail. This is demonstrated by the scrubbed surface of the head scales and scars expanding from head to neck which are visible until summer. These scars and other injuries (fresh or healed) in the neck region which were also recorded for *P. apodus* again suggest that male-male combat occurs very often during the mating season. On the other hand, it seems that biting does not lead to possibility of tail autotomy. Tail loss happens relatively rarely in *P. apodus*, tail breaks with difficulty and usually regenerate very slowly and insufficiently (significantly shorter and darker). However, Kukushkin (pers.comm.) recorded in some of populations of Crimea 50 – 60% rate of tail injuries, especially in males as a result of high predation pressure. Similarly as discussed Böhme (2006), the data by Vences (1993) and Blosat (1997) suggest that regenerated tails in *A. fragilis* are the results of predation pressure instead of intraspecific (male-male) interactions. Even though biting is probably often used in male-male combat of both genera, injuries and autotomy of the tail originating by combats probably occur very rarely. Here we can find three main phases during biting: (a) initial biting, when the more successful male bites into the back of head of the rival and holds it tightly its jaw, (b) combat, when the male holds the side of rival's head in the mouth and pushes it to the ground, (c) loosening, when the victorious male opens its jaw and the defeated individual usually leaves the combat site, the winner can chase them and the cycle repeats. As Böhme (2006) noticed in *A. fragilis*, these aggressive encounters are much more diverse and include specific behaviors rather than just mutual uncoordinated bites, which suggests a degree of combat ritualization.

Observed male-male combats consisted of mutual turning and pushing of twisted bodies, together with (a)



mutually strong and long-lasting bites to the rival's body, (b) alternate biting to the rival's body with an aim to turn it on its back by quick flick of the head (Malkmus, 1995; Böhme, 2006). In the case described by Malkmus (1995), the weaker individual was trying to escape right after his rival bit him, by doing rotating movements. The similar behavior was observed in these two cases at *P. apodus*. Therefore, twisting of elongated bodies is a common phenomenon in male-male combat of "snaky" lizards as it has been observed in numerous snake species (e.g., Shine et al., 1981). However, the mating of slow worms is occasionally accompanied with twisting of the body and biting of female head as is during the combat. This may lead to overlook the male-male combat or its confusion (Girolla, 1996).

According to my observations, I consider it crucial in male-male combat of *P. apodus* for the dominant lizard to gain advantage by pushing rival head to the ground to by biting the neck region of the rival. These signs can decide the winner of the particular combat. The similar (but without biting) is observed in ritual male-male combat in snakes (e.g., Shine et al., 1981). Capula et al. (1998) evaluated several observations of male-male combat ( $n = 21$ ) of *A. fragilis* in north-eastern Alps, where they found that bigger males always won. If males were of similar size, the length of the fight would be longer. Thus male body size probably plays an important role during twisting (see Capula et al., 1998). Therefore, authors expect that a size-based male dominance exists. Moreover, both genera compared herein are sexually dimorphic, with head size larger in males than in females (Obst, 1981; Sos and Herczeg, 2009). It also suggests an evolutionary pressure resulting in inter-sexual differences in body and head size. According to Herrell et al. (1999) morphometric and bite force data clearly indicate that animals with larger heads indeed bite harder. It can be explained as a result of sexual selection on the head structure caused by male-male combat. The similar is seen in other reptiles (Vitt, 1983; Kratochvíl and Frynta, 2002).

Male-male combat in lizards has been interpreted as a male strategy for (i) the defense of specific territory, (ii) searching and defending females, (iii) critical resources such as food or thermoregulatory sites, (iv) equal dispersion of males on particular localities after hibernation (Herrel et al., 1999; Moravec and Gvoždík, 2015). As Herrel et al. (1999) discuss, the only potentially limited resources for males might be the access to female conspecifics as observed in some other lizard species. Thus, during the springtime, active males of *P. apodus* are probably very aggressive, intolerant and attack other males. It also allows an equal dispersion of individuals in the particular area. As suggested by observations, male-

male combat may occur in the presence as well as in the absence of female.

In conclusion, the present paper is the first documentation of the male-male combat in *P. apodus* under natural conditions, thereby contributing to a better understanding of the biology of this understudied species.

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