The
HERPETOLOGICAL BULLETIN

Number 113 – Autumn 2010

THE HERPETOLOGICAL BULLETIN

Contents

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Front cover illustration. *Typhlonectes natans* © Ben Tapley. See article on page 23.

BRITISH HERPETOLOGICAL SOCIETY COUNCIL 2010/2011

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EVOLUTION OF BIPARENTAL CARE AND MONOGAMY IN AN AMPHIBIAN.

American biologists have discovered in Peru the first confirmed species of monogamous amphibian. *Ranitomeya imitator*, better known as the mimic poison frog, has provided groundbreaking insight into the ecological factors that influence mating behaviour. The scientists' work may be the most solid evidence yet that monogamy can have a single ecological cause.

Analyzing data on 404 frog species the authors found a strong association between the use of small pools for breeding and the evolution of parental care, including intensive parental care involving egg-feeding and the participation of both parents.

To test their theory, scientists moved tadpoles from both species into differently sized pools. Tadpoles in larger pools thrived while tadpoles in smaller pools did not grow. This, the authors believed, signalled that tadpoles living in the larger, more nutrient-rich pools did not need the work of two parents as much as their smallerpond counterparts. Species that raised tadpoles in smaller ponds were more likely to require the skills of both parents. The researchers used genetic analyses based on techniques similar to the DNA-based forensic methods used in human paternity cases to investigate the mating system of the mimic poison frog. Surprisingly, all but one of the families investigated were the offspring of monogamous pairs. Many animals thought to practice

Figure 1. Left, *Ranitomeya imitator* - deposits tadpole in tiny pools and exhibits biparental care/monogamy. Right, *Ranitomeya variabilis* - deposits tadpole in larger pools with no biparental care/monogamy. © Jason L. Brown.

The researchers then focused on the mating and parenting habits of two similar frog species which breed in pools of different sizes; the mimic poison frog *Ranitomeya imitator* and the variable poison frog *Ranitomeya variabilis* (Fig. 1). The researchers theorized that the differences in parental care and mating system between these otherwise similar species stemmed from the availability of resources in the breeding pools. The tadpole of the mimic poison frog grows in much small, nutrient poor water pools that form in the folds of tree leaves. Tadpoles are ferried there after hatching by males, who monitor them in the months following birth. About once a week, the male calls for his female partner, who lays non fertile eggs for the tadpoles to eat. The variable poison frog, however, raises its tadpoles in larger pools.

monogamy have been found through genetic testing to be less faithful than previously believed. Monogamy is relatively rare in any animal so finding a frog that has a monogamous mating system is notable. The authors' work has already attracted attention from scientific and popular media at an international level. While the idea that ecological factors like scarcity of resources have contributed to monogamous behaviour in humans and other animals is well accepted, the authors cautioned against drawing inferences about human behaviour from the findings.

Brown, J.L., Morales, V. & Summers, K. (2010). A key ecological trait drove the evolution of biparental care and monogamy in an amphibian. *Am. Nat.* **175**, 436-446.

NOVEL PROTEINS IDENTIFIED FROM KING COBRA VENOM.

Snake venoms contain a rich cocktail of pharmacologically active peptides and proteins that have contributed greatly to scientific advances. The authors of this paper have now added another member to a class of valuable peptides, providing a detailed structural and functional characterisation of a novel neurotoxin from the venom of the king cobra. Their 1.5-Å crystal structure revealed that the new toxin, haditoxin, exists as a homodimer, similar to the k-neurotoxin family. Interestingly, however, themonomeric subunits of haditoxin, which consist of a three-finger protein fold, closely resemble shortchain a-neurotoxins, unlike k-neurotoxin monomers, which resemble longchain a-neurotoxins. Perhaps more interestingly, while haditoxin could antagonise several classes of nicotinic acetylcholine receptors (nAChRs) in neurons and muscle, its greatest potency is against a7-nAChRs, which are recognised by neither shortchain a-neurotoxins nor k-neurotoxins.

Haditoxin is structurally unique and therefore expected to have unique pharmacological properties. The toxin is like a conjoined twin. It has a relatively large complex made up of two identical protein molecules. The three-finger toxins display diverse biological actions on the human nervous system, cardiovascular system and blood clotting. Some have directly led to the development of compounds with potent analgesic and blood pressure reducing properties so it is likely that haditoxin in its 'conjoined twin' state or as individual components could offer novel uses.

Researchers have been studying king cobra venom for over 50 years and yet are still identifying new compounds. It is a complex cocktail of biological molecules that can change composition depending on the environment, season or even the snake's diet. The venom primarily acts on neurotransmitter receptors which regulate communication between nerve cells or between nerves and muscles, resulting in symptoms such as paralysis and respiratory failure. The worldwide burden of snakebite is high with up to 125,000 deaths each year, and significant public health costs associated with snakebite treatment.

While not every new toxin will convert directly into a clinically useful drug, there is potential for haditoxin to be a lead compound or template from which to design other drugs. Haditoxin may also be useful as a 'molecular probe' which will help studies of neurotransmitter receptors and their role in disease. These receptors are also important in neurodegenerative conditions such as Alzheimer's and Parkinson's diseases as well as in schizophrenia, anxiety and depressive disorders and nicotine addiction.

The haditoxin research was conducted by an international team from the National University of Singapore, Griffith University and University of Geneva.

Roy, A., Zhou, X., Chong, M.Z., D'hoedt, D., Foo, C.S., Rajagopalan, N., Nirthanan, S., Bertrand, D., Sivaraman, J. & Kini, R.M. (2010). Structural and functional characterization of a novel homodimeric three-finger neurotoxin from the venom of *Ophiophagus hannah* (king cobra). *J. Biol. Chem.* **285**, 8302-8315.

MOLECULAR INVESTIGATION OF INFRA-RED DETECTION BY SNAKES.

Snakes possess a unique sensory system for detecting infrared radiation, enabling them to generate a 'thermal image' of predators or prey. Infrared signals are initially received by the pit organ, a highly specialised facial structure that is innervated by nerve fibres of the somatosensory system (Fig. 1.). How this organ detects and transduces infrared signals into nerve impulses is not known. In this article the authors use a technique called transcriptional profiling to identify infrared receptors on sensory nerve fibres that innervate the pit organ. These nerve fibres (called Transient Receptor Potential Channels from pit-bearing snakes (vipers, pythons and boas) are the most heat-sensitive vertebrate ion channels thus far identified, a factor consistent with their role as primary transducers of infrared stimuli. Thus, snakes detect infrared signals through a mechanism involving radiant heating of

the pit organ, rather than photochemical transduction. These findings illustrate the broad evolutionary tuning of transient receptor potential channels as thermosensors in the vertebrate nervous system.

Gracheva, E.O., Ingolia, N.T., Kelly, Y.M., Cordero-Morales, J.F., Hollopeter, G., Chesler, A.T., Sánchez, E.E., Perez, J.C., Weissman, J.S. & Julius, D. (2010). Molecular basis of infrared detection by snakes. *Nature* **464**, 1006-1011.

Figure 1. Anatomy of the pit organ. © Wikimedia.

POPULATION AND AGE STRUCTURE OF PALMATE NEWTS.

Studies of urodele newts in Europe are common but not a huge amount of literature exists on population and longevity in smaller bodied newt species. In this study the authors used capture-recapture techniques and skeletochronological analysis to investigate body size, population size, and age structure of a population of palmate newts (*Lissotriton helveticus*) living in two adjacent lakes at 2,300 m in Andorra (Eastern Pyrenees).

They found that females were larger than males and heavier. The total adult population of the two lakes was estimated to be between 338 and 245 individuals. A number of population tests were performed. The study ascertained that both sexes matured in three years with males living for nine years and females up to eight years. There were no differences in age structure in the sexes. Inter-population differences in demographic traits between the population studied and low altitude populations of *L. helveticus* did not result in the predicted pattern of delayed sexual maturity and greater longevity that would typically be expected in higher altitude populations. To explain this complex and unexpected demographic pattern, the authors suggest that a differential effect of competition and predation exists along the altitudinal range of these populations. Competition for trophic resources in communities of aquatic newts is important at an intraspecific level because newt species have evolutionary strategies that reduce the interspecific competition (e.g. microhabitat use and body size. The study suggested that in communities consisting of two or three species of aquatic newts there was a gradual reduction of interspecific competition from low to mid-altitude populations.

Amat, F., Oromi, N. & Sanuy, D. (2010). Body size, population size, and age structure of adult palmate newts (*Lissotriton helveticus*) in Pyrenean Lakes. *J. Herpetol.* **44** (2), 314-320.

Figure 1. Male *Lissotriton helveticus*. © James K. Lindsey.

RESEARCH ARTICLES

Geographic distribution and parturition of *Mabuya arajara* Rebouças-Spieker, 1981 (Squamata, Sauria, Scincidae) from Ceará, northeastern Brazil

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ABSTRACT - *Mabuya arajara* Rebouças-Spieker, 1981 has been considered an endemic species from the southern of state of Ceará, restricted to the Deciduous Dry Forests in the slopes of Plateau of Araripe (Chapada do Araripe). Here, we present an updated distributional map for the species and demonstrate that its range is not restricted as formerly believed. In addition, we had an opportunity to observe a gravid female and we describe aspects regarding parturition and number of offspring for the species.

THE skinks of genus *Mabuya* Fitzinger, 1826 comprise 33 species (Uetz et al., 2009), 13 of which are distributed within Brazilian territory (Bérnils, 2009). In northeastern Brazil, five species *Mabuya agmosticha* Rodrigues, 2000, *Mabuya arajara* Rebouças-Spieker, 1981, *Mabuya heathi* Schmidt & Inger, 1951, *Mabuya macrorhyncha* Hoge, 1947, and *Mabuya nigropunctata* (Spix, 1825) are recorded in the Caatinga and/or Atlantic Rain Forest Biomes (Rodrigues, 2000). The taxonomy of the genus is poorly known, sometimes ambiguous, and there is a need for a major taxonomic revision (Avila-Pires, 1995; Rodrigues, 2000).

The South and Central American species of *Mabuya* have an interesting reproductive biology. They are lecithotrophic viviparous lizards that present certain similarities to therian mammals in terms of placental structure and function (Blackburn & Vitt, 1992). Studies of the reproductive biology of a few Brazilian species of *Mabuya* have been conducted in the last four decades, and information is available for *Mabuya agilis* (Rocha & Vrcibradic, 1999; Rocha et al., 2002), *Mabuya*

caissara (Vanzolini & Rebouças-Spieker, 1976), *Mabuya dorsivittata* (Vrcibradic, 2001), *Mabuya frenata* (Vrcibradic & Rocha, 1998), *Mabuya heathi* (Vitt & Blackburn, 1983; Blackburn & Vitt, 1992, 2002), *Mabuya macrorhyncha* (Rocha et al., 2002), and *Mabuya nigropunctata* (Vitt & Blackburn, 1991; Blackburn & Vitt, 1992). *Mabuya arajara* is placed in a large species group with a normal snout, paired frontoparietals, and no vertebral stripes on the body (Rodrigues, 2000). It is considered closely related to *M. nigropunctata* (sensu Avila-Pires, 1995), with the main difference between them being colour pattern. In *Mabuya arajara*, the dark lateral stripe begins in the loreal region and starts to fade away in the middle of the body. The white dorsolateral stripe, which begins in the superciliaries, dwindles behind the arm. In *M. nigropunctata*, both stripes are well defined and marked all over the body, reaching the tail (Rebouças-Spieker, 1981).

Mabuya arajara is the least known species of the group; it was described based on specimens collected from a single locality, the district of Arajara, municipality of Barbalha, southern of state

of Ceará. No ecological data or new distributional records are known for the species and it is considered endemic to the locality. Therefore, in order to cover gaps in information we present an updated distribution map for *Mabuya arajara*, and describe the parturition process and offspring size for the first time.

METHODS AND MATERIALS

During October 2005 and May 2009, we carried out field trips in several localities in the state of Ceará in order to find new records of occurrence for *M. arajara*. Specimens were obtained through time constrained searches (Campbell & Christman, 1982) and opportunistic encounters. Effort was concentrated on mountainous areas (120-950 m ASL) as there is no indication that this species occurs in open areas from lowlands. To create a distribution map for *M. arajara* we compiled our data with that available in literature. The map was constructed using the DIVA -GIS software (www.diva-gis.org) (Hijmans et al., 2002). In order to find possible relationships between the occurrences of the species and altitude, we incorporated an altitudinal layer of 2.5 miles (ca. 5 km) of spatial resolution in the final map. For each specimen we recorded data on type of substrate, typography, geographical coordinates and altitude. Geographical coordinates and altitude were obtained with a portable GPS Garmin Etrex Legend ®.

Parturition events were observed from a pregnant female found during a field trip. The specimen was kept in a terrarium covered with a layer of sediment and leaf litter to simulate natural conditions. The air temperature was not controlled. The female was fed with crickets and mealworms, and monitored daily until the newborns' birth. Body measurements of the pregnant female and her neonates were taken with the aid of a digital caliper (scale graduation = 0.01 mm), and body weight was obtained with a digital balance (scale graduation = 0.01 g).

Collecting permits were authorized by Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) (Processes 16381-1 and 17400-2). Voucher specimens were deposited in Universidade Federal de Brasília Herpetological collection (CHUNB 57367, 57370), Brasília, Distrito Federal, Brazil; Universidade de Campinas Natural History Museum (ZUEC 3407), Campinas, São Paulo, Brazil.

RESULTS AND DISCUSSION

Geographic Distribution

Several expeditions were conducted in the main mountainous areas of Ceará state. The new records of occurrence for *M. arajara* were exclusively located in the northwestern and southern parts of Ceará state (Fig. 1). Descriptions for each area and for *M. arajara* records are given below. Four specimens of *M. arajara* were recorded in the Ubajara's National Park located at the municipality of Ubajara (03°49'50"S; 40°53'16"W; 390 m ASL): an adult gravid female (SVL = 91.89 mm; tail length = 123.72 mm) on 25 October 2008, kept in a terrarium to observe parturition aspects described in this study, and three adult specimens between November and December 2008. Two main habitat types were observed in this area. The first one is the Sub-evergreen Tropical Nebular Rainforest, a relictual wet forest with a canopy more than 20 m high, extending about 150 km in length, between 400 and 950 m wide, covering the eastern and northern regions of Plateau of Ibiapaba (Planalto da Ibiapaba). The second is the Deciduous Dry Forest, a forest located at low altitudes (120-450 m), exhibiting trees up to 20 m high with straight trunks and an understorey composed of small trees and short-lived bushes. All individuals were found foraging in the leaf litter in the areas of the Deciduous Dry Forest.

Two other specimens of *Mabuya arajara* were collected on 2 December 2005 in an expedition to Ubatuba hills (Serra da Ubatuba), municipality of Granja, state of Ceará (03º18'04"S; 41º08'37"W; 645 m ASL). The vegetation of the area is characterized by Deciduous Dry Forest on the slopes, with gallery forest and savannah vegetation (cerrado) in the rocky outcrops of the plateau. Individuals were found basking on the leaf litter of the Deciduous Dry Forest.

Two new distributional records were obtained in the slopes of Plateau of Araripe (Chapada do Araripe). Individuals of *Mabuya arajara* were observed in the leaf litter at the border of the Sub-

Figure 1. Current knowledge of *Mabuya arajara* range (altitudinal and geographical).

evergreen Tropical Nebular Rainforest near a stream in the locality of Granjeiro, municipality of Crato (07°16'50"S; 39°26'19"W; 708 m ASL), and in the municipality of Missão Velha in the locality of Arajara Park (07°36'17"S; 39°24'43"W; 751 m ASL). The specimens were found in the border of the relictual forest, in leaf litter and under fallen logs.

Mabuya arajara has been considered to be endemic to a very restricted distribution in the Plateau of Araripe mountain, municipality of Barbalha (Rebouças-Spieker, 1981; Borges-Nojosa & Caramaschi, 2003; Ribeiro et al., 2008). Borges-Nojosa & Cascon (2005) mentioned the presence of a similar species (*Mabuya* sp. [aff. *arajara*]) outside its known range, in the municipality of Crateús, in a Deciduous Dry Forest of the Almas hills complex (complexo Serra das Almas) (05°16'04"S; 40°54'13"W; 681 m ASL). However, based on the photograph of the individual from Almas hills (see Borges-Nojosa & Cascon [2005], p. 242), which clearly shows the typical coloration pattern of *M. arajara*, and, based on our records of lower latitudes, we can confirm the presence of the species in the area.

Therefore, considering the species presence confirmed for Almas hills and the new records for Ibiapaba Plateau complex (municipalities of Ubajara and Granja) we demonstrate *Mabuya arajara* is not endemic to Araripe Plateau. In addition, we believe the species has a high probability of occurring in the neighbouring states of Piauí and Pernambuco considering the current knowledge of its range (altitudinal and geographical) (Fig. 1).

The *Mabuya* appear to have different habitat preferences. *Mabuya arajara* prefers the Deciduous Dry Forests among ca. 350 to 700 m ASL, although it can also be found eventually in the border of the Sub-evergreen Tropical Nebular Rainforest. *Mabuya heathi* should be considered the most habitat flexible species but it is more frequently found in the steppe savannah (low altitude Caatinga). *Mabuya nigropunctata* is mainly associated with the Sub-evergreen Tropical Nebular Rainforest.

The Deciduous Dry Forests in the state of Ceará are exclusively located in areas with irregular topography, characterised by elevated humidity, low temperatures and high degree of rainfall when compared to "Caatinga *sensu strictu*" areas. These abiotic conditions seem to occur along all of *M. arajara's* distribution: the Araripe Plateau, Almas hills, and Ibiapaba Plateau complexes. In fact, these complexes are relatively interconnected, and the Poti River is the major altitudinal/fluvial barrier found in the area. Even so, there is no evidence that Poti River should be considered a barrier for any reptile species inhabiting the mountain complexes. On the other hand, there is no indication (Borges-Nojosa & Caramaschi, 2003; present study) that *M. arajara* inhabits other mountainous areas of the state of Ceará with similar altitude and physiognomy such as Maranguape hills (03°53'36"S; 38°43'26"W), Baturité hills (04°16'55"S; 38°56'46"W), Pacatuba hills (03°58'02" S; 38°38'06"W), and Uruburetama hills (03°36'25"S; 39°34'58"W). The wide track of steppe savannah (low altitude Caatinga) formation (> 100 km of extension) amidst these mountain chains (Araripe Plateau, Almas hills, and Ibiapaba Plateau) seems to be a possible reason for the species not to occur on these mountains.

According to the Vanishing Refuge Theory (Vanzolini & Williams, 1981), during the dry periods of climate cycle events the in Holocene, species from forested areas pre-adapted to live in open formations could have endured a speciation process in forest refuges. In order to corroborate this theory the authors focused mainly on *M. arajara* as the species seems to have originated *M. nigropunctata*, a species specialised to live in forested areas.

Mabuya nigropunctata occurs throughout Brazilian Amazonia, in the gallery forests of cerrado areas (Blackburn & Vitt, 1992) and in the Atlantic rain forest of northeastern Brazil, in the states of Pernambuco, Alagoas, and Ceará (Vanzolini, 1981; Borges-Nojosa & Caramaschi, 2003). This species is well adapted to living outside forested areas, occupying open spots at the edge of the forest (Vitt & Blackburn, 1991; Vanzolini, 1992; Avila-Pires, 1995). Therefore, its ecology is very similar to *M. arajara* which may have experienced an ecological reversal from the forest adapted life of its origin to life in open environments (Vanzolini, 1992) such as the Dry Deciduous Forests in the plateaus of Ibiapaba and Araripe.

Reproductive Aspects

The gravid female of *M. arajara* (91.89 mm SVL; 123.72 mm tail length) that was kept in the terrarium gave birth to four neonates on 19 November 2008 (see Table 1. for body measurements).

Newborn	Weight (g)	SVL (mm)	TL (mm)
1	0.80	33.58	39.45
2	0.79	32.85	39.54
3	0.71	32.43	40.18
4	0.82	32.02	40.36

Table 1. Weight, snout-vent length and tail length in mm, of the four neonate *Mabuya arajara* collected in the Ubajara National Park, municipality of Ubajara, state of Ceará.

During observations of the birth of one of these at 17:21 the female did not eat the embryonic membranes to help the newborn to be freed (Fig. 2). A brood size of four newborns documented by *M. arajara* seems to be very common among the South American viviparous species of *Mabuya* which can vary from 1-9 (Vanzolini & Rebouças-Spieker, 1976; Vitt & Blackburn, 1983; Vitt & Blackburn, 1991; Blackburn & Vitt, 1992; Vrcibradic & Rocha, 1998; Rocha & Vrcibradic, 1999; Vrcibradic, 2001; Rocha et al., 2002; Blackburn & Vitt, 2002). *Mabuya nigropunctata*, a closely related species to *M. arajara*, was documented to have a brood size of 2-9 embryos, with a gestation period of 10 to 12 months. The number of embryos was positively correlated with female size (Vitt & Blackburn, 1991). *Mabuya heathi*, a sympatric species to *M.*

Figure 2. The gravid female *Mabuya arajara* with neonates.

arajara, also has a brood size of 2-9 and gestation period of 8 to 12 months with parturition occurring at the end of the dry season (Vitt & Blackburn, 1983). This partuition regime seems the same for *M. arajara* in the municipality of Ubajara. One interesting aspect of the neonates was the presence of a well defined dark stripe from the snout to the tail, just like the adults of *M. nigropunctata*. It is possible that the colour pattern shifts during ontogeny and starts to fade away in adulthood. This reinforces the possible process of speciation that *M. nigropunctata* may have undergone to originate *M. arajara* - as proposed by Vanzolini & Williams (1981).

Vanzolini & Rebouças-Spieker (1976) described maternal care by a female in *M. macrorhyncha*, an aspect that was not observed for *M. arajara*. There are two possibilities to explain the difference. First, it is possible that stress induced by confined conditions in the terrarium caused the female to leave her offspring without maternal care after parturition. Second, maternal care may not constitute a characteristic in the Scincomorpha as proposed by Vanzolini & Rebouças-Spieker (1976). There is still little information about *M. arajara* ecology and future studies are necessary to further understand the reproductive biology of the species.

ACKNOWLEDGEMENTS

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Notes on the occurrence of *Riama simotera* (Squamata, Gymnophthalmidae) in Colombia

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ABSTRACT - We document for the first time the presence of *Riama simotera* in Colombia. We demonstrate that previous claims about the occurrence of this species in Colombia were based on misidentified specimens or unsubstantiated reports. The new records are from Nariño department, southwestern Colombia, close to previously known records from Ecuador.

O'SHAUGHNESSY (1879) described *Emphrassotis simoterus* on the basis of a single specimen from Intac [=Intag, Imbabura], Ecuador. Boulenger (1885) used the combination *Proctoporus simoterus* for the first time and a century later Ayala (1986) included this species in his list of the lizards of Colombia. Ayala (1986) did not cite specimens to substantiate that claim and among the collections that he listed only the Instituto de Ciencias Naturales (ICN, Universidad Nacional de Colombia) actually includes Colombian specimens of this species in its holdings. The material in all of the other collections Ayala (1986) listed corresponds to another species (SJSP, pers. obs.).

Kizirian & Coloma (1991) and Kizirian (1995) reported additional material from northern Ecuador, and Kizirian (1996) redescribed the species based on the holotype and additional specimens, most of which originate from near the border of Colombia. Kizirian (1996) stated: "all species treated herein are endemic to Ecuador except *Proctoporus simoterus*, which also occurs in Colombia but may comprise more than one species." In his list of specimens examined he did not include the Colombian material because other workers claimed to be revising the species of Colombia at that time. The revision was not published but this statement was based on three specimens (KU - University of Kansas, Museum of Natural History - 169943-45) from 8 km NE Pasto, Nariño department, Southwestern Colombia (D.A. Kizirian, pers. comm.). Finally, Doan (2003) and Doan & Castoe (2005) included the same KU specimens in the phylogenetic analysis of *Proctoporus sensu lato* and the phylogenetic taxonomy of the Cercosaurini respectively (the former including the new combination *Riama simotera*).

Because Doan (2003) recorded these specimens in her list of examined specimens, we consider this to be the actual "first record" of *Riama simotera* from Colombia. However, our examination of the only specimens associated with such claims (KU 169943-45) lead us to conclude that they represent an undescribed species (Sánchez-Pacheco & Kizirian, in prep.) that is differentiated from *R. simotera* by the following traits (condition of *R. simotera* in parentheses): superciliary series incomplete (complete), postparietals in contact

Figure 1. Dorsal (A) and ventral (B) view of a male of *Riama simotera* from Colombia (ICN 9817).

(usually separated by interparietal), dorsal scales keeled (smooth), and femoral pores per hind limb in males nine (6-7).

Specimens that we regard to be the first "true" *Riama simotera* from Colombia include (1) ICN 9818-22, collected on 16 November 1982 by José Vicente Rueda-Almonacid (JVR) at municipio de Cumbal, km 4 Cumbal-volcan Cumbal, departamento de Nariño, Colombia, 3260 m (ca. 0º 54' 40" N, 77º 47' 02" W); (2) ICN 9817 (Fig. 1), a male, collected on 16 November 1982 by JVR at municipio de Tuquerres, km 10 carretera Tuquerres-Guachucal, hacienda Alsacia, departamento de Nariño, Colombia, 3140 m (ca. 1º 04' 13.7" N, 77º 36' 49" W); and (3) Instituto Alexander von Humboldt, Colombia [formerly IND-R] 1553, a female, collected by Felipe Moran and Alirio Fajardo at municipio de Pupiales, departamento de Nariño, Colombia (ca. 0º 52' 12" N, 77º 37' 37" W) (Fig. 2). The characteristics of these specimens agree with those of *R. simotera* as detailed by Kizirian (1996). All the specimens were collected on the shoulder of an unpaved road or in open areas by day, under rocks or fallen trunks, or inside the leaves of fallen frailejones (field notes of JVR).

Figure 2. Distribution of *Riama simotera* in Colombia. Map with collection localities (black triangles). Numbers correspond to the localities referenced in the text.

Although this range extension of *R. simotera* is not unexpected, it is noteworthy because of the limited knowledge about distributional range and habitat of several congeners, and suggests that at least four species of *Riama* occur in sympatry near the Colombian-Ecuadorian border (SJSP, pers. obs.).

The re-identification of KU 169943-45 has potential consequences in *Riama systematics*. Doan (2003) used these specimens to score morphological characters for *Riama simotera* in her densely sampled phylogenetic study of *Proctoporus sensu lato*, thus morphological evidence for the relationships of *R. simotera sensu stricto* is lacking. Castoe et al. (2004) included DNA sequences of *R. simotera* in their molecular phylogenetic analysis. However, their study included only five of the 25 currently recognized species of *Riama*. Therefore, although it is possible that *R. simotera* is nested within *Riama* and the precise relationship of it within the genus remains unclear.

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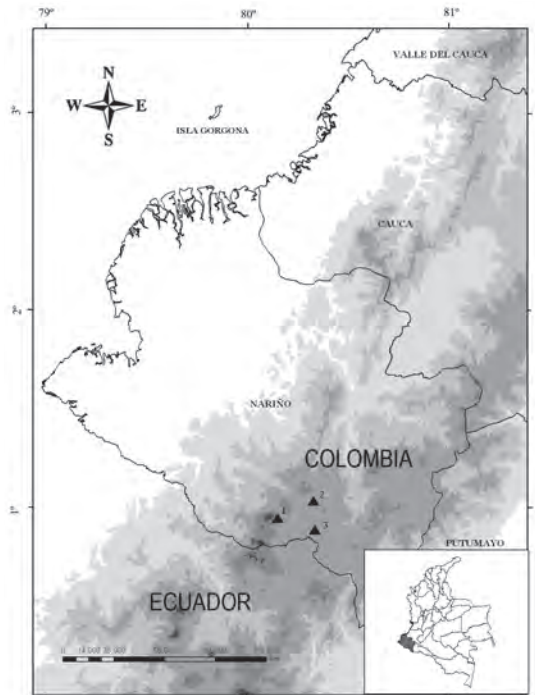Boulenger, A. (1885). *Catalogue of Lizards in the British Museum (Natural History).* 2: l-497. London: Taylor & Francis.

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APPENDIX

Specimens examined: - *Riama simotera*: ECUADOR: Carchi: 14.6 km NW El Carmelo, 3130m (KU 179478); km 13 carretera a El Carmelo, 3300m (ICN 9823-34); km 16 Tulcan-Tufiño, 3130-3160m (ICN 9835-36); 15.3 km W Tulcan on road to Tufiño, 3080m (QCAZ 915, 918; KU 217208); km 13 desvío carretera Panamericana, El Angel (ICN 9837). COLOMBIA: Nariño: municipio de Pupiales (IAvH [formerly IND-R] 1553); municipio de Tuquerres, km 10 carretera Tuquerres-Guachucal, hacienda Alsacia, 3140m (ICN 9817); municipio de Cumbal, km 4 Cumbal-volcan Cumbal, 3260m (ICN 9818-22). KU 217208. - *Riama* sp.: COLOMBIA: Nariño: 8 km NE Pasto, 3020m (KU 169943-45).

Patterns of resource use, overlap and partitioning among three sympatric species of south Indian pitvipers

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ABSTRACT - We examined resting substrate utilization, habitat occupancy, altitudinal preference, size/age class distribution and encounter rate estimates of three, sympatric pitviper species, *Hypnale hypnale*, *Trimeresurus malabaricus* and *Trimeresurus macrolepis* in the Cardamom Hills of the Western Ghats Mountain Range, southern India and found that the resource use pattern of *Trimeresurus malabaricus* overlaps with that of *Hypnale hypnale* and *Trimeresurus macrolepis*, but *Hypnale hypnale* and *Trimeresurus macrolepis* have mutually exclusive, non-overlapping resource use patterns.

PITVIPERS in southern India are found only in hilly forest tracts (Smith, 1943; Whitaker, 1978; Das, 2002; Whitaker & Captain, 2004). The work-area of our study, Cardamom Hills (09ºN 077ºE; ≈100-2020 m ASL), is situated in the Western Ghats Mountain Range of southern India (Fig. 1). Here the habitat type is correlated with altitude, with deciduous, evergreen and montane forest types occurring correspondingly in low, middle and high altitudes (Fig. 2) (Champion & Seth, 1968). Four species of pitvipers are reported here (Whitaker & Captain, 2004). Of these, *Hypnale hypnale* (Fig. 4) is a member of the *Ancistrodon* complex while, *Trimeresurus macrolepis* (Fig. 5), *T. malabaricus* (Fig. 6) and *Tropidolaemus huttoni* are members of the *Trimeresurus* complex. *Tropidolaemus huttoni* is very rare (David & Vogel, 1998) and was not recorded in this study. Barring *T. huttoni*, the remaining three common species were investigated. *Ancistrodon* (*sensu lato*) are predominantly terrestrial taxa while *Trimeresurus* (*sensu lato*) are both arboreal and terrestrial, and the habit is more or less correlated to the dorsal coloration, i.e., green ones being more arboreal while brown ones being more terrestrial (Whitaker, 1978; David & Vogel, 1998; Gumprecht et al., 2004). These three pitviper species are frequently reported to be sympatric, with dynamic relationships of co-existence (Inger et al., 1984; Aengals, 1995; Kumar et al., 2001; Kannan et al., 2006). In a few Indian pitviper species, adults and juveniles are reported to use different resting substrates (Whitaker & Captain, 2004). Species exhibiting age-based microhabitat selection are considered as two different Occupational Taxonomic Units (Brown, 1992). Limited similarities, spatial niche segregation and character displacement are demonstrated analogous to resource-heterogeneity based niche partitioning (Christiansen et al., 1980). Given this scenario, the following questions were raised.

1. Does resting substrate preference influence pitviper sympatry?
2. Does habitat type and quality affect pitviper sympatry?
3. Will altitudinal preference allow pitvipers to be sympatric? If yes, to what extent?
4. When morphology and age-class play significant roles in resting substrate preference of pitvipers, how do these variables affect them being sympatric?
5. What is the relative abundance of these pitviper species? Are they equally abundant?

MATERIALS AND METHODS

Surveys were conducted for a period of four months from December 2007 to March 2008. Visual Encounter Surveys (VES) were used to detect the presence/apparent absence of pitvipers (Crump

Figure 1. Map of southern India showing the location of the Cardomom Hills.

Figure 2. Evergreen Forest; Natural climax vegetation type.

Figure 3. Cultivated tea plantation.

Figure 4. *Hypnale hypnale* (Merrem, 1820).

Figure 5. *Trimeresurus macrolepis* Beddome, 1862.

Figure 6. *Trimeresurus malabaricus* (Jerdon, 1854).

& Scott, 1994). Possible resting substrates such as fallen logs, rocks, branches, base of trees, and leaf-litter were examined. Surveys were conducted in both riparian and non-riparian habitats between 9.00 and 13.00 hrs. Transects were of a fixed length, determined using K & R pedometer (L.C. = 250 m). The forest path transects were 1 km long and the stream transects were 0.5 km long, as streams in Western Ghats harbour twice as much habitat diversity, herpetofaunal diversity and density as non-riparian vegetation (Ganesh et al., 2007). All forest path transects were narrow footpaths, no greater than 1 m width, that were not necessarily in a straight line. Stream transects were small river courses, with maximum stream width no greater than 3 m. The vegetation type classification follows Champion & Seth (1968). The total length of the smallest female was used to determine size/age

class (Smith, 1943; Whitaker & Captain, 2004). Altitude was determined using Garmin 12 channel Global Positioning System. Encounter rate was expressed as the ratio of sighting frequency to the total distance surveyed.

RESULTS

In all, 49 sightings of pitvipers were recorded; *Hypnale hypnale* (n = 13), *Trimeresurus malabaricus* (n = 20) and *Trimeresurus macrolepis* (n = 16). The values obtained for the selected factors like resting substrate, habitat type, altitudinal range, size/age class and encounter rate estimates are shown in Table 1.

Resting Substrate
Fallen logs were mostly used by *H. hypnale* (38.4%), rocks were mostly used by *T. malabaricus*

Factors	Variables	*H. hypnale* (n = 13)	*T. malabaricus* (n = 20)	*T. macrolepis* (n = 16)
Resting Substrate	Fallen log	5*# (38.4%)	2* (10%)	0
	Rock	2* (15.3%)	11*# (55%)	0
	Branch	0	5* (25%)	16*# (100%)
	Tree base	2* (15.3%)	1* (5%)	0
	Leaf-litter	2* (15.3%)	1* (5%)	0
	Bare ground	2 (15.3%)	0	0
Habitat Type	Deciduous	6*# (46%)	3* (15%)	0
	Evergreen	4* (30.7%)	13*# (65%)	0
	Montane	0	0	7# (43.7%)
	Tea	0	0	2 (12.5%)
	Coffee	3* (23%)	3* (15%)	2* (12.5%)
	Cardamom	0	1* (5%)	5* (31.2%)
Altitude (m)	500-800	12*# (92.3%)	3* (15%)	0
	800-1000	1* (7.7%)	13*# (65%)	0
	1000-1300	0	4* (20%)	4* (25%)
	1300-1600	0	0	12# (75%)
Size/Age Class	Sub-adults	4/13; (31%)	7/20; (35%)	6/16; (37%)
	Adults	9/13; (69%)	13/20; (65%)	10/16; (63%)
	Ratio	31:69%	35:65%	37:63%
Encounter Rate Est. (km)	Paths	10/17=0.58#	6/26=0.23	13/20=0.65#
	Streams	3/8=0.38	14/13=1.07#	3/10=0.30
	Overall enc. rate	13/25=0.52	20/39=0.51	16/30=0.53

Table 1. Values of various selected factors and variables for three species of pitvipers. Numbers denote sighting frequency; * denotes overlap; # denotes maximum value.

(55%) and *T. macrolepis* exclusively used branches (100%). Overlap was observed in the resting substrate usage of *T. malabaricus* with both *H. hypnale* and *T. macrolepis*. But *H. hypnale* and *T. macrolepis* had mutually exclusive resting substrate preferences.

Habitat Type
Sighting frequencies of pitvipers were greater in pristine forests (15-65%) than in estates (5-31.2%), regardless of the species or the habitat. Deciduous and evergreen forests were occupied by *H. hypnale* and *T. malabaricus*. Montane forests and tea estates were occupied only by *T. macrolepis* (Figs. 2 and 3). Cardamom estates were occupied by *T. malabaricus* and *T. macrolepis*. Coffee estate was the only habitat occupied by all three species.

Altitude
Overlap was observed between *H. hypnale* and *T. malabaricus* in 500-1000 m and between *T. malabaricus* and *T. macrolepis* in 1000-1300 m. But there was no overlap between *H. hypnale* and *T. macrolepis*. Exclusive sightings of *T. macrolepis* were from 1300-1600 m. The altitudinal range where *T. malabaricus* was recorded (500-1300 m) also harboured the other two species.

Size/Age class
Juveniles were scarcer (31-37%) than adults (63-67%), among all three pitviper species. The least frequency of sub-adults (i.e., the highest frequency of adults) was recorded in *H. hypnale*, followed by *T. malabaricus* and *T. macrolepis*. The ratio of sighting frequencies of sub-adults: adults ranged from 31-37:63-69%.

Encounter Rate Estimates
All the species were uniformly sampled, with proportionately equal number of riparian and non riparian transects surveyed. Total distance walked was comparable with respect to the number of days surveyed for all three species. Number of transects walked for each species differed due to inevitable natural constraints like correlation between habitat type and altitudinal range. Encounter rates were also comparable for all the three species (0.52, 0.51 and 0.53 respectively). Thus, a distance-coverage of two km will yield one pitviper sighting, regardless of species, habitat, elevation and size/age class in this season, in this hill range. The species will depend on the habitat and altitude.

DISCUSSION
H. hypnale is predominantly terrestrial as inferred by our study and literature records (Smith, 1943; Whitaker & Captain, 2004). Smith (1943) reported *H. hypnale* resting on shrubs but we did not observe this behaviour. We recorded *T. macrolepis* only on branches of trees and shrubs. This species is regarded as arboreal and terrestrial (Smith, 1943; Malhotra & Davis, 1991; Whitaker & Captain, 2004). Moreover, those species of pitvipers that are primarily green in colour are said to be arboreal, while the many-coloured species like the Malabar Rock Pitviper (*T. malabaricus*) are said to be terrestrial forms (Whitaker, 1978). *T. malabaricus* was more frequently sighted in riparian habitats, as inferred by our study. The frequent arboreal tendencies of juvenile *T. malabaricus* has been widely reported (Smith, 1943; Whitaker & Captain, 2004). Our observation of all six juveniles and sub-adults on shrubs is strongly supportive to literature.

We sighted *H. hypnale* in deciduous forests, *T. malabaricus* in evergreen forests and *T. macrolepis* in montane forests, the most. Whitaker (1973) and Kumar et al. (2001) stated that montane forests were preferred by *T. macrolepis*. Aengals (1995) and Malhotra & Davis (1991) recorded *T. malabaricus* and *T. macrolepis* from Valparai and Srivilliputhur hills respectively, which are primarily montane forest habitats; while Inger et al. (1984) recorded *H. hypnale* and *T. malabaricus* from Ponmudi, an evergreen forest habitat, and found both species to be more abundant in this habitat than deciduous belts. Kumar et al. (2001) recorded all three species from Anaimalai hills, which has both evergreen and montane forests.

Whitaker & Captain (2004) mention the altitudinal range of *H. hypnale* to be 300-600 m. In the present study one individual of *H. hypnale* was seen above 800 m. Thus there are good chances for it to occur sympatricly with other higher-elevation species. Whitaker & Captain (2004) states that, both *T. macrolepis* and *T. malabaricus*

occur from 610-2134 m. But in the present study, no *T. macrolepis* was recorded below 1000 m and no *T. malabaricus* was sighted above 1300 m. It is noteworthy to mention here that this survey was undertaken from 500-1600 m, in hills covered with all the three habitat types inhabited by pitvipers. In general, literature states that, higher elevation forests (> 1000 m) were often recorded to have either or both *T. macrolepis*, *T. malabaricus* (Aengals, 1995; Kumar et al., 2001; Malhotra & Davis, 1991) and lower elevation forests (< 1000 m) were reported to have either or both, *H. hypnale*, *T. malabaricus* (Inger et al., 1984; Kannan et al., 2006). However, in one instance *H. hypnale*, *T. macrolepis* and *T. malabaricus* all coexisting in the same forest has been recorded from Andiparai (1000 m), in Anaimalai hills (Kumar et al., 2001). In the present study however, we did not observe all the three species to be syntopic. This confusing state regarding altitudinal distribution of south Indian pitvipers necessitates further field studies.

We observed fewer juveniles (31-37%) than adults (63-67%) revealing an equal and homogenous recruitment of populations. Thus our data corroborates previous findings that suggest the result of high mortality in juveniles and increased life expectancy with age is that the adult populations of snakes represent the accumulation of many years' reproduction (Porter, 1972).

Our study produced equal encounter rate estimates and hence equal relative abundance (0.51-0.53 sightings per km) equating to one sighting per 2 km. The relatively lower encounter rates in anthropogenic (5-31.2%) than pristine habitats (15-65%) is in accordance with Porter (1972) who remarked that snake populations seem to be regulated by conditions of cover, food and basking sites. The high optimal conditions found in pristine conditions support higher densities and diversities of snakes than less favourable conditions, as anthropogenic pressures will degrade its abiotic and thus its biotic content.

CONCLUSION

It is well understood that, of the three species of pitvipers studied, one is terrestrial, another is arboreal and the other both terrestrial and arboreal. Thus they differed in resting substrate usage, with

a marginal overlap. It was also observed that there was an altitudinal separation in their distribution, with a marginal overlap. It is clear that all three species of pitvipers are equally abundant, as inferred from their encounter rates. Thus, theoretically these three pitviper species with different resting substrate preferences can be sympatric, although altitude is a limiting factor. They were indeed sympatric in a wider altitudinal range of 500-1300 m, the transition zone of deciduous - evergreen - montane forest types, where *T. macrolepis* was not dominant. The other two species were observed to be dominant in this altitudinal range. The sighting frequencies of the three species were relatively low in intermediary altitudinal zones where they were sympatric.

One species differed from the other two in terms of niche breadth. *T. malabaricus* is (1) both arboreal and terrestrial (vs. predominantly terrestrial *H. hypnale* and predominantly arboreal *T. macrolepis*), (2) has preference for mid-altitude zones (vs. predominantly low altitude preferring *H. hypnale* and predominantly high altitude preferring *T. macrolepis*) and (3) is primarily a riparian habitat species (vs. primarily non-riparian habitat preferring *H. hypnale* and *T. macrolepis*). Therefore *T. malabaricus* has diverged preferences thus avoiding resource-competition with *H. hypnale* and *T. macrolepis*. *H. hypnale* and *T. macrolepis*, despite being capable of occurring sympatricly with one another (due to their mutually exclusive resting substrate preferences) were observed separately because of their diverse altitudinal preferences. This was an advantage for the mid-elevation preferring *T. malabaricus*. Thus the resource use pattern of *T. malabaricus* overlaps with that of the other two species, which in turn have mutually exclusive, non-overlapping resource use patterns. This is a preliminary study and a more detailed, long-term study, involving a greater sample size of each pitviper species and increased geographical range, is needed for a better understanding of their ecology.

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Radix cf. *labiata* (Gastropoda, Lymnaeidae) as an opportunistic predator and scavenger of *Rana temporaria* egg clutches

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BROWN frogs (*Rana* spp.) are r-strategic, explosive-breeding amphibians distributed over most of Europe. They deposit characteristic egg clutches at communal breeding sites (generally ponds, temporary or permanent, and small lakes). These egg clutches face severe mortality from weather related conditions like frost and desiccation, pathogens such as *Saprolegnia*, and predation. Such factors can have further influence recruitment and sometimes induce variation in hatching time and physiological parameters (e.g., earlier hatching [Laurila et al., 2002], altered morphology in populations exposed to egg predation [Mandrillon & Saglio, 2008], and/or reduced tadpole size following egg exposure to *Saprolegnia* [Uller et al., 2009]). Communal spawning with accumulation of individual egg clutches in large masses reduces the effect of predation (Hakansson & Loman, 2004). Knowledge of the predators of brown frogs is therefore important in relation to the conservation needs of these species and to better understand their integration in local, small-scale food chains.

Various predators have been documented to feed upon the eggs of brown frogs in Europe and Romania. These include invertebrates such as free-living flatworms, leeches, crustaceans, aquatic insects and their larvae (especially caddis-fly and dipteran larvae, aquatic heteroptera and dytiscid beetles) (Laurila et al., 2002; Kwet, 1996; Wells, 2007). Vertebrates such as fishes, sometimes with tremendous impact (Leu et al., [2009]) and newts are also predators (Kwet, 1996; Sas et al., 2006, and literature quoted therein; Denoël & Demars, 2008; Iftime et al., 2009).

Freshwater snails such as *Planorbis* and *Lymnaea* – L. (*Stagnicola*) *palustris* – are sometimes recorded as predators of amphibian eggs (Kwet, 1996; Kuzmin, 1999, reviewed in Wells, 2007) and sometimes as competitors for tadpoles of brown frogs (Brönmark et al., 1991). They, like all known predators of European brown frog eggs, are not specialized for this type of alimentation but consume frog eggs occasionally and opportunistically (Wells, 2007).

Here we document a small lymnaeid, *Radix* cf. *labiata* feeding upon egg clutches of *Rana temporaria*. The snails observed were morphologically most similar to *Radix* cf. *labiata*, which is the most common species in montane areas in Romania – see Glöer & Sârbu (2005) for evidence of the difficulties of morphological identification in *Radix* spp. (cf. Pfenniger et al. [2006], we treat them as *Radix* cf. *labiata*). The *R. temporaria* egg clutches were in the process of hatching, in April 2009, in a brook, in the foothills of the Buila massif, Southern Carpathians of Romania (4 April 2009, ca. 13.50; Otăsău valley, 45º11'37''lat. N, 24º6'55'' long. E; see location on map of Romania, Fig. 1, and habitat photo, Fig. 2). The snails had congregated on the surface of an egg clutch laid in a small brook-side pond (Fig. 3). The clutch provided food for the snails in the form of algal growth on the outer jelly layer of eggs, but the snails appeared to ingest the jelly layer of healthy, un-hatched eggs as well (see detail, Fig. 4), and probably also the remains of hatched eggs. Although *R. temporaria* egg clutches and *Radix* cf. *labiata* were present together in other small ponds, the behavior was only seen at the single location, suggesting the predatory behaviour to be uncommon.

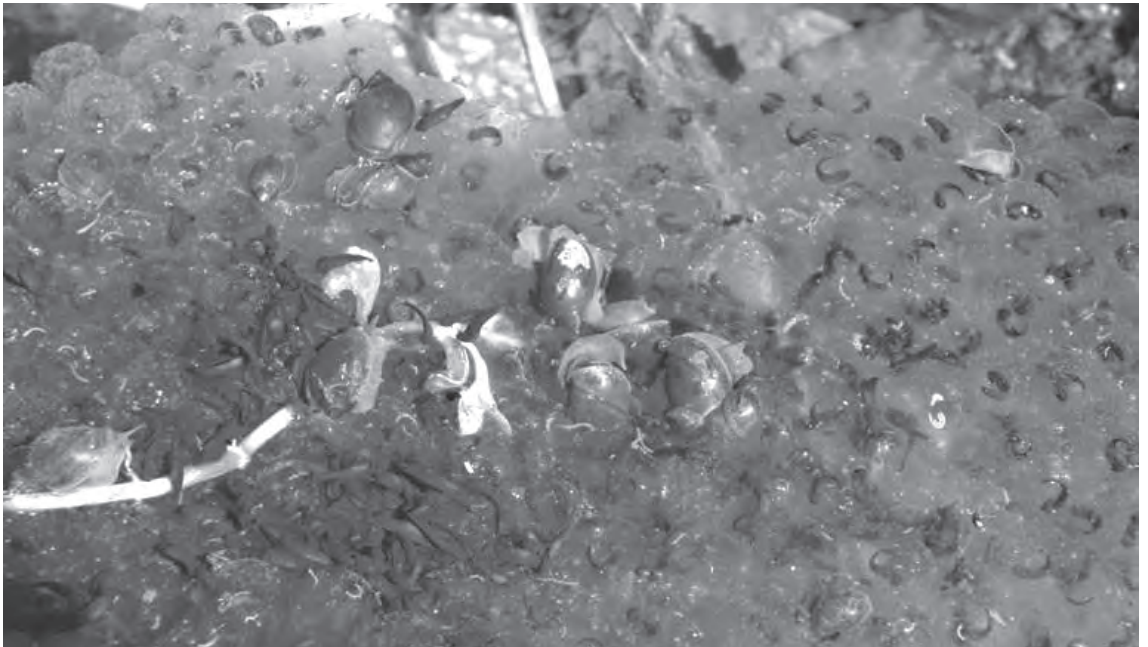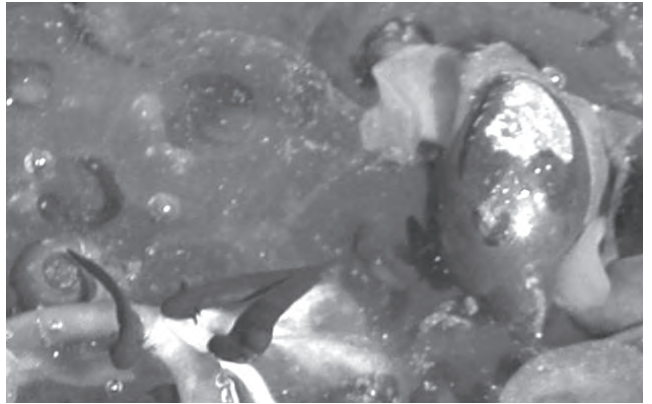Thus, *Radix* cf. *labiata* may sporadically act

Figure 1. Study area located on the map of Romania. ▲

Figure 2. General aspect of the habitat in April 2009. ▲►

Figure 3. *Radix* cf. *labiata* snails congregating on hatching *Rana temporaria* egg clutch. ▼

Figure 4. *Radix* cf. *labiata* snail ingesting egg jelly. ►

as an opportunistic predator of *R. temporaria* egg clutches. While we consider that its impact upon the frog population is minimal, there is a potential for influencing the hatchling morphology because hatching is influenced by chemical cues released from crushed eggs (Mandrillon & Saglio, 2008). Our observation thus validates further studies.

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Distribution of *Typhlonectes natans* in Colombia, environmental parameters and implications for captive husbandry

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ABSTRACT - The distribution, ecology and habitat requirements of most caecilians are unknown. We reviewed the distribution of the Typhlonectid caecilian *Typhlonectes natans* in Colombia using published reports and our own collecting experience. *T. natans* is more widely distributed than previously reported. This caecilian is the most commonly kept in captivity. Published reports regarding the captive requirements of the species are conflicting. We recorded the environmental parameters in habitats where *Typhlonectes natans* was found to allow for an improved captive management of the species. Without exception this species was found associated with flowing water. It is apparent that this species disperses into floodplains during the rainy season.

CAECILIANS (order Gymnophiona) remain enigmatic to a large extent. Their tropical distribution and often subterranean habits mean that they are rarely encountered in routine herpetological surveys (Gower & Wilkinson, 2005). The population and therefore conservation status of many caecilian species is unknown (IUCN et al., 2006). There are two species in the neotropical genus *Typhlonectes* (Typhlonectidae) and they are both completely aquatic (Kupfer et al., 2006). *T. natans* has been caught by hand (Verdade et al., 2000), by hook (Taylor, 1968) and by line (Kupfer et al., 2006). Kupfer et al. (2006), also report the passive trapping of *T. compressicauda* using funnel traps.

The distribution of *Typhlonectes natans* (front cover and Fig. 1) in Colombia was first reviewed by Lynch (1999). Its status and distribution were then proposed by IUCN et al. (2006) in the global amphibian assessment (GAA). The current distribution of *T. natans* does not entirely concur with the localities of collected specimens that are held in several scientific institutions in Colombia (IUCN et al., 2006; Nelson, 2008). This study reviews the literature for *T. natans* and produces an updated map of the localities where the species has been collected in Colombia.

T. natans is one of the few caecilians that can be purchased regularly in Europe and there are several publications that detail its captive care and breeding (Herman, 1994; Wake, 1994; Kowalski, 2001; Parkinson, 2004). However, there is a lack of consensus regarding finer captive requirements such as exact temperatures and water parameters. Whitaker & Wright (2001) state that water harder than 150 ppm may cause skin lesions in captive Tyhlonectid caecilians. This study aimed to document the environemtnal parameters of the natural habitat occupied by *T. natans* to allow for improved captive management.

METHODS AND MATERIALS

We combined the distribution of *T. natans* from Lynch (1999) and the following locations;

Location 1. Hacienda La Condesa, 294 m ASL, (5°18'9.6''N 074°48'4.6''W, Department Tolima, Colombia). A slow flowing stream feeding into a large lagoon situated in a mosaic of pastures and xerophytic forest. The stream bed was littered with boulders, pebbles and detritus. Stream banks supported thick vegetation and stream sides were bordered with dense mats of floating vegetation.

Location 2. Hacienda La Condesa, 294 m ASL, (5°18'9.6''N 074°48'4.6''W, Department Tolima, Colombia). A Lagoon fed by a small stream (Fig. 2), with an outlet stream leading to Guarinó river. The Lagoon substrate consisted of sand covered with detritus and some rounded rocks. Its edge was characterised by dense mats of floating sedges and grasses. Fish observed in the lagoon included *Caquetia kraussii*, *Poecilia caucana* and *Hoplias malabaricus*. Vegetation mats were suprisingly devoid of invertebrates, although we did encounter Nepidae and Odonata larvae. A single *Caiman crocodilus* was observed.

Location 3. Village of Guarinócito (Fig. 3), 209 m ASL (5°20'28.8''N 74°44'9.9''W, Department Caldas, Colombia). A slow flowing stream leading to an Oxbow lake (at the time of the survey, the wet season, the oxbow lake was continuous with the Rio Magdalena). The stream substrate was composed of rocks, small boulders and broken concrete. Associated vegetation included *Pistia stratiotes*, *Eichornia* sp. and *Colocasia* spp. *Bufo marinus* was also observed in the stream. There were many cat fish *Primelodus* cf. *blochii* and characins.

Location 4. Nechi River, 120 m ASL (7°46'18.4''N, 74°46'19.2''W, Department Antioquia, Colombia). This location has a lagoon associated with the Nechi river. The lagoon was surrounded by grasses and sedges. Five specimens of *Typhlonectes natans* were captured. Water parameters were not recorded in this location.

Location 5. Marbella farm, 30 m ASL (9°2'13''N, 75°54'38''W, Department Sucre, Colombia). A muddy complex associated with floodplains at the junction between Magdalena and Cauca Rivers (Fig. 5). One specimen of *T. natans* was captured. Other amphibians observed in and around this aquatic habitat included *Pseudis paradoxa* and the terrestrial caecilian *Caecilia caribea*. Water parameters were not recorded in this location.

Water temperatures for the Rio Magdalena at Honda (the closest monitoring station to location 1, 2 and 3) were obtained from the Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia (IDEAM). This data set included monthly temperatures for the Rio Magdalena from 1988 to 2006.

Water parameters were recorded at locations 1, 2 and 3 using a max-min thermometer (ETI Ltd ©) and Aquarium Pharmaceuticals Incorporated © master test kit and Aquarium Pharmaceuticals Incorporated © KH and GH test kit. pH readings were taken using OAKTON © pH/mV/°C Meter, pH 300 Series.

RESULTS

The farm workers at Hacienda La Condesa informed us that when they were cleaning the lagoon of floating vegetation they often encountered *T. natans* wrapped around the dense roots of the floating vegetation mats. We used a rake and hauled mats of floating vegetation from the lagoon and the stream feeding it onto land (Fig. 4). Once on land these mats were searched for specimens. In two hours of work at location 2, one specimen was captured at 12:30 but unfortunately escaped before any data could be recorded. *Typhlonectes natans* was not observed in location 1. A mask and snorkel were used at sites 1 and 2 to search for *T. natans* but none were found.

In location 3, four specimens were caught by hand. Specimens were visually located and slowly approached under water and grasped securely by the mid-body and temporarily removed from the the water into a bucket. Two additional specimens were caught by enticing them out from their refugia using water scented with fish blood and placing fish viscera at the entrance to rock crevices. Once enticed out of refugia specimens were apprehended by hand. Specimens were captured between 16:00 and 17:30.

The five specimens captured at location 4 were found at night (19:00-20:00) by wading through the water. Specimens were located swimming against the current from the Nechi river into the alluvial floodplain. The water was approximately 1.3 m deep. Specimens were caught using a snake hook.

All specimens captured at location 3 were

Figure 2. Location 2 lagoon at Hacienda La Condesa. © Ben Tapley. ◄

Figure 1. *Typhlonectes natans*. © Ben Tapley. ▼

Figure 3. Location 3, Guarinócito. © Ben Tapley.

Figure 4. Searching vegetation mats for *Typhlonectes natans*. © Ben Tapley.

Figure 5. Location 5 Floodplains in Caimanera area Departamento of Sucre. © Andrés Acosta.

	Location 1	**Location 2**	**Location 3**
Date	22.11.08	22.11.08	25.11.08
Time	14:00	14:30	16:00
Weather conditions	Sun no wind	Sun no wind	Sun no wind
Water temperature (°C)	28.2	28.7-30.7	29.2
pH	7.06	6.17	6.92
Ammonia (ppm)	0.00	0.25	0.00
Nitrite (ppm)	0.00	0.00	0.00
Nitrate (ppm)	0.00	0.00	10.00
GH (ppm)	71.6	71.6	107.4
KH (ppm)	71.6	71.6	107.4

Table 1. Water parameters from locations 1, 2 and 3 where *Typhlonectes natans* occur or are thought to occur.

weighed in life. Three of the specimens captured at location 3 (1 male, 2 females) were housed in an aquarium in Bogotá. These three specimens were photographed with a scale to obtain total length in mm (Table 2). The remaining three specimens captured at location 3 were preserved as voucher specimens. Specimens were euthanized using Chloretone (2 drops/10 ml water) and total length taken post death (Table 2). Specimens were fixed in buffered 10% formalin and then transferred to 70 % ethanol. They were then deposited at the Pontificia Universidad Javeriana, Bogotá. Specimens were sexed by examining the diameter and shape of the cloacal disc. The diameter of the cloacal disc in males is greater than that of the females (Stebbins & Cohen, 1995) and the cloacal disc of the female is slit-like and more elongated.

In location 5 the single specimen was captured by hand at night (20:00). Local fishermen explained that the species can be captured in fishing nets.

DISCUSSION

Collection localities of *Typhlonectes natans* in Colombia are shown in Fig. 6. Lynch (1999) reported specimens from the department of Atlántico, municipality Barranquilla, extending the northern range of *T. natans* reported by the GAA. Lynch (1999) also reported specimens from the department of Cordobá, municipality Tierra Alta, extending the westerly range of *T. natans* reported by the GAA. The distributional map of *T. natans* provided by the GAA does not regard habitat type or altitude. Subsequently the species distribution according to IUCN et al. (2008) encompasses high-altitude paramo habitat. Lynch reports the altitudinal range of *T. natans* in Colombia to be

100-1000 m ASL. We believe that *T. natans* may occur further south in the Magdalena valley (High Magdalena) than Fig. 6 shows. This region requires further investigation to ascertain the presence or absence of this species in the area. We also suggest that *T. natans* may occur further south at the source of the Urrá river. Our thoughts need verification by future prospecting for *T. natans* in this region. The evaluation of voucher specimens held by institutions outside of Colombia was beyond the scope of the study.

From the four capture sites described in the methods section it is apparent that *Typhlonectes natans* is associated with alluvial floodplains of the Magdalena and Cauca rivers. *T. natans* appears to migrate to the floodplains, against the river flow during the wet season. This information was supported by observations from local fishermen of Guarinócito who said that they did not encounter *T. natans* during the dry season. They reported that the area where we collected specimens in Guarinócito shrinks in volume to become a very small stream in the dry season. Without exception *T. natans* was associated with flowing water in all sites where we observed them.

Villagers at Guarinócito concurred with our observations to support the findings of Hoffer (2000). Hoffer (2000) stated that Typhlonectids are often associated with fishing villages and will feed on the discarded entrails of fish. In Guarinócito the local people explained that they did not encounter small (juvenile/neonate) specimens. One small, and possibly young, specimen was captured on the floodplain in location 4, indicating that all age classes of *T. natans* migrate to the floodplains during the wet season.

Sex	Total length (mm)	Weight (g)
Female	434.0	52.6
Female	439.0	55.5
Female	413.0	51.1
Female	637.0	172.2
Female	415.0	57.3
Male	374.0	37.9

Table 2. Morphometric data for specimens captured in Guarinócito.

The local name for *Typhlonectes natans* is 'Anguila' (Spanish for eel). Many locals did not recognise *T. natans* as an amphibian, but instead believed that it was a fish and belonged with the ichthyological fauna of the region. This point is important to remember when working with local rural communities when interviewing them about observations. Despite its illusive nature, *T. natans* is notorious enough in the region to earn its place in local folklore. At Hacienda La Condesa locals explained that if a woman's hair is placed in a bottle, and the bottle is left under water, the next day a caecilian will appear in the bottle.

The water temperatures in location 2 (Table 1) varied between 28.7-30.7ºC. The water was at its warmest amongst the submerged roots of vegetation mats, exactly where the single *T. natans* was captured. Unfortunately we were unable to obtain night-time water temperatures at this location.

There was little variation in the water parameters between sites. The water parameters and temperature records are valuable as a base line for maintaining *T. natans* ex situ. The Ammonia, Nitrite, Nitrate, general hardness (GH) and Carbonate hardness (KH) were recorded using aquaria test kits which are known for their approximate results. Therefore data presented herein for these values should be considered as approximate. The purchase of more sophisticated water test kits was not possible for
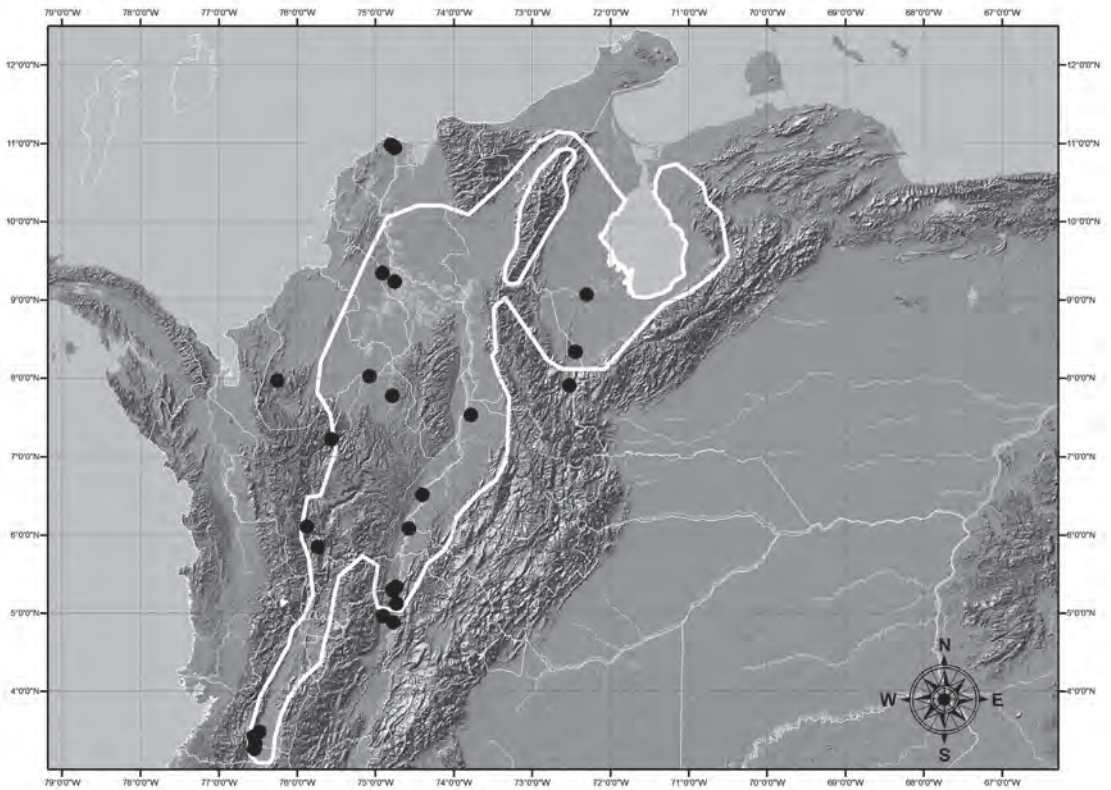

Figure 6. Additional localities to the range of *Typhlonectes natans* (dots) in Colombia; the yellow line corresponding to the distribution of (Mijares et al. 2009).
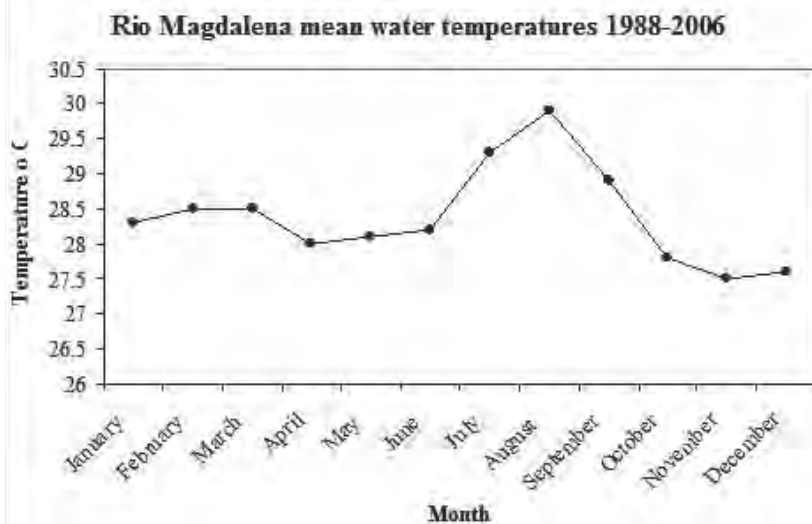
Figure 7. The mean temperatures of the Rio Magdalena at Honda from 1988-2006.

this study. The time of year the temperature data (Table 1) were collected coincided with the end of the wet season. At this time the Magdalena river was in full flood, swollen with rainwater carried to it by the numerous streams and tributaries. We therefore believe that our data exhibit lower daytime temperatures that *T. natans* would experience annually. This suggestion is supported by the temperature data in Figure 7.

Many reports of *T. natans* in captivity suggest that the animals be maintained at 24-28ºC, a temperature range significantly lower than that experienced by the species in the wild, at least in this area of Colombia (Fig. 7). The stream at location 3 was used by villagers for washing, rinsing clothes and washing vehicles. When many local people were washing upstream the water smelt strongly of soap. At this time, we noted that fish temporarily dispersed and it is unclear whether *T. natans* would have also reacted in this way.

It is hoped that the environmental data collected in this study will allow for greater precision when keeping this species in captivity. We suspect that the seasonal temperature fluctuations may prove an important reproductive trigger for this species. Seasonal changes in other water parameters would require further investigation to conclude any recommendations. In both locations where *T. natans* was found the specimens were associated with flowing water. The occurrence of *T. natans* in lagoons and streams in the wet season also provides a glimpse at of the species' seasonal movement patterns.

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Notes on sexual size dimorphism in the Iranian Short-fingered Gecko *Stenodactylus affinis* (Reptilia, Gekkonidae)

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ABSTRACT - Using univariate and multivariate techniques, I evaluated sexual dimorphism in 12 external characteristics from 36 specimens of the gecko lizard *Stenodactylus affinis*. For this study, I chose *Stenodactylus affinis* sampled from northern Persian Gulf littorals. Results obtained from this study are based on 36 specimens (19 females and 17 males) and revealed that female specimens had significantly larger body features than male specimens (P <0.05). Larger body size in female *S. affinis* is likely a reproductive advantage as females develop two large eggs in the abdomen.

SEXUAL dimorphism in size and shape is a common feature of many organisms and has been reported for many species of vertebrates. Several theories have been developed to explain ecological and evolutionary significance for sexual size dimorphism (SSD). Darwinian sexual selection is likely the most important single cause that generates dimorphism, but other factors such as mate choice or mating system, selection on reproductive life history traits, and intersexual ecological divergence have been considered to be significant. For instance, Selander (1966) presented a case for a relationship between sexual dimorphism and differential niche utilization and suggested reasons why such dimorphism would develop. Alternative hypotheses such as bio-energetic pressures, predation pressures, non-monogamous mating systems, or various combinations of these factors have been suggested. By any mechanism large females are presumably able to support more offspring than small females and males increase their reproductive success by mating with large, more fecund females.

Stenodactylus affinis (Murray, 1884) is a medium sized gecko that is distributed in southwestern and southeastern Iran (Afrasiab, 1987; Anderson, 1999). There is no available information on sexual dimorphism for this species. In this short paper, I report on sexual dimorphism in *S. affinis*.

METHODS AND MATERIALS

I collected 36 specimens (19 females; 17 males) of *Stenodactylus affinis* from Bandare-Genave, western Bushehr province, coastal Persian Gulf, southern Iran (50º 20´ E; 29º 44´ N) at an elevation is 40 m, in late spring and early summer 2008. A total of 12 characters were taken: SVL: snout-vent length; TL: tail length; IL: inter-limbs distance; RF: rostral to forelimbs; HW: head width; HD: head depth; HL: head length (snout to posterior border of the ear opening); YD: eye diameter (horizontal); RD: diameter of ear opening (vertical); F: forelimb length (including fingers); H: hind-limb length (including toes) AW: annual width. Measurements were taken in mm with a digital caliper. Statistical procedures used to test for differences included t-tests (at 95% confidence level [0.05]) and Principle Component Analysis (PCA).

RESULTS

Descriptive statistics of 12 characters are shown in Table 1. Based on these results seven characters are significantly different between male and female. Body size (t = 19.12, P >0.01), tail length (t = 8.67, P >0.01), inter-limbs (t = 2.89, P >0.01), head size including head length (t = 5.11, P >0.01), head width (t = 7.52, P >0.01) and head depth (t = 0.01, P >0.01) were significantly greater in females than males. Nevertheless, differences in other characters were not statistically significant. These included lengths of forelimbs (t = 1.43, P = 0.16) and hind-limbs (t = 1.51, P = 0.14) which was greater in females (P <0.05). In general all characters except ear diameter in females were greater than males (Table 1). With regard to the PCA, male results

	SVL	IL	TL	RF	HW	HL	HD	YD	RD	F	H	AW
Female (N=19)												
Mean	59.04	28.64	32.73	21.10	12.09	16.94	8.55	3.18	1.20	21.71	24.53	4.68
SEM	0.35	0.38	0.3	0.49	0.21	0.15	0.11	0.04	0.03	0.47	0.45	0.1
Min	55.89	26.2	30.81	18.51	10.89	15.45	7.41	2.95	1.03	19.1	22.01	3.45
Max	61.52	31.79	36.53	24.82	13.99	17.95	9.8	3.73	1.45	27.74	27.46	5.39
Male (N=17)												
Mean	50.53	27.36	29.54	20.09	9.96	15.38	6.68	2.99	1.22	20.80	23.79	4.48
SEM	0.25	0.18	0.19	0.54	0.18	0.27	0.13	0.09	0.02	0.41	0.13	0.13
Min	48.74	25.98	28.36	17.06	9.05	13.9	5.8	2.02	1.05	17.21	22.76	3.42
Max	52.67	28.56	31.12	23.65	11.44	17.95	7.25	3.56	1.37	23.22	24.52	5.39
t-test												
t	19.12	2.89	8.67	1.37	7.52	5.11	10.45	1.88	0.66	1.43	1.51	1.23
P	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.06	0.51	0.16	0.14	0.22
DD	F>M	F>M	F>M	F>M	F>M	F>M	F>M	F>M	M>F	F>M	F>M	F>M

Table 1. Descriptive analysis and results of t-test (at the 0.05 level) in 12 characters of *Stenodactylus affinis*. SEM: standard error of mean; Min: minimum; Max: maximum; DD: direction of difference (for character abbreviations see Methods and Materials).

were distant from females indicating distinct size differences (Fig. 1).

DISCUSSION

Sexual size dimorphism is exhibited from the measurements herein. There are also other qualitative differences between the sexes. Body colour in females is generally lighter than males and limb radius in males was smaller than in females. Similarly, scales on the dorsum (granules) in females were relatively larger than in males. While the tail in both sexes is slender, it is more robust in females. Dark spots on the female body were more abundant than on male bodies. Similarly, granules in females were larger than in males.

Arnold (1980) suggested that female *Stenodactylus affinis* to have a larger body size than male specimens. This study reports quantitatively that females of *S. affinis* generally have larger dimensions than males (Fig. 2). Arnold (1980) reported the largest body size from a female to be 60 mm and for a male to be 45 mm. In this study I found a slightly larger diameter in a female (61.52 mm) and a male (52.67 mm) *S. affinis*. Arnold's study is based on only five specimens of *S. affinis,* but I report this larger body size from a sample of 36 specimens from southern Iran.

Based on Arnold's (1980) study, female specimens in all species of *Stenodactylus* have larger body sizes than males. All females of
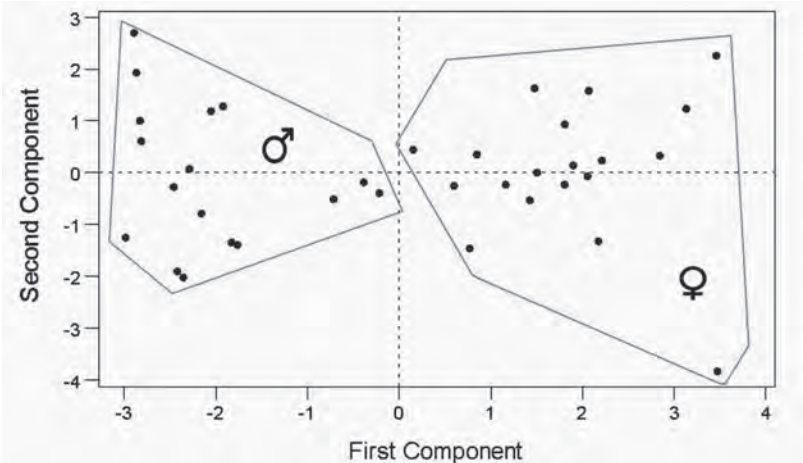

Figure 1. The results of PCA among 12 characters in *Stenodactylus affinis*.
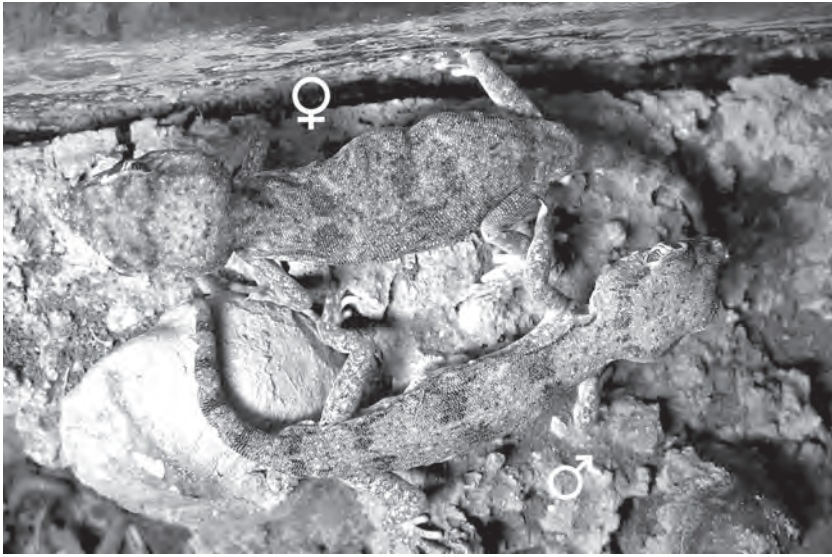
Figure 2. Male and female specimens of *Stenodactylus affinis*. © Farhang Torki.

S. doriae from all sample areas are larger than males, except in one locality, Oman, where males have a larger body size. It could be possible that the male specimens in the *S. doriae* samples were not adults but were subadults. The size of the sample group was also only based on five specimens from Oman. It is possible that, considering my study herein, and the above low sample size, that an altered morphology and maximum size for *S. doriae* may exist in wild populations. Further collection of wild specimens would be needed to prove this.

Arnold's (1980) study also reported maximum body size differences between the sex of *S. doriae* (24 mm) and *S. leptocosymbotes* (20 mm), and these are currently the largest known specimens of each species (Arnold, 1980). Differences of similar size contrast can be found in other species. In *S. grandiceps* the females differ from males by 2.5 mm and by 3.0 mm in *S. khobarensis*. Other *Stenodactylus* spp. also have maximum sizes between these ranges. Differences between the largest male and female of *S. affinis* in Arnold (1980) was 15 mm. Herein I report a a maximum difference to be 8.8 mm for *S. affinis*. This reduced difference could be because of an increased, and perhaps more accurate, sample size. It is possible that the number of specimens sampled may influence the relationships between body size divergence in Arnold (1980). He measured 182 specimens of *S. doriae* and 120 *S. leptocosymbotes* but only a few specimens of *S. grandiceps* (11), *S. affinis* (5) and *S. yemenensis* (9).

Although female specimens in all *Stenodactylus* have a larger body size, sexual divergence occurs in only two species (*S. doriae* and *S. leptocosymbotes*). To compare my study with Arnold (1980), body size divergence in *S. affinis* (8.8 mm) is similar to *S. pulcher* (8.5 mm), *S. petrii* (9.0 mm), and *S. slevini* (9.0 mm). Head size of females in these species is bigger than males. This is similar to some other geckos, for example, *Tropiocolotes helenae fasciatus* (Torki, 2007).

Head-size dimorphism, which is common in squamate reptiles is a trait that may be influenced by both ecological segregation as well as by sexual selection (Shine, 1991). Camilleri & Shine (1990) suggest that head-size dimorphism in some snakes is the result of morphological adaptation for prey-size specialization. Head-size dimorphism in lizards is usually attributed to sexual selection or resource defense where males with larger heads are more successful in intra-sexual confrontations (Carothers, 1984; Hews, 1988).

Body size, as expressed by inter-limb distance, is one factor that shows fecundity selection. Interlimbs in females of some geckos such as *T. h. fasciatus* are significantly larger than males. This aspect is similar for *S. affinis*. Larger inter-limbs

in females may also affect reproductive success because larger females can support larger clutches more effectively (by holding two large eggs as opposed to just a single egg). There may also be a similar contribution to the reproductive success for the role of body width as this character is also larger in females (Torki, 2007). This is in contrast with available information for some non-geckos such as *Liolaemus occipitalis* (Verrastro, 2004) in which annual width in males is greater than females. However, this difference in annual diameter in gecko and non-geckonid lizards may well be the result of large, developing eggs. Female specimens in *Stenodactylus affinis* are possibly larger because they are more reproductively successful than small females. Phylogenetic relationships between *Stenodactylus* spp. are understudied and further studies are recommended to unravel relationships between sexual divergence and evolution in the genus.

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TRACHEMYS DORBIGNI (Brazilian Slider Turtle): ALBINISM. The occurrence of albino turtles is widely disseminated in marine species (Godfrey & Mrosovsky, 1995), but reports about freshwater albino turtles are rare (Basu et al., 2003).

On 7 January 2005 three albino hatchlings of *Trachemys dorbigni* were collected from a total of 2,114 individuals, other hatchlings and eggs from an illegal trade apprehension. The apprehension was conducted in Capão Seco district, city of Rio Grande, RS, Brazil (UTM 22J 379079 E 6475207 N). The hatchlings were located next to each other in the collection and were probably from the same clutch.

The albino hatchlings were yellowish-white (Fig. 1), whereas all other *T. dorbigni* showed the characteristic colour pattern for this species. They all had red eyes and tail atrophy. Carapace and plastron morphometric comparisons were made between the normal (non-albino) animals (n = 100) and the albino hatchling (n = 3). The average size of the albino hatchlings was 31.9 mm CL; 34.6 mm CW; 34.0 mm PL and a carapace height (CH) of 15.5 mm. The average size in the normal hatchlings was 35.9 mm CL; 33. mm CW; 35.0 mm PL and 15.5 CH. In these hatchlings the length of the carapace always exceeded the width in a 1.06 ratio. In the albino hatchlings this proportion was inversed, with the carapace width being larger than the length (0.92). Bager (unpublished data) previously measured over a thousand normal hatchling *T. dorbigni* and none showed a larger carapace width than length. The albino hatchlings also presented variation in the pattern of carapacial scutation. One of the hatchlings had six vertebral scutes, another had five right costal scutes and the third had two cervical, six vertebral, five right costal and thirteen right marginal scutes. There was no variation on the plastron scutation. Changes in carapacial scutation is common for this species (Bujes & Verrasto, 2007) and therefore this observation is not an exclusive albino characteristic.

To the best of my knowledge this is the first known occurrence of an albino hatchling of *Trachemys dorbigni* collected from the wild.

Figure 1. Albino hatchling of *Trachemys dorbigni* from Rio Grande do Sul, Brazil.

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DENDROPSOPHUS DECIPIENS and ***DENDROPSOPHUS MINUTUS***: DEFENSIVE BEHAVIOUR. Amphibians are preyed upon by a vast array of invertebrates and vertebrates. As a result, amphibians have developed a wide variety of defensive behaviors (Duellman & Trueb, 1994; Wells, 2007). *Dendropsophus minutus* is a small sized frog belonging to the *D. minutus* group (Faivovich et al., 2005). It is widely distributed throughout South America (Frost, 2009). *Dendropsophus decipiens* is a small sized frog belonging to the *D. microcephalus* group (Faivovich et al., 2005). It occurs from southeastern

to northeastern Brazil, near the Brazilian Atlantic coast (Frost, 2009). On 9 November 2009 at around 19:30, MRM observed a defensive behaviour displayed by specimens of *D. decipiens* (Fig. 1) and *D. minutus* (Fig. 2) upon capture. Once individuals of these species were grasped with the hand or stimulated by tapping on the dorsal region they both exhibited a similar reaction behaviour, in which the hands of the frog were placed next to its face, close to the eyes, and with fingers outstretched. The observation took place in a permanent pond in the Serra do Brigadeiro State Park, a conservation unit in the municipality of Araponga, State of Minas Gerais, Brazil (20º43'19"S, 42º28'43"W, elev. 1320 m, datum SAD1969).
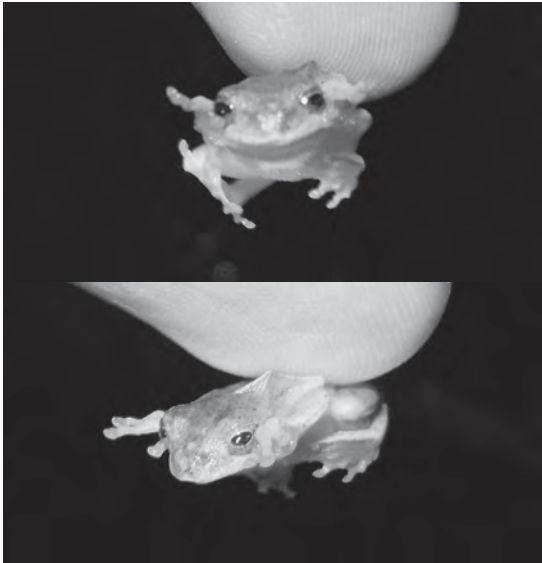
its falls from the vegetation after an attack, that it serves to protect the eyes (Azevedo-Ramos, 1995), that it is used for sending an anti-signal to potential predators by changes in the familiar frog outline, or that it could challenge predator ingestion (Angulo & Funk, 2006). Angulo et al. (2007) verified that after a brief period of time some individuals that displayed "boo behaviour" modified their defensive position, moving the hands close to the body and scrunching fingers until reaching a death-feign position. Angulo et al. (2007) also suggest plasticity in anti-predator strategies, with the "boo behavior" strategy being a variant of a death-feigning posture. Voucher specimens were deposited at the herpetological collection of the

Figure 1. Defensive behaviour displayed by *Dendropsophus decipiens*.
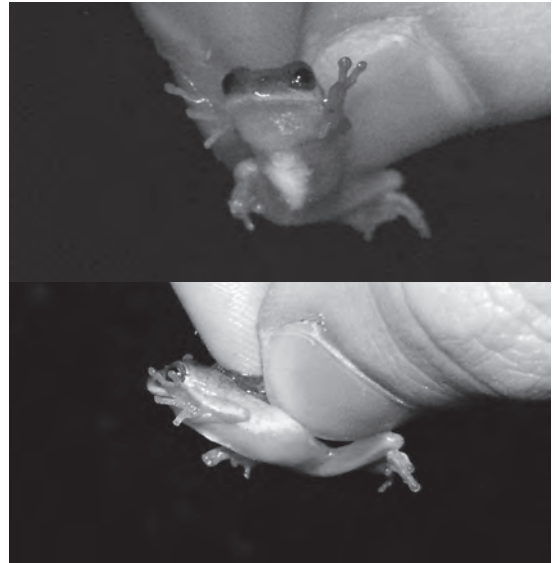

Figure 2. Defensive behaviour displayed by *Dendropsophus minutus*.

Angulo & Funk (2006) suggested the term "boo behaviour" for this kind of defense. It has been reported for other Hylinae species such as *Hypsiboas semilineatus* (Azevedo-Ramos, 1995), *Hypsiboas calcaratus* and *Hypsiboas fasciatus* (Angulo & Funk, 2006), and *Hypsiboas geographicus* (Angulo et al., 2007), although the term "boo behaviour" has not always been used.

Different functions have been suggested to explain the adaptive value of this behaviour in arboreal species. It has been proposed that it makes it difficult for a predator to rediscover a treefrog if

Museu de Zoologia João Moojen, Universidade Federal de Viçosa, in Viçosa, Minas Gerais, Brazil (*D. decipiens*, MZUFV 10172-10173; *D. minutus* MZUFV 10174-176).

logistic support. Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for fellowships granted to MRM.

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LEPTODACTYLUS OCELLATUS (Butter frog): DIET. *Leptodactylus ocellatus* is a large frog species, widely distributed throughout South America, east of the Andes, occurring from Venezuela to Argentina (Cei, 1980). It inhabits a wide variety of aquatic environments and is often found in altered landscapes (Solé et al., 2009). Information about its diet is available for populations from Argentina (Gallardo, 1958; Gallardo, 1964; Lajmanovich, 1996; Sanabria et al., 2005), Uruguay (Maneyro et al., 2004) and Brazil (Teixeira & Vrcibradic, 2003; França et al., 2004; Kokobum & Rodrigues, 2005; Solé et al., 2009), and indicate that the species is a generalist predator (Teixeira & Vrcibradic, 2003; Solé et al., 2009). Arthropods and vertebrates of different groups have been reported as prey of *L. ocellatus* and also other amphibian species (Gallardo, 1964; Solé et al., 2009). Here we present information about the diet of *L. ocellatus* from a locality in the southeast of Brazil.

The stomach contents of eight specimens (six females and two males) were analyzed from frogs collected at an artificial pond near the urban area of Coimbra municipality, Minas Gerais state, Brazil (20°52'31"S, 42°48'26"W) on 2 December 2008, 9 and 15 January 2009. All specimens were found on the ground near pond margins. Five of them were housed as voucher specimens at the herpetological collection of Museu de Zoologia João Moojen (MZUFV), Universidade Federal de Viçosa, Viçosa municipality, Minas Gerais state, Brazil under the register numbers MZUFV 9046-9050. The prey items were identified to the lowest possible taxon, weighed to the nearest 0.01 g and separated as "intact" and "fragmented". The snout vent length (SVL) of frogs ranged from 66.99 mm to 103.38 mm, and frog's mass ranged from 30.09 g to 124.16 g. A total of eight prey categories were found among the intact prey items, and four among the fragmented ones, along with non identified arthropod remains (Table 1). Coleopterans, both intact and fragmented, were the majority of prey items (25%), followed by Formicidae (21.43%) and Gastropoda (Pulmonata) (10.71%).

Two adult specimens of *Physalaemus cuvieri* (Anura, Leiuperidae) (Fig. 1) were identified among the stomach content of a female *L. ocellatus* collected on 2 December 2008 (MZUFV 9046). This anuran prey item was the dominant prey in relation to the content mass (42.59%). The *P. cuvieri* specimens were dissected and revealed that they were a couple (possibly amplectant at the time of death). The female had numerous cream to white coloured oocytes and the testicles of the male were dark pigmented, indicating sexual maturation

Stomach contents	N	%N	mass (g)	% mass
Intact prey				
Gastropoda (Pulmonata)	3	10.71	1.16	10.95
Araneae	2	7.14	2.95	27.86
Blatodea	1	3.57	0.03	0.28
Coleoptera (Cicindelidae)	3	10.71	0.59	5.57
Hemiptera (Cercopidae)	1	3.57	0.04	0.38
Hymenoptera (Formicidae)	6	21.43	0.36	3.40
Lepidoptera (larvae)	2	7.14	0.14	1.32
Anura (*Physalaemus cuvieri*)	2	7.14	4.51	42.59
Fragmented prey				
Coleoptera	4	14.29		
Araneae	1	3.57	0.09	0.85
Orthoptera	1	3.57		
Hemiptera	2	7.14		
Arthropod remains	---	---	0.07	0.66
Plant remains and sediments	---	---	0.65	6.14

Table 1. Summary of stomach contents of *Leptodactylus ocellatus* from Coimbra, Minas Gerais, Brazil. N = number of prey items; % N = percentage of prey items.
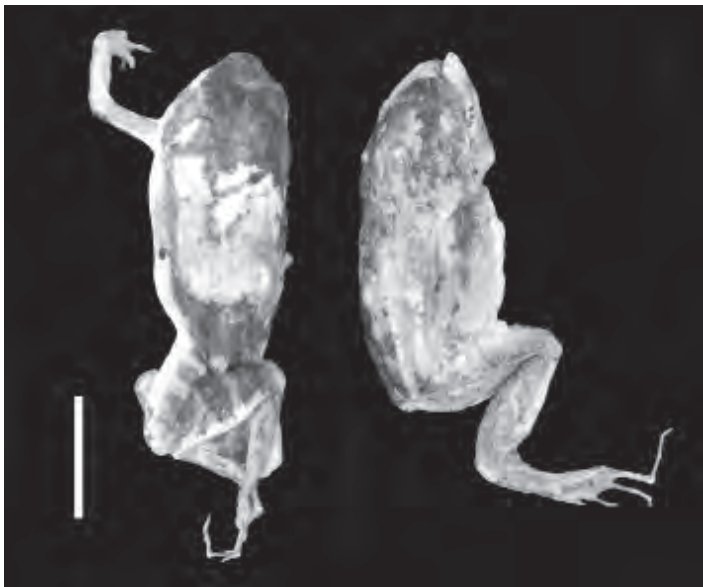

Figure 1. Couple of *Physalaemus cuvieri* ingested by a female *Leptodactylus ocellatus* (see text). White vertical bar = Scale: 1 cm.

(Moresco & Oliveira, 2009). As Gallardo (1964) stated that amphibians gathering for reproduction can be preyed upon by *L. ocellatus*, it is possible that the couple were ingested while mating or attempting to mate.

Physalaemus cuvieri is widespread in Brazil, south of the Amazon rainforest and like *L. ocellatus*, is well adapted to a wide variety of aquatic habitats, breeding in temporary and permanent puddles, streams or swamps (Bokermann, 1962; Eterovick & Sazima, 2004). Males of this species call mainly at night, floating in water (Bokermann, 1962; Eterovick & Sazima, 2004), making them a susceptible prey for *L. ocellatus*. *P. cuveri* has also been reported as prey of water bugs and snakes (Toledo, 2003; Pombal Jr., 2007) but this is the first record of its presence in the diet of *L. ocellatus.*

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GAVIALIS GANGETICUS (Indian Gharial): BEHAVIOUR. *Gavialis gangeticus* is one of the more recognisable and iconic species on our planet which is presently in decline and at immediate risk of extinction (Loh et al., 2008). Currently, it is listed as critically endangered under the IUCN Red List with population levels dropping drastically in recent years to just 220 breeding adults in the wild (Choudhury et al., 2009). Declines are attributed to: illegal hunting for its prized snout ('Ghara'), skin and eggs; accidental trapping from illegal fishing; and habitat loss from a variety of sources including sand-mining, agriculture, dams, and siltation. All of these are major threats that show no sign of abating (Whitaker, 2007). Limited surveillance of the number of wild animals hampers population monitoring and detailed information on its ecology is still relatively sparse (Sharma & Basu, 2004).

The Gharial (*G. gangeticus*) and False Gharial (*Tomistoma schlegelii*) have distinct morphological characteristics which differentiate them from all other crocodilians. These traits, in particular the elongate and narrow jaw, have long been regarded as an adaptation to aid their ichthyophagous diet (Singh & Bustard, 1982; Whitaker & Basu, 1982; Thorbjarnarson, 1990). Recent molecular advances suggest that convergent adaptation has not shaped morphological characters in *T. schlegelii* but rather it should be placed into Gavialidae with *G. gangeticus*, becoming a sister family to the Crocodylidae (Norell, 1989; Poe, 1996; Gatesy et al., 2003, 2004, 2008; Willis et al., 2007). This taxonomic shift suggests the morphological characters observed in the Gavialidae likely evolved early on in the radiation of the family.

In this note I present preliminary observations of male combat by *G. gangeticus*, involving its unusual morphological characters that may be unique among Crocodylia. On 1 June 2007 between 14:30 and 15:00 at the Madras Crocodile Bank Trust (MCBT), 40 km south of Chennai, Tamil Nadu, India, two large adult male *G. gangeticus* (approximately 4-5 m) were observed showing typical territorial signs of chasing each other and displaying to females by arching their dorsum out of the water. During these displays the two males presented an unrecorded behaviour that the staff and I at the MCBT have named 'fencing'.

The males moved towards each other (head on), propelled themselves out of the water, and using their jaws like swords, tried to push each other to the water's edge (Fig. 1). No biting or mouth gaping was observed, only strong swipes to the jaw of the opponent. The fight continued for approximately 30 minutes before one male retreated to the far side of the enclosure whilst the winner (in this case, also the larger) male moved closer toward the females. Several unconfirmed reports of this behaviour have been recorded at MCBT. Due to this style of territorial fighting, I recommend that males be housed independently of each other with a small group of females (between 5-7) when specimens are held in captivity for essential conservation breeding programmes.

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Figure 1. *Gavialis gangeticus*, male-male combat ('fencing'). © Simon T. Maddock.

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BOOK REVIEWS

Extinction in Our Times: Global Amphibian Declines

James P. Collins and Martha L. Crump
2009, Oxford University Press, 273 pp.

'Something is very wrong'. These words are taken from the 20 April 1989 journal entry of Martha Crump in her excellent 'In Search of the Golden frog.' (Crump, 2000). With increasing desperation she was coming to realise that the Dink Frogs, Glass Frogs, Harlequin Toads and, most famously, the Golden Toad (*Bufo periglenes*) that had been abundant only a few years before, were now absent completely from her study area in Costa Rican cloud forest. That same year, at the First World Congress of Herpetology in Canterbury it became apparent that this was not an isolated incident but that similar declines were happening in anuran populations in parts of the globe as varied as Tanzania (Kihansi Spray Toads *Nectophrynoides asperginis*), Australia (Gastric Brooding Frog *Rheobatrachus silus*), Canada (Western Chorus Frogs *Pseudacris triseriata*) as well as many others, and affecting not just frogs and toads but salamanders too, such as many species of the North American *Plethodon* genus.

In 'Extinction in Our Times' Collins and Crump pick up the story of how workers first realised the chilling fact that stories and anecdotes of disappearing amphibians were starting to become significant and how this catalysed the formation of working groups and organisations such as the Declining Amphibians Population Task Force and the many others that have followed in the years since. These groups led the coordination and extensive monitoring and research that has been taking place ever since, slowly building up a clearer picture of why these devastating losses might be occurring.

Gloomy as its subject matter is I couldn't help but enjoy reading this book! This is a fascinating story of scientific detective work as the intricacies of amphibian reproductive modes, habitat use, distribution and other factors are investigated in a new light with the added urgency of an ongoing collapse in many populations. Understandably the shadow of Chytrid fungus (*Batrachochytrium dendrobatidis*, or Bd) looms over this book, with many pages devoted to the description of its effects, ominous spread and possible causes. Other potential causes of stress to amphibians and their environments are not ignored however, with sections on introduced species, the pet trade, pollution and global climate change. Habitat loss, therein called 'land use change', is covered, although this section is surprisingly brief. The fact that many declines are likely caused by a combination of factors interacting synergistically is what makes the problem such a difficult one to solve – a fact that is well represented in the book as the various scenarios and hypotheses are explored. The authors put forward both sides of any arguments and do not hide the fact that there are sometimes tensions within the herp community as to how facts are interpreted (such as the disputed 'Chytrid-thermal-optimum' hypothesis).

I was pleased that the book quickly puts to rest the inappropriate and often repeated 'Canary in the coalmine' metaphor, designed to show that amphibians are the ideal indicator species to warn of impending environmental problems (see also Beebee et al., 2009; Sewell & Griffiths, 2009). This misleading statement seems to be regularly trotted out in any mainstream article about amphibian

extinctions when one would actually think the deployment of straight facts would suffice – the disappearance, 'forever', of any animal is surely enough to grab attention? Fragile and sensitive skin notwithstanding, I think a 350 million year tenure on earth to date is testament to a certain amount of resilience for our humble amphibians!

This is not a despairing book resigned to the inevitable loss of all of our amphibians but more of a review of the progress that specialists, and importantly, not only herpetologists, but also experts in many other disciplines such as climate change, toxicology, ecology and policy have made in documenting current threats and supporting education and funding. It serves as a summary of the current status of our collective knowledge of the problem and a timely reminder to all that are not actually engaged in researching and mitigating the issue that this is not a problem that will resolve itself. In fact the book ends with the phrase 'one mystery yields another' – in other words, although we have discovered much and made steps toward understanding and combating the range of problems we have also opened up new avenues of thought and with it new puzzles to solve. Among these problems is the issue of an increasing reliance on maintaining threatened species in captivity (albeit forced by circumstances, to ensure at least some survival). This becomes a problem when an amphibian is unable to be reintroduced into a safe and disease free natural habitat until further discoveries are made about Bd, its life history and the possibilities of producing animals from captive stock with immunity or reduced susceptibility.

Anyone with an interest in our planet and its wildlife will be able to grasp the importance of these events and even if not an avid herper themselves will be able to see that the title could refer to a number of different taxon groups in the very near future – mammals being one of them. We are watching species drop out of existence before our eyes, not just in one place but across the globe – and there is a very good chance that we are at least partly to blame. This book is not an epitaph for amphibians worldwide, but a quietly inspirational reminder that there is a major problem. However, it is one that can hopefully be solved with continued focus and funding.

This book understandably does not provide answers to all the problems of amphibian declines and extinctions but it certainly illustrates in a clear, readable and not prohibitively scientific way how the race to get to the bottom of the problems is well under way. There have been many papers published on amphibian declines in recent years and keeping anywhere near up to date has been a tall order. This book provides a very welcome synthesis in drawing together different strands of current research and investigation to date. I sincerely hope that a second volume can follow in time and that the message will be a positive one.
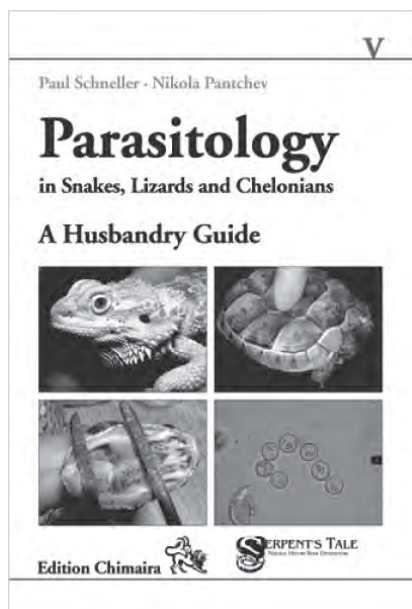
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Parasitology in Snakes, Lizards and Chelonians: A Husbandry Guide.

Paul Schneller and Nikola Pantchec
2008, Edition Chimaira,
Frankfurt am Main, 203 pp.

'Parasitology in Snakes, Lizards and Chelonians, a Husbandry Guide', by Paul Schneller and Nikola Pantchec is a 203 page hard-bound text that was translated from the original German by Dr. Nina Norden. The reviewer considers this a beginner's text for this subject material covered in this book. The guide is divided into four sections (chapters) that run together one after the other: 1. General Parasitology in Snakes, Lizards, and Chelonians; 2. Specific Parasitology in Snakes, Lizards and Chelonians; 3. Zoonoses; and 4. Glossary.

Section 1 covers detrimental effects of parasites, the need for parasitological examinations and correct sampling, quarantine enclosures, terrarium decontamination, treatment of parasitic diseases, and recognizing health problems in reptiles. Several typographical errors can be found here and throughout other portions of the book due to the translation. They are minor points but should be mentioned. The photographs of parasite eggs and oocysts are occasionally out of focus, but overall they are generally good to excellent in quality. Occasionally a figure does not match with the statement made in the text. For instance, the authors state on page 31 "Dosage and duration of treatment must be agreed between reptile keeper and skilled veterinarian (fig 1)". Figure 1 is that of a Russian tortoise with a pharyngostomy tube for food and drug administration.

While there is an extensive table of antiparasitic drugs, no dosages or frequency of administration are provided. Potential toxic effects should have been included. Disinfectants are also mentioned within the text but recommended concentrations and more detail on how they should be used is needed. Terrariums are commonly used for small reptiles in Europe while in the US cages or enclosures of reptiles tend to be less intricate. Good information is provided on how to manage a terrarium. On page 14, the authors state that "Reptiles kept in captivity are often infected with parasites and the resulting parasite-disease can lead to severe health problems". However, today we see that more and more reptiles are being captive bred and overall fewer parasitic diseases are being seen. Some persist and some have even intensified as a result of captive breeding practices, but in the reviewer's experience there has overall been a decline in captive bred reptiles. This is not the case for those reptiles that are still being imported from the wild. On page 15, the authors state that "Reptiles held in captivity are more susceptible to parasite infection than wild reptiles." The reviewer is unsure of the point the author is trying to make. Possibly what is meant is that wild caught reptiles with parasite infections are more susceptible to detrimental effects of the parasites. Susceptibility to infection should remain the same, whether in captivity or the wild. Prevalence of infection will vary.

Comments in this chapter and elsewhere in the book about detrimental effects of oxyurids on the host may be more speculation than actual fact. There are few reports in the literature concerning detrimental effects of oxyurids in reptiles. Some clinicians consider them normal fauna of the colon of herbivorous reptiles and do not administer parasiticides to make them oxyurid

free. The section on mites, images of mites and their control is particularly good. However, some American products such as Provent-a-Mite (Pro-Products, www.pro-products.com/) are not mentioned.

Section 2 covers major groups of external parasites, internal parasites (helminths), and internal parasites (protozoa). On page 40, the authors state that "Disease eradication from the environment is as important as treatment of the affected animals (see Chapter 1.4). This is a mistake commonly made in the medical literature. Disease is a change in structure and function of tissue and may result from a pathogen for those infectious diseases or result from toxicosis, metabolic disturbance, nutritional deficiencies, and neoplasia, etc. Disease is not present in the environment, but present in the host. Pathogen eradication from the environment should be attempted. Figure 60 may be an egg of *Rhabdias* and not *Strongyloides*. Eggs of the two should have been shown side-by-side to exhibit distinguishing features. These may be difficult to distinguish. Throughout this section and other sections of this book, arrows should have been added to point to specific parasites or other structures in various figures. Figure 123A is probably a Burmese python rather than a reticulated python. One important parasite missed in this chapter is intranuclear coccidiosis of tortoises. Several papers can be found in the scientific literature. A brief review should have been included. Infection vs infestation should have been clarified. At times the wrong term is used. Infestation should have been included in the glossary. Additional terms that are often confused are clinical signs vs. symptoms. Clinical signs are what we observe in an animal when doing an examination. Symptoms are subjective human sensations. On page 169, the authors state that *Entamoeba invadens* infections in chelonians are usually asymptomatic. This may be the case but deaths of chelonians associated with amoebic infections have been reported in chelonians. Also, *Caryospora* fungi has been reported as an important pathogen in sea turtles.

The third section on zoonosis is short and reflects the limited number of zoonotic parasitic diseases reported to be transmitted from reptiles to humans. More references could have been added here and elsewhere throughout the book.

Section 4 is a Glossary of terms used throughout the book. This is a welcome addition. As mentioned above, several important definitions are lacking but overall the authors do a good job in defining the most pertinent terminology.

While many of my comments above are critical in nature, I want to make sure the readers of this review understand that I critique written works through the eyes of a scientist who has reviewed many scientific publications throughout his career. Overall I recommend this book for anyone interested in an overview of parasitic infections/ infestations in reptiles.

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