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Front Cover: A hatchling king cobra from Uttarakhand, India, photographed by Jignasu Dolia, see article on p. 35.

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RESEARCH ARTICLE

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Vocalisations, territoriality and aggressive interactions of the Chaco tree frog *Boana raniceps*

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ABSTRACT – Various types of intra and interspecific vocalisation are a primary means of communication among anuran species. In intraspecific interactions, male anurans emit calls to attract females and repel rival males. This study describes new vocalisation types for reproductively active *Boana raniceps* (Anura: Hylidae) and provides a commentary on aggressive intraspecific behaviour that was recorded at ten sites. In addition to advertisement calls, our findings reveal that males emit two types of aggressive call, one territorial call and one encounter call. We identified a sequence of different aggressive behaviours displayed during physical combat between two males. Our findings show that *B. raniceps* exhibits complex intraspecific behaviours in a reproductive context.

INTRODUCTION

Vocalisations in anurans are considered the primary form of communication for most species and a critical reproductive isolation mechanism (Wells, 1977a). During the breeding season, acoustic signalling may enable adult anurans to aggregate; the males emitting advertisement calls to attract females but also to defend territories for the prime purpose of reproduction which leads to aggressive interactions between individual males (Duellman & Trueb, 1986). Most territorial disputes have a sexual context and aggressive behaviours can occur when males are very close to each other, sometimes resulting in physical combat (Bastos & Haddad, 1996; Giasson & Haddad, 2006; Dautel et al., 2011). The mate choice and maintenance of territories by male-male interactions during the breeding season are energetically costly (Guimarães & Bastos, 2003), especially for species with long reproductive life spans (Wells, 1977a). A fundamental characteristic of anuran species with prolonged reproduction is the use of a variety of call types with distinct functions (Wogel et al., 2004; Dautel et al., 2011) and their investment in complex vocal repertoires may positively influence reproductive success (Vilaça et al., 2011). There are several known anuran call types documented for species in the Neotropics (Toledo et al., 2015).

In this study, our focus is on the vocalisations and aggressive behaviours of the Chaco tree frog *Boana raniceps* (Cope, 1862), a wide-ranging species. *Boana raniceps* belongs to the *Boana albopunctata* group and is widely distributed in South America, occurring from the Amazon of Venezuela to Colombia, French Guiana, Brazil, Paraguay, Argentina and Bolivia (Frost, 2023). Male *B. raniceps* typically call during twilight hours whilst situated on elevated surfaces. At nightfall, they tend to migrate towards bodies of water and can be found perched on the branches of shrubs, grasses, trees and bulrushes (Guimarães & Bastos, 2003).

MATERIALS & METHODS

Study area

The study was undertaken in the north of the State of Paraná bordering the State of São Paulo in southern Brazil, at ten sampling sites in the municipalities of Alvorada do Sul, Sertaneja, Porecatu, Centenário do Sul and Rancho Alegre (Fig. 1). According to the Köppen-Geiger climate classification (Peel et al., 2007), the region's climate is categorised as subtropical humid (Cfa) and the vegetation type was originally dominated by semi-deciduous seasonal forests, with only a few fragments of forest remaining today. The region is located along the contact zone between the Atlantic Forest and the open formations of the Cerrado.

We surveyed temporary and permanent water bodies across agropastoral environments and reforestation areas near the Tibagi River during the summer from October 2016–February 2017 on 30 days from 18:00 h to 24:00 h, totalling 180 hours. To minimise disturbance, headlamps with white

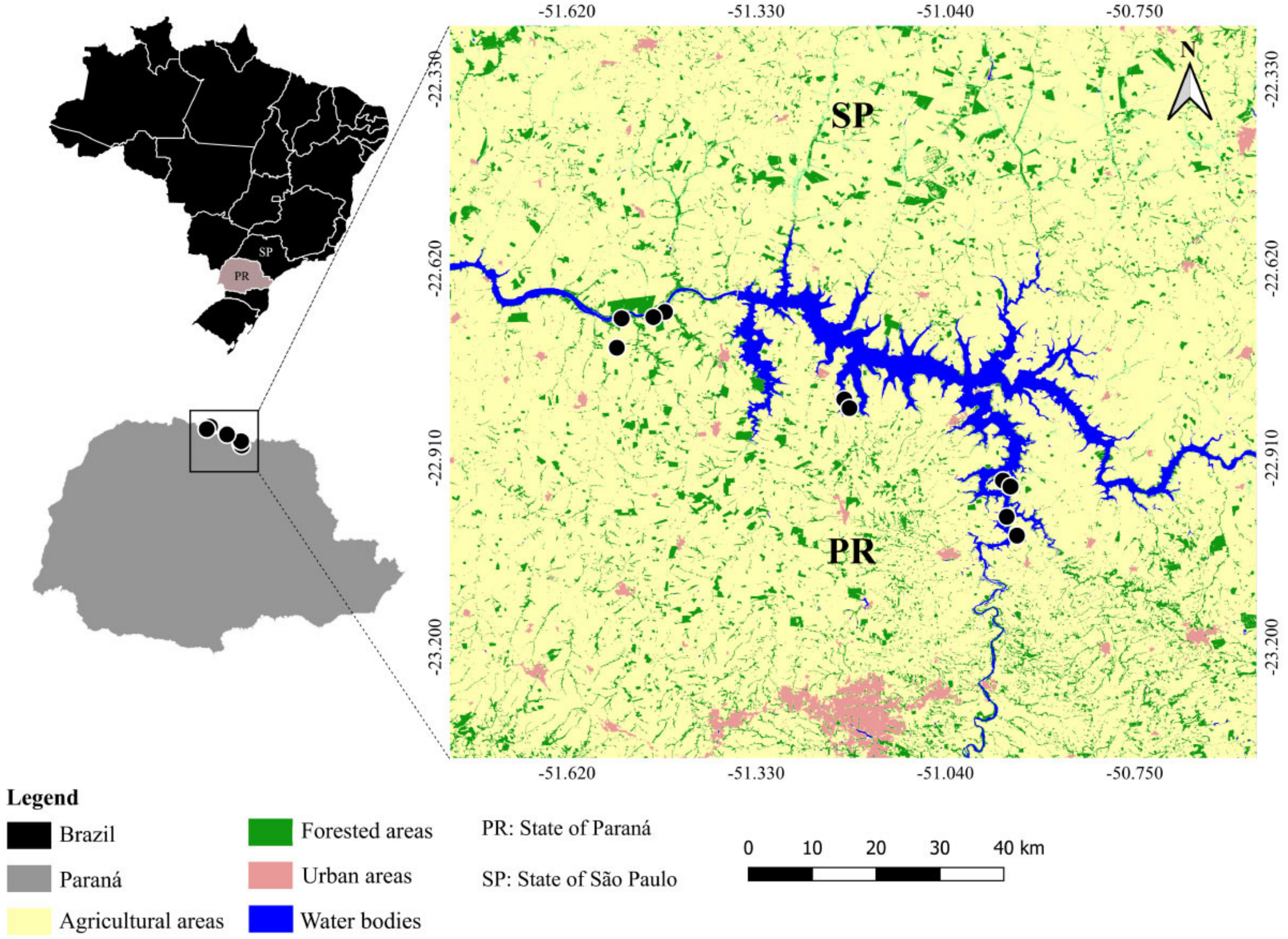

Figure 1. Map of the study area showing the sampled sites (black circles) in the north of the State of Paraná, southern Brazil, the co-ordinates are in WGS84

light were used to search for calling males, and red light (RGB night vision option of the Black Diamond Icon 500 Headlamp) were used to observe males after they had been found and provided the illumination to observe the frequencies of call and aggressive interactions. A straightforward approach was used by locating a focal animal and recording all observed behaviours (Lehner, 1979; Martin & Bateson, 1986). Male frogs were selected for study when they were within a 5-metre range, at which time a digital laser tape measure (model Bosch GLM50C) was used to give accurate and precise measurements of distance from the observer.

Boana raniceps was identified by its morphology in particular by its size (medium to large) and the presence of dark brown to black cross-bands that extend onto the concealed surfaces of its hind limbs (Boulenger, 1889; Duellman, 1970) and by its typical vocal calls (identified by personal field experience). The sex of individuals was determined by the presence or absence of vocal sacs, which are only present in males (Duellman & Trueb, 1986). The resident male was identified by his behaviour during the event. He vocalises while standing on the grass and emits advertisement calls for a time (about 8 minutes), while an invading male subsequently approaches at a distance (< 5 m) from the resident male. The

Figure 2. Vocalising male *Boana raniceps* in a reforestation area near the Tibagi River, State of Paraná, Brazil

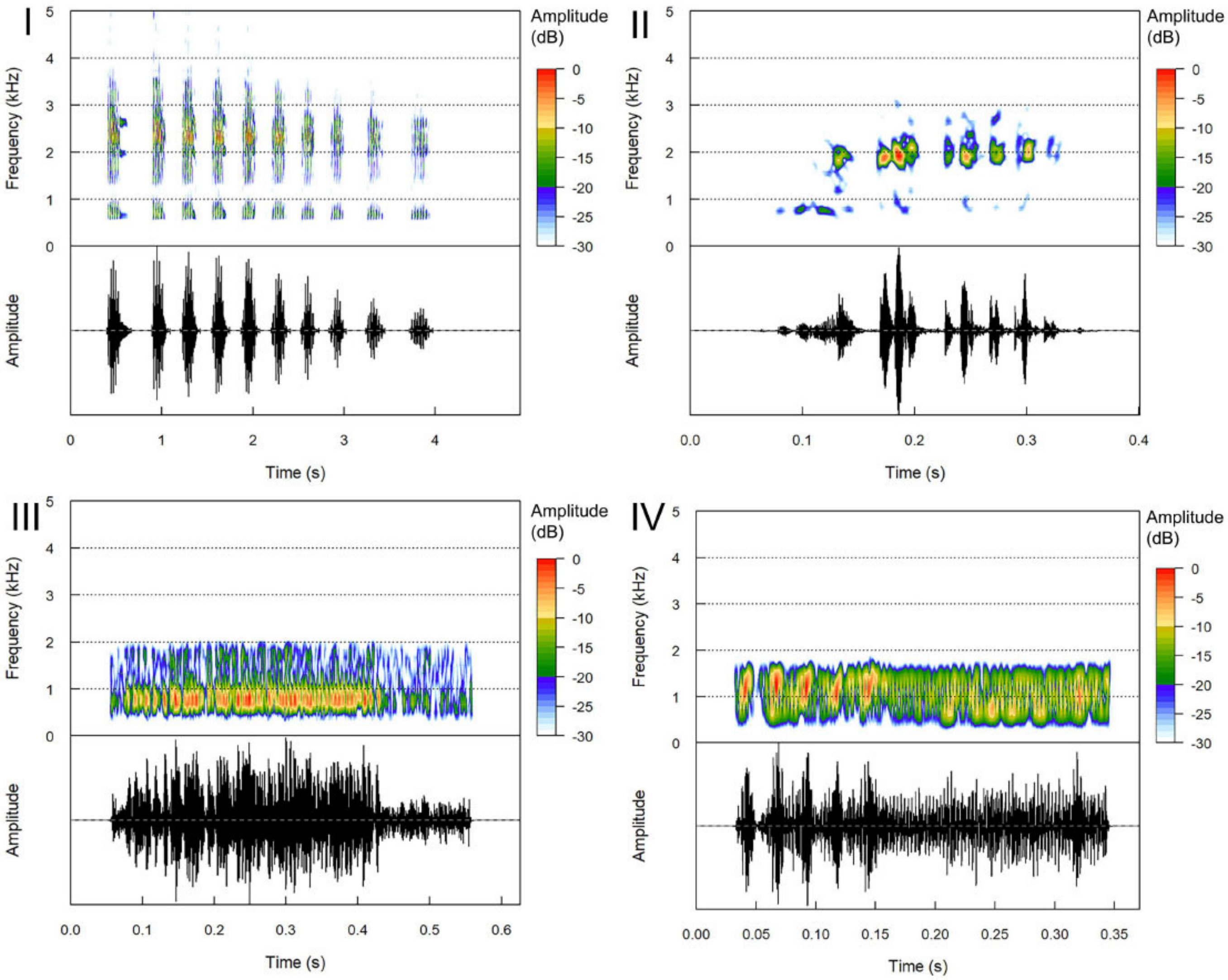

Figure 3. Sound spectrograms and oscillograms of four calls types made by male *Boana raniceps* - **I.** Advertisement call, **II.** Territorial call, **III.** Unidentified call, **IV.** Encounter call. The air temperature at the time of advertisement call was 23.2 °C and the other calls recorded simultaneously was 25.4 °C.

vocalisations of *B. raniceps* males (Fig. 2) were recorded, using a TASCAM DR-05 digital recorder coupled with a YOGA HT-81 unidirectional microphone, in 24-bit wav format, with a 96 kHz sampling rate. A call-based approach was used and the methodology for call description followed the recommended terminology of Köhler et al. (2017). The following parameters were used to describe calls: dominant frequency (kHz), call duration (s), pulses (present or absent) and harmonic (present or absent). The records were edited through the Raven Pro 1.5 software (Cornell Laboratory of Ornithology, Ithaca, NY). The images of the individuals' acoustic activity were assessed in the R statistics program (R Development Core Team 2017), using the Seewave package (Sueur et al., 2008), with the following settings: window name = hanning; window length = 512; overlap = 90%; air temperature = 23.2 °C for the advertisement call and 24.5 °C for the others calls. The calls were vouchered in the Fonoteca Neotropical Jacques Vielliard with number IDs FNJV 74362 to 74369.

RESULTS

Male *B. raniceps* vocalised to attract females and defended their territories through aggressive social interactions. In some instances, resident males displayed aggressive behaviour towards other males entering their territory. The territorial disputes among males were observed at a range of 0.7–3.6 m. The closest pair of males, just 0.7 m apart, were engaged in territorial conflict and emitted territorial and encounter calls before initiating physical combat. More distant males were too far apart to engage in combat.

Vocalisation activities began at dusk around 19:00 h, with the peak of males calling at 21:00 h and declining by 24:00 h. *Boana raniceps* type calls are complex, featuring various note types that can be arranged in both regular and irregular sequences. In some instances, individuals may emit either a territorial call or an advertisement call exclusively, while others emit both territorial and advertisement calls simultaneously within the same call.

Table 1. Four call types of *Boana raniceps* presented as ranges and as mean values ± standard deviation. These values are based on a total of 108 advertisement calls, 75 territorial calls, six unidentified calls and five encounter calls. The air temperature for all advertisement calls was 23.2 °C and the other calls recorded simultaneously was 25.4 °C.

Call type	Dominant frequency (kHz)	Call duration (s)	Pulses	Harmonic
Advertisement call	861.3–2411.7 (1860.86 ± 613.37)	0.214–0.347 (0.224 ± 0.06)	yes	yes
Territorial call	1722.7–2411.7 (2190.23 ± 238.19)	0.182–0.312 (0.240 ± 0.038)	yes	yes
Unidentified call	775.2–861.3 (732.15 ± 72.03)	0.339–0.624 (0.4763 ± 0.113)	yes	yes
Encounter call	1033.5–1205.9 (1162.82 ± 86.15)	0.311–0.643 (0.4 ± 0.16)	yes	yes

Figure 4. Two male *Boana raniceps* **A.** With fully inflated vocal sac, indicated by the white arrow when emitting the territorial call, **B.** Emitting the encounter call, the red arrow indicates the anterior portion of the vocal sac inflated while the posterior portion remains uninflated, indicated by the white arrow

However, we registered the emission of other calls that can vary depending on the specific reproductive context. In total, we examined four types of male vocalisation: 1. Advertisement call (Fig. 3I), 2. Territorial call (Fig. 3II), 3. Unidentified call (Fig. 3III), and 4. Encounter call (Fig. 3IV). We did not record any distress calls in males but we did hear (but not record) this type of defensive call when handling a gravid female. We observed a total of 12 events of physical combat but only one was recorded in detail. Among the males observed in this study, the advertisement call was the most frequently emitted vocalisation. Territorial calls were only produced when two or more males were emitting advertisement calls simultaneously (Fig. 4A). Encounter calls were always produced during interactions between two males before physical combat. During these interactions, it was noted that the encounter calls were emitted by males using only the anterior portion of their vocal sacs while the posterior part was not inflated (Fig. 4B).

We recorded a sequence of distinct aggressive behaviours exhibited during physical combat between two individual males. The intruding male was observed approaching the territory of the resident male while emitting territorial calls. In response, the resident male jumped in a circle and emitted territorial calls (Fig. 5I). When the intruding male entered the territory of the resident male, both began emitting encounter calls (Fig. 5I&II). When the intruding male approached the resident male closely, physical combat was initiated by the intruding male who attempted to jump on the back of the resident male, but this was unsuccessful as the resident male dodged and grabbed the intruder from behind. From that moment on, the resident male initiated a series of aggressive behaviours. These included blows and jerks directed towards the ventrolateral region of the intruding male using its forelimbs, accompanied by territorial calls (Fig. 5III&IV). Then, the resident male applied a blow with the ventral-cephalic part of his body propelled with the hind limbs resting on the floor (Fig. 5V), and shortly after that, he lifted his body and performed two scrapes with the anterior limbs in the ocular region of the intruding male (Fig. 5VI). Subsequently, the resident male grabbed the intruder's cephalic region with the anterior limbs and pulled backward (Fig. 5VII). After that moment, the intruding male escaped (Fig. 5VIII) and jumped straight forward, emitting territorial calls at the resident (Fig. 5IX). In a subsequent phase of the physical combat between the two males, the resident male performed another attack on the intruder. This involved leaping backward (Fig. 5X) and applying a series of strikes with its hind limbs (Fig. 5XI), followed by two additional blows using its forelimbs (Fig. 5XII&XIII). Despite this, the intruding male resisted the resident male's series of behaviours (Fig. 5XIV). Both males remained close to each other and continued to emit territorial calls (Fig. 5XV). Finally, after this sequence of aggressive behaviours the battle ended when the resident male jumped away leaving his territory to the intruder (Fig. 5XVI).

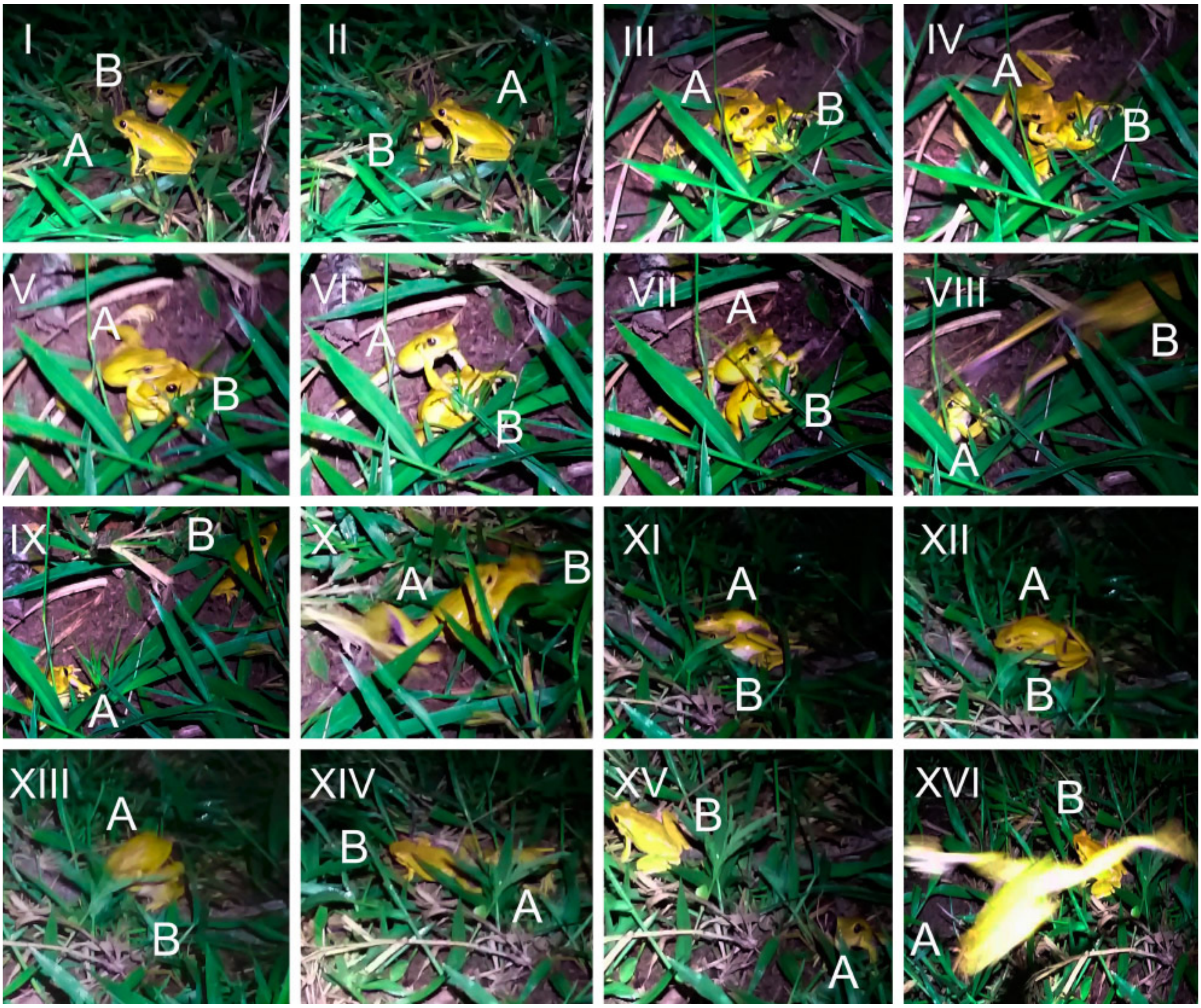

Figure 5. The sequence of aggressive behaviours between two male *Boana raniceps*, **A.** a resident male in its territory and **B.** an intruder. Details on the behaviours are described in the results section.

DISCUSSION

This study shows that *B. raniceps* presents complex intraspecific behaviour that is mediated by at least four types of call made in different contexts. First, individuals make advertisement calls that, in addition to having the function of attracting females, also warn other males about their territory issuing an alternation of advertisement calls and territorial calls. As mentioned in Köhler et al. (2017), for some species the territorial call and advertisement call are part of the same call. When one male intrudes on another's territory and persists, the territorial call is emitted, if this is not enough then physical combat begins preceding a series of different calls (i.e. territorial call and encounter call). The territorial call is emitted from a fully inflated vocal sac whereas the encounter call is emitted from only the anterior portion of the vocal sac while the posterior portion remains uninflated (Fig. 4A&B). It was observed that an unidentified call (Fig. 3III) is made in a territorial context when several males are vocalising. It may be a variation of the territorial call, although it is structurally, parametrically and sonically dissimilar. Therefore, we have referred to it as an unidentified call.

Boana raniceps has a prolonged breeding period (Guimarães et al., 2001) and it is considered that such anuran species generally do not actively search for females during the breeding season but instead tend to use different acoustic signals to attract females to their calling sites (Wells, 1977b). Consequently, such anurans have more complex vocal repertoires, usually associated with their acoustic competition for females, oviposition sites, calling sites and feeding (Wells, 1977a; Duellman & Trueb, 1986). Males can defend their microhabitats with territorial calls, emitting threatening signals, termed 'encounter' calls (Wells, 1977a; Toledo et al., 2015). When the intruding male fails to heed these threats, physical combat typically ensues (Wells, 1977a). This may involve the use of butting and pushing with the forelegs, as well as more aggressive fighting involving grips and kicks. In some cases, secondary sexual traits (e.g. the prepollex) may also be used as weapons (Bittencourt-Silva et al., 2020).

Physical combat has a high energy cost, and increases the chances of predation, and the risk of injury (Wells, 1977b; Martins et al., 1998; Bastos & Haddad, 2002; Batista et al., 2015). Consequently, physical combat only occurs in extreme cases (Kluge, 1981). As observed in *Boana rosenbergi* (Kluge, 1981) and *Boana faber* (Martins et al., 1998), combat in *B. raniceps* occurs in choruses with large numbers of calling males (Guimarães et al., 2001), where dense aggregation results in aggressive calling responses and offensive or defensive behaviours. Our results suggest that calling sites were faithfully defended against intruding males through acoustic interactions and defensive behaviours. The battles observed in *B. raniceps* for access to females and territories occur within a mating system based on resource defence competition (Guimarães et al., 2001).

The species-specific acoustic repertoire of *B. raniceps* males is an aspect of their ecological niche, defined by acoustic competition amongst species (Krause, 1993). When many males are vocalising in the chorus, the most frequent vocalisation strategy observed is to emit the advertisement call and territorial call simultaneously. The encounter call of *B. raniceps* has also been described. It has a complex acoustic structure comprising a multi-pulsed note with irregular pulses. In addition to the acoustic signals, this study provides evidence that violent aggression within the genus *Boana* is not limited to the *B. faber* group but also occurs in the *B. albopunctata* group. These findings justify further research into the breeding behaviour of *B. raniceps*, in particular, to investigate the function of the unidentified call.

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SHORT NOTE

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Active forest nesting site, mating and cannibalistic oophagy behaviour in the Asian water monitor *Varanus salvator*

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INTRODUCTION

The Asian water monitor *Varanus salvator* is the second largest species of lizard (Briggs-Gonzalez et al., 2022), with a distribution encompassing most of south-east Asia. Unlike most varanids they are semi-aquatic, inhabiting the banks of streams, river deltas and coastal regions (Gleeson, 1981; Wikramanayake & Dryden, 1993; Guerrero-Sanchez, 2019). They are generalist carnivores, typically consuming the most abundant or accessible food source (Yu et al., 2022), taken as live prey (Gaulke 1991; Uyeda, 2009) or by opportunistic scavenging (Traeholt, 1994a; 1994b; Briggs-Gonzalez, 2022). Thus, their diet is highly varied, eating insects, spiders, myriapods, bony fish, crustaceans, gastropods, amphibians, reptiles and their eggs, birds and their eggs, mammals, fruit (Rashid, 2004; Rahman et al., 2017; Yu et al., 2022), rotten carcasses (Rahman et al., 2017), human food waste (Traeholt, 1993; Uyeda, 2009; Rusli et al., 2020), human corpses (Gunawardena, 2016), and even juveniles of their own species (Gaulke, 1991; Shine et al., 1996). Although common in anthropogenic landscapes, their wary behaviour around humans (Cota, 2011) has resulted in gaps in knowledge regarding vulnerable behaviours such as mating and nesting. Only two studies have described mating, and exclusively in urban landscapes (Cota, 2011; Trivalairat & Srikosamatara, 2022). Additionally, while burrows have an important role in the social life of most varanid species (Traeholt, 1995), only one active nesting site, dug into a termite mound in a sanctuary (Biswas & Kar, 1981), has ever been described in the literature. This report contains the first descriptions of an active nesting burrow and of mating behaviour in a natural setting, and also contains the first known instance of cannibalistic oophagy in *V. salvator*.

MATERIALS & METHODS

These observations originate from an unpublished study investigating the use of underground burrows and tree hollows in the life history of the Asian water monitor in the Lower Kinabatangan Wildlife Sanctuary (LKWS) in Sabah, Malaysian Borneo. This research was facilitated by a separate unpublished study, which established a network of video camera traps recording one-minute videos to monitor Sunda pangolins. The camera model used was a Recon Force Elite HP4 trail camera (Browning Arms Company), with passive infrared sensors (PIRs) measuring thermal contrast between the target and background to trigger automatically (Swann et al., 2011; Welbourne, 2014). A burrow of interest was discovered (5° 418’120” N, 118° 034’443” E) in an area of seasonally inundated secondary forest, within 20–25m of the Kinabatangan River (Fig. 1). The burrow was identified as a monitor lizard burrow through the placement of a camera trap. Two more cameras were placed outside the burrow on 29 March 2023, as the behaviour exhibited at this burrow was not comparable to that observed at any other site.

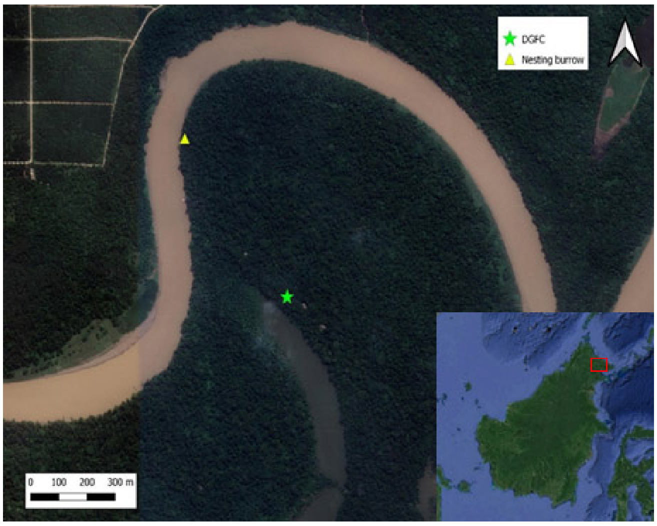

Figure 1. The location of the monitor lizard nesting burrow, close to the Danau Girang Field Centre (DGFC), the inset map shows the location of the study site within Borneo, Malaysia

OBSERVATIONS & DISCUSSION

Unusual behaviour was observed from 21–23 April 2023, when a monitor lizard filled in the burrow entirely (see Fig. 2) by scraping soil into the hole with its front legs; as

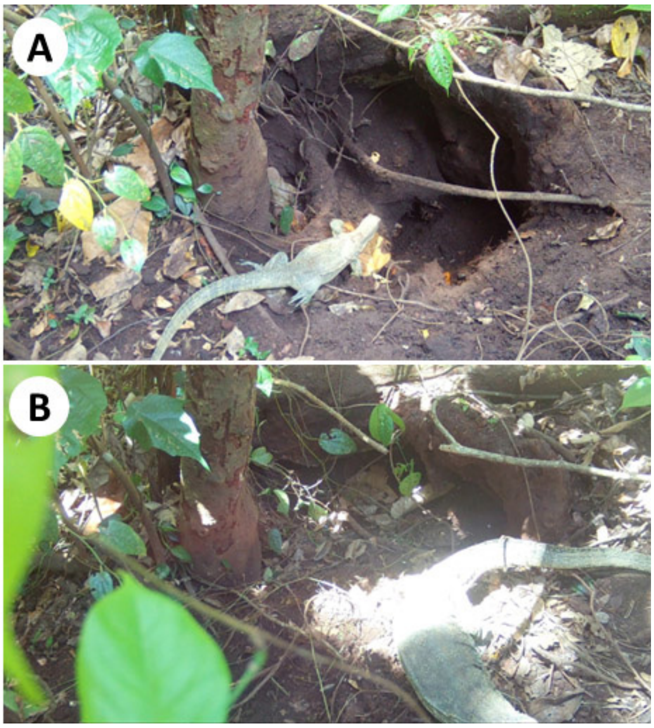

Figure 2. Camera trap images of *Varanus salvator* and its burrow- **A.** 21 April 2023 at about 11:00 h showing the monitor lizard burrow just before it was filled in. The exact time cannot be given due to a camera malfunction, **B.** 23 April 2023 from 12:45 h showing the burrow after it was filled in by a monitor lizard.

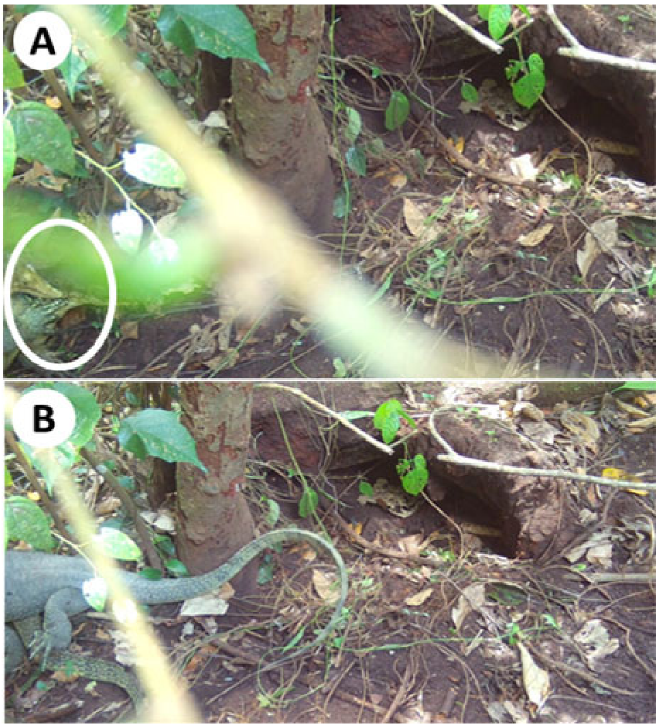

Figure 3. Camera trap images of the mating behaviour of *Varanus salvator* - **A.** 23 April 2023 from 19:16 h showing the male biting onto the neck of the female in a mating display (circled), **B.** Another image from shortly afterwards showing the male mounting the female.

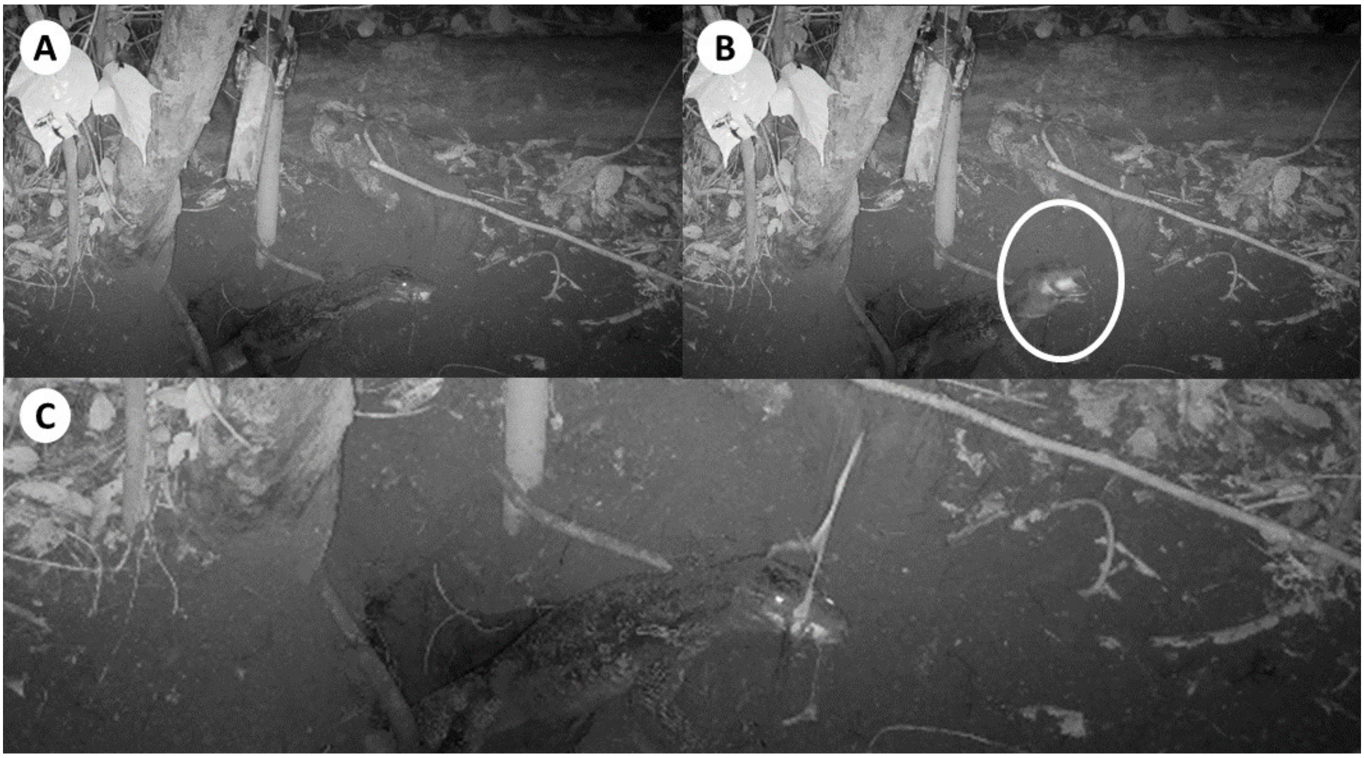

Figure 4. A series of still images taken on 30 June 2023 from 20:29 h showing a monitor lizard raiding the burrow - **A.** The monitor lizard carrying an egg out of the burrow, **B.** the monitor lizard swallowing an egg by holding its head upwards and stretching and nodding the neck (circled), **C.** the monitor lizard biting an egg and popping the yolk out of the shell.

revealed later this was associated with egg laying but egg-laying was not caught on camera. Over the following week what appeared to be the same individual, based on size and behaviour, returned to the burrow multiple times each day. This is challenging to confirm, as in this species identification of individuals in images captured by camera traps is often not possible. This lizard exhibited frequent alert behaviours, including standing still and raising the head and neck to increase perception, likely the nest guarding behaviour previously reported in *V. salvator* (Anonymous, 1978; Biswas & Kar, 1981; Somma, 2003). Scraping of the head and neck on nearby trees and logs was also a frequent behaviour, though this was not unique to this burrow. Furthermore, during this period there was an incident of mating (Fig. 3) that appears to involve the same individual. This coincided with the first heavy rains of the hot season, which may trigger hormonal changes in both males and females (Cota, 2011), yet it is unclear why mating behaviour occurred so soon after egg laying. We suggest that this may be nest guarding behaviour, with the female mating with the male as a distraction to prevent it from cannibalising the nest. The presence of eggs was confirmed on 30 June 2023 at approximately 20:30 h, when a monitor lizard raided the nest and consumed at least one egg (Fig. 4); the total clutch size is unknown. Oophagy has been shown to be a common feeding strategy in *V. salvator* (Cota, 2011), with the eggs of snakes, crocodiles, turtles, lizards and birds constituting between 5% (Rahman et al., 2017) and 37% (Rusli et al., 2020) of their diet. Cannibalism is seen less frequently, with some unpublished records of large adults eating smaller *V. salvator* adults (Gaulke, 1991; Shine et al., 1996) and no observed instances of cannibalistic oophagy.

Camera trapping has not been widely adopted for use on reptiles, with 3% of camera trapping studies targeting reptile species (Meek, 2015), although cameras have successfully recorded species over 100 g (Welbourne, 2014), including the Asian water monitor (Naim et al., 2012). Cameras enable the gathering of long-term, high-resolution datasets, something unprecedented in reptile ecology (Richardson et al., 2018). This is particularly true for vulnerable behaviours such as mating and nesting, as active searches do not facilitate observation of natural behaviour. However, there are drawbacks, for instance the inability to mark individuals, making it unclear whether behaviours are representative of the population or the result of individual specific variation. One solution may be to use software such as I3S (den Hartog & Reijns, 2008), which identifies intraspecific spot patterning on the dorsal surface to recognise individuals. I3S has been used in the sympatric lizard *V. giganteus* (Moore et al., 2020), though has not been trialled for the Asian water monitor. Additionally, the low body temperature of *V. salvator*, which stays close to ambient temperatures, results in a low gradient between the target and the background (Welbourne, 2014), meaning they are less likely to trigger cameras when passing through the detection zone (Rovero et al., 2010).

In conclusion, camera traps have enabled us to observe vulnerable behaviour in natural habitat, something not possible with other techniques. The findings shed light on underexplored behaviours in *V. salvator*, however definitive inferences cannot be made from a handful of observations, so it is clear that more long-term research is needed.

ACKNOWLEDGEMENTS

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SHORT COMMUNICATION

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Diet of the Galam white-lipped frog *Amnirana galamensis* in southern Nigeria deduced from faecal samples

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Anurans are generalist foragers that feed not only on insects but also on a wide diversity of active invertebrates and vertebrates (e.g. Anderson et al., 1999; Hirschfeld & Rodel, 2011; Vignoli & Luiselli, 2012; Farina et al., 2023). Understanding the variability of their dietary habits across habitats and geographic regions is of natural history interest and of relevance to conservation. In the past, studies of anuran stomach contents have commonly entailed killing and dissecting many specimens (e.g. Onadeko, 2011; Jamdar & Shinde, 2013) but techniques can be used that are safer for the anurans and inexpensive for researchers, such as examination of faecal material or stomach flushing (Sole et al., 2005; Mahan & Johnson, 2007; Hirschfeld & Rodel, 2011). We report here an evaluation of the dietary composition of *Amnirana galamensis* (Fig. 1) in a forest-plantation area of southern Nigeria, using a harmless field technique.

The Galam white-lipped frog *Amnirana galamensis* is a widespread species inhabiting a variety of habitats, including freshwater swamps, wetlands, rural and urban gardens, ponds, ditches, rivers, shrublands and moist savannahs (Rodel et al., 2004; Oussou et al., 2022). Despite this, it appears that there is only a single report giving quantitative data of its diet, based on the stomach contents of dissected frogs (Onadeko, 2011).

During June and July 2023 (wet season) a field study was undertaken in a plantation area close to a poultry farm in Rumuagholu Town (040 53’ 02’’N, 060 58’ 11’’ E), Obio/Akpor Local Government Area, Rivers State (Nigeria) (Fig. 2). The study area was suburban/residential with no surface water flooding but with a small irrigation channel, plantain suckers, fruit trees, oil palms and grassy spots. More specifically, the study site was at about 200 m from an annually inundated swamp forest, and 321 m from the Rumuagholu road. The axis was a forested area with a rich variety of plant flora but in places was cleared and converted into settlements and subsistence farming plots. The main plant species were banana and plantain (*Musa* spp), *Carica papaya*, *Citrus sinensis*, *Citrus tangerina*, *Syzygium malaccense*, *Pachylobus edulis*, *Annona muricata*, *Vernonia amygdalina*, *Occimum gratissimum* as well as grasses that are always cleared from the ground. The rainfall pattern of the area is characteristic of the Niger Delta zone, with an extended rainy season from April to September and a dry season from October to March. At night time (20:00 h to 01:00 h) and with the aid of a flashlight, we captured frogs by hand while wearing latex gloves for the frog’s protection. The frogs were safely placed in transparent, perforated plastic containers where they were kept for nine hours in order to collect faeces. After defecating, the frogs were gently transferred into another empty container from where they were released unharmed at their precise point of capture. The faeces were allowed to air dry for two hours and then gently placed in labelled Petri dishes. The stored faeces were then transferred to the Animal and Environmental Biology Departmental Wildlife Laboratory (Rivers State University of Science and Technology, Port Harcourt) for analysis. They were examined under a dissection microscope and the fragments of the various prey categories were identified to the lowest taxon possible. Since it was impossible to count the exact number of prey ingested by each frog, we recorded only the presence/absence of each category of prey in the faeces. Thus we report the number of frogs that have consumed a specific prey item, not the number of prey items actually consumed.

Figure 1. *Amnirana galamensis* from the study area in southern Nigeria

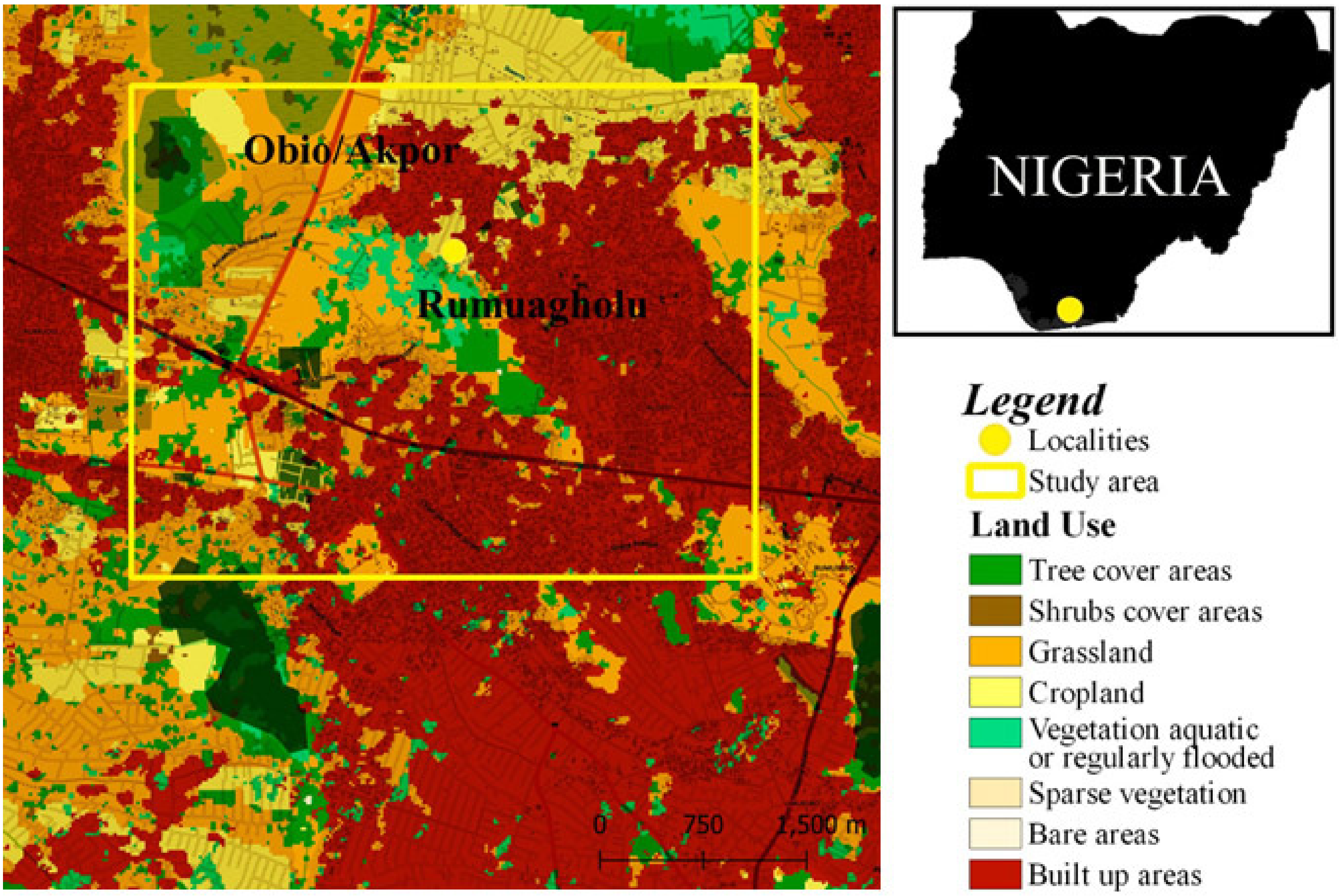

Figure 2. Map of southern Nigeria showing the land-use of the study area, in the Port Harcourt metropolitan territory

Table 1. Taxonomic listing of ingested animal-material observed in the faeces of *Amnirana galamensis* (N = 19)

Prey type	No. frogs	% of frogs
Insecta		
Blattodea	13	68.4
Diptera (larvae)	1	5.3
Hymenoptera (Formicoidea)	19	100.0
Orthoptera	4	21.1
Lepidoptera	3	15.8
Coleoptera	3	15.8
Arachnida		
Araneae	2	10.5
Annelida		
Opistophora	2	10.5
Aves		
Unidentified feather	1	5.3

We obtained identifiable prey items from 19 frog individuals (Table 1). The frogs appeared to be mostly insectivorous, as the remains of at least one insect was observed in all frogs, whereas arachnids and earthworms occurred in just 10.5% of frogs (Table 1). The study species appeared to be a dietary generalist, as (i) both very small (ants) and relatively large (earthworms) species, and (ii) both terrestrial (e.g. Blattodea) and flying (e.g. Lepidoptera) species were found in its faeces. However, there was a clear preponderance of terrestrial prey (Formicoidea, Blattodea, etc.) rather than flying prey, and a preponderance of small prey (especially ants).

Overall, our data are qualitatively similar to those of Onadeko (2011), who also found insects to be dominant in the diet of 15 dissected specimens from south-western Nigeria. However, Onadeko 's (2011) data differed from our own as he found that the proportion of frogs with Hymenoptera and Coleoptera in their diet was the same but that Coleoptera were numerically a much more frequent prey item. The quantitative differences between the present study and Onadeko (2011) may be due to the fact that these frogs, being dietary generalists, tend to prey on the most abundant appropriate insects, and this suggests that ants are the most readily available prey at our study area and perhaps beetles were at Onadeko's site. However the differences might have arisen also from different seasonalities in the two studies. In fact, Onadeko (2011) appears to have worked across the wet and dry seasons but it is not clear whether he did actually study *A. galamensis* in both wet and dry seasons, and so we could not exclude that beetles were especially eaten in dry season, which was not sampled by us. Interestingly, we recorded an avian feather in one individual, this was likely ingested accidentally by the frog without being a case of predation. In *A. galamensis*, Onadeko (2011) also recorded plants in several individuals, also clearly secondarily ingested by these frogs. Most of the individuals examined had many prey items in the faeces, as already observed in many other anurans (e.g. Petrozzi et al., 2021). From a qualitative point of view, the preference of our frogs for small bodied terrestrial prey is similar to that of closely-related species, such as *Amnirana nicobariensis* (Matsui, 2016).

As our study was conducted during the wet season, we cannot exclude the possibility that there may be a dietary shift in the dry season. Indeed, diet compositions are known to differ significantly between seasons in other anurans (*Sclerophrys regularis* and *Sclerophrys maculata*) from the West African coastal region, with Oligochaeta, Gastropoda and Coleoptera being eaten significantly more often during the wet season whereas Formicoidea more often in the dry season (Petrozzi et al., 2021). Further studies should focus on seasonal variations in diet composition of *A. galamensis.*

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Notes on the behaviour, habits and natural history of *Caecilia atelolepis*

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Caecilians are usually regarded as timid, seldom encountered, limbless amphibians that are only found by chance, often during or after heavy rainfall (Dunn, 1942; Taylor, 1968; Lynch, 2000). In Colombia, the actual diversity of Gymnophiona had been underestimated mainly because the old studies (especially those of Dunn, 1942 and Lynch, 2000) relied too heavily on groove counts as the main taxonomic character for species identification, undermining the role of auxiliary morphological characters. The use of additional morphological characters such as body proportions, colouration, dentition and squamation (pioneered by Taylor, 1968) has resulted in many taxonomic surprises, such as the recently described *Caecilia atelolepis* (Fernández-Roldán et al., 2023).

The original description of *C. atelolepis* (Fernández-Roldán et al., 2023) reported little about the natural history of this caeciliid that is known from the cloud forests of the western slopes of the Cordillera Oriental of Colombia in departamentos Boyacá, Cundinamarca and Santander (1700–2300 m a.s.l), aside from the fact that the holotype had been found beneath a rotten log and that a paratype was dug out of a swamp. Nonetheless, we now have new information that we thought was worth sharing given that caecilian natural history is a neglected field (Gower & Wilkinson, 2005).

On 23 March 2023 two caecilians were observed in the garden at Reserva Natural Cuzcungos in Supatá, Cundinamarca, Colombia (5° 2’29’’ N, 74° 14’29’’ W, 2000 m a.s.l.). The study site consists of a farm that contains small relicts of Andean cloud forest that have been preserved since 2003. Alejandro López (owner of the reserve) informed us that, at 11:00 h a blue-coloured, large-sized individual of *Caecilia atelolepis* was found active while hunting, biting, and swallowing a slug (Mollusca: Gastropoda) or ‘’babosa’’, as locally known. The caecilian held its prey in its mouth and proceeded to move its head rapidly from side to side – very much like a snake would – and then swallowed the slug; the caecilian then retreated and escaped.

Precisely one hour later (noon) a second, smaller-sized, darker conspecific appeared by the garden and was also searching for slugs, which are abundant at the reserve; this individual was captured by A. López and left in a bucket with ample humid leaf litter until our arrival at reserva Cuzcungos in the morning of 25 March 2023. Even though the first caecilian was not captured, we consider this to be *C. atelolepis* given that the only other caeciliid known to inhabit the western slopes of the Cordillera Oriental of Colombia in departamento Cundinamarca is *Caecilia thompsoni*, but this species does not inhabit cloud forests above 1600 m a.s.l. and bears numerous secondary grooves (Fernández-Roldán et al., 2023), unlike the non-captured individual observed and photographed by A. López (https://www.inaturalist.org/observations/152044732).

Upon our arrival, we received the caecilian, took it out from the bucket and about 30 minutes after being handled by JDF for photographs the caecilian surprisingly emitted a series of soft squeaky noises (chirps). Unfortunately, we were unable to record the call but some caecilians such as *Sylvacaecilia grandisonae* from Ethiopia, an unidentified Gymnophiona supposedly from Colombia or Peru, as well as some species of *Ichthyophis* and *Siphonops* are known to emit certain soft, squeaky, chirp-like calls as well as very soft croaks (Largen et al., 1972; Thurow & Gould, 1977; Duellman & Trueb, 1986); the calls of *C. atelolepis* fit this description. We were recently informed of another call by an individual of *Caecilia abitaguae* from eastern Ecuador (Santiago Maigua Salas, pers. comm). We hesitate to term this a ’defence mechanism’ given that such a soft sound can only be heard in near silence and within close proximity to the ear.

The keepers of the farm informed us that a third caecilian was recently found dead, and was allegedly killed by the chickens of the farm, JDL recalls a similar experience while collecting a *Caecilia nigricans* (ICN 41232) in San José del Palmar, Chocó, Colombia. He heard a loud noise emitted by a flock of chickens that were attacking a caecilian in the farm that he was using as a field station, to the extent that one of the chickens had decapitated the caecilian and run away with the head, leaving only the body to be preserved. The neighbours of Reserva Cuzcungos shared a couple of video recordings of more caecilians (allegedly *C. atelolepis*), which are also frequently seen on their farms in broad daylight.

On 27 April 2023, the caecilian that had been captured was brought to Universidad de Los Andes, Bogotá D.C., euthanised and preserved following standard protocols (Heyer et al., 1994) and deposited at the Museum of Natural History C.J. Marinkelle, where it was assigned the collection number ANDES-A 5444. We identified ANDES-A 5444 as *C. atelolepis* because it has the following meristics and measurements. An adult male witha total body length of 780 mm, a body width of

Figure 1. General view of *Caecilia atelolepis* (ANDES-A 5444) from Reserva Natural Cuzcungos, Supatá, Cundinamarca, Colombia

Figure 2. Closeup view of the dorsal surfaces and flanks of the body showing the bite marks (scars at top centre of photo) potentially inflicted by a conspecific between primary grooves 44 and 45

15.4 mm at mid-body point, an attenuation index (i.e. length divided by width) of 51.9 times, and a dark blue head against an overall light grey body colouration in preservative (70% ethanol), darker on the dorsal surfaces and lighter towards the flanks and ventral surfaces, with 127 primary grooves (the last two complete ventrally but not so dorsally) and no secondary grooves (Fig. 1), bearing five denticulations on the anterior margin of the vent and five on the posterior margin of the vent; the anterior margin of the vent bears two very small anal glands. All teeth monocuspid, overall big, pointed and widely separated from each other, with 5-6 premaxillary-maxillaries, 7-8 vomeropalatines, 5-5 dentaries and 1-1 inner mandibulars (Table 1S, see Supplementary Material).

On the morning of 25 April 2023, the main body colouration of the caecilian was blackish, darker on the dorsal surfaces than on the ventral surfaces, which were grey; the head was dark blue, in contrast to the mainly black colouration. On the evening 27 April 2023 the caecilian had changed from its previous blackish colouration pattern and was now bearing a blue head, a mostly purple body, darker on the dorsal surfaces and lighter on the flanks and ventral surfaces (Fig. 1). Subdermal scales are present within the connective tissue of the skin but the specimen is peculiar or atypical in that it lacks dermal scales within the dermal pockets of the body, a peculiarity shared by two other conspecifics from Pauna, Boyacá, Colombia (IAvH 15926 and UPTC-Am 184) (Fernández-Roldán et al., 2023), these three scaleless specimens come from sites at above 2000 m a.s.l.

We detected a set of notable bite marks on the skin of ANDES-A 5444 between the primary grooves 44 and 45, which given their size and contour, could have been inflicted by another *C. atelolepis* (Fig. 2); the head and body also bear many small scratches or scars. In the African *Schistometopum thomense* larger-sized males are known to aggressively bite smaller males – but not females – when put within proximity of each other, especially in the head and collars (Teodecki et al., 1998). Our observations concur with those of Teodecki et al. (1998) in that only the teeth on the upper jaw (i.e. premaxillary-maxillary and vomeropalatine teeth) were evident on the skin of ANDES-A 5444. JDF recalls being bitten by an agitated individual of *Caecilia perdita* (CPZ-UV 6074) in September of 2019 brought from Buenaventura, Valle del Cauca, Colombia, to Universidad del Valle, Cali, that left him with a set of similar bite marks on his fingers as he attempted to euthanise it.

The recent natural history observations of *C. atelolepis* in Supatá, Cundinamarca, Colombia in 2022–2023 could indicate that this is not a particularly rare or difficult species to find, meaning that it probably does not require a lot of digging on behalf of the researchers. This should encourage biologists to do much-needed long-term ecological/behavioural studies that are instead often focused on frogs (Granados-Pérez & Ramírez-Pinilla, 2020) or to a lesser extent on salamanders (Ortega et al., 2009). The fact that these fossorial, limbless amphibians are active above the ground during the daytime, especially without previous rainfall, suggests that the traditional view of caecilians as mysterious, rarely encountered animals merely found by chance is, at least in the case of *C. atelolepis*, unsubstantiated.

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SHORT COMMUNICATION

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Sticky traps for rodents can be fatal for snakes in India

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Sticky (glue) traps for rodent control were introduced into India in the 1980–90s and have been effective for the management of house mice and rats (Srivastava & Srivastava, 1985). Nevertheless, the use of such traps in India is in violation of the Prevention of Cruelty to Animals Act, 1960, Wildlife Protection Act, 1972, Environment Protection Act, 1986, Indian Forest Act, 1927 and Indian Penal Code, but due to ignorance they are used and threaten our wildlife. Such traps have also been used to capture lizards and other reptiles for ecological studies but the ensuing mortality rates are high (Whiting, 1998; Glor et al., 2000; Vargas et al., 2000).

In Pune, snakes are increasingly at risk from sticky (glue) traps. We responded to a total of 67 snake rescue calls from January 2023 to November 2023, out of which 7 snakes were found in sticky traps (Table 1 & Fig. 1). Six of these snakes died on the same or other day, one snake was rescued and treated at veterinary hospital and released after 7 days.

The use of sticky trap risks capture of non-target animals including snakes, where death comes very slowly by suffocation, stress, dehydration or starvation (Vargas et al., 2000). We believe that snakes fall prey to these traps as they feed on rats and follow their scent to the trap but the snakes may also fall victim to the trap even before the rodents arrive at them. As soon as the snakes reach the trap, the front part of their body gets stuck and while they move to free themselves, the rest of their body also gets stuck. Attempting to remove a snake from a trap is extremely challenging and may result in permanent damage to its scales and skin.

The fatality rates are high with sticky traps (Vargas et al., 2000) and this risk to wildlife has resulted in restrictions on the use of these traps in some countries, such as the USA, United Kingdom and New Zealand (Chapple, 2016; Baker et al., 2020; Fay, 2022) and India. Further studies to quantify the extent of this problem would be of value in understanding the full impact of this type of trap and may provide evidence for the need for enforcement of the rules against them.

Figure 1. Snake victims of sticky traps in Pune, India in 2023- **A.** Common wolf snake *Lycodon aulicus*, **B.** Common trinket snake *Coelognathus helena*, **C.** and **D.** Juvenile spectacled cobra *Naja naja*

Table 1. Details of snakes found in sticky traps in Pune, Maharashtra, India, in 2023

Snake species	Age	Date	Location	WPA*	Remarks
Coelognathus helena	Subadult	6 January	Residential	Sch II (Part C)	Found dead
Ptyas mucosa	Subadult	18 January	Residential	Sch I (Part C)	Died after 2 days
Lycodon aulicus	Subadult	25 January	Residential	Sch II (Part C)	Died same day
Naja naja	Juvenile	21 February	Industrial	Sch I (Part C)	Died after 1 day
Lycodon aulicus	Juvenile	11 March	Research Institute	Sch II (Part C)	Found dead
Oligodon tillacki	Subadult	13 April	Residential	Sch II (Part C)	Died after 2 days
Naja naja	Juvenile	22 October	Residential	Sch I (Part C)	Rescued, treated and released

*WPA = Indian Wildlife Protection Act, 1972

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SHORT COMMUNICATION

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Occurrence of *Caiman latirostris* and *Caiman yacare* in the Middle Delta of the Paraná River, Argentina

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There are two species of caiman in Argentina. The yacare caiman *Caiman yacare*, which is found in the provinces of Chaco, Corrientes, Formosa, Misiones, Salta and Entre Ríos, and the broad-snouted caiman *Caiman latirostris* that inhabits Chaco, Corrientes, Entre Ríos, Formosa, Jujuy, Misiones, Salta, Santa Fe and Santiago del Estero (Prado et al., 2012). Both species are listed as of Least Concern in the IUCN Red List (Siroski et al., 2020; Campos et al., 2020). There have been anecdotal reports of both species in various localities of the Middle Delta of the Paraná River in the north of Buenos Aires (Chebez, 2008). Caiman occasionally use rivers for dispersal, thus reaching more southern latitudes than is usual for them, these are generally adult individuals, often males that move south in the summer, but it is unknown if they manage to survive the winter (Restivo et al., 2011).

It has been proposed that between 30° and 34° south latitude, the thermal conditions may be incompatible for the feeding and digestion of *C. latirostris* for about 5 months of the year (Diefenbach, 1988). This is because, during winter and into early spring, the air temperatures and limited sunlight (due to short daylight hours, and a high frequency of cold and overcast days) do not allow the animals to reach their preferred body temperature. Furthermore, a critical limitation for the survival of *C. latirostris* eggs is the strong seasonality, with minimum temperatures dropping below 0 °C in winter (Simoncini et al., 2009; Viotto et al., 2022). The objective of the current study was 1) to record caiman occurrences in the Middle Delta of the Paraná River during the extraordinary low water of the Paraná River that occurred between 2020 and 2022, and 2) confirm the winter survival of caiman in this area.

Table 1. Caiman recorded in the Middle Delta of Paraná River, 2020–2022

Species	Date	Locality	Catalogue number
Caiman latirostris	May 2020	Port of Campana, Campana district	
	April 2021	Santos Vega island, Ramallo district	CFA-IMG-2587
	June 2021	Vuelta de Obligado, San Pedro district	CFA-IMG-2589
Caiman yacare	May 2020	Coast of San Nicolás, San Nicolás district	
	May 2020	Club Náutico de San Nicolás, San Nicolás district	
	Sept. 2020	Lechiguanas islands, Ramallo district	
	April 2021	Celiz lagoon, San Pedro district	
	May 2021	KM 274 of the Paraná river, Baradero district	
	June 2021	Ternium factory, Ramallo district	
	June 2021	Las Pirañas stream, Baradero district	CFA-IMG-2591
	June 2021	Vuelta de Obligado, San Pedro district	CFA-IMG-2590
	January 2022	Coast of San Pedro, San Pedro district	
	June 2022	Paraná Miní, Tigre district	
	Sept. 2022	La Rinconada lagoon, San Pedro district	CFA-IMG-2594

We reviewed the data from observation reports of caiman received by the Directorate of Flora and Fauna of Buenos Aires, which originate from citizen complaints. Each record has been previously corroborated with photographs, videos and interviews with informants when necessary. Some photographs were deposited in the Digital Repository of Argentine Nature of the Félix de Azara Natural History Foundation (CFA). In addition, we monitored two specimens on the Santos Vega island (Ramallo district, 33° 32’48.23” S, 59° 52’21.78” W), travelling a 4 km transect weekly for three months by kayak in the stream of the island where

Figure 1. Observations of caiman in the Middle Delta of the Paraná River - **A.** Female *Caiman yacare* captured in Arroyo Las Pirañas (CFA-IMG-2591), **B.** Male *Caiman latirostris* captured near the fishermen's dock in Vuelta de Obligado (CFA-IMG-2589), **C.** Undetermined *Caiman latirostris* found in an internal stream on Santos Vega Island (CFA-IMG-2587)

they were. These two specimens, a *C. latirostris* and a *C. yacare* were captured in June 2021 by the park rangers of the Vuelta de Obligado Municipal Reserve and personnel from the Argentine Naval Prefecture, to avoid conflicts with the locals. They were then released in the Santos Vega island area on 15 & 17 June 2021, 10 and 40 km from where they were captured respectively and where the presence of another *C. latirostris* was already known (Fig. 1c) since April 2021. Between 2020 and 2022, during a historically low water event, eleven *C. yacare* and three *C. latirostris* were recorded in the north of Buenos Aires province (Table 1) according to the photos and videos received by Directorate of Flora and Fauna of the Province of Buenos Aires.

Regarding the monitoring of the caimans released on Santos Vega Island, we found that after being released, they remained in the water for a day before choosing a place to sunbath on land. The *C. yacare* specimen left the location a week after being released, while the *C. latirostris* stayed in the same place until it was last seen on 25 September 2021. This finding suggests that *C. latirostris* could survive the winter months (June to September) in the Middle Delta of the Paraná River.

Our observations suggest that current climatic conditions are suitable for the survival of *C. latirostris* during winters in the Middle Delta of the Paraná River, and the same could be assumed for *C. yacare*, since this species is known to range further south. This would explain the appearance of so many specimens of both species of caiman in these latitudes during the historic low water event. We can assume that the specimens that arrive during the cyclical floods of the Paraná River, which occur approximately every three to seven years (the last one having been in 2016), settle in the internal lagoons of the islands, which would be a favourable environment for them. However, during the extraordinary low water phenomenon resulting from a severe drought caused by the La Niña year (negative ENSO phase; Penalba & Rivera, 2016) and other atmospheric oscillations such as Madden-Julian (Díaz et al., 2022), these lagoons remained completely dry. This forced the specimens from the Middle Paraná Delta to go to the streams and the main channel of the river in search of favourable environments, which allowed so many specimens to be sighted in a period of three years. Despite this, although adult specimens are capable of surviving in the area, the low density of individuals of both species would make encounters between males and females difficult. On the other hand, if there were nesting events, the clutches would not be able to survive due to the limitation imposed by temperatures below 0 °C in winter.

For the future, it would be of interest to collect long-term data on changes in water temperature to be able to project the distribution of these species in a climate change scenario.

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SHORT COMMUNICATION

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Breeding of the anguid lizard *Diploglossus lessonae* in north-east Brazil

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The anguid lizard *Diploglossus lessonae* Peracca, 1890, known locally as the "chalango-liso", is an active forager, with diurnal, semifossorial habits, and is associated with leaf litter, fallen tree trunks and rock crevices (Passos et al., 2011; Caldas et al., 2016). It has a serpentine, elongated body, with a reduction or disappearance of constrictions between the head, torso and tail (Vanzolini, 1958). The species is endemic to Brazil and occurs in the north-east of the country, with a wide distribution in this region. It is encountered in semiarid areas of caatinga (Rodrigues et al., 2005), as well as higher altitude swamps (Borges-Nojosa & Caramaschi, 2005) and Atlantic Forest regions (Schmidt & Inger, 1951; Freire, 1996). Currently, there is little available information regarding its ecology, while information about reproductive aspects is even more limited. Here, we present a report on the birth of *D. lessonae* neonates and their colouration.

On 29 September 2022, at around 09:00 h, an adult female *D. lessonae* was captured in a caatinga area in the municipality of Ruy Barbosa (12° 17'02" S, 40° 29'38" W), in the centre-north meso region of Bahia state, north-east Brazil. The capture was conducted in strict compliance with the legal guidelines established by the Authorisation for Scientific Activities with reference number #51743, granted by the Biodiversity Authorisation and Information System - SISBIO, ensuring the legality and ethics of the process. The animal was taken to the Animal Conservation and Ecology Centre – ACEC, located at the Universidade Católica do Salvador UCSal, and added to the herpetology collection. However, a swollen abdomen, uncommon for the species, was observed; consequently the specimen was kept under observation in a terrarium (53 cm x 26 cm x 26 cm), containing 6 cm of soil covered by 2 cm of leaf litter, with the soil temperature monitored continuously. After 58 days of observation, maintaining average soil temperature of 28 °C, the birth of three young was recorded. Their mean dimensions (± SD) were head width 8.07 ± 0.67 mm, head length 11.03 ± 1.56 mm, snout-vent length 55.73 ± 4.33 mm, tail length 42.97 ± 2.72 mm, and weight 2.67 ± 0.58 g. The female's body dimensions were recorded after birth of the young and were – head width = 15.2 mm; head length = 19 mm; SVL = 184.4 mm; regenerating tail length = 45.3 mm; weight = 9.9 g. Given that Vitt (1985) indicated that the typical adult weighs about 54 g, the recorded weight of the female is exceptionally light. It seems that this may be explained by the fact that the female had recently given birth, did not accept any of the food that was offered, and had lost part of her tail.

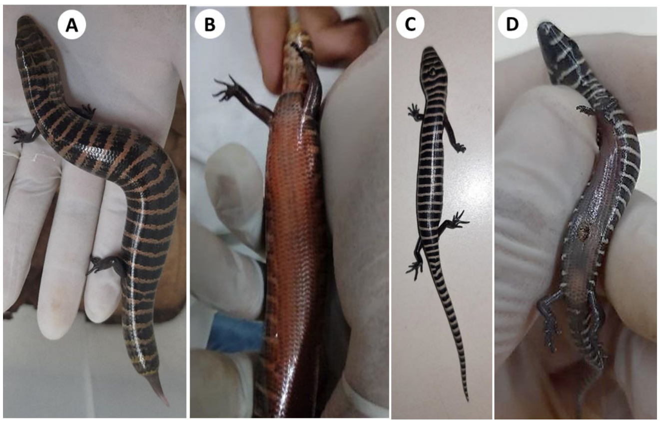

Figure 1. Adult female and neonate *Diploglossus lessonae* from Bahia state, north-east Brazil - **A.** Adult female dorsal view, **B.** Adult female ventral view, **C.** Neonate born to the female, dorsal view, **D.** Neonate born to female ventral view

The female was monitored consistently from arrival but no eggs or eggshells were observed, which was strange since it has been stated that this is an egg-laying (oviparous) species (Vitt, 1985; 1992a). Our observation suggests that this species must be either viviparous or even ovoviviparous. Furthermore, we observed that the colouration of the neonates and adult differed. While the adult had black-brown transverse stripes on a brownish/pink background and was red ventrally (Fig. 1 A&B), the young had black transverse bands dorsally against a white background but ventrally they were translucent reddish-brown (Fig. 1 C&D). It has been recorded that the young have red bellies and that this is a case of Batesian mimicry of the venomous millipede *Rhinocricus albidolimbatus*, which is coloured with red and white rings and is sympatric with *D. lessonae* (Vitt, 1992b). However, it seems that the red colouration takes time to develop in the young lizards.

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SHORT COMMUNICATION

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Range expansion of white lipped foam-nest frog *Leptodactylus fragilis* on to the Caribbean slope of Costa Rica

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The family Leptodactylidae contains around 233 species in 15 genera (Frost, 2023). Its species are distributed from southern Texas to South America, although some species can also be found on certain Caribbean islands (Rodríguez-Cabrera et al., 2018; AmphibiaWeb, 2023). These frogs are characterised by depositing their eggs in foam nests, which are created by the male with its hind legs during mating (Leenders, 2016). In Costa Rica, this family includes six species in two genera and they are distributed on both the Caribbean and Pacific versants (Leenders, 2016; Frost, 2023).

The white-lipped foam-nest frog, *Leptodactylus fragilis* (Brocchi, 1877), is a medium-sized, short-limbed leptodactylid with snout-vent lengths of 25–40 mm (Savage, 2002). In the past, the species was referred to as *Leptodactylus labialis*, although the valid and current name of *L. fragilis* was established by Heyer (2002). The body is covered with tubercles with a pair of dorsolateral folds and a spotted dorsum (Heyer et al., 2006; Leenders, 2016). It is distinguished from other leptodactylids by having a light stripe on the upper lip and white tubercles on the soles of the feet and lower surfaces of the tarsi (Savage, 2002; Leenders, 2016).

Leptodactylus fragilis can be found in natural and man-made swamps, ponds and any temporary pools during rainy periods (Savage, 2002; Leenders, 2016). This species ranges from Texas to Venezuela (Heyer et al., 2006; Mendez-Narvaez et al., 2009), and in Costa Rica was, until recently, considered to be a species restricted to the lowlands of the Pacific versant and marginally in the Northern Zone (Savage, 2002). There is only one previous report of this species on the Caribbean side of Nicaragua (Bluefields), and no previous reports for the Caribbean side of Costa Rica and west of Colón, Panama (iNaturalist, 2023).

Here we present new reports and localities for *L. fragilis* on the Caribbean versant of Costa Rica (Fig. 1). The first record was in 2019 from Villa Hermosa, Limón (9.976448° N, -83.064387° W, 54 m a.s.l.). The next records were in 2020 from Puerto Viejo, Sarapiquí, Heredia (10.453169° N, -84.010525° W, 41 m a.s.l.), in 2022 from Guápiles, Limón (10.243905° N, -83.799177° W, 185 m a.s.l. and 10.24034° N, -83.729173° W, 140 m a.s.l.), and in 2023 from Chilamate, Sarapiquí, Heredia (10.2653° N, -84.0558° W, 99 m a.s.l.). These frogs were detected by their vocalisation and the species was later confirmed using species diagnostic traits.

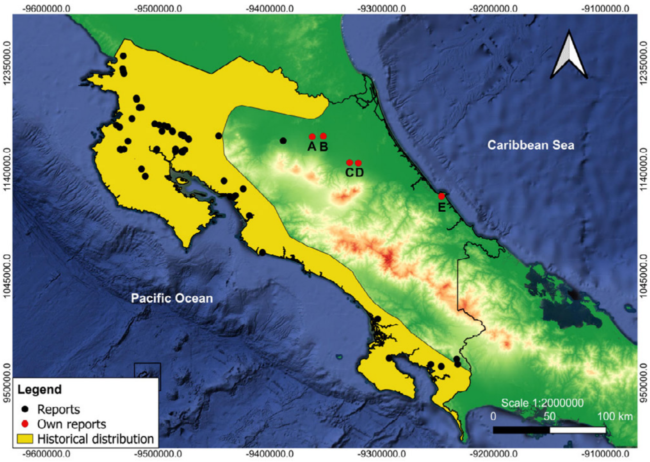

Figure 1. Historical distribution of *Leptodactylus fragilis* on mostly the Pacific versant of Costa Rica and reports of range expansion onto the Caribbean versant. The black dots represent the reports from the database and the red dots are own reports. **A** & **B** correspond to the reports in Chilamate and Puerto Viejo, Sarapiquí, **C** & **D** in Guápiles, Limón, and E in Villa Hermosa, Limón.

All observations took place in open areas with temporary pools and small water bodies and disturbed by human activity, in the same habitat as the variable foam-nest frog *Leptodactylus melanonotus*. We were able to distinguish *L. fragilis* (Fig. 2) from the *L. melanonotus* in the field using the following traits: 1) vocalisation, 2) a light longitudinal stripe on the posterior surface of the thighs only present in *L. fragilis* (Savage, 2002), 3) colouration of the venter (mottled with dark pigment in *L. melanonotus* and uniform white to cream in *L. fragilis*, Fig. 2C), and 4) a white stripe on the upper lip only present in *L. fragilis* (Fig. 2D) (Leenders, 2016).

Several factors have likely contributed to the range expansion of *L. fragilis* on the Caribbean versant of Costa Rica, one of which would be alterations of habitat that

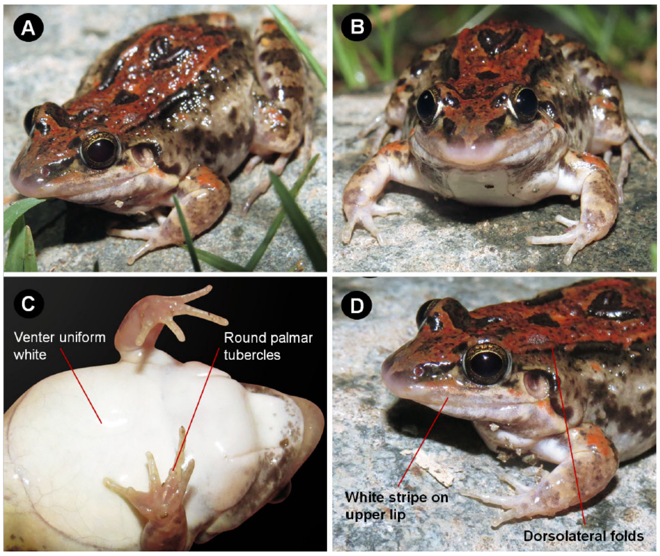

Figure 2. An adult male *Leptodactylus fragilis* caught at Villa Hermosa, Limón, Costa Rica – **A.** & **B.** Frontal views, **C.** & **D.** Specific traits to identify the species

include changes in land use patterns and deforestation. The lowlands of the Caribbean side of Costa Rica have experienced an expansion of urbanisation and agriculture during the past three decades (Segovia-Fuentes, 2018). *Leptodactylus fragilis* is quite adaptable and able to use disturbed areas such as plantations and roadside ditches (Leenders, 2016). Thus, human settlements and cultivated fields could have facilitated the colonisation of new areas across the Caribbean versant.

The range expansion of *L. fragilis* onto the Caribbean side of Costa Rica has ecological implications such as competition with *L. melanonotus*, since both species use similar water bodies (Savage, 2002; Leenders, 2016). Additionally, the arrival of *L. fragilis* might alter the predator-prey relationships within the ecosystems. Therefore, monitoring the spread of the species and population dynamics will enhance our understanding of the factors influencing range expansions and the consequences for amphibian populations and ecosystems.

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SHORT COMMUNICATION

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Common toad *Bufo bufo* and hazel dormouse *Muscardinus avellanarius* cohabiting in a dormouse nesting box

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The common toad *Bufo bufo* is one of seven amphibians native to Britain and is considered widespread despite declines in some areas (Young & Beebee, 2004; Inns, 2011). Outside the breeding season this species tolerates dry conditions, and can be found some distance from water in a range of natural and semi-natural habitats (IUCN, 2008). This includes gardens, grasslands, woodlands and hedgerows, where they hunt for food at night and shelter under features such as logs, rocks, debris and artificial refugia during the day (Billings, 1984; Inns, 2011). In Denmark, common toads have been reported climbing trees where they shelter in holes and crevices (Bringsøe, 2016), and in England data from diverse taxonomic surveys has shown their ability to climb and utilise above ground structures including artificial nest boxes and tree cavities (Petrovan et al., 2022). In their study, Petrovan et al. (2022) analysed 51 toad records within tree cavities and dormouse nest boxes, but did not report cohabitation between the hazel dormouse *Muscardinus avellanarius* and toads. Here we build on this work by reporting an instance of cohabitation between these two species within a dormouse nest box.

Throughout the summers of 2022 and 2023 we undertook dormouse surveys at Goss Moor National Nature Reserve (NNR), Cornwall, UK (50° 24’16” N, 04° 52’15” W), a designated Site of Special Scientific Interest and Special Area of Conservation (Natural England’s Devon, Cornwall and Isles of Scilly Area Team, 2017). Surveys were part of the National Dormouse Monitoring Programme (NDMP) where licensed individuals monitor nest boxes throughout England and Wales during the dormouse active season (April–October; for the full NMDP survey protocol, see PTES, 2022). At Goss Moor specifically, there were ten surveys of 100 traditional wooden nest boxes (two distinct transects) in both 2022 and 2023. In 2023, we discovered one dormouse and four toads in nest boxes (Table 1).

Table 1. Nest boxes containing toads and a dormouse at Goss Moor NNR in 2023

Date	Time	Box #	Transect #	Species present	Age
25/06/2023	10:30 h	23	1	Toad	Juvenile
30/07/2023	10:40 h	23	1	Toad	Juvenile
30/07/2023	11:45 h	1	2	Toad	Juvenile
29/09/2023	11:45 h	2	1	Toad and dormouse	Juveniles

Although toads have previously been found to inhabit features of trees that are above ground and use disused rodent burrows for hibernation (Inns, 2011; Petrovan et al., 2022), to the authors knowledge, this is the first time they have been observed cohabiting with a dormouse in a nest box (Fig. 1A). This box (Fig. 1B) is attached to a goat willow tree *Salix caprea* at a height of approximately 150 cm, with a 3.5 cm entry/exit hole facing the tree trunk. The tree is located at the edge of goat willow-dominated wet woodland which regularly becomes flooded after heavy rainfall. Whilst both individuals were found together in September 2023, neither were present in October 2023, although the dormouse nesting material remained.

Figure 1. Nest box 2 at Goss Moor NNR - **A.** Nest box 2 at the time of processing showing a juvenile dormouse and juvenile toad (circled in red) **B.** Location of nest box attached to a goat willow tree

It has been suggested that toads may use arboreal structures for shelter, to avoid predators or parasites, and to hunt for prey (Bringsøe, 2016; Petrovan et al., 2022). To deter predators, toads secrete toxins from granular skin glands that can cause a range of biological complications, such as cardio inhibitory effects (Kowalski et al., 2018). Some reptiles and mammals are able to prey on toads despite these protections, but their effects on hazel dormouse are unknown (Petrovan et al., 2022). Dormice eat seeds and fruits, and opportunistically feed on bird eggs (Adamík & Král, 2008;

Juškaitis et al., 2016; Sarà & Sarà, 2007) and both species feed on invertebrates (Inns, 2011; Büchner et al., 2018; Chanin et al., 2015; Goodwin et al., 2020). It is therefore unlikely that predation would occur between these two species and our observation suggests passive cohabitation.

Both tree cavities and nest boxes offer micro-climates that differ from ambient conditions, but natural tree cavities are more efficient thermal insulators and maintain higher humidities than nest boxes. Whilst nest boxes have relatively poor thermal insulation, they do at least maintain humidities above ambient (Marziarz et al., 2017). Furthermore, the solitary behaviour of toads and dormice, especially at this life stage, lead us to suggest that the nest boxes surveyed at Goss Moor were likely providing suitable temporary shelter and protection for two nocturnal species that otherwise occupy different ecological niches.

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SHORT COMMUNICATION

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Will climate change affect the proportion of melanistic northern vipers *Vipera berus* in a western European population with an exceptionally high rate of melanism?

GRÉGORY DESO

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The northern viper *Vipera berus berus* has populations scattered across western Europe that include a proportion of melanistic individuals (Thiesmeier & Voelkl, 2002). The occurrence of melanism is particularly prevalent in the colder parts of its range, melanism being considered an advantage for thermoregulation (Luiselli et al., 1994; Monney, 1996; Broennimann et al., 2014) as well as for physical and reproductive performance (Clusella-Trullas et al., 2007). Populations of melanistic reptiles can also be found in good proportions in warmer regions of the globe (Ineich et al., 2009) and according to Lorioux et al. (2008), the phenomenon of melanism could also be non-adaptive while providing protection against sun damage. In France, there are almost no *V. berus* populations with a high rate of melanism (Guiller et al., 2019; Graitson et al., 2023), but there is one in the east of the country in the Jura region, along the Drugeon river (Guyétant et al., 1980). In a study 24 years ago, a remarkable melanism rate of 53% was found in a sample of 62 individuals (Pinston et al., 2000). This high rate of melanism is probably due to the humid, cold and forested nature of the study area. Melanism in vipers of the Jura region occurs mainly in humid forest environments (Monney, 1996). The high proportion of melanistic individuals is maintained by frequency-dependent negative natural selection in males and females (Madsen et al., 2022).

The study site along the Drugeon river covers the whole of the ENS (Espace Naturel Sensible) of the Etang de Bouverans and the Varot marshes, as well as the sites of the RNR (Réserve Naturelle Régionale des Tourbières de Frasne), which extend over three communes: Bouverans, Bonnevaux and Frasne (46° 49’46’’ N, 6° 12’16’’ E). Our study site is located at altitude (between 800 and 900 metres), which is also one of the conditions for the presence of a high rate of melanism in this viper (Andren & Nilson, 1981). These sites cover around 500 hectares of highly diverse wild habitats, including lakes, marshes, wet meadows, active peat bogs, beech-fir forests, mountain meadows and dry grasslands (Fig. 1). Due to climate change, the average global temperatures have already risen by 1.1 °C between the years 1850 and 2020 (IPCC, 2023) and it has been suggested that melanism trends in snakes can change depending on climatic conditions (Bury et al., 2022). The climate projections to 2050 for our study area, made by the DRIAS platform (https://www.drias-climat.fr/decouverte), include three scenarios (RCP2.6/ RCP4.5/ RCP8.5) which all predict a greater rise in temperatures, with an increase of 1.56 °C (RCP 2.6), 1.82 °C (RCP 4.5) and a potentially extreme rise of up to 2.14 °C (RCP 8.5). Surprisingly, our study area, where temperatures are forecast to rise sharply, is today one of the coldest areas in France and western Europe. The accumulation of droughts and heatwaves is expected to result in geographical variations in morphology and hydro-regulation strategies (Chabaud et al., 2022). The lack of water for female European viper species is a constraint that has a strong impact on their physical condition, particularly when they are gravid (Le Galliard et al., 2021). Besides global warming, genetic isolation of population, due to their confinement within natural barriers, is also a threat to the Drugeon and Monts D’Or viper populations (Ursenbascher et al., 2009). The loss of genetic diversity has an impact on the functioning of populations, as it leads to lower ecological resilience (adaptability to disturbance) and a reduction in reproductive success.

Figure 1. Location of the study area in the Jura region of eastern France

We undertook field surveys to provide an updated estimation of the proportion of melanistic individuals at the study sites. To do this we photo-identified the head scale

Figure 2. Reproduction between the melanistic and typical zigzag phenotypes of *Vipera berus* in the Jura region of eastern France

patterns of the vipers to enable individual recognition, a technique commonly used for this species as it is considered very reliable (Bauwens et al., 2018), and supports capture-mark-recapture population estimates. The population census was undertaken from 2020 to 2023, although survey effort was not equal between the sites, with five days per year on the ENS site (i.e. a total of 15 days over three years) compared with eight days in a single year on the RNR site. We identified 76 vipers by photo-recognition and made 19 isolated viper records without recognition, i.e. a total of 95 viper contacts over four years, with a recapture rate of 25%. Of these vipers 56.84% were melanistic (Fig. 2) and 43.16% had the normal zigzag pattern. From this, we have concluded that there has been little or no change in the rate of melanism since the year 2000. Although melanistic individuals were more numerous, a very balanced sex ratio (52.3% female and 47.7% male) was noted among both melanistic individuals (with a slight tendency in favour of melanistic females 52.83%) and individuals with a zigzag pattern (also with a slight trend in favour of females at 51.43%). The fact that our population here has more melanistic females than in the zigzag pattern is positive because, according to Forsmann (1995), melanistic females have an advantage when it comes to breeding, whereas males, because of their ecology, are more likely to be predated (Andren & Nilson, 1981). During the sampling period, only two young individuals were found in the study area, one of which had a zigzag pattern and one of which was already fully melanistic, suggesting that individuals may be born already melanistic.

The large numbers of melanistic vipers we observed were most often found not far from water (70%) and in dense, cool forest areas (30%). According to Yenmis et al. (2022), melanistic populations of *Natrix natrix* in Anatolia were living three times closer to water than those with typical colouration and they frequently used areas with numerous insulating rock shelters at the water's edge, which allowed them to cool down more quickly during the hottest periods of the year. The hypothesis that melanistic reptile populations need moister conditions apparently also applies to those living in the tropics (Ineich et al., 2009). In order to combat the effects of rising temperatures and low rainfall, it seems important for reptile populations to have wet shelters and good access to water (Sears et al., 2016; Rozen-Rechels et al., 2020; Chabaud et al., 2022). The high melanism rate reported in our study site (56.84%) has apparently been constant since 2000 but given the expectation of rising temperatures due to climate change, the sites offer a good opportunity to study the effects of climate change on the proportion of melanistic vipers within the population. The capture-mark-recapture monitoring protocol we have established will be replicated over time and will enable us to monitor any future changes in the proportion of melanistic individuals.

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SHORT COMMUNICATION

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Predation of the swamp racer *Palusophis bifossatus* by the caiman *Caiman yacare* and by the otter *Lontra longicaudis*

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Most Brazilian caimans are generalist feeders (Barreto-Lima et al., 2021). The yacare caiman, *Caiman yacare* (Daudin, 1801), the most abundant central Brazil wetland species (Pantanal), has a varied diet (Santos et al., 1996). The same is noted for the Neotropical otter, *Lontra longicaudis* (Olfers, 1818) (Mustelidae) a generalist, diurnal predator (however, see Carrasco et al., 2020 for other observations on this behaviour) historically considered as piscivorous, although it occasionally feeds on mammals, birds, reptiles and amphibians (see Muanis & Oliveira, 2011 for diet and variations, although see Rheingantz et al., 2012 for other comments). This species also consumes invertebrates, such as crustaceans, molluscs and insects, albeit to a lesser extent (Colares & Waldemarin, 2000; Gori et al., 2003), in addition to some vegetable matter (Gori et al., 2003).

Here we report the swamp racer *Palusophis bifossatus* (Raddi, 1820) being preyed upon by two large predators, *C. yacare* and *L. longicaudis*, along the banks of the Rio Negro river at the Barranco Alto Farm in the municipality of Aquidauana, Mato Grosso do Sul, Brazil. The region is typically seasonal with humid summers and dry winters and composed of gallery forests, savannas and semi-deciduous forests. The local wet season ranges from November to March, with high rainfall rates from December to February, while the dry season ranges from April to October, with July being the driest month (Nunes et al., 2021). This system determines local river and water body flooding events.

During a morning boat excursion on the Rio Negro river on 21 July 2022 at 09:56 h, an adult *C. yacare*, measuring approximately 2 m in length, was observed on the river bank close to the water's edge (-19.587778° S, -56.174444° W) with an adult snake (*P. bifossatus*) in its mouth (Fig. 1A). The caiman was not moving. The swamp racer was apparently still alive, occasionally moving its head, although its movements were slow and subtle. The expedition then continued downriver. On its return about half an hour later (10:28 h), the *C. yacare* still had the snake in its mouth but had swallowed half of its body, head first (Fig. 1B). The snake's belly exhibited injuries caused by the caiman's teeth. Following this observation, the caiman was left undisturbed. Complete ingestion was not observed but was expected given the extent of ingestion at the second sighting.

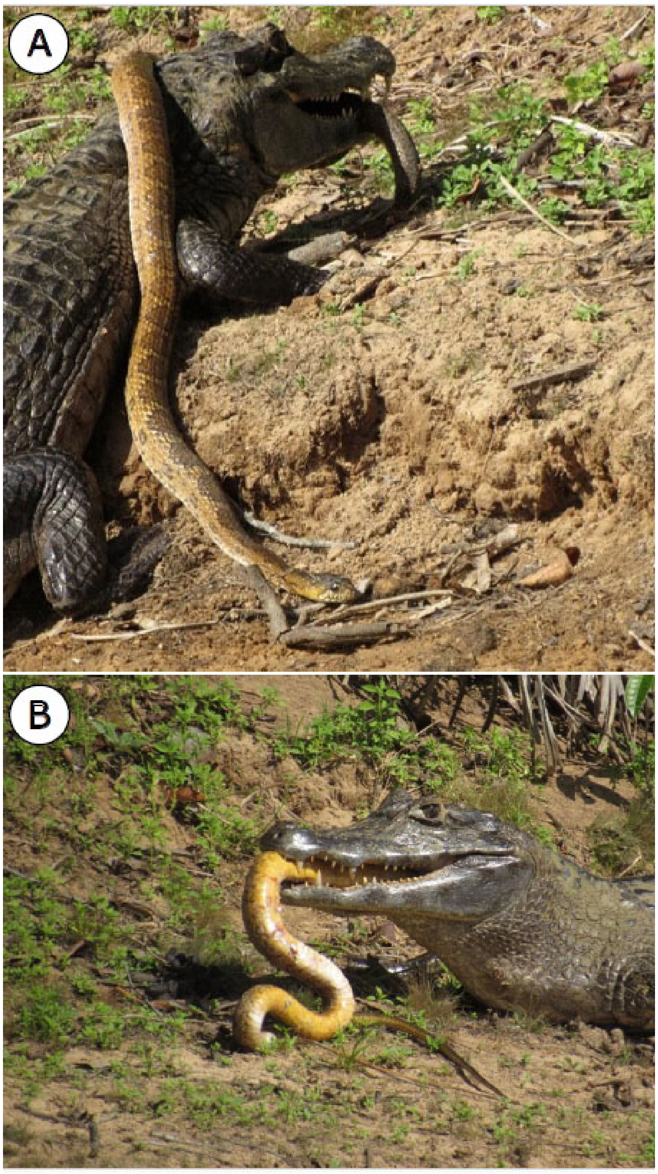

Figure 1. Adult *Caiman yacare* consuming an adult Swamp Racer *Palusophis bifossatus* on the banks of the Rio Negro river (Barranco Alto Farm, Brazil) - **A.** Caiman has captured the swamp snake by the tail, **B.** Caiman with half of the preyed snake's body in its mouth. The snake was swallowed headfirst and exhibited belly injuries caused by the caiman's teeth

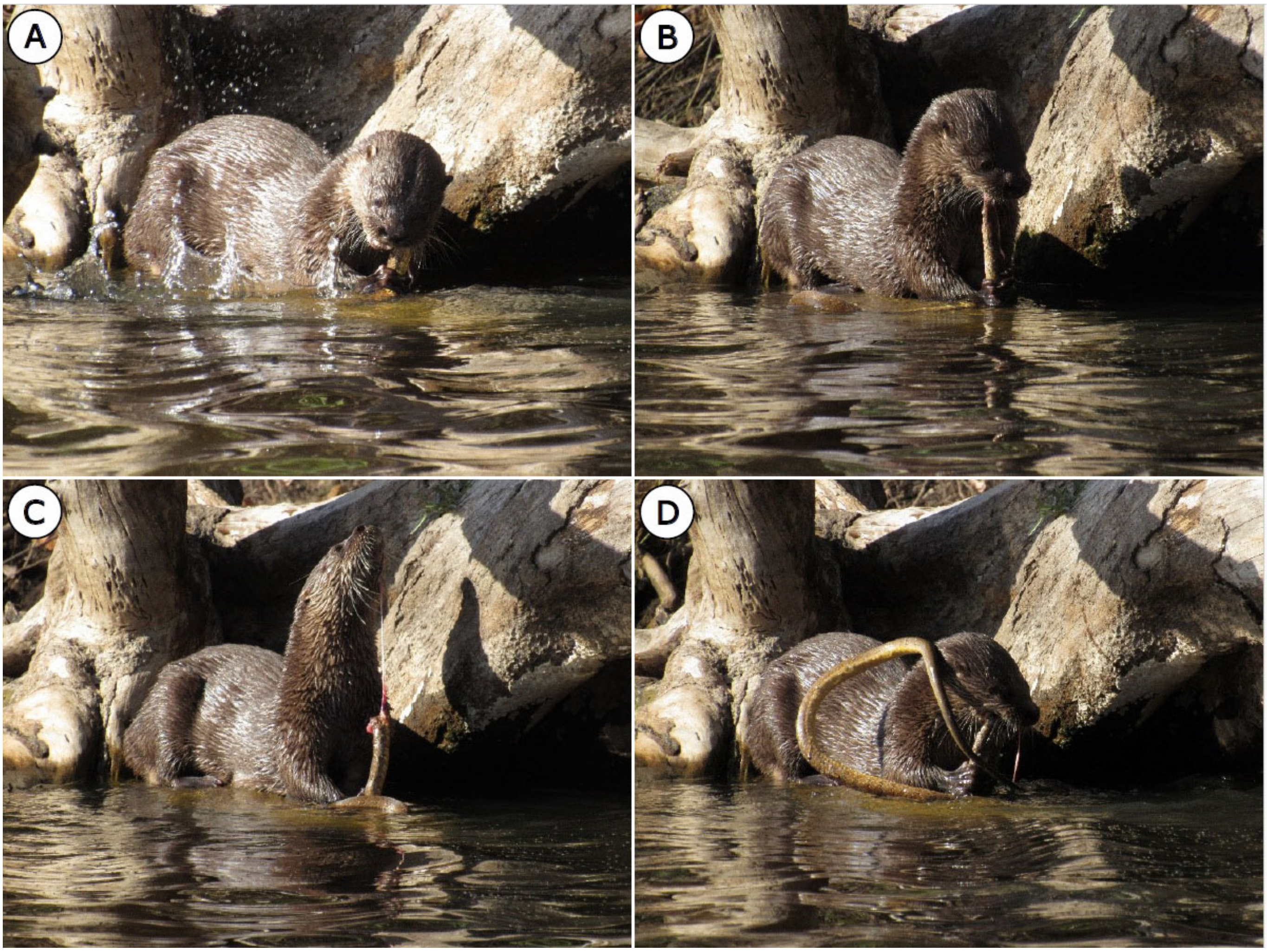

Figure 2. A Neotropical Otter *Lontra longicaudis* consuming an adult Swamp Racer *Palusophis bifossatus* on the banks of the Rio Negro river (Barranco Alto Farm, Brazil) - **A.** The otter holding the snake with its front paws and biting its head. **B., C.** and **D.** The otter feeding on the snake from head to tail, tearing off pieces to chew on

One week later, on 28 July 2022, during another morning boat trip on the Rio Negro river (-19.582500° S, -56.162778° W), between 08:44 h and 08:50 h an adult *L. longicaudis* was seen apparently hunting under roots at the base of the riverbank. At the same time, a swamp racer was noted inspecting a hole in the riverbank about 40 cm above the otter's location, also apparently foraging. At this moment, the typical sound of a baby yacare caiman calling its mother was heard (the specimen was not seen), which seemed to come from the hole the snake was exploring. The otter had not yet seen the snake. When it did, it immediately reacted and caught it. The snake attempted to escape but without success. The otter grabbed the snake with its front paws and began biting its head (Fig. 2A). The otter then retired to a calm place near the trunk of a fallen dead tree beside the riverbank and spent the following minutes feeding on the snake (Fig. 2), from head to tail. As with the caiman, the scene was observed without disturbance.

Snakes comprise a resource occasionally exploited by both otters (Vázquez-Maldonado & Delgado-Estrella, 2022) and crocodilians (Barreto-Lima et al., 2021). Evidence-based sampling methods (e.g. stable isotopes, bones, scales and/or teeth in otter latrines and stomach remains in crocodilians), for many groups, including reptiles, enable the identification of food items at a taxonomic level higher than genus or species (e.g. Santos et al., 1996; Gori et al., 2003), with the result that snakes as prey items may be underreported.

The predation of snakes by *L. longicaudis* in coastal south Brazil environments includes aquatic species, such as the dipsadids *Erythrolamprus semiaureus* (Cope, 1862) (Colares & Waldemarin, 2000) and *Helicops infrataeniatus* (Jan, 1865) (Quintela et al., 2012). These water-dwelling snakes may also be a relatively important food for crocodilians, despite usually occurring at very low frequencies (Barreto-Lima et al., 2021). However, to date swamp racers have not been reported as food for yacare caiman, and although their high population density is remarkable and they are widely distributed throughout the Pantanal biome, this is the first predation event recorded for this species. Thus, the opportunistic records reported herein indicate *C. yacare* and *L. longicaudis* as predators of *P. bifossatus*, contributing to basic natural history data and food web interactions between species that inhabit freshwater environments and their surroundings.

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SHORT COMMUNICATION

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One-year growth and development of a recaptured juvenile king cobra *Ophiophagus hannah* in the foothills of the Western Himalayas

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The king cobra, *Ophiophagus hannah* (Cantor, 1836), the world's longest venomous snake, has naturally varying ventral hood markings that are known to vary sufficiently among individuals for them to be used for individual identification (Jones et al., 2020). We are aware of multiple recaptures of an adult male king cobra in our study area during previous years, which was easily recognisable due to its large size and an unmistakable, unique band pattern on its dorsal hood. Apart from dorsal and ventral hood pattern variations, king cobras also possess unusual combinations of subcaudal scale arrangement, which can provide additional information in support of individual identification (Jones et al., 2020). The subcaudal scales in these snakes are usually undivided near the cloaca but divided further down the tail and the transition from undivided scales to divided scales may occur more than once in the same individual. Jones et al. (2020) published a protocol that combined subcaudal scale arrangement/count and ventral hood markings to potentially differentiate between individual king cobras in Thailand. We present here, for the first time, evidence on the survival and growth-rate in the wild of a king cobra during the first year of life. The cobra was examined at the time of hatching, released into the wild and then recaptured one year later when it was identified by the following external features - total band count, unique band number/pattern, undivided subcaudal scale number and ventral hood pattern. The combination of these features, recorded at the time of birth, made its subsequent identification robust.

During July–September 2021, we monitored and protected a king cobra's nest in the Nainital Forest Division of Uttarakhand, India. The nest, located close to human habitation at an elevation of 1,511 m a.s.l., consisted of a mix of Chir Pine *Pinus roxburghii* and Baanj Oak *Quercus leucotrichophora* leaves. It contained 24 eggs from which 24 young cobras emerged in late September. As part of a long-term research and conservation study on this species, hatchlings were taken from the nest for morphometric measurement and photographs (Dolia et al., 2023 for detailed methods), prior to their safe release in the nearest suitable forest away from human habitation.

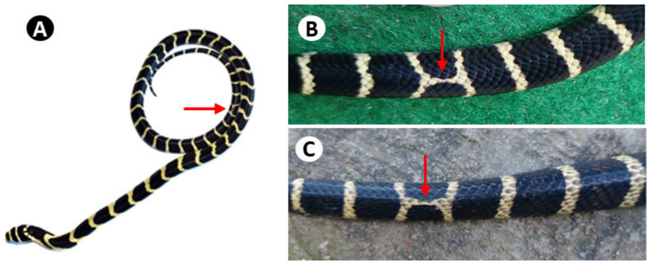

Figure 1. Hatchling king cobra and the same individual about one year later to show the unique band mark (red arrows) - **A.** King cobra hatchling N27_16 in 2021, **B.** Close-up of the unique band mark in 2021, and **C.** The same unique band a year later in 2022

We collected a range of morphometric data for each hatchling (see Table 1). When counting the bands on the dorsal surface we excluded the three bands on the head of a hatchling and began at the first chevron on the forebody and included the last band/dot usually present on the tail tip. We used a non-elastic string and tape measure to take length and girth measurements. In addition to these data, we also noted the band number that intersected (or was closest) to the cloaca of each individual. For example, for this particular recaptured hatchling/juvenile king cobra, the 41st band passed through the cloaca on the ventral side (the range for this feature varied from a minimum of 37 to a maximum of 47 for the 24 siblings of this nest). We took descriptive notes in case any unique band patterns were observed for any individual. We also took multiple photographs of each hatchling (including ventral hood, dorsal hood, whole-body and unique band pattern, if any) to build a photographic database of individual king cobra hatchlings to aid individual identification in the case of recapture.

One of the 24 hatchlings from this nest had a unique band pattern, thanks to which it was easily recognisable. In this individual (with the unique Identification Code, N27_16), bands # 38 & 39 were joined by a perpendicular white line along the dorsum to form an unmistakable, clearly visible white 'H' shaped mark (Fig. 1). In general, the bands, or cross-bands, in king cobras are distinct and are usually not connected to one another. This detectable feature, combined with the total band count, total number of undivided subcaudal scales (Fig. 2) and matching ventral hood markings (Fig. 3) enabled us to confidently identify the juvenile snake

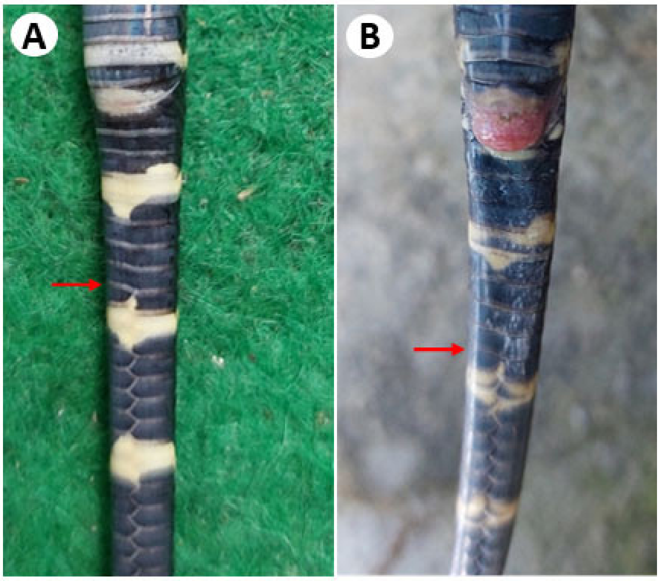

Figure 2. Ventral, cloacal, and subcaudal scales in king cobra N27_16 - **A.** As a hatchling, and **B.** As a juvenile, approximately a year after it was born. Red arrows indicate the transition from undivided to divided subcaudal scales

Table 1. Morphometrics and scalation for the young king cobra N27_16 in Nainital District, Uttarakhand, a day after emergence from its nest (29 September 2021) and when it was recaptured approximately a year later (15 October 2022)

Morphometric variable/ ID feature	29 September 2021	15 October 2022
Total length (mm)	565	1,160
Tail length (mm)	95	190
Mass (g)	23	75
Mid-body girth (mm)	31	60
Total no. of bands	54	54
Band passing through cloaca	41st	41st
Total no. of undivided subcaudal scales	8	8
Total no. of subcaudal scales	-	85
Total no. of ventral scales	-	251

as individual N27_16, when it was recaptured on 14 October 2022. This was a little over a year after its initial release. We also noticed that the three yellowish-white bands (bars) on the head of the hatchling snake (which all king cobra neonates are born with) were now absent from the yearling juvenile (compare Figs. 3A and 3B). The disappearance of these head-bands with age from juvenile king cobras is a well-known fact, but we have not found any earlier published information with regard to the time-frame within which this occurs.

To our knowledge, this is the first report of the growth and development of a juvenile king cobra in the wild. In a period of just over one year, this young king cobra had more than doubled in length from 565 mm to 1,160 mm and tripled in weight from 23 g to 75 g (Table 1). For comparison, in captivity, well-fed juvenile king cobras can attain lengths of 2000 mm in 18 months (Pfaff, 2008). The distance between the release and recapture sites (as measured using the ruler tool in Google Earth Pro) was ~ 2.3 km, and there was a gain in altitude as the snake was first released at 1,615 m and recaptured at 1,751 m a.s.l., an increase of 136 m. The release site was an oak-forest patch beside a stream and the recapture site was a grassy habitat, close to human habitation. The recapture site was north of the release site and to reach this location it is possible that the juvenile king cobra had navigated a small stream, moderately steep slopes, tarred roads, and a few settlements/villages with bare land and cultivations around the houses.

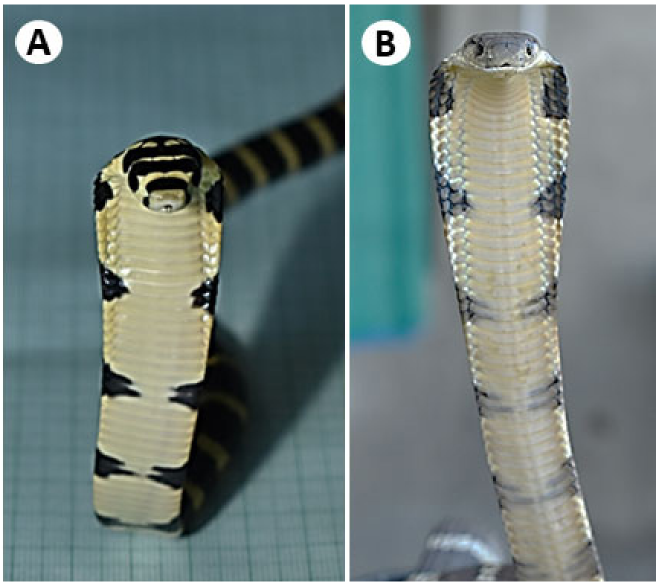

Figure 3. Ventral hood markings of king cobra N27_16 - **A.** As a hatchling in September 2021, and **B.** As a juvenile in October 2022

Figure 4. The juvenile king cobra N27_16 regurgitating a northern white-lipped pit viper

On recapture, the juvenile king cobra was found to have consumed an adult *Trimeresurus septentrionalis* (northern white-lipped pit viper), one of the most common venomous snakes in the mid-elevation hills of Kumaon (pers. obs., JD). The king cobra regurgitated its prey (Fig. 4), probably as a result of capture/handling-related stress. The approximate total length of the dead pit viper was 600 mm, and it weighed 105 g, i.e. shorter but heavier than the king cobra. In all likelihood, the juvenile king cobra must have hunted the pit viper the previous day (i.e. 14 October 2022), as the former was found lying among grass in a sunny patch, for over an hour before it was rescued by KK at around 15:00 h. The king cobra may have been basking to accelerate digestion, which had already proceeded as the head of the regurgitated pit viper was partly digested. After necessary data collection, the king cobra was safely released on 15 October, close to its original capture site, but away from human habitation.

This is the first time that we have seen or rescued a juvenile king cobra in over 15 years of research on this species in this subtropical, montane Himalayan landscape. The current observation adds valuable data for this rather elusive snake and corroborates findings by Jones et al. (2020) that ventral hood markings and subcaudal pholidosis can indeed be used to identify individual king cobras. It also shows that ventral hood markings, body band patterns and other natural features of hatchling king cobras appear to remain temporally consistent and can be used for accurate identification up to at least a year later, and possibly much longer.

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NATURAL HISTORY NOTE

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The first observation of an attempt by *Natrix natrix* to predate an aquatic snail with an operculum

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Specialists slug- or snail-eating snakes can be found across all continents except Europe, Australia and Antarctica. They have evolved specific morphological adaptations in the structure of their heads and in certain cases feeding apparatus, such as their mandibular dentition (Hoso et al., 2007). *Natrix natrix* (L., 1758) is a widely distributed species encompassing four subspecies. Their habitat stretches from central Europe to the southern regions of Iraq and Iran, extending eastwards to Mongolia and Baikal (Asztalos et al., 2021; Jablonski et al., 2023). *Natrix natrix* is an adaptable generalist feeder and usually prefers amphibians and fish if conditions allow (Luiselli et al., 2005). There are documented observations of these snakes consuming invertebrates (Hemmer, 1966). Despite the absence of specialised snail-eating snake species in Europe, there have been sporadic reports of several snakes, including *N. natrix*, preying on this kind of prey. This note highlights an incident in which a *N. natrix* died whilst attempting to ingest a snail with an operculum.

On 19 May 2022, at about mid-day, we discovered a subadult male *N. natrix* with an aquatic snail *Viviparus contectus* (Millet, 1813) in its mouth (Fig. 1). The total length of the snake was 415 mm. The observation was made within the boundary of Pustý Mlyn village near the Rudava river (48° 33’12” N, 17° 18’02” E). The Rudava river is a slow running stream, with littoral vegetation formed mainly of *Phragmites australis* and *Carex* sp. The snake with the snail in its jaws was found on littoral vegetation, whereas the snake´s tail was in the stream (Fig. 1B). The head of the *N. natrix* was trapped between the snail’s shell and closed operculum (Fig. 2). The outer lip of shell was situated on the dorsal part of the snake’s head (Fig. 1A), meanwhile the snail´s operculum was pressed onto the snake’s lower jaw (Fig. 2F). The trapped part of the head originally included the whole of the frontal scale and included some of the parietal scales (Fig. 1A). The snake and snail were collected and placed in a vivarium for further observation. During capture the position of the snail shell moved so that the most caudal part of frontal scale became visible (Fig. 2E). The trapped part of the head still included the eyes, and the snake could still protrude its glottis through the left side of the jaws enabling it to breathe (Fig. 2D); in this way it survived 10 hours in captivity. The snail and dead snake were subsequently preserved in ethanol and both specimens (no. 12992) are available at the herpetological collection curated by the last author. Based on the snake being trapped, we assume that the snake had bitten the snail’s head while the snail was moving along the bottom of the stream. According to our observations *V. contectus* is the most common species of water snail at the locality, although other species of water snail observed were *Lymnaea stagnalis* and *Planorbarius corneus*.

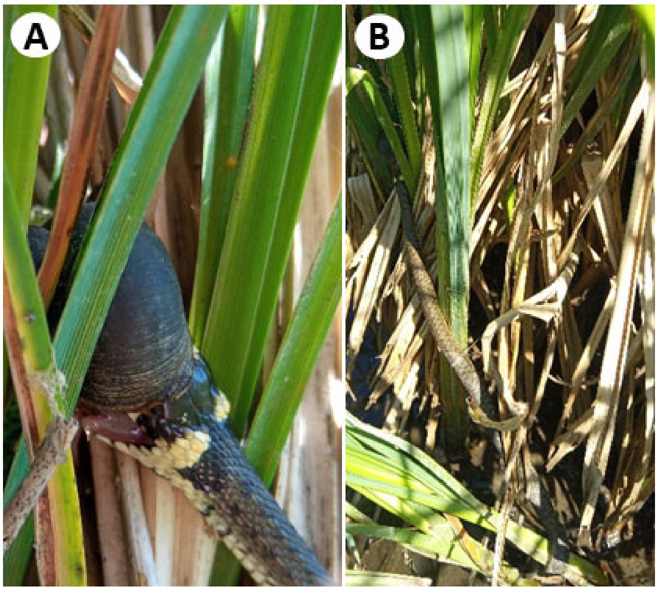

Figure 1. The position of the snake *Natrix natrix* with the snail *Viviparus contectus* during the observation - **A.** Close up, and **B.** Wider angle to show general alignment of snake to the vegetation

To the best of our knowledge, this represents the fourth documented record of *N. natrix* attempting to consume a snail (Opatrný, 1960; Consul, 2009; Zimić & Klisura, 2016). The first published account (Opatrný, 1960) describes a preserved dead specimen of *N. natrix* with a permanently clinched upper jaw in a body of an aquatic snail *P. corneus* from the collection of the Charles University, Prague. The shell of the snail covers the eyes of the snake meanwhile the snake’s glottis is protruded. There is an assumption that after biting the snail, the snake lost its orientation, and this led to drowning (Opatrný, 1960). Subsequent observations detail two successful instances of at least partial consumption of a *P. corneus*. The authors of these observations noted that during ingestion, the snake’s eyes were covered by the shell, significantly limiting its sight, and so rendering these individuals vulnerable to predators (Consul, 2009; Zimić &

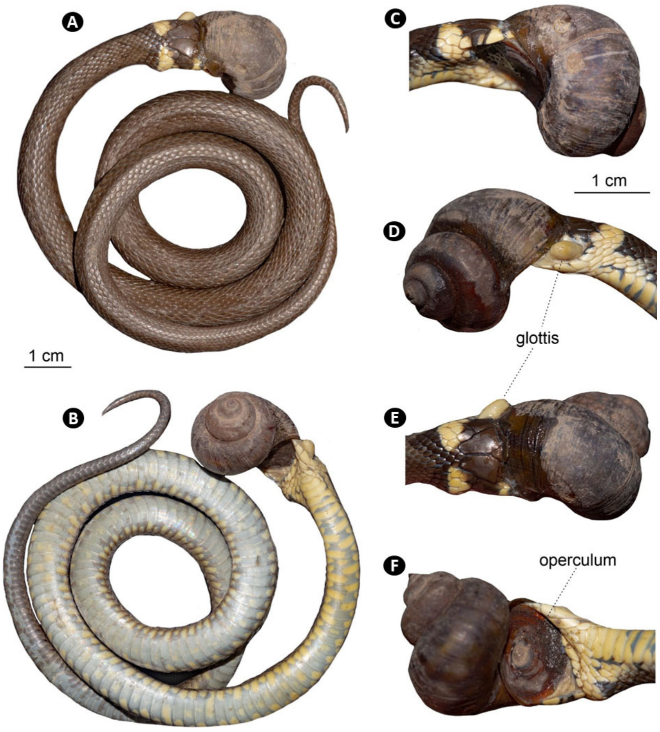

Figure 2. The dead specimen of *Natrix natrix* with its head trapped between the shell and operculum of the aquatic snail *Viviparus contectus*, found in Pustý Mlyn at Rudava River, Slovakia- **A.** to **F.** The same specimens from a variety of angles

Klisura, 2016). The first documented record (Opatrný, 1960) of *N. natrix* attempting to consume a snail mentions that the snake is a medium-sized individual whereas the other three discoveries (Consul, 2009; Zimić & Klisura, 2016), including our observation, the snakes were subadults. There might be a relationship between the snakes' age in these observations; this has been suggested by other authors (Christopoulos & Kotselis, 2023).

Even though four groups of snakes are specialist feeders on snails (Sazima, 1989; Hoso & Hori, 2006), previous records and our own observation suggest that non-malacophagous snake species are typically exposed to danger when attempting to feed on a snail. This assertion is supported by the documented case of an individual from another natricid snake species, *Amphiesma stolatum*, whose lower jaw became trapped between the shell and operculum of a *Pila* sp. snail (Sing & Purkayastha, 2023). On the other hand, there is a finding which indicates that slugs might be commonly predated by *Zamenis situla* (Christopoulos & Kotselis, 2023).

While our observation is not the first case of a snake trapped by a snail, to the best of our knowledge it is the first record of *N. natrix* attempting to consume a snail with an operculum.

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NATURAL HISTORY NOTE

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Yellowish instead of green - A case of leucism in the Italian pool frog *Pelophylax bergeri*

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We present here the first documented case of leucism in the Italian pool frog *Pelophylax bergeri*. Leucism is a pigmentary anomaly similar to albinism and involves partial or total absence of integumentary pigmentation giving an individual a whitish to yellowish appearance (Duellman & Trueb, 1994; Henle et al., 2017). However animals with leucism are characterised by eyes with normal iris rather than red or pink of those with albinism.

During field investigations carried out for a monitoring survey on the herpetological fauna of the Sirente Massif (Abruzzo, central Italy) one leucistic female *Pelophylax bergeri* was found on 28 September 2023 in a large drinking trough fed by a spring located at 1355 m a.s.l., in the municipality of Secinaro (Province of L'Aquila, Abruzzo, central Italy). Integumentary pigment of this individual was completely lacking on body, head and limbs (Fig. 1A). The head and dorsal side were light yellow, the ventral side white. The iris was dark. The individual was active and appeared in good health. In the same drinking trough and on the same date 18 normally pigmented individuals (10 males, 8 females) were observed (Fig. 1B). After collecting, all individuals were sexed, photographed and released in the same collection place.

Pelophylax bergeri is native to peninsular Italy, Sicily, Corsica and Elba Island (Capula et al., 2007; Dufresnes et al., 2016; Di Nicola et al., 2019). This species belongs to a sinklepton, i.e. a particular species group composed by two closely related taxa from the genetic point of view, one of which (*P. bergeri*) is the parent species, and the other (*P.* kl. *hispanicus*) is the hybridogenetic hybrid or klepton hybrid (Dubois & Ohler, 1994; Günther & Plötner, 1994; Capula et al., 2007; Dubey & Dufresnes, 2017). The genetic makeup of the Italian hybridogenetic hybrids has recently been analysed and a new endemic lineage of eastern-Mediterranean origin as one parental ancestor of *P.* kl. *hispanicus* identified. Apparently, this ancestor "is nowadays extinct in the wild but its germline subsists through its hybridogenetic descendant (*P*. kl. *hispanicus*), which can thus be considered as a semi living fossil" (Dubey & Dufresnes, 2017). *Pelophylax bergeri* and *P.* kl. *hispanicus* are morphologically and chromatically very similar (Capula et al., 2007) and they often coexist in the same habitat (Capula et al., 2007; Di Nicola et al., 2019).

To date cases of partial or complete albinism and leucism within the European frogs of the genus *Pelophylax* have been documented for tadpoles and adults of *P. epeiroticus, P.* kl. *esculentus*, *P. kurtmuelleri, P. lessonae, P. perezi* and *P. ridibundus* (see Dubois, 1979; Meyer & Grosse, 1997; Pabijan et al., 2004; Monzò & Navarro-Lozano, 2021). Thus to our knowledge the case we report here is the first documented record of leucism for *P. bergeri*.

Figure 1. Adults *Pelophylax bergeri* from the drinking trough in the municipality of Secinaro (Province of L'Aquila, Abruzzo, central Italy) - **A.** Leucistic female, **B.** Normal pigmented female

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NATURAL HISTORY NOTE

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Wasp spider *Argiope bruennichi* preys on a juvenile viviparous lizard *Zootoca vivipara*

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Predation is the primary cause of death among lizards (Vitt & Caldwell, 2014); they fall prey to certain species of both vertebrates and invertebrates (Jehle et al., 1996; Valdez, 2020; Nyffeler & Gibbons, 2022). In the case of invertebrate predators, they generally target juvenile lizards and/or those with small body sizes (Vitt & Caldwell, 2014). In the case of wasp spiders (*Argiope* spp.), small lizards are considered rare and unusual prey (de Armas & Alayón, 1987; Pantoja & Pinya, 2020; Turner, 2018).

Zootoca vivipara (Lichtenstein, 1823) is a widely distributed Eurasian lizard that is commonly found in a wide range of habitats. The viviparous lizard's diet consists mainly of small invertebrates (Speybroeck, 2018). The wasp spider *Argiope bruennichi* (Scopoli, 1772) is a widely distributed species found in most of Europe and central to east Asia (WSC, 2024). It inhabits various grassland habitats, building a typical orb web with a centrum stabilimentum among herb vegetation, usually near the ground. *Argiope bruennichi* is a generalist predator, with insects, mainly grasshoppers (Pasquet, 1984), being its usual prey.

On 17 August 2020, we observed the body of a juvenile *Z. vivipara*, poorly enveloped in silk, in the web of a wasp spider; the female spider was at the edge of the web feeding on the lizard (Fig. 1). We did not observe the capture of the lizard but did watch the spider for several minutes in which time it was biting various parts of the lizard's body, especially the tail, and feeding on it. The observation was made at Natural Reserve Baroch (50° 5'39" N, 15° 46'56" E; 225 m a.s.l.) in the eastern Bohemia region, Czechia. The locality consists of wetlands with reed growth, wet meadows and remnants of old ponds.

Possibly the first record of juvenile *Z. vivipara* as prey of *A. bruennichi* was a photograph of the lizard in the spider's web in Great Britain (Mayer, 2014); the wasp spider is a recent introduction to Great Britain. In Ireland, the non-native spider *Steatoda nobilis* has been observed predating a juvenile *Z. vivipara* (Dunbar et al., 2018). In this case, the body of the lizard was densely wrapped in silk with the limbs aligned along the anterior to posterior axis of the body, suggesting that the spider actively wrapped the lizard in silk with the intent to trap it. In the case we have observed, it cannot be definitively concluded whether the spider actively trapped and killed a healthy lizard or was presented with an already weakened, possibly dead, lizard.

Figure 1. Female wasp spider *Argiope bruennichi* feeding on juvenile viviparous lizard *Zootoca vivipara*

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NATURAL HISTORY NOTE

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First record of Caucasian smooth newt *Lissotriton lantzi* from Iran

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The Caucasian smooth newt *Lissotriton lantzi* (Wolterstorff, 1914), inhabits Russia, Azarbijan, Armenia, South Ossetia, Abkhazia, Georgia and Turkey (Skorinov et al., 2014). Herein we report the presence of this species in northern Iran, which is the first record in the country. Prior to this report, six urodeles species belonging to four genera were known from Iran (Safaei-Mahroo et al., 2023).

On 4 April 2023 the first record of this newt was of a live juvenile specimen on the roadside in Astaneh-ye Ashrafiyeh city, Gilan province (37° 15’29.2” N, 49° 57’11.4” E) made by the first author. Then seven months later, on 22 October 2023, we found six adults at the same location (Fig. 1). This locality is approximately 180 km from the nearest records in Azerbaijan (Fig. 2). Using published distribution data and images (Skorinov et al., 2014; 2022) we identified the newts as *Lissotriton lantzi*, which was confirmed from photographs by Barbod Safaei-Mahroo of the Pars Herpetologists Institute, Iran. Two specimens have been deposited at the Museum of Biodiversity of the Environment Department of Iran (MMTT.Z.A.AMP.0000898 & MMTT.Z.AMP.0000899).

Figure 1. Female Caucasian smooth newt *Lissotriton lantzi* from northern Iran

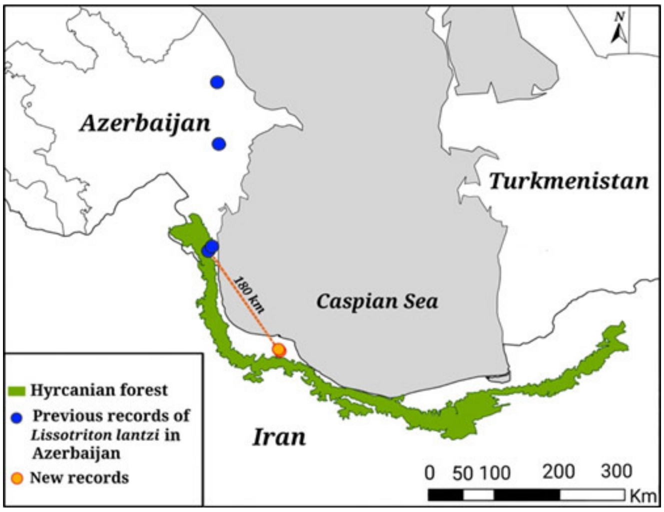

Figure 2. Known distribution of *Lissotriton lantzi*, blue circles - previous records, red circle - new record in Gilan province Iran

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NATURAL HISTORY NOTE

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Congenital bilateral pseudobuphthalmos in the dice snake *Natrix tessellata*

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The dice snake *Natrix tessellata* (Laurneti, 1768) has a wide distribution from central and southern Europe eastward to China, across countries of the Middle East, Iran, Russia, and Central Asia. On 4 July 2023, in relation to research on snake reproductive biology, we caught ten gravid female *N. tessellata* from the northern-most population of the species (53° 21’51.5” N, 49° 12’59.0” E, WGS84; Samara Region, Russia). The individuals were temporarily kept in the laboratory until the eggs were laid. Between 7 July and 13 July, a total of 139 eggs were laid by the snakes, after which the snakes were returned to their capture sites. The eggs were then incubated following an established protocol (Eplanova & Klenina, 2013) at an average temperature of 29.5 ± 0.5 °C. Hatching occurred between 10–16 August, with an incubation period ranging from 25 to 34 days. Out of the 139 newborns hatched, one neonate (0.7%) was born with abnormally enlarged eyes (Fig. 1). The diameter of the spectacle of the right and left eyes was 4.91 mm and 4.90 mm respectively. The eye size of one of the siblings without the anomaly was 2.10 mm. Its upper jaw was deformed due to severe distention of the sub-spectacular space and was not completely covered by the lower jaw at the edges (Fig. 1B). The remaining individuals had no congenital deviations, except for a few cases of scale abnormalities.

The possible cause of this eye malformation may be a congenital blockage of the lacrimal duct resulting in development of pseudobuphthalmos, also known as bullous spectaculopathy (Millichamp, 2022; Hellebuyck & Vilanova, 2023). This condition is usually observed in neonates (Hellebuyck & Vilanova, 2023). In snakes, the sub-spectacular space contains secretion produced by the Harderian gland inside the eye orbit. The fluid in the sub-spectacular space is drained into the mouth through the lacrimal ducts. In case of the lacrimal drainage obstruction the fluid from the gland will accumulate in the sub-spectacular space, causing the spectacle to bulge and distend away from the eye (Millichamp, 2022). The spectacle is shed at regular intervals during normal ecdysis and in some cases pseudobuphthalmos resolves at the time of ecdysis (Millichamp, 2022).

The reported neonate specimen shed its skin three times: shortly after hatching, and then again at three and five months old. After the second ecdysis the pseudobuphthalmos was resolved on the left side but developed again in five days. With the third ecdysis the condition resolved bilaterally, but spectacles were left dented (Fig. 1D) along with the facial deformations and recurrent accumulation of fluid with time. The eyes under spectacles were of normal size. Recurrence in the development of pseudobuphthalmos is a sign of permanent obstruction of lacrimal duct drainage (Millichamp, 2022).

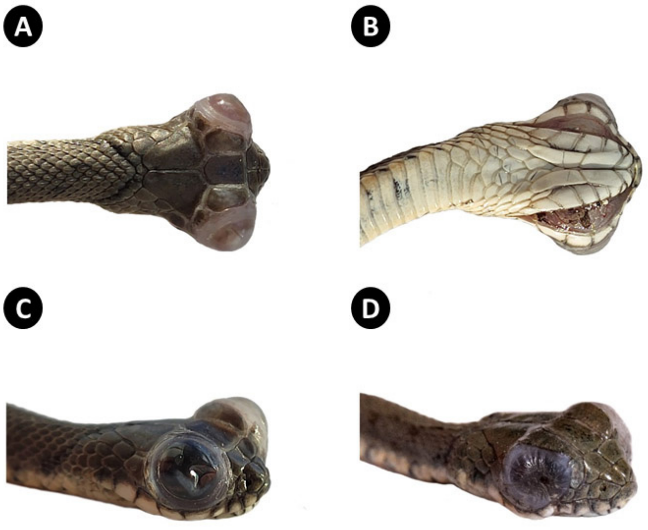

Figure 1. Neonate dice snake *Natrix tessellata* with congenital bilateral pseudobuphthalmos possibly associated with developmental abnormalities in the lacrimal duct **A.** Dorsal view, **B.** Ventral view, **C.** Lateral view, **D.** Later view after ecdysis

There are reports of up to 60% of newborns from a single clutch being affected by pseudobuphthalmos, for example in the Malayan pit viper *Calloselasma rhodostoma* (Hellebuyck & Vilanova, 2023). Cases of congenital pseudobuphthalmos have also been reported in Dumeril’s boa *Acrantophis dumerili*, *Boa constrictor*, corn snake *Pantherophis guttatus* and Mexican black milksnake *Lampropeltis nigritus*. In oviparous species, such as *N. tessellata*, the completion of embryonic development depends, in part, on the interplay between genetic factors and environmental conditions, which could lead to congenital malformations that are mostly incompatible with life (Martín-del-Campo et al., 2021). The clutch from which the discussed individual hatched was laid by the female after being maintained in a terrarium for six days. The egg laying date fits within published limits for the species in this area (Klenina, 2015). The temperature was the same for all ten clutches obtained (or for all 139 eggs), and a such pronounced deviation appeared in only a single individual (0.7%). Thus, we argue that the incubation temperature is very unlikely to have led to the development of this defect.

The spectacle covering the eye plays a crucial role in the quality of snake vision (Millichamp, 2022) implying that the vision of the specimen was heavily disturbed. The neonate was also unable to dive underwater and could not feed itself. It is obvious that this individual would not have survived in the wild and would instead require captive care and artificial feeding.

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BOOK REVIEW

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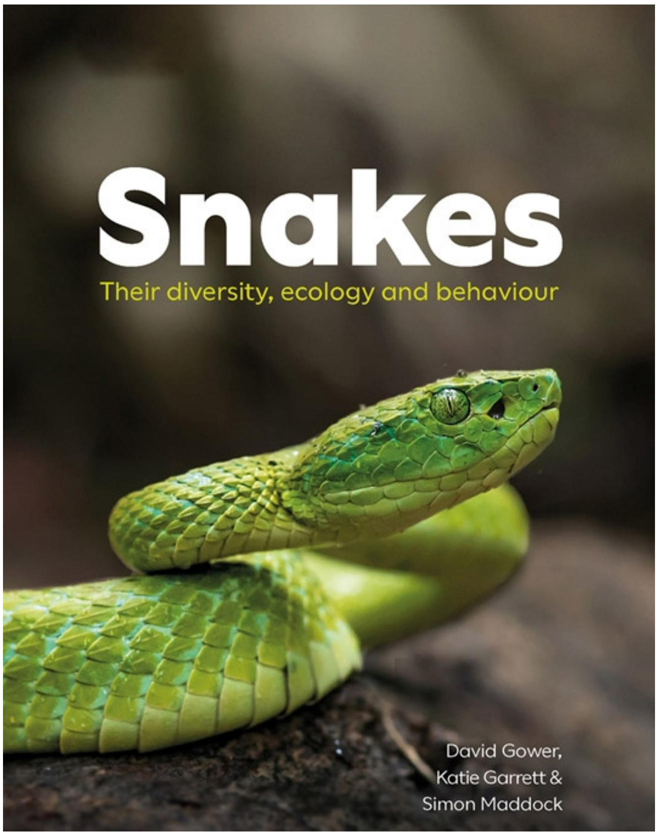
Snakes: Their diversity, ecology and behaviour

David Gower, Katie Garrett & Simon Maddock
Natural History Museum, 2023.
ISBN 978-0-565-09550-5, 192 pp.



The Natural History Museum has a rich history of publishing books on all topics of life on Earth, both past and present. Some subjects are easier to write about than others, with snakes (ophidians) presenting a challenge when it comes to writing a text for the general reader that is engaging, well informed, and matching the quality of well-established authors. The first of many such publications produced by the Natural History Museum was by Parker (1965) titled 'Natural History of Snakes', which was quite technical – perhaps a sign of the time. This was then revised in the mid-1970s to include a number of new diagrams, with changes to the text to make it less technical (Parker & Grandison, 1977). From the new millennium onwards, the Museum has published a new lineage of books focused on snakes that with each updated issue has been more accessible to the general reader (as detailed below).

The first book in this new lineage, was 'Snakes' authored by Stafford (2000), a former Editor of The Herpetological Bulletin. This book demonstrates a change of pace from its predecessors with plentiful colour photos, illustrations, information boxes, and information that is not too technical, making it easy for the general reader to understand. Two additional resources were provided to give readers more information - a glossary of terms used throughout and a list of relevant internet websites. Following Stafford's untimely death in 2009, an updated edition of 'Snakes' was published posthumously in 2012, building on the themes that made the original so successful (Stafford et al., 2012). Fast-forward to current times, and the authors have produced a modern synthesis of our understanding of ophidians, which is also reflected in the updated title. Since Parker's original publication, we are aware of a much larger number of snake species due to advances in systematics, technological advances have revolutionised our understanding of snake ecology, and advances in analytical methodology mean that we now know much more about snake venom. This growing base of knowledge is evident by the increased page count of subsequent iterations and the content within, with the most recent being more than twice the length of the original.

Chapter 1 focuses on the structure of snakes and their lifestyle, with various sub-sections on topics ranging to their anatomy, evolution, and senses. All of these are important for helping to set the scene and build a picture of snake ecology and behaviour. This information, whilst complex at times, is laid out in an easy-to-follow manner and copiously illustrated with relevant photographs. It is very clear that each of the images used throughout the book was carefully chosen to ensure that they helped to convey the correct message, and reinforced or highlighted what is mentioned in the text.

Chapter 2 is a lot shorter than the previous one, only four pages long, but it has the complicated task of trying to provide an accessible explanation of snake classification while also providing a detailed evolutionary tree. The authors also inform the reader that the current understanding of snake evolution is likely to change as new evidence is presented. I am impressed by the way that the authors have tackled this task, and also guide the reader so that they are able to read a cladogram and understand evolutionary relationships for themselves. This is no easy feat and it will certainly be a part of the book that I refer back to in the future, as long as snake systematics does not change too drastically over the coming years.

Chapter 3 constitutes the majority of the book, with a family-by-family breakdown of snakes, following the order of the cladogram introduced in the previous chapter. This is an ingenious way of providing such information, and reinforces the facts that have already been presented. There are also additional info boxes that provide the reader with more details on the ecology and behaviour of ophidians in the relevant sections, such as egg-eating snakes and convergent evolution, with relevant information in the main text too. Depending on the family or subfamily, there are multiple examples of species within, including a number of photographs and skull diagrams. Twinned with informative text, this chapter displays the authors' knowledge and writing abilities, which leaves the reader wanting to know more about each of the snake species featured.

At the back of the book is a comprehensive glossary that makes this book more accessible to the general reader. There are also further reading recommendations covering many aspects of snake biology, some of which were not covered within. Finally, there are a handful of key internet resources for intrepid readers who may be looking for something slightly more advanced.

To my mind, there should have been a fourth chapter, dedicated to the threats and conservation of snakes globally. There are small amounts of information throughout relating to snake harvesting and emerging infectious diseases within appropriate info boxes, but there is a lack of information related to threats such as climate change or habitat loss, at the broader scale, with information only relating to specific examples such as the Round Island boa *Casarea dussumieri* and Antiguan racer *Alsophis antiguae*. Given that the Natural History Museum prides itself on education, they missed a great opportunity to highlight the current conservation status of snakes globally and what is being done by various researchers and conservation organisations to prevent their extinction.

While this book may be aimed at the more general reader, there is information within that will be useful for most herpetologists. At a retail price of £14.99 for a paperback (23 x 17.3 cm in size), it is a quality publication with an affordable price.

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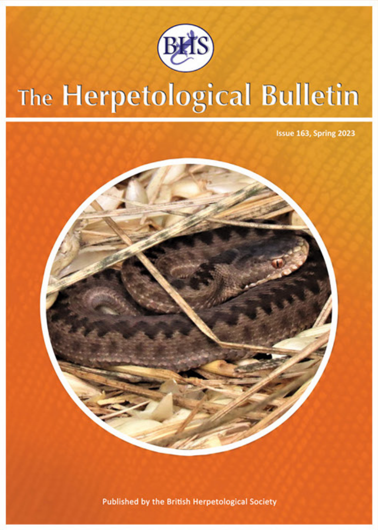

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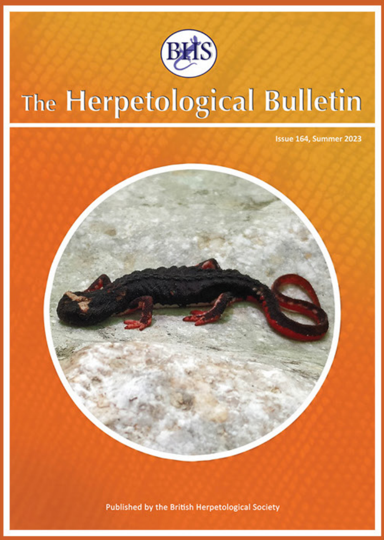

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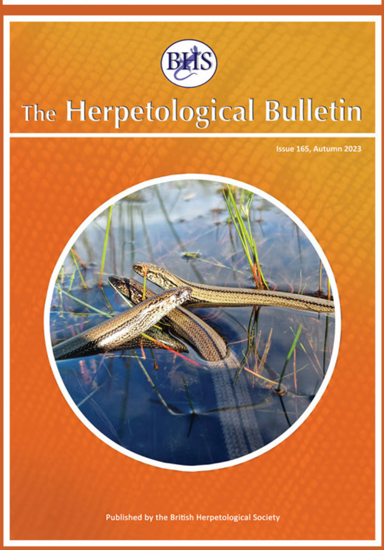

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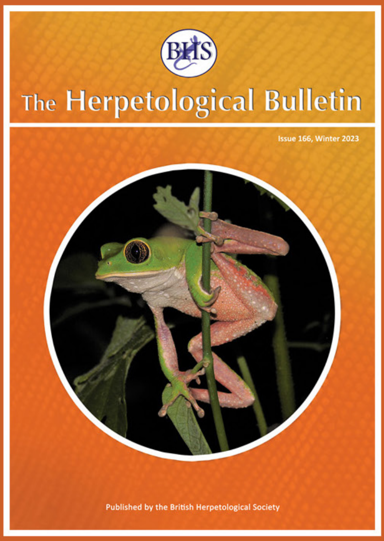

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