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Front cover illustration. *Pedioplanis husabensis*, Namibia © W. Conradie. See article on page 42.

Impact of *Ranavirus* on garden amphibian populations

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ABSTRACT - Many species of amphibians have bred in a Woodingdean garden pond for more than 30 years. In summer 2007 an outbreak of *Ranavirus* occurred and this paper describes its impact on three species of anurans living wild in the garden and two species kept in an outdoor vivarium. Common frog *Rana temporaria* numbers were reduced by >80%. Common toads *Bufo bufo* decreased by perhaps 20% whereas pool frogs *Pelophylax lessonae* were scarcely affected. A single natterjack *B. calamita* died in the vivarium where at least five survived, but all midwife toads *Alytes obstetricans* (adults and larvae) in the same enclosure perished. There was no sign of recovery of the common frog population over the ensuing five years.

Ranavirus infections have been decimating frog populations in southern and eastern England for several decades (Cunningham et al., 1996). The disease mostly affects *Rana temporaria* in the UK, though there are reports of common toad *Bufo bufo* mortality as well. Unlike North America where vulnerable species are often killed at the tadpole stage (Gray et al., 2009) common frogs mainly die as adults during the summer months. Garden ponds at Woodingdean in Sussex, England have supported several species of amphibians for more than 30 years (Beebee, 2007). In the summer of 2007 *Ranavirus* arrived. Here I describe the consequences of this infection in that year and in the five years following. Numbers of common frogs and toads assembling to breed were best estimated by counting spawn clumps or peak numbers of adults respectively, in early spring. Water frogs were the largest number of individuals seen basking on one occasion each year, usually in April. Dead animals were the sum of those observed in the garden and outdoor vivarium throughout the mortality period.

RESULTS AND DISCUSSION

At total of 32 dead and dying *R. temporaria* including adults of both sexes, and immatures, turned up in the garden between June and September 2007 with a peak after midsummer (Fig. 1). No dying tadpoles were observed but a metamorph was found expiring at the pond edge. This was among several individuals collected by Amanda Duffus from the Institute of Zoology, London who later confirmed *Ranavirus* as the pathological agent. Three common toads were also found dead but water frogs (mostly *Pelophylax lessonae*) were apparently unaffected. On two occasions male pool frogs were separated from amplexus with dead common frogs but no sick or dead pool frogs were ever seen. Similarly, no newt corpses were found in the ponds. However, the disease somehow entered an outdoor vivarium sustaining small breeding populations of *Bufo calamita* and *Alytes obstetricans*. A single natterjack died in August, presumably from *Ranavirus* infection though that was not confirmed. There was no other obvious cause and natterjack deaths have not otherwise been seen in the vivarium before or since. The remaining natterjacks (five adults) survived without sign of infection. Unfortunately the consequences for midwife toads were devastating. Their tadpoles in the vivarium pond all died early in August and soon afterwards so did every adult (nine altogether), including one which had escaped into the garden and in which *Ranavirus* was confirmed. High susceptibility of

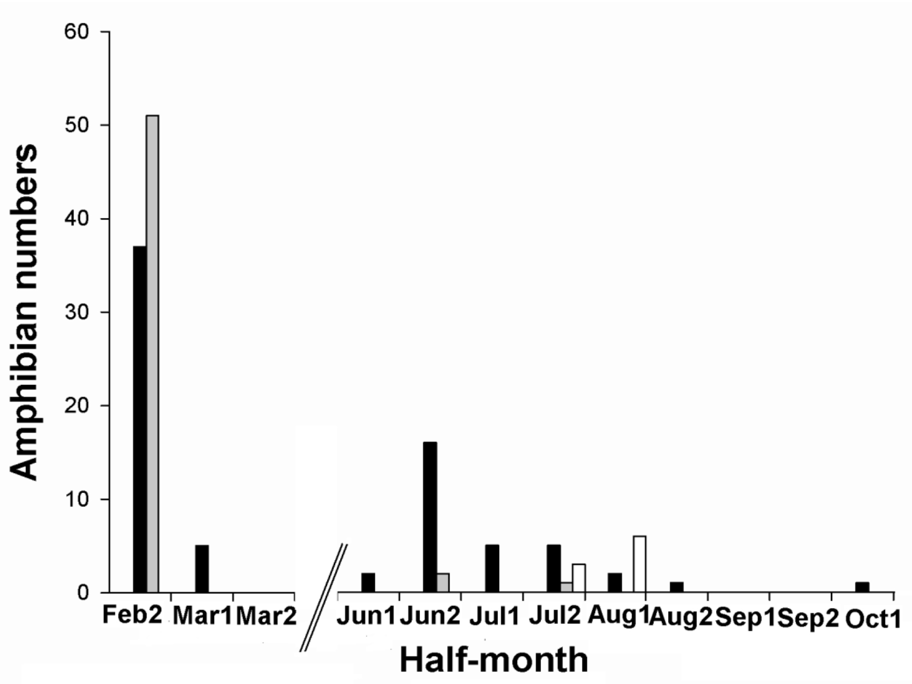

Figure 1. Amphibian breeding and mortality during 2007. Dark bars: *Rana temporaria* spawn clumps (spring) or dead animals (June onwards). Pale grey bars: Numbers of *Bufo bufo* breeding in spring or found dead in summer. White bars: Numbers of *Alytes obstetricans* dying in the vivarium.

midwife toads to this pathogen has also been observed in Spain (Balseiro et al., 2009). A common symptom in all species when suffering from late-stage disease was emergence from cover and an attempt to reach water. Overall the pattern of susceptibility could not have been predicted on the basis of taxonomic relationships among amphibians in the garden. *Rana* is much more closely related to *Pelophylax* than it is to *Bufo* and *Alytes* is phylogenetically distant from all the rest.

Fig. 2 shows numbers of common frogs, pool frogs and common toads assembling to breed in the Woodingdean ponds for several years before and after the *Ranavirus* outbreak. These numbers confirmed the impression of events seen during summer 2007. Common frogs were badly hit with numbers declining by just over 80%. This decrease, based on counts over 2008-2012 compared with 2003-2007, was highly significant (Wilcoxon rank sum test, U = 25.0, exact P = 0.008). On that basis about 40% of the frogs presumed to have died were actually found in the garden during summer 2007. Frogs have continued to breed every year since but with, as yet, no sign of recovery to their previous population size. This mortality rate was similar to the average declines reported in a wide-ranging study of *Ranavirus* effects in England (Teacher et al., 2010). Toad numbers were fewer, on average, after the outbreak but only by about 20% (an insignificant difference, P = 0.389) and water frogs also did not decline substantially although there were insufficient pre-2007 data for formal testing. No dead amphibians were found in the garden in any year subsequent to 2007. The mechanism by which *Ranavirus* causes mortality in summer remains mysterious. Deaths began several months after the animals congregated together for spawning and then extended over many weeks. Frogs and toads are solitary after the breeding season and live mostly away from water. Two midwife toads given to a friend just before the outbreak began survived for two weeks in a vivarium and then both died on the same day. Evidently there is a period of latency during which

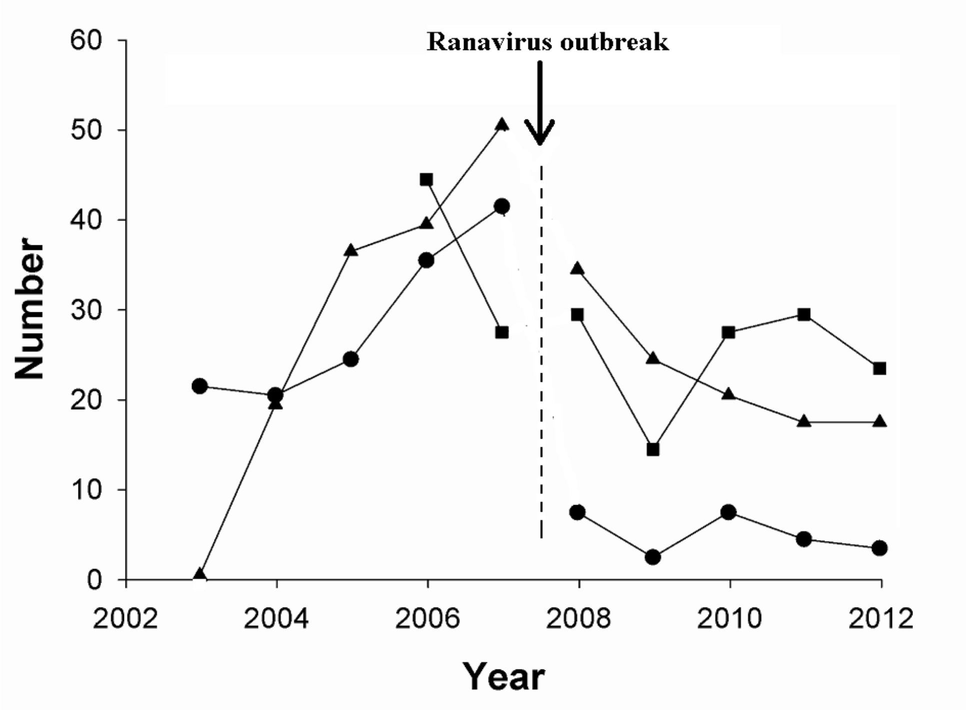

Figure 2. Amphibian numbers in the Woodingdean ponds, 2003-2012. ●, *R. temporaria* spawn clumps; ▲, *B. bufo*, largest number seen on single night; ■ , *P. lessonae*, largest number seen at one time basking in spring (no counts before 2006).

the infection develops but surely not long enough to explain the twelve week gap between spawning and the first dying as seen in Woodingdean. However, *Ranaviruses* may survive for long periods in water or on soil and have a fairly wide host spectrum so either or both of these properties may facilitate delayed infection.

ACKNOWLEDGEMENTS

Thanks to Amanda Duffus for collecting the dead amphibians and analysing them for the presence of *Ranavirus*.

REFERENCES

Balseiro, A., Dalton, K.P., del Cerro, A., Marquez, I., Cunningham, A.A., Parra, F., Prieto, J.M. & Casais, R. (2009) Pathology, isolation and molecular characterisation of a *Ranavirus* from the common midwife toad *Alytes obstetricians* on the Iberian peninsula. *Dis. Aquat. Org.* **84**, 95-104.

Beebee, T.J.C. (2007) Thirty years of garden ponds. *Herpetol. Bull.* **99**, 23-28.

Cunningham, A.A., Langton, T.E.S., Bennett, P.M., Lewin, J.F., Drury, S.E.N., Gough, R.E. & MacGregor, S.K. (1996) Pathological and microbiological findings from incidents of unusual mortality of the common frog (*Rana temporaria*). *Phil. Trans. Roy. Soc. B* **351**, 1539-1557.

Gray, M.J., Miller, D.L. & Hoverman, J.T. (2009) Ecology and pathology of amphibian *Ranaviruses*. *Dis. Aquat. Org.* **87**, 243-266.

Teacher, A.G.F., Cunningham, A.A. & Garner, T.W.J. (2010) Assessing the long-term impact of *Ranavirus* infection in wild common frog populations. *Anim. Conserv.* **13**, 514-522.

Anthropogenic sources of mortality in the western whip snake, *Hierophis viridiflavus,* in a fragmented landscape in Western France.

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ABSTRACT - Whip snakes (*Hierophis viridiflavus*) frequently enter urban areas and suffer mortalities as a consequence. Information collected over a seven year period in Vendée, Western France from 36 casualties indicated humans killed more snakes, particularly sub adults/hatchlings, than dogs or cats. Domestic cats killed only sub adults/hatchlings but dogs killed both size classes, mostly when they entered gardens. Adult snake mortalities occurred predominantly during May, which is the main period for reproduction; those of sub adults/hatchlings were more frequent during August/September, the period of dispersal from nest sites. Humans killed a little more than half of sub adults/hatchlings when they entered houses, frequently in the belief they were vipers (*Vipera aspis*). Snakes with total body lengths between 600 - 1000mm were killed in less than expected frequency compared to their frequency in a live sample whilst those of sub adults/hatchlings were greater than expected. However, questions of bias in the data base are likely for several reasons and this is discussed.

Mortality is a key factor in animal population dynamics affecting both abundance and population continuity and over extended time periods the evolution of anti-predator strategies, habitat selection and activity patterns occurs (Roff, 1992). Sources of mortality include predation, lack of nutrition, effects of injury and climate. Snakes also suffer mortalities from road vehicles in Europe and elsewhere (e.g. Bonnet et al., 1999; Andrews et al., 2006; Meek, 2009) with direct killing by humans, domestic dogs and cats adding to these numbers (Whitaker & Shine, 2000; Akani et al., 2002). In the bocage-dominated landscape of Western France where snakes have limited useable habitat, many species employ hedgerows as pathways for movement to reach prime habitat patches (Saint Girons, 1996). When these pathways are interrupted by urban structures snakes may be constrained to enter urban areas where, in addition to humans, they also encounter domestic animals increasing mortality risk (Rugerio & Luiselli, 2004). Mainly due to its wide foraging lifestyle (Coifi & Chelazzi, 1991; 1994, Arnold & Ovenden, 2002), the species most likely to enter urban environments in Western Europe is the whip snake *Hierophis viridiflavus* a habitat generalist attaining around two metres in length (Capula et al., 1997). Obtaining useful information on anthropogenic mortalities other than road-kill requires a data base with adequate sample size, but incidents are rarely reported. This paper presents information on anthropogenic related mortalities in *H. viridiflavus* in Western France.

MATERIALS AND METHODS

Data was collected between 2005 and 2011 in the Vendée region of Western France (46°27`N) and sourced from seven households where the owners reported snakes entering their properties. Five of these were situated close to the edge of or inside villages (St Denis-Du-Payre, Lairoux and La Brettoniere-La-Clay - see Meek, 2009 for map) with two households remotely situated between villages. Both of the latter had large ponds on their properties and were frequented by snakes, which included *H. viridiflavus*, grass snakes (*Natrix natrix*) and viperine snakes (*N. maura*). The study locality is a fragmented landscape consisting mostly of hedgerow bordered agricultural land linking small patches of woodland. When a report of mortality was received the snake was inspected and measured for total length (TL) and if possible sexed. Sub adult/hatchlings were defined as snakes with a maximum TL of 500 mm, the size when there is a change to adult pattern and colouration, which is attained around the 4 - 5th year (Arnold

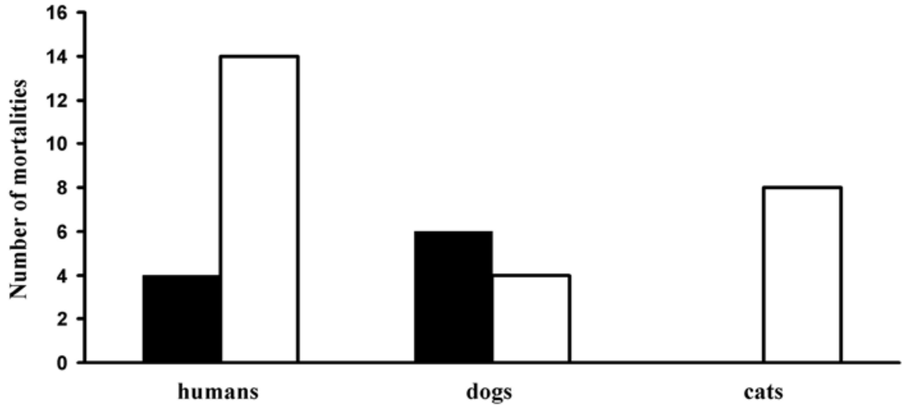

Figure 1. Sources of *H. viridiflavus* mortalities. Solid histograms represent adults, open histograms sub adults/ hatchlings.

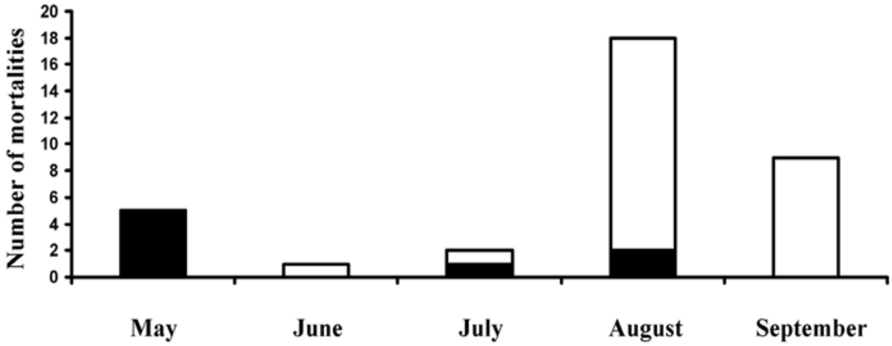

Figure 2. Seasonal distribution of mortalities indicating adult mortalities predominating in May and sub adult/ hatchlings mostly in August and September. Age class representations as in Fig 1.

& Ovenden, 2002). The date and nature of the mortality (i.e. from humans, dogs or cats) was noted and a photograph taken of the corpse and its injuries.

To test predictions of size class vulnerability to mortality the distribution was compared to the distribution of live snakes found in the study locality. The live sample included snakes crossing roads, moving in hedgerow corridors, basking at woodland edges and found under rocks etc. Capture of live snakes was not always possible so they were photographed first and their size estimated from some object in the immediate environment. After measurement all captured snakes were released at the point of capture but not marked. This means they could have been counted more than once but given the large area covered and time period involved, repeated capture or observation should have been minimal.

Statistical analysis. A Kolmogorov - Smirnov one sample test (designated D_{max}) was applied to monthly and annual mortalities to test for regularity. The test evaluates the degree the observed pattern of categorical frequencies differs from the expected under a null hypothesis. To test for monthly and

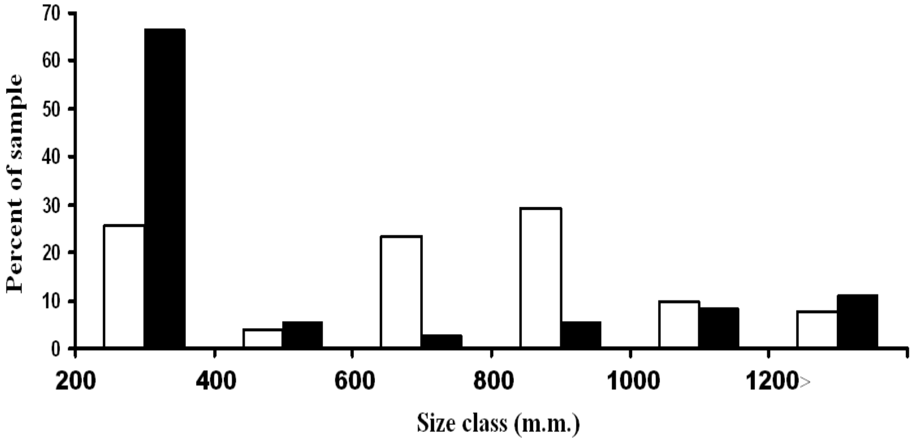

Figure 3. Size class distributions of observed frequencies of anthropogenic mortalities (n = 36) in relation to expected frequencies based on a live sample (n = 51). Solid and open histograms represent snake mortalities and live snakes respectively. See text for further details.

annual mortalities the null hypothesis was equal cell distribution. For size class related mortalities the live distribution (n = 51) was treated as the expected proportions with size class intervals set at 200mm increments. The major advantage of the Kolmogorov - Smirnov test over χ^2 is that it is not sensitive to cell size (i.e. <5) and for intermediate sample sizes is more powerful (e.g. Birnbaum & Tingey, 1951).

RESULTS

Between 2005 and 2011, 36 snakes (10 adults, 26 sub adults/hatchlings) were reported killed (Fig. 1). Mortalities ranged from 1-9 per annum (mean with standard deviation = 5.14±2.73) with no significant annual departures from regularity (D_{max} = 0.075, $p > 0.05$). Of the total found 18 (= 50% of which 11.1% were adults and 38.9% sub adults/hatchlings) were killed by humans, 10 (27.8%) by dogs and 8 (22.2%) by cats. Entry into houses (53.8%) was an important source of sub adult/hatchling mortality but reported on only one occasion in an adult. Cats killed or mortally injured sub adult/hatchlings mostly when they entered gardens (87.5% of casualties). Two snakes survived the initial cat attacks but succumbed within two days, despite no apparent surface wounds suggesting internal injury. Of 10 adults killed, 8 were males and 9 were killed at the remote households. The two largest snakes (males with TL`s 1320 & 1430mm) were shot by a landowner in the belief that they were persistently preying on ducklings at a farm pond. On only one occasion was there an attempt by either cat or dog to consume a freshly killed snake. This was by a Siberian Husky that killed a large male (TL = 1230m.m.). Mortalities from dogs and cats were usually caused by a deep penetrating single bite with no evidence of mastication.

Monthly mortalities deviated significantly from regularity (D_{max} = 0.371, $p< 0.01$; Fig. 2). August casualties were 154% greater than expected (mainly due to sub adult/hatchlings) but 85.7% and 71.4% less than expected during June and July respectively. Size class distribution of mortalities differed significantly from the distribution of live snakes (D_{max} = 0.429, $p<0.01$) with lower than expected mortalities in the 600 - 1000 size classes

(88.1 & 88.2% less than expected) but greater (161.4%) than expected for sub adults/hatchlings (Fig. 3).

DISCUSSION

Although insight is gained from this type of information there are questions of bias in the data base. For instance, only a limited number of households supplied information and hence only a subset of total mortalities recorded. Furthermore dogs and cats may inflict casualties out of view and domestic poultry that consume wall lizards (*Podarcis muralis*) are also capable of preying on small snakes. Despite these limitations size and seasonal differences in mortalities were identified. Large adults were found to be at risk from humans and dogs; cats were apparently only a threat to smaller snakes mostly when they entered gardens. Perhaps unexpected was the frequency that sub adult/hatchlings entered houses, where they were killed by local people on the assumption they were `vipers`. The extent of this practise is unknown but it is probably widespread and could impact on recruitment into the adult population.

Entering urban areas may be a non-optimal behaviour decision (Fahrig, 2007) but foraging movements alone do not explain the discrepancy between *H. viridiflavus* mortalities and those of sympatric *N. natrix* (n = 2) and *N. maura* (n = 0) both of which may also forage (Hailey & Davies, 1986; Nagy & Korsos, 1998; Wisler et al., 2008). Species abundance may partly explain the differences but anti-predator behaviour could also be relevant. Many snakes show hierarchical anti-predator behaviours but with crucial differences (for discussion see Duval et al., 1985). For instance, *H. viridiflavus* initially adopts passive defence such as flight followed by threat of bite. Striking out at the potential predator is a last resort but once this stage is reached aggressive defence persists in both adults and sub adult/hatchlings (pers. obs.). Confronted by a dog (or a cat in the case of small snakes) this is probably fatal since a strike or bite effectively decreases the distance between the snake and the predator and exposes key body areas to injury. Furthermore hedgerows provide limited escape opportunities with optimal movement possible in only two directions. The surrounding open habitat presents even greater predation risk. Both *Natrix* species resort to passive defence including death feigning or balling if flight is ineffective (e.g. Hailey & Davies 1987; Gregory et al., 2007; Gregory 2008), which may reduce predatory instinct in dogs or cats.

The results are in good agreement with a study in Italy where Rugiero & Luiselli (2004) found *H. viridiflavus* sustained injuries - mainly from cats, when they entered urban areas on the outskirts of Rome. Research on other species gave similar results. Around 50% of snake mortalities in towns and villages in tropical Africa were due to humans (Akani et al., 2002); in Australia venomous species were among the snakes killed by people and domestic cats in urban areas (Whitaker & Shine, 2000). Reading et al., (2010) have drawn attention to a possible global decline in snake populations whilst Dodd (1987) cites malicious killing as a significant conservation issue and hence mitigation to reduce any possible decline is needed. Mortalities from domestic animals are difficult to eliminate but direct killing by humans, especially due to misidentification or perceiving defensive displays as attacks requires mitigation to reduce snake mortalities. This could take the form of education in schools or posters in village halls identifying venomous and non-venomous species along with basic information on behaviour.

REFERENCES

Akani, G.C., Eyo, E. Odegbune, E., Eniang, E.A. & Luiselli, L. (2002). Ecological patterns of anthropogenic mortality of suburban snakes in an African Tropical region. *Israel J. Zool*. **48**, 1 -11.

Andrews, K.M., Gibbons, J.W. & Jochimson, D.M. (2006). *Literature Synthesis of the Effects of Roads and Vehicles on Reptiles and Amphibians*. Washington D.C. Federal Highway Administration (FHWA),US Department of Transportation, Report No FHWA-HEP-08-005.

Arnold, N & Ovenden, D. (2002). *Field Guide to Reptiles and Amphibians of Britain and Europe.* HarperCollins, London.

Birnbaum, Z.W. & Tingey, F.H., (1951). One sided confidence contours for probability distribution function. *Ann. Math. Stat.* **22**, 592-596.

Bonnet, X. Naulleau, G. & Shine, R. (1999). The dangers of leaving home: mortality and dispersal in snakes. *Biol. Conserv.* **89**, 39–50.

Capula, M., Filipi, E., Luiselli, L. & Jesus, V.T. (1997). The ecology of the western whip snake, *Coluber viridiflavus*, in Mediterranean Central Italy. *Herpetozoa* **10**, 65 - 79.

Coifi, C. & Chelazzi, G. (1991). Radio tracking of *Coluber viridiflavus* using external transmitters. *J. Herp.* **25**, 37 - 40.

Ciofi, C. & Chelazzi, G. (1994). Analysis of homing pattern in the colubrid snake *Coluber viridiflavus*. *J. Herp.* **28**, 477 – 484.

Dodd, K. (1987). Status, conservation and management. In, *Snakes. Ecology and Evolutionary Biology*. Seigel, R.A., Collins, J.T. & Novac, S. S. (Eds) pp 478 – 513. MacMillan, New York.

Duvall, D., King, M. B. & Gutzwiller, K. J. (1985) Behavioural ecology and ethology of the prairie rattlesnake. *Natl. Geogr. Res.* **1**, 80 - 111.

Fahrig, L. (2007). Non-optimal animal movement in human-altered landscapes. *Funct. Ecol.* **21**, 1003-1015.

Gregory, P. T. (2008). Bluffing and waiting: handling effects and post-release immobility in a death-feigning snake (*Natrix natrix*). *Ethology* **114**, 768 - 774.

Gregory, P. T., Isaac, L. A. & Griffiths, R. A (2007). Death feigning by grass snakes (*Natrix natrix*) in response to handling by human "predators." *J. Comp. Psychol.*, **121**, 123-129.

Hailey A. & Davies P. M. C. (1986). Diet and foraging behaviour of *Natrix maura*. *Herpetol. J.* **1**: 53-61.

Hailey, A. & Davies, P.M.C. (1987). Effects of size, sex, temperature and condition on activity metabolism and defence behaviour of the viperine snake *Natrix maura*. *J. Zool. Lond.* **208**, 541 - 558.

Meek, R. (2009). Patterns of reptile road-kills in the Vendée region of Western France. *Herpetol. J.* **19**, 135 – 142.

Nagy, Z. T. & Korsos, Z. (1998). Data on movements and thermal biology of grass snake (*Natrix natrix* L.) using telemetry. In *Current Studies in Herpetology* pp 339 – 343 Miaud, C. & Guetant, R. (Eds.). France (SEH 1998): Le Bourget du Lac.

Reading, C. J., Luiselli, L. M., Akani, G. C, Bonnet, X., Amori, G., Ballouard, J. M., Filipi, E., Naulleau, G., Pearson, D. & Rugiero, L. (2010). Are snakes in widespread decline? *Biology Letters* **6**, 777 - 780.

Roff, D. A. (1992). *The Evolution of Life Histories: Theory and Analysis.* Chapman and Hall, New York.

Rugiero, L. & Luiselli, L. (2004). Ecological notes on two colubrid snakes (*Coluber viridiflavus* and *Elaphe longissima*) in a suburban habitat (Rome, central Italy). *Herpetol. Bull.* **87**, 8 – 12.

Saint Girons, H. (1996). Structure et evolution d`une petite population de *Vipera aspis* (L) dans une region de bocage de l`ouest de la France. *Terre Vie-Rev. Ecol.* A **51**: 223 – 241.

Whitaker, P. B. & Shine, R. (2000). Sources of mortality of large elapid snakes in an agricultural landscape. *J. Herp.* **34**, 121 - 128.

Wisler, C. Hofer, U. & Arletta, R. (2008). Snakes and monocultures: habitat selection and movements of female grass snakes (*Natrix natrix* L) in an agricultural landscape. *J. Herp.* **42**: 337 – 346.

Management of problem saltwater crocodiles (*Crocodilus porosus* Schneider) - A case study in the Andaman and Nicobar Islands, India

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ABSTRACT - The Andaman and Nicobar Islands comprise a chain of 349 major islands and 223 islets and rocky outcrops, extending over 800km² in the Bay of Bengal between latitudes 06º and 14º N and longitudes 92º and 94º E. The archipelago has a total land area of 8249 km² and a coastline of 1962 km. The Saltwater Crocodile *Crocodilus porosus* is a common species throughout the Andaman and Nicobar Islands. It can be encountered in open sea, near the shore, mangrove creeks, freshwater rivers and in swamps. Human-animal conflicts have increased with exploitation of natural forest resources in India. The growth of human population, intensified land-use, increased livestock population e.g. goat, cattle, dog, poultry etc., human pressure, modification of natural resources, habitat fragmentation, and lack of foresight in the implementation of policies are some of the factors behind the current disputes. Crocodile attacks on human beings and livestock have been reported since the early 1970s in the Andaman and Nicobar Islands. Recently, a crocodile killed a woman snorkelling at the famous Radha Nagar Beach, Havelock forest division. Immediately, the Department of Environment and Forests of the Andaman and Nicobar Administration urged locals to be vigilant of the presence of crocodiles around Radha Nagar Beach, and a warning sign board was placed on the beach. The Forest Department decided to capture the problematic crocodile, and gathered a team to do so. The captured crocodile was transported and released into the mini zoo at Port Blair, and peace was restored at Radha Nagar Beach. In such a situation, removal of the problem crocodile might provide a temporary fix, but another male will eventually dominate the creek, and may again be a threat to tourism. Possible reasons for crocodile attack on humans include defending individual territories, attractive food-sources such as livestock and other domestic animals, and dumping of high-protein waste food materials on banks or beach areas. The indigenous technology developed for capturing the crocodile is discussed in this paper.

The Andaman and Nicobar islands comprise 572 islands, extending over 800 km. These islands were once a part of the Asian mainland, but were detached some 100 million years ago during the Upper Mesozoic period due to geological upheaval. The existing group of islands constitute the physiographic continuation of the mountainous ranges of the Naga and Lushai Hills, and Arakan Yoma of Burma, through Cape Negrais to the Andaman and Nicobar Islands, and southeast Sumatra. The chains of these islands are the seven 'camel backs' of submerged mountain ranges projecting above sea level, running north to south between 6°45' N and 13°30' N latitudes, and 90° 20' E and 93°56' E longitudes. These islands are tropical, with a warm, moist and equable climate. The proximity of the sea and the abundant rainfall prevent extremes of heat. The mountainous parts of the southern islands receive about 300 cm of rain annually, whereas the northern islands receive less. The period from December to February is comparatively cool due to the effect of the northeast monsoon. Warm weather extends from March to April, the driest months. In May, the southwest monsoon breaks over the area, and continues until October. The variation of temperature over the islands is relatively small (23-31° C).

The crocodiles are among the only living remnants of reptiles which ruled during the Mesozoic era. Crocodiles are top predators, and as such, perform an important role in maintaining the structure and function of ecosystems (Glen et al., 2007; Leslie & Spotila, 2001; Ross, 1998). They are sometimes described as 'living fossils', highly-evolved and superbly designed for the environment in which they live. In the Indian subcontinent, three species of crocodile occur: the Gharial (*Gavialis gangeticus*), the Saltwater crocodile (*Crocodylus porosus*), and the Mugger crocodile (*Crocodylus palustris*). The diet of crocodiles varies with age, with small crocodiles depending mainly on invertebrates and fish, and adults feeding on large animals including livestock and humans (Ross, 1998).

Crocodiles are declining on a global scale (Whitefield Gibbons et al., 2000). Out of 23 crocodilian species, seven are listed as endangered or critically endangered on the IUCN red list (CSG, 2008). Habitat loss and degradation, introduced invasive species, environmental pollution, disease, unsustainable use and global climatic change have been suggested as the most significant threats (Whitefield Gibbons et al., 2000). The saltwater crocodile occurs in the Andaman and Nicobar Islands, where it grows over 6m in length, and can be encountered in open sea, near the shore, mangrove creeks, freshwater rivers, and swamps.

Early literature on crocodiles in India mainly dealt with the biology of the species, and documentation of folklore (D'Abreu, 1915; McCann, 1935; Dharam, 1947). De Vos (1982) prepared a manual on crocodile conservation and management in India which formed the basis for crocodile conservation in India. Ross et al. (2000) discussed the problems of success in crocodile conservation. Many authors reported on aspects such as conservation (Bustard, 1975; Chaudhury & Bustard, 1975), sexing of crocodiles in captivity (Kar & Bustard, 1979), growth of captive crocodiles (Krishnamurthy & Bhaskaran, 1979; Krishnamurthy, 1980; Bustard & Chaudhury, 1980; 1981), attacks on domestic livestock and man (Kar & Bustard, 1981; 1983), food requirement and movement (Singh, 1984a,b; Rao & Chaudhury, 1992) and other issues (Sagar & Singh, 1993; Kumar et al. 1999; Pillai, 1999).

. In recent years, human-wildlife conflict has increased worldwide due to growing human populations and associated land use changes (Madden, 2004). Crocodile and alligator attacks are increasing in many parts of the world (Langley, 2005). Many researchers have highlighted these conflict trends in developed nations, including saltwater crocodiles in Australia (Caldicott et al., 2005), Mississippi alligators (*Alligator mississippiensis*) in the USA (Langley, 2005), and mugger crocodiles in Neyyar Wildlife Sanctuary, India (Jayson et al., 2006). Human-crocodile conflict in the Andaman and Nicobar Islands has been poorly documented however. The aim of this study was to assess saltwater crocodile populations, and examine issues of human-crocodile conflict and management of problem crocodiles.

MATERIALS AND METHODS

To assess the population of crocodiles in the Andaman and Nicobar Islands, data were collected by examination of the available literature. Several personal sightings were also included. Information on human-crocodile conflicts was quantified by interviewing victims, questionnaires, and by visiting sites where attacks have occurred.

RESULTS AND DISCUSSION

Population estimates of saltwater crocodiles in the Andaman and Nicobar Islands are presented in Table 1. The highest number of crocodiles was reported from the North Andaman Islands, followed by Landfall Island.

Human-crocodile conflicts

About 26 crocodile attacks were reported between 1986 until the present in the Andaman and Nicobar Islands. Details of the various attacks are presented in Table 2. During the period of the present study, no specific time was observed in the pattern of attacks. The attacks took place near the shore and in mangrove creeks. In some cases, there is a relationship with the dumping of waste food on the sea shore. If crocodiles followed regular patterns of such activity, it might have helped them to locate humans, and wait for their arrival. All the attacks followed the known pattern of hunting behaviour reported in crocodiles (Daniel, 1983; Jayson et

Islands	Number of individuals	Reference / Source
North Andaman	15 breeding females; (100 - 200 total)	Whitaker & Whitaker, 1978
North Andaman	50 breeding females	Choudhury, 1980; Choudhury & Bustard 1979
North Andaman	95	Andrews & Whitaker, 1994
Landfall Island	38 adults	Andrews & Whitaker, 1994
North Andaman Islands, North Reef, and Interview Islands	31 adults 10 nests	Andrews & Whitaker, 1994
Middle Andaman	17 adults 9 sub-adults 15 juveniles	Andrews, 1997
Little Andaman	27 adults 11 sub-adults	Andrews, 1997
Rutland, Tarmugli	19 adults 35 sub-adults	Andrews, 1997
Baratang Island	2 adults	Sivaperuman 2008 (Pers. Observation)
South Andaman (Whimberligunj, Tushnabad, Marina Park, Corbynscove, Caddlegunj)	5 adults 1 sub-adult	Senthil Kumar 2011 (Pers. Observation)
Great Nicobar (Indira Point, Mahar Nallah, Gandhi Nagar, Shastrinagar)	6 adults 3 sub-adults	Questionnaire

Table 1. Crocodile population estimates in the Andaman and Nicobar Islands

al. 2006). Large crocodiles over 3 m length were involved in all the major and fatal attacks. Any individuals that occur within areas of recreational use or human occupation can be defined broadly as 'problem crocodiles.'

Capture and translocation of a problematic crocodile

The Andaman and Nicobar police confirmed that a 25-year-old American tourist was missing from Radha Nagar Beach, Havelock. After a massive search operation, the decomposed body of Lauren Elizabeth Failla was recovered. Immediately, the Department of Environment and Forests urged locals to be vigilant of the presence of crocodiles around the Radha Nagar Beach area, and a warning sign board was placed on the beach. The Department of Environment and Forests decided to capture the problematic crocodile, in the hope of solving the problem immediately, and a team was gathered for the purpose. The identification of the crocodile was confirmed from a video recording from an underwater video camera which was recovered from the scene, and the characteristic features of the animal were studied thoroughly. The animal was monitored by direct and indirect observation in shallow water, mudflats, mangroves and creeks. It was an adult male and 4.25 meters in length.

Accessories and equipment used for capturing the crocodile

The following locally-available and indigenously-developed materials were used for capture the crocodile: floating cage of cane and bamboo, harpoons, wire mesh, nylon rope, bamboo pole,

Location	Number of Crocodile attacks	Reference / Source
North Andaman (Kalighat, Kishorinagar and Paschimsagar)	4	Andrews, 1997
South Andaman (Tirur Creek and Shoal Bay Creek)	3	Andrews, 1997
Middle Andaman (Kadamtala Creek, CFO Nallah & Rangat Nallah)	3	Andrews, 1997
Middle Andaman (Kadamtala, Kora Nallah)	2 (1 killed)	Questionnaire & Forest Department Records
Baratang Island	2 (killed)	Questionnaire & Forest Department Records
South Andaman (Havelock, Whimberligunj, Tushnabad, Beach Dera)	6 (4 killed)	Questionnaire & Personal observation
Little Andaman (Machi Dera, Nanchappa Nagar, Nethaji Nagar)	6 (4 killed)	Questionnaire & Forest Department Records

Table 2. Numbers of crocodile attacks in the Andaman and Nicobar Islands between 1986 - until present

jerry cans, bundles of discarded PET bottles, fishing buoys, dinghy, and chicken for bait. Three traps were placed in potential sites used by the crocodile.

Capture of the problem crocodile
After two months of attempts, the problem crocodile was captured. It measured 4.25m in length, an adult male and 480 kilograms of weight. Three floating cages, two sets of net and noose traps were laid in the territory of the crocodile. On 6th June 2010 at 2245 hours, we started routine monitoring activity from Char Nariyal Camp by small fibre boat and loaded with harpoon, search lights, reserve fuel, ropes, mosquito repellents and water. The search was continued, and around 0115 hours we reached the last cage, it was the splashing sound of water which was alerted us. Our Forest Guard spotted the animal first and alerted the team, which was struggling in the cage. The animal sensed our presence and warned us by groaning and performing a couple of dead rolls in despair to cut the jaw rope. At that moment, we decided to harpoon the animal to avoid escape. The harpoon was a small piece of metal with two sharp inward curving hooks. The metal hook was tied with a 20 m nylon rope and a buoy. Our team made an attempt to place an additional top jaw rope from the boat using a pole. Unfortunately, the jaw rope present in the crocodile was on the initial portion of the snout and was not allowed to insert any more noose. Two of our Forest Guards decided to risk their life by walking close to the animal from the side of mangrove to insert the noose from the inner jaw of the crocodile using a stick. It worked and two additional top jaw ropes were placed. Immediately, the tail was also secured by another team, and then the animal movement was controlled. Thereafter, the animal was secured to the nearby trees at 0400 hours. The captured crocodile was secured in the stretcher, transported to Havelock jetty by dinghy, and subsequently translocated to the Mini Zoo at Port Blair.

This action by the Department of Environment and Forests restored safety and wellbeing for tourists and the local population in Havelock, at least in the short term. However, in such a situation, removal of the problematic crocodile might only solve a people problem temporarily. Following battles for supremacy, another dominant male will inevitably dominate the area, and may again pose a threat to people and livelihoods.

Possible reasons for attacks

Crocodile habitat destruction and sharing of the same habitat (syntopy) by humans and crocodiles are the major reasons for such human-crocodile conflict. The increasing human activities such as fishing in the mangrove areas, and crossing the creeks without adequate protection, result in crocodile attacks on humans. One of the possible reasons for attacks on people is territorial defense. During the breeding season from May to June, females are laying eggs and defending nests, and attacks are more common. Dominant males are also likely to defend individual territories.

The presence of livestock and other domestic animals on the sea shore may also attract crocodiles to inhabited areas. In addition, the dumping of waste food materials on the sea shore provides an added attraction for the crocodiles e.g. chicken waste, fish waste, other food waste etc. The high human population density on the sea shore contributes to the human-crocodile conflict. The best solution is to change people's behaviour so that they are unlikely to encounter crocodiles. The provision of enclosures within which people can access the water's edge in safety to use the beaches is possible on the Andaman and Nicobar Islands. It is also possible to manipulate the size distribution of the crocodiles by removing some of the larger and more dangerous individuals to other locations in the Islands (Ross, 1998). The relocation problem of crocodiles has been suggested as a management strategy in Australia (Walsh & Whitehead, 1993).

Community Awareness and Participation

The Department of Environment and Forests in the Andaman and Nicobar Islands promotes crocodile awareness among residents and visitors by disseminating educational information via brochures, pamphlets and warning boards. A public awareness campaign is repeated regularly to minimise crocodile attacks, with sign boards placed at popular beaches. A research programme is recommended, to monitor the effectiveness of policies and human-crocodile relationships in the Andaman and Nicobar Islands, in order to minimise human-crocodile conflict in the future.

REFERENCES

Andrews, H.V. 1997. *Population dynamics and ecology of the saltwater crocodile (*Crocodylus porosus *Schneider) in the Andaman and Nicobar Islands.* Interim report. Phase III. Submitted to the Andaman and Nicobar Forest Department and the Centre for Herpetology (AN/C-3-97). 6 pg.

Andrews, H.V. & R. Whitaker. 1994. *Population dynamics and ecology of the saltwater crocodile (*Crocodylus porosus *Schneider) in the Andaman and Nicobar Islands*. Interim survey report. Phase II. Submitted to the Andaman and Nicobar Forest Department and the Centre for Herpetology (AN/C-2-94). 18 pg.

Bustard, H.R. 1975. Crocodile conservation in India. *Tiger Paper* **2**, 17.

Bustard H.R. & B.C. Chaudhury 1980. Parental care in the Salt water crocodiles (*Crocodylus porosus*) and management implications. *J. Bombay nat. Hist. Soc.* **77**, 64-69.

Bustard, H.R. & B.C. Chaudhury 1981. Marking crocodiles for release back into the wild for subsequent identification. *Indian Forester* **102**, 447-485.

Caldicott, D.G.E., D. Croser, C. Manolis, G. Webb & A. Britton 2005. Crocodile attack in Australia: An analysis of its incidence and review of the pathology and management of crocodilian attacks in general. *Wilderness & Environmental Medicine* **16**, 143-159.

Choudhury, B.C. 1980. The status, conservation and future of the saltwater crocodile (*Crocodylus porosus*, Schneider) in North Andaman Island, Union Territory of Andaman & Nicobar Islands. Indian Crocodiles- Conservation and Research. *Occl. Publ*. **No. 1**. pp 1-7.

Chaudhury, B.C. & H.R. Bustard 1975. Restocking Mugger crocodile *Crocodylus palustris* (Lesson) in Andhra Pradesh: Evaluation of a pilot release. *J. Bombay nat. Hist. Soc.* **79**, 275-289.

Choudhury, B.C. & H.R. Bustard 1979. Predation on natural nests of the saltwater crocodile

(*Crocodylus porosus* Schneider) on North Andaman island with notes on the crocodile population. *J. Bombay nat. Hist. Soc.* **75**, 43-49.

CSG 2008. Conservation Status, Vol. 2008. IUCN - Crocodile Specialist Group.

D' Abreu, E.A. 1915. Note on the Mugger (*Crocodilus palustris*) contents of their stomach's, folklore, etc. *J. Bombay nat. Hist. Soc.* **23**, 780.

Daniel, J.C. 1983. *The Book of Indian Reptiles*. Bombay Natural History Society. pp11.

De Vos, A 1982. *A Manual on Crocodile Conservation and Management in India*. FAO Project IND/82/003, Dehra Dun, Uttar Pradesh.

Dharam, A.K. 1947. Mating and the parental instinct of the Marsh crocodiles (*Crocodilus palustris*). *J. Bombay nat. Hist. Soc*. **47**, 175.

Glen, A.S., C.R. Dickman, M.E. Soule & B.G. Mackey 2007. Evaluating the role of the dingo as a trophic regulator in Australian ecosystems. *Austral Ecology* **32**, 492-501.

Jayson, E.A., C. Sivaperuman & P. Padmanabhan 2006. Review of the reintroduction programme of the Mugger crocodile *Crocodylus palustris* in Neyyar Reservoir, India. *Herpetological Journal* **16**, 69-76.

Kar, S.K. & H.R. Bustard 1979. Sexing of crocodiles in captivity. *Indian Forester* **106**, 545-546.

Kar, S.K. & H.R. Bustard 1981. Attacks on domestic livestock by the saltwater crocodiles (*Crocodilus porosus*) in Orissa, India. *British Journal of Herpetology* **6**, 135-136.

Kar, S.K. & H.R. Bustard 1983. Saltwater crocodile attacks on man. *British Journal of Herpetology* **25**, 377-382.

Krishnamurthy, V.S. 1980. Some observations on the growth of captive crocodiles. *J. Bombay nat. Hist. Soc.* **77**, 516-521.

Krishnamurthy, V.S. & R. Bhaskaran 1976. Growth studies on two species of crocodiles in captivity. *J. Bombay Nat. Hist. Soc.* **73**, 532-533.

Kumar, V.V., R. Vayas & B.C. Chaudhury 1999. Status of Mugger in Gujarat State (India). *Crocodile Specialist Group Newsletter* **18** (2), 7-8.

Langley, R.L. 2005. Alligator attacks on humans in the United States. *Wilderness & Environmental Medicine* **16**, 119-124.

Leslie, A.J. & J.R. Spotila 2001. Alien plant threatens Nile crocodile (*Crocodylus niloticus*) breeding in Lake St. Lucia, South Africa. *Biological Conservation* **98**, 347-355.

Madden, F. 2004. Creating coexistence between humans and wildlife: global perspectives on local efforts to address human-wildlife conflict. *Human Dimensions of Wildlife* **9**, 247-57.

McCann, C. 1935. The Mugger (*Crocodilus palustris*) feeding on large water beetles (*Cybister* sp.). *J. Bombay nat. Hist. Soc.* **38**, 409.

Pillai, K.G.M. 1999. Crocodile conservation in Kerala. *Envis* **2** (1), 58-61.

Rao, R.J. & B.C. Chaudhury 1992. Sympatric distribution of gharial Gavialis gangeticus and Mugger (*Crocodylus palustris*) in India. *J. Bombay nat. Hist. Soc.* **89** (3), 312-315.

Ross, J.P. 1998. *Crocodiles. Status Survey and Conservation Action Plan*, 2nd edition. IUCN/SSC Crocodile Specialist Group. IUCN, Gland, Switzerland and Cambridge UK.

Ross, J.P., M.S. Cherkiss & F.J. Mazzotti 2000. Problems of success: Conservation consequences of crocodilian-human conflict. Pp. 442-445 In *Crocodiles, Proceedings of the 15th Working Meeting of the Crocodile Specialist Group*, IUCN-The World Conservation Union, Gland Switzerland and Cambridge UK.

Sagar, S.R. & L.A.K. Singh 1993. Captive breeding and rehabilitation of Mugger crocodile (*Crocodylus palustris*) in Similipal Tiger Reserve, Orissa, India. *Indian Forrester*. **119** (10), 807-815.

Singh, L.A.K. 1984a. Observations on food requirement and food conservation in the Mugger (*Crocodilus palustris*) reared in captivity. *J. Bombay nat. Hist. Soc.* **80**, 418 – 423.

Singh, L.A.K. 1984b. Observations on the movement of two captive- reared Mugger crocodiles, *Crocodylus palustris* Lesson when returned to the wild. *J. Bombay nat. Hist. Soc.* **80**, 86-90.

Walsh, B. & P.J. Whitehead 1993. Problem crocodiles, *Crocodylus porosus*, at Nhulunbuy, Northern Territory: An assessment of relocation as a management strategy. *Wildl. Res*. **20** (1), 127-135.

Whitaker, R. & J.C. Daniel 1978. The status of Asian crocodiles. *Tiger Paper* **5**, 6.

Whitaker, R. & Z. Whitaker. 1978. A preliminary survey of the saltwater crocodile (*Crocodylus porosus*) in the Andaman Islands. *J. Bombay nat. Hist. Soc.* **76**, 311-323.

Whitfield Gibbons, J., David, E., Scott, B., Travis, J., Ryan, B., Kurt, A., Buhlmann, C., Tracey, D., Tuberville, B., Brian, S., Metts, B., Judith, L., Greene, B., Tondy Mills, B., B., Y.L., Sean Poppy, B., Christopher, T., & Winne, B. (2000) The global decline of reptiles, Déjà Vu Amphibians. *BioScience*, 653–666.

Local distribution and notes on reproduction of *Vitreorana aff. eurygnatha* (Anura: Centrolenidae) from Sergipe, Northeastern Brazil

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ABSTRACT - Species of the family Centrolenidae are poorly known, especially concerning the basic features of their natural history, especially those distributed at eastern Brazil. During the rainy season of 2006, we studied the local-scale pattern of spatial distribution and some aspects of reproduction, including behaviour, of a population of *Vitreorana aff. eurygnatha* from Sergipe State, Brazil. Individuals were clumped-distributed and reproduced on vegetation overhanging streams, between 0.30 and 4.00m height. The species exhibits sexual dimorphism in size, with females slightly larger than males. Their egg clutches consisted of about 18 eggs and were laid mostly on the upper side of leaves. We also describe the overall calling pattern and present the first record of chorus leadership in Centrolenidae. Additional ecological traits plus some notes of a male-female and a male-male encounter are presented and compared to other Hyalinobatrachinae glass-frogs.

INTRODUCTION

Glass-frogs (Anura: Centrolenidae) are amongst the largest endemic families of the Neotropical anurans, with 148 species recognized (Cisneros-Heredia et al. 2009). They are geographically distributed from Mexico to Argentina and Brazil and show recognizable ecological features concerning microhabitat use and reproductive mode (Cisneros-Heredia & McDiarmid, 2007). The latter consists of the deposition of a jellylike mass of eggs on leaves or rocks along streams, where advanced staged exotrophic larvae fall or are washed down to the water to develop (Cisneros-Heredia & McDiarmid, 2003, 2006).

Recent studies have stressed the taxonomic and phylogenetic relationship among glass-frogs (Cisneros-Heredia & McDiarmid, 2006, 2007; Guayasamin et al., 2009), but the knowledge on population ecology, behaviour and reproductive biology are remarkably scarce, particularly from those species distributed in eastern Brazil (Cisneros-Heredia & McDiarmid, 2003, 2007). Available data on the autoecology of Centrolenids generally consist of naturalistic reports (e.g. Duellman & Tulecke, 1960; McDiarmid & Adler, 1974; Greer & Wells, 1980; Bolívar et al., 1999) or notes on natural history from taxonomic comparison and description of new taxa (e.g. Ruiz-Carranza & Lynch, 1991; Cisneros-Heredia & McDiarmid, 2006). Generally they conform to the overall ecological traits of glass-frogs, but specific characterization is still limited.

A population of glass-frogs at the Brazilian State of Sergipe was first recorded by Carvalho et al. (2005). We studied this population to examine the local pattern of spatial distribution and reproductive traits related to breeding site, clutches and behaviour and compare the observed features

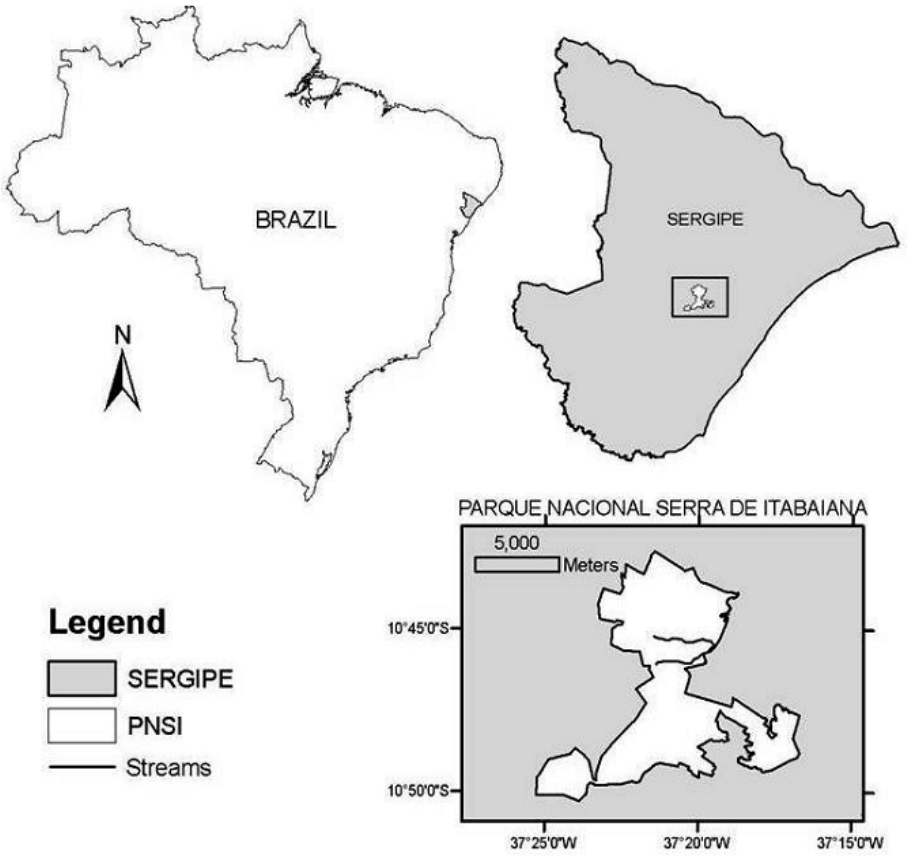

Figure 1. Location of the study site, PNSI, Sergipe State, Brazil.

to some other species of Centrolenidae.

MATERIAL AND METHODS

The study was conducted at the protected area Parque Nacional Serra de Itabaiana (PNSI) (10°45'S, 37°20'W), Sergipe state, Northeast Brazil (Fig. 1). The PNSI encompasses 7,966 ha of a small and round-shaped mountain region inserted at the Atlantic Forest biome (IBGE, 2004). The local altitude ranges from 200 to 670 m and the local climate is A's according to Köppen's classification – tropical with dry and moderate summer and hydric excess at winter – with an annual precipitation between 1100 and 1300 mm (Ab'Saber, 1967).

Observations were carried out during the rainy season, once a week, between May and August

X_i	f_i	Px_i	F_i
0	141	0.666	199.988
1	21	0.270	48.654
2	10	0.055	9.864
3	3	0.007	1.332
4	4	0.000	0.126
5	1	0.000	0.108
6	0	0.000	0.000

Table 1. Frequency of occurrence (f_i) of different amounts of individual (x_i) per section with the associated probabilities (Px_i) and Chi-square statistics (F) for a Poisson distribution.

		Action	
Time (am)	Distance	Male	Female
00:56	1 m	Calling on shrub	On the same plant
00:57 to 01:03	1 m to 10 cm	Keeps calling	Moving towards the male
01:04	10 cm	Calling	On the same leaf as the male
01:06	0	Clasps the female	Standing
01:30	0	Clasping	Displaces at nearby leaves
02:52	0	Clasping	Laid the clutch
02:53	0	Immediately released female and emitted calls	Stayed near the clutch until dawn.

Table 2. Sequence of events of a male-female encounter of *Vitreorana aff. eurygnatha* at Água Fria Stream, PNSI, Sergipe. Distance between individuals are aproximations.

2006. Visits lasted from one to four consecutive days, beginning at 18:00hrs to 00:00h local time. Two streams, Coqueiro (37°20'48"W; 10°45'57") and Água Fria (37°20'35"W; 10°45'19"S), were surveyed by walking through the stream beds.

To assess the individual pattern of spatial distribution (clumped, random or uniform) we surveyed the streams in segments of four meters lengths throughout each margin (resulting in two parallel lines of segments). This summed 360 meters along both streams, totalizing 180 sections. We then determined the presence of individuals along the streams margins, by systematically examining leaves, tree trunks and rocks, counting all individuals within each segment. During the search we recorded the substrate, height of perching, time of activity and any relevant behaviour, which were recorded ad libitum. We also recorded characteristics of the clutches and sites of oviposition, such as clutch size, height from the surface (water or ground), face of the leaf used (upper side or lower side) and size and texture of the leaves.

Six male-female pairs were captured and held in plastic bags to obtain clutches. Each individual had its snout-vent length (SVL) measured to test for sexual dimorphism and all clutches and eggs were measured to the nearest 0.01 mm immediately after deposition.

The pattern of spatial distribution was analyzed through Poisson distribution with a Chi-square goodness-of-fit test. The preference for the leaf side was tested through the Chi-square test and Student t test was used to verify sexual dimorphism (Zar, 1996). All tests were considered significant at ≤ 0.05.

RESULTS

During the visits the temperature varied from 20 to 27°C, and the moisture from 66 to 81%. The rain was irregular and individuals were active in the absence of rainfall. We recorded 69 individuals, which showed a clumped pattern of local distribution $\chi^2 = 6.5148$; df = 179; $p < 0.001$) along the streams (Table 1). Groups of frogs distanced each other from 4 to 24 m, with no more than four individuals per segment and nine individuals (including males and females) per group, considering consecutive occupied segments. Individuals used marginal vegetation along the streams as breeding sites. The height of perching varied from 0.30 to 4.00 m. The size of leaves used as calling site ranged from 7x4 cm to 28x11 cm and all leaves had a totally glabrous (smooth) limb. The main species of plant used was Inga sp. (Leguminosae), followed by Bonnetia stricta (Theaceae), Heliconia sp. (Heliconiaceae), epiphites in tree trunks and others less frequently. The upper (adaxial) surface of the leaves was significantly preferred for egg-laying (77% of clutches, n= 62; $\chi^2 = 22.35$; df = 1; $p < 0.001$). The clutches consisted of gelatinous, circular, and transparent mass of individual capsules involving cream-colored to greenish eggs. Immediately after the deposition, the clutches measured approximately 10 mm in diameter, and eggs about 2.18 ± 0.23 mm. The surrounding gelatinous layers were thin and doubling their diameter once in contact with water. Clutch size varied from 10 to 25 eggs (17.77 ± 2.70 mm). Adults were not seen attending clutches.

Females were significantly larger (20.55 ± 0.79 mm) than males (18.18 ± 0.60 mm), (t = 7.41; df = 11; $p < 0.001$). Males were observed calling alone or forming choruses of up to six individuals, not necessarily from the same group. After the first male's call, others replied, including males from a different group distant by a few meters. The sequence of vocalizations always started by the same individual, and always followed the same order, remaining in silence from 30 seconds to 2 minutes, until the next sequence.

We observed only two encounters: one involving a male and a female (cohort followed by amplexus), and a second between two males. The male-female encounter lasted almost two hours (see full description in Table 2) similar to the time of interaction between pairs inside plastic bags. The male-male encounter lasted around 25 minutes and involved a calling male and a silent one. During the encounter, the latter frog remained in a flattened position, while the former called continually. After four minutes standing 20 cm apart from each other, the calling male hopped closer to the non-caller one, i.e., on the same leaf, remaining in an upright stance while calling for 20 minutes until it left the site. In both encounters only one type of call was heard.

DISCUSSION

Among amphibians the pattern of clumped distribution is common and known as 'lek behaviour' (Wells, 1977). It is also widespread among birds, mammals and insect (Hoglund & Alatalo, 1995), in which males position themselves close to each other, while attracting females, which in turn move among the males to select a mate. According to Wells (1977), this behaviour is not fully understood but might be related to the scarcity of resource (space) or due to the mechanisms of female choice. We favour the latter explanation, since we noted many vacant, but apparently suitable, microhabitats throughout the study area.

Centrolenids are known to use the vegetation along streams and other bodies of water (Greer & Wells 1980, McDiarmid & Adler, 1974) and the use of high perch locations (0.30 – 4.00 m) is in agreement with other Centrolenidae (Greer & Wells, 1980), including Vitreorana eurygnatha and (1.00 - 3.00 m) (Heyer et al., 1990). Greer and Wells (1980) suggest that differential use of perch heights may influence the male reproductive success in H. fleischmanni, although other territorial and behavioural traits may interfere in female choice. The height of the clutches (0.45-4.00 m) agrees with that of adults, although it is possible that the preference of sites to lay eggs may be different from male's calling-site, as we saw with the amplected female, which was continuously searching for a definitive site for egg deposition. Information on plant selection for breeding (calling and/or egg-laying) site is limited. Greer & Wells (1980) mentioned the use of large leaves such as Dieffenbachia, bromeliads and tree-trunk epiphytes by *H. fleischmanni*. We suggest that differential use of specific plants reflects their local abundance (although not measured, it is evident from the predominance of Inga). But the predominant use of smooth leaves in the studied population may indicate a specific requirement related to the adult displacement and the gliding of larvae down to the water.

Clutch characteristics such as egg size and colour are similar to most Centrolenids. Certain species show differences, for example the eggs are black in *Hyalinobatrachium prosoblepon* (Starrett, 1960) and black-and-white in *H. euknemos*, (Savage & Starrett 1967). In respect to size, there is a more variation, with means ranging from two and three eggs in *H. munozorum* and *H. midas*, respectively (Crump, 1974), but 80 eggs in H. chirripoi (Kubicki, 2004).

Ruiz-Carranza & Lynch (1991) drew attention to historical differences among groups related to leaf size preferences. Species of *Hyalinobatrachium* (sensu Guayasamin et al., 2009) tend to lay those eggs on the lower side (e.g. Crump 1974; Greer & Wells, 1980), whereas Atlantic Forest centrolenids (genus Vitreorana) use both sides (Lutz, 1947). The preference for upper leaf side found here may supports the Ruiz-Carranza & Lynch's (1991) idea, which has been phylogenetically confirmed by Guayasamin et al. (2009).

The absence of parental care also support the distinction previously discussed. In the genus *Hyalinobatrachium*, this behaviour is widespread and may involve males (McDiarmid, 1978) or female (Jacobson, 1985), and may be nocturnal (Duellman & Trueb, 1986) or diurnal-nocturnal (McDiarmid, 1978). Conversely, as far we know, no previous study has recorded this behaviour among glass-frogs from Atlantic Forest, which may indicate a reliable feature and further evolutionary distinctiveness.

Chorus formation is common in amphibians (Duellman & Trueb, 1986), including glass-frogs. Duellman (1967) cites trios in *H. fleischmanni* and Heyer et al. (1990) documented rapid and overlapping call replies, followed by a long silence in *V. eurygnatha*. However this appears to be the first record of chorus leadership within the Centrolenidae, which is characterized by the same male opening the calling sequence. It is not known, however, if chorus leaders achieve more reproductive success than non-leaders.

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REFERENCES

Ab'Saber, A.N. (1967). Domínios morfoclimáticos e províncias fitogeográficas do Brasil. *Orientação* **3**, 45-48. Departamento de Geografia, Universidade de São Paulo.

Bolívar, W., Grant L. & Osorio A. (1999). Combat behaviour in *Centrolene buckleyi* and other centrolenid frogs. *Alytes* **16**, 77-83.

Carvalho, C.M., Vilar, J.C. & Oliveira, F.F. (2005). Répteis e Anfíbios. In *Parque Nacional Serra de Itabaiana – Levantamento da Biota*, 39-61 C. M. Carvalho & J. C. Vilar (coords). Aracaju, Sergipe, Brasil: Ibama, Biologia Geral e Experimental – UFS.

Cisneros-Heredia, D.F. & McDiarmid, R.W. (2003). Ecuadorian Glass Frogs: Current state of knowledge, new research trends and conservation. Abstracts, *Joint Meet. Ichthyol. Herpetol.*, Manaus, Brasil.

Cisneros-Heredia, D.F. & McDdiarmid, R.W. (2006). A new species of the genus *Centrolene* (Amphibia: Anura: Centrolenidae) from Ecuador with comments on the taxonomy and biogeography of glass-frogs. *Zootaxa* **1244**, 1–32.

Cisneros-Heredia, D.F. & McDiarmid, R.W. (2007). Revision of the characters of Centrolenidae (Amphibia: Anura: Athesphatanura), with comments on its taxonomy and the description of new taxa of glass-frogs. *Zootaxa* **1572**.

Crump, M.L. (1974). Reproductive strategies in a tropical anuran community. *Mus. Nat. Hist. Univ. Kansas, Mis. Pub.* **61**.

Duellman, W.E. (1967). Social organization in the mating calls of some neotropical anurans. Am. Midl. Nat. **77**, 156-163.

Duellman, W.E. & Savitsky, A.H. (1976). Aggressive behaviour in a centrolenid frog, with comments on territoriality in anurans. *Herpetologica* **32**, 401-404.

Duellman, W.E. & Trueb, L. (1986). *Biology of Amphibians*. The Johns Hopkins Univ. Press. Baltimore and London.

Duellman, W.E. & Tulecke, J.B. (1960). The Distribution, Variation, and Life History of the Frog *Cochranella viridissima* in Mexico. *Am. Midl. Nat.* **63**, 392-397.

Greer, B.J. & Wells, K.D. (1980). Territorial and reproductive behaviour of the tropical American tree frog *Centrolenella fleischmanni*. *Herpetologica* **36**, 318-326.

Guayasamin, J.M., Castroviejo-Fisher, S., Trueb, L., Ayarzagüena, J. Rada, M. & Vilà, C. (2009). Phylogenetic systematics of Glassfrogs

(Amphibia: Centrolenidae) and their sister taxon *Allophryne ruthveni*. *Zootaxa* **2100**, 97 pp.

Heyer, W.R., Rand, A.S., Cruz, C.A.G., Peixoto, O. L. & Nelson, C.E. (1990). Frogs of Boracéia. São Paulo, *Arq. Zool. Univ. São Paulo* **31**, 235-410.

Hoglund, J. & Alatalo, R. (1995). *Leks*. Princeton University Press, Princeton, NJ.

IBGE – Instituto Brasileiro de Geografia e Estatística. 2004. *Mapa de Biomas do Brasil, primeira aproximação*. Rio de Janeiro, Brasil: IBGE.

Jacobson, S.K. (1985). Reproductive behaviour and male mating success in two species of glass frogs (Centrolenidae). *Herpetologica* **41**, 396-404.

Kubicki, B. (2004). Rediscovery of *Hyalinobatrachium chirripoi* (Anura: Centrolenidae) in southeastern Costa Rica. *Rev. Biol. Trop.* **52**, 215-218.

Lutz, B. (1947). Trends towards non-aquatic and direct development in frogs. *Copeia* **4**, 242–252.

McDiarmid, R.W. & Adler, K. (1974). Notes on Territorial and Vocal Behaviour of Neotropical Frogs of the Genus *Centrolenella*. *Herpetologica* **30**, 75-78.

McDiarmid, R.W. (1978). Evolution of parental care in frogs. In *The Development of Behaviour: comparative end evolutionary aspects*, 127-147. Burghardt, G.M. & Beckoff, M. (eds). New York, Garland.

Ruiz-Carranza, P.M. & Lynch, J.D. (1991). Ranas Centrolenidae de Colombia I. Propuesta de una nueva clasificación genérica. *Lozania* **57**: 1-30.

Savage, J.M. & Starrett, P.H. (1967). A new fringe-limbed tree-frog (Family Centrolenidae) from lower Central America. *Copeia* **3**, 605-609.

Starrett, P.H. (1960). Descriptions of tadpoles of Middle American frogs. *Misc. Pub. Mus. Zool. Univ. Michigan* **110**.

Wells, K.D. (1977). The social behaviour of anuran amphibians. *Anim. Behav.* **25**, 666-693.

Zar, J.H. (1996). *Biostatistical analysis*. New Jersey: Prentice Hall.Ab'Saber, A.N. (1967).

Anti-predator behaviour in the Brazilian lizard *Tropidurus itambere* (Tropiduridae) on a rocky outcrop

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ABSTRACT - We recorded anti-predator behaviour in the Brazilian saxicolous lizard *Tropidurus itambere* on a rocky outcrop in southeastern Brazil. The lizards used cryptic colouration associated with immobility as primary defence but when discovered employed locomotor escape. When handled a variety of defensive behaviours were displayed: gular expansion, forced escape, cloacal discharge, threat display (the lizard opening the mouth and trying to bite), tail wave, death-feigning and bite. All individuals displayed gular expansion but only males bit the researcher. Females showed higher frequency of autotomized or regenerate tails than males, however, this difference was not statistically significant. There was no significant difference between the number of adults and juveniles with autotomized or regenerate tails.

Predation risk is a key factor in the lives of animals and to understand risk and the behaviours used to avoid predators requires detailed studies of different behaviour repertoires in different species. Lizards are a particularly useful group to study in this respect, partly because they are prey for a wide range of predators (see Mckinney & Ballinger, 1966; Greene, 1988; Rocha, 1993; Rocha & Vrcibradic, 1998; Ávila & Morando, 2002; López et al., 2003; Shepard, 2005) and also because they have evolved a variety of defensive strategies (Rocha, 1993). Two basic defensive behaviours have been observed: a primary defence that involves behaviour and morphological characteristics that decrease the chance of discovery followed by behaviour e.g. flight, biting or cloacal emissions, initiated when the primary defences have failed (Edmunds, 1974). Understanding such behaviours are key for insight into the relationship between predator avoidance/behaviours and the environment they are used in - for instance behaviours employed in closed structurally complex habitats may be differ from those used in open less structurally complex habitats.

This paper describes anti-predator behaviour in the lizard *Tropidurus itambere* Rodrigues, 1987, a *Tropidurus* of the *Torquatus* group (Frost et al., 2001), that commonly occurs in open, sometimes rocky, areas in central and southeastern Brazil (Rodrigues, 1987). It is a diurnal medium-sized (mean snout-vent length adult = 71.8 mm) sit-and-wait forager (Van Sluys, 1992) mostly feeding on ants (Van Sluys, 1993a). Although several studies on the general ecology of *T. itambere* have been carried out (Van Sluys, 1992, 1993a, b, 1995, 1997, 1998, 2000, Van Sluys et al., 1994) details of behaviour is largely unknown.

MATERIALS AND METHODS

We recorded anti-predator behaviour of 109 individuals of *T. itambere* (48 females, 39 males and 22 juveniles) between February and November 2007, in a rupestrian field situated in the Ibitipoca State Park (21°41'48"S, 43°53'21"W), Minas Gerais state, southeastern Brazil. The Park presents an area of 1488 hectares and varies in altitude from 1200 to 1800 metres (Cetec, 1983). The climate of the area is classified as Cwb (Köppen classification): humid mesotermic, with rainy summers and dry winters. The mean annual precipitation is 1530 mm and mean temperature 18.9ºC (Cetec, 1983). The average minimum temperature at summer is 21.5ºC and maximum 36°C, in winter these temperatures are from 2 to 14.5°C (Dias et al., 2002). The vegetation of the Park is dominated by Orchidaceae, Velloziaceae, Bromeliaceae, Cactaceae, Poaceae and Compositae families.

Defensive Behaviour	Males (N = 39)	Females (N = 48)	Juveniles (N = 22)	Sexual difference (N = 87)	Ontogenetic Difference (N = 109)
Gular expansion	100%	100%	100%	*	*
Forced escape	61.5%	29.2%	27.3%	χ^2 = 9.16; p = 0.00	χ^2 = 1.96; p = 0.16
Cloacal discharge	46.2%	45.8%	36.4%	χ^2 = 0.00; p = 0.97	χ^2 = 0.65; p = 0.41
Threat display	28.2%	12.5%	13.6%	χ^2 = 0.37; p = 0.07	χ^2 = 0.40; p = 0.52
Tail wave	15.8%	8.3%	9.1%	χ^2 = 1.05; p = 0.30	χ^2 = 0.10; p = 0.74
Death feigning	10.2%	10.4%	4.5%	χ^2 = 0.00; p = 0.98	χ^2 = 0.70; p = 0.40
Bite	7.7%	0%	0%	χ^2 = 3.82; p = 0.05	χ^2 = 0.78; p = 0.37

* We did not apply the chi-square test for gular expansion behaviour because all lizards exhibited it.

Table 1. Frequency of males, females and juveniles of *Tropidurus itambere* that exhibited defensive tactics during the handling in Ibitipoca State Park, southeastern Brazil: sexual and ontogenetic differences.

We conducted fieldwork monthly in three-day trips per month and searched for lizards between 07:00 and 18:00 hrs during the wet season (February, March, September, October and November 2007) and between 08:00 and 17:00 hrs during the dry season (April, May, June, July and August 2007). When one individual was found, we recorded its initial behaviour at a distance of 3-4 meters, with the aid of binoculars, without disturbing the lizard. Afterwards, to simulate an attack, one of the researchers, always the same and always wearing similar clothes, approached the lizard and then its behaviour was registered again and the type of refuge selected after the flight. The lizards were then captured with a nylon noose and snout-vent length (SVL) measured to the nearest 1.0 mm with a manual calliper and then weighed with a Pesola micro line/30g to the nearest 0.25g. Lizards were classified as adults if SVL equalled or exceeded 57.3mm for males and 56.1mm for females (Van Sluys, 1993b). Sex was determined using body ventral area condition, which in adult males shows black ventral patches on the thighs, pre-cloacal flap and abdomen (Rodrigues, 1987). Juveniles were not sexed.

To avoid recapture and pseudo-replication elastic hair bands were attached to the lizards as necklaces in the way described by Ribeiro & Sousa (2006) and the tail base painted using nail varnish. The necklaces were not removed after the completion of the study. However monitoring of the study population indicated the collars dropped of after around five months. The necklaces did not appear to have influenced behaviour which is in agreement with other studies (e.g. Ribeiro & Sousa, 2006). Defensive behaviours exhibited during handling were quantified and converted to frequencies for males, females and juveniles. We also recorded the number lizards with autotomized tails. Lizards were released at the point of capture and their behaviour recorded.

We used the chi-square test (Zar, 1999) to test for differences defensive behaviour between males and females and between adults and juveniles. The significance level was set at p = 0.05.

RESULTS

After initial contact the lizards remained motionless on the substrate using cryptic colouration as the primary defence mechanism. After discovery the lizards initiated locomotor escape but this varied: (1) they ran either towards rock crevices (65.1%; N = 71), (2) towards vegetation (15.6%; N = 17), (3) they ran certain distance, stopped and remained

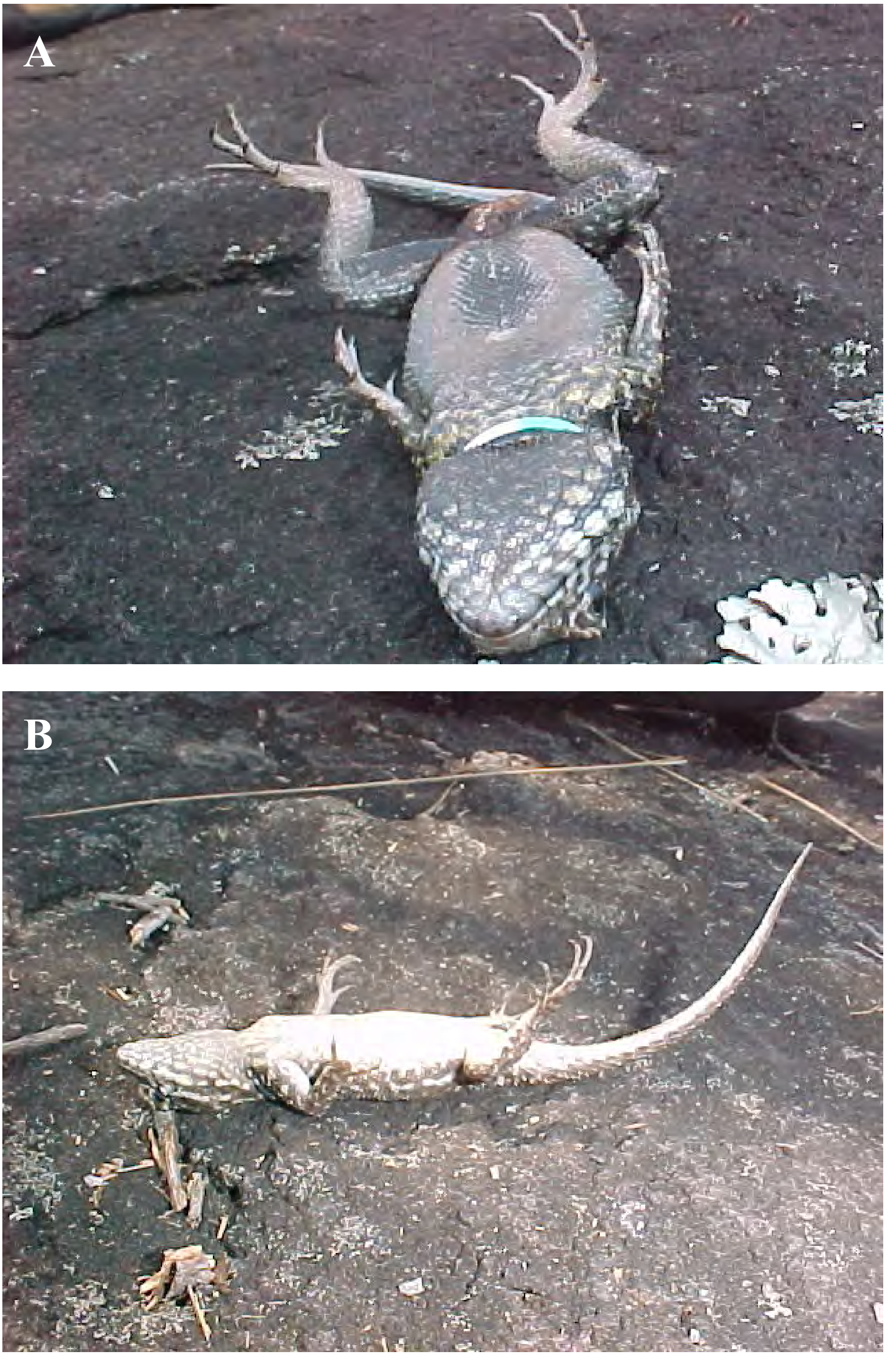

Figure 1. Individuals of *Tropidurus itambere* exhibiting death-feigning after liberation on the ground in the Ibitipoca State Park, Minas Gerais state, southeastern Brazil: (a) adult male (89.8 mm SVL) and (b) juvenile (50.5 mm SVL) with closed eyes.

motionless again (12.9%; N = 14) or (4) they made several short runs alternated with brief stops, during which exhibited head bobs and push ups and then became motionless (6.4%; N = 7).

When handled the lizards displayed a variety of defensive behaviours: gular expansion, physically attempting to break free, cloacal discharge, threat display (mouth opened and trying to bite), tail wave, death-feigning and bite. All individuals displayed gular expansion but only males bit the researcher (Table 1). Tail waving always preceded attempting to escape. Males attempted forced escape and bite behaviours more frequently than females but there was no significant difference in the frequency of defensive behaviours exhibited during handling between adults and juveniles (Table 1).

The lizards did not attempt to tail break during handling, however, 13.7% of those examined showed autotomized or regenerate tails. Females had higher frequency of autotomized or regenerate tails (20.8%; N = 10) than males (7.7%; N = 3), but the difference was not ($\chi^2 = 2.9$; p = 0.087; N = 87). Two juveniles (9.1%) showed autotomized tails. There was no significant difference between the number of adults (pooled male and female data) and juveniles with autotomized or regenerate tails ($\chi^2 = 0.5$; p = 0.47; N = 109).

After the handling released lizards either immediately exhibited locomotor escape, running towards rock crevices (77.1%; N = 84) or vegetation (13.7%; N = 15) or remained motionless (9.2%; N = 10). The lizards that remained motionless were those that exhibited death-feigning during handling and released on the ground. Eight remained in thanatosis for several minutes (1-5 min). Two individuals recovered after 10-20 sec and fled rapidly. During thanatosis, the lizards lay on their backs with all four legs and sometimes the tail, extended upward but their eyes were open (Figure 1a) except in a death-feigning juvenile where the eyes were closed (Figure 1b).

DISCUSSION

The defensive behaviours displayed by *T. itambere* in this study were observed in response to the presence of human researchers. It has been proposed that this could alter experimental results because coexistence with humans may affect behavioural and physiological anti-predator behaviour in lizards (Labra & Leonard, 1999). However, the use of humans as a surrogate predator to assess the anti-predator behaviour can still provide useful information (see Schall & Pianka, 1980; Snell et al., 1988; Machado et al., 2007; Martín et al., 2009). An additional factor that may interact with anti-predator behaviour is social behaviour since lizards must also be aware of not only potential predators but also with competitors for territory (Díaz-Uriarte, 1999; Machado et al., 2007). However, in this study, we did not evaluate the influence of the social context on the defensive behaviours exhibited by *T. itambere*.

The individuals of *T. itambere* of the Ibitipoca State Park used cryptic coloration and immobility as primary defense mechanism. This has been observed in other sit-and-wait foraging lizards that inhabit open environments (e.g. Rocha, 1993; Galdino et al., 2006; Machado et al., 2007). According to Rocha (1993) lizards that inhabit open environments are more at risk to visually oriented predators and hence cryptic coloration is adaptive increasing chances of survival. Foraging mode may also influence defence behaviour (Cooper, 1994): active foraging lizards use locomotor escape as the primary defence mechanism, while sit-and-wait foraging lizards generally use cryptic coloration for primary defence and only use locomotor escape when risk is greatest. When discovered, *T. itambere* usually ran directly towards rock crevices (65.1%; N = 71) and therefore the abundance granite rocks present on the study site plays a key role in escaping from predators.

Defensive behaviours exhibited by *T. itambere* during handling were similar to those displayed in the congeneric *T. montanus* (Machado et al., 2007) in a rocky outcrop area, however with differences; *T. itambere* did not inflate the body and *T. montanus* did not exhibit gular expansion. Gular expansion was the most frequent defensive behaviour exhibit by *T. itambere*. It is an aggressive display used during agonistic interactions and may be used as a behavioural modifier to enhance information conveyed by lizards (Ord et al., 2002; Labra et al., 2007).

During handling lizards exhibited threat display (mouth open and attempting or threatening to bite). *T. itambere* exhibited tail waving during handling. This behaviour is well known and, for example, has been described in *L. lutzae* by Rocha (1993), in *Eurolophosaurus nanuzae* by Galdino et al. (2006) and in *Tropidurus montanus* by Machado et al. (2007) However, there was no difference in the frequency that adults and juveniles of *T. itambere* using the behaviour.

The observation of tail waving in *T. itambere* is well known and, for example, has been described in *L. lutzae* by Rocha (1993), in *Eurolophosaurus nanuzae* by Galdino et al. (2006) and in *Tropidurus montanus* by Machado et al. (2007). It is a well known method of diverting the attention of predators by exposing the tail to reduce the risk of potential injury to vital parts of the body lizard (Vitt, 1983; Rocha, 1993). No lizard exhibited tail break during handling, however, 13.7% of those examined showed autotomized or regenerate tails. This value is smaller than found for another *T. itambere* population living in grassland in Valinhos, São Paulo (Van Sluys et al., 2002), where 23% showed autotomized or regenerated tails. We believe that this difference is due to Valinhos grassland population to be more susceptible to predation and to agonistic interactions due to a smaller number of refuges compared to a rupestrian field. Many factors play a role in the frequency of tail autotomy in lizards including prevalence and type of predators, type of habitat and frequency of intraspecific aggression (Bellairs & Bryant, 1985).

In *T. itambere* the absence of a significant difference in frequency of tail autotomy between the sexes may relate to the presence of agonistic territorial behaviour in both males and females (Van Sluys, 1997; Van Sluys et al., 2002; Nunes et al., 2008). Both sexes are therefore equally susceptible to injuries as found in *E. nanuzae* (Galdino et al., 2006). Tail break frequency may also differ between juveniles and adults (Vitt et al., 1977; Daniels et al., 1986; Brandl & Volkl, 1988, Rocha, 1993) but we could not obtain a significant result for this in our study. Tail autotomy may have physiological and behavioural impacts that differ according the age of a lizard and stage of development. Tail loss in a juvenile incurs not only an energy cost for regeneration but impacts on somatic growth; the behavioural and physiological impact of tail loss may therefore be more extreme for juveniles than for adults (Bateman & Fleming, 2009).

Thanatosis (death feigning) has been observed in other *Tropidurus* (see Bertoluci et al., 2006) and is a frequent behaviour among lizards (and snakes) and considered a primitive characteristic in tropidurids (Bertoluci et al., 2006). Death feigning can inhibit predator attack through loss of interest by the predator increasing the possibility of escape (Edmunds, 1974; Rocha 1993). Bertoluci et al. (2006) recorded death-feigning for *T. itambere*, but did not make clear if it was exhibited by adults and/or by juveniles and did not describe the behaviour in detail.

The great number of defensive behaviours used by *T. itambere* of Ibitipoca State Park indicates that this species has evolved a variety of mechanisms to avoid or to escape from different types of predators in an open environment. Although no lizards were observed being predated during the study period, there was a constant presence of potential predators including birds of prey, snakes and other lizard species.

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REFERENCES

Avila, L.J. & Morando, M. (2002). *Liolaemus petrophilus* (NCN). Saurophagy. *Herpetol. Rev.* **33**, 52.

Bateman, P.W. & Fleming, P.A. (2009). To cut a long tail short: a review of lizard caudal autotomy studies carried out over the last 20 years. *J. Zool.* **277**, 1-14.

Bauer, A.M. (1990). Geckonid lizards as prey of invertebrates and predators. *Herpetol. Rev.* **21**, 83-87.

Bellairs, A. & Bryant, S.V. (1985). Autotomy and regeneration in reptiles. In *Biology of the Reptilia*, pp. 301-410.

Bertoluci, J. Cassimiro, J. & Rodrigues, M.T. (2006). Tropiduridae (Tropiduridae Lizards) Death-feigning. *Herpetol. Rev.* **37**, 472-473.

Brandl, R. & Volkl, W. (1988). Tail break rate in the Maderian lizard (*Podarcis dugesii*). *Amphibia.-Reptilia* **9**, 213–218.

Cetec. (1983). *Diagnóstico Ambiental de Minas Gerais*. Belo Horizonte: Engegraf. 158 pp.

Cooper, W.E. (1994). Prey chemical discrimination, foraging mode and phylogeny. In *Lizard Ecology,* pp. 95-116.

Daniels, C.B. Flaherty, S.P. & Simbotwe, M.P. (1986). Tail size and effectiveness of autotomy in a lizard. *J. Herpetol.* **20**, 93-96.

Díaz-Uriarte, R. (1999). Anti-predator behaviour changes following an aggressive encounter in the lizard *Tropidurus hispidus*. *Proc. R. Soc. Lond. B.* **266**, 2457-2464.

Dias, H.C.T., Filho, E.I.F., Schaefer, C.E.G.R., Fontes, L.E.F. & Ventorim, L.B. (2002). *Geoambientes do Parque Estadual do Ibitipoca,* Município de Lima Duarte-MG. R. Árvore. **26**, 777-786.

Edmunds, M. (1974). *Defence in Animals – A Survey of Anti-predatory Defences*. Harlow: Longman Group Ltda. 357 pp.

Frost, D. R. Rodrigues, M. T. Grant, T. & Titus, T. A. (2001). Phylogenetics of the lizard genus *Tropidurus* (Squamata: Tropiduridae: Tropidurinae): Direct optimization, descriptive efficiency and sensitivity analysis of congruence between molecular data and morphology. *Mol. Phylogenet. Evol.* **21**, 352-371.

Galdino, C.A.B. Pereira, E.G. Fontes, A.F. & Van Sluys, M. (2006). Defense behaviour and tail loss in the endemic lizard *Eurolophosaurus nanuzae* (Squamata, Tropiduridae) from southeastern Brazil. *Phyllomedusa* **5**, 25-30.

Greene, H.W. (1988). Antipredator mechanisms in reptiles. In *Biology of the Reptilia*, pp. 1-152.

Labra, A. Carazo, P. Desfilis, E. & Font, E. (2007). Agonistic interactions in a *Liolaemus* lizard: structure of head bob displays. *Herpetologica* **63**, 11-18.

Labra, A. & Leonard, R. (1999). Intraspecific variation in antipredador responses of three species of lizards (*Liolaemus*): possible effects of human presence. *J. Herpetol.* **33**, 441-448.

López, P. Juque-Lorena, J.J. & Martín, J. (2003). *Lacerta monticola* (Iberian rock lizard). Predation. *Herpetol. Rev.* **34**, 245.

Machado, L.P. Galdino, C.A.B. & Sousa, B. M. (2007). Defensive behaviour of the lizard *Tropidurus montanus* (Tropiduridae): effects of sex, body size and social context. South Am. *J. Herpetol.* **2**, 136-140.

Martín, J. Luque-Larena, J.J. & López, P. (2009). When to run from an ambush predator: balancing crypsis benefits with costs of fleeing in lizards. *Anim. Behav.* **78**, 1011-1018. .

Mckinney, C.O. & Ballinger, R. E. (1966). Snake predators of lizards in western Texas. *Southwest. Nat.* **11**, 410-412.

Nunes, J. V. Elisei, T. & Sousa, B. M. (2008). *Tropidurus itambere.* Social interactions. *Herpetol. Rev.* **39**, 351–352.

Ord, T.J. Peters, R.A. Evans, C.S. & Taylor, A.J. (2002). Digital video playback and visual communication in lizards. *Anim. Behav.* **63**, 879-890.

Ribeiro, L. B. & Sousa, B. M. (2006). Elastic hair bands: an effective marking technique for lizards in mark-recapture studies. *Herpetol. Rev*. **37**, 434–435.

Rocha, C.F.D. (1993). The set of defense mechanisms in a tropical sand lizard (*Liolaemus lutzae*) of Southeastern Brazil. *Ciência e Cultura* **45**, 116-122.

Rocha, C.F.D. & Vrcibradic, D. (1998). Reptiles as predators of vertebrates and as preys in a restinga habitat of southeastern Brazil. *Ciência e Cultura* **50**, 364-368.

Rodrigues, M.T. (1987). Sistemática, ecologia e zoogeografia dos Tropidurus do grupo torquatus ao Sul do Rio Amazonas (Sauria, Iguanidae). *Arq. Zool.* **31**, 105-230.

Schall, J.J. & Pianka, E.R. (1980). Evolution of escape behaviour diversity. *Am. Nat.* **115**, 551-566.

Shepard, D.B. (2005). *Eumeces fasciatus.* (Five-Lined Skink). Predation. *Herpetol. Rev.* **36**,

177.
Snell, H.L. Jennings, R.D. Snell, H.M. & Harcourt, S. (1988). Intrapopulation variation in predator-avoidance performance of Galapagos (Ecuador) lava lizards. The interaction of sexual and natural selection. *Evol. Ecol*. **2**, 353-369.
Van Sluys, M. (1992). Aspectos da ecologia do lagarto *Tropidurus itambere* (Tropiduridae) em uma área do sudeste do Brasil. *Rev. Brasil. Biol.* **52**, 181-185.
Van Sluys, M. (1993a). Food habits of the lizard *Tropidurus itambere* (Tropiduridae) in southeastern Brazil. *J. Herpetol.* **27**, 347-351.
Van Sluys, M. (1993b). The reproductive cycle of *Tropidurus itambere* (Sauria: Tropiduridae) in southeastern Brazil. *J. Herpetol.* **27**, 28-32.
Van Sluys, M. (1995). Seasonal variation in prey choice by the lizard *Tropidurus itambere* (Tropiduridae) in southeastern Brazil. *Ciência e Cultura* **47**, 61-65.
Van Sluys, M. (1997). Home range of the saxicolous lizard *Tropidurus itambere* (Tropiduridae) in southeastern Brazil. *Copeia* **1997**, 623-628.
Van Sluys, M. (1998). Growth and body condition of the saxicolous lizard *Tropidurus itambere* in Southeastern Brazil. *J. Herpetol*. 32, 359-365.
Van Sluys, M. (2000). Population dynamics of the saxicolous lizard *Tropidurus itambere* (Tropiduridae) in a seasonal habitat of southeastern Brazil. *Herpetologica* **56**, 55-62.
Van Sluys, M. Rocha, C.F.D & Ribas, S.C. (1994). Nematodes infecting *Tropidurus itambere* (Sauria: Tropiduridade) in southeastern Brazil. *Amphibia-Reptilia* **15**, 405-408.
Van Sluys, M. Vrcibradic, D. & Rocha, C.F.D. (2002). Tail loss in the syntopic lizards *Tropidurus itambere* (Tropiduridae) and *Mabuya frenata* (Scincidae) in Southeastern Brazil. *Stud. Neotrop. Fauna Environm.* **37**, 227-231.
Vitt, L. J. (1983). Tail loss in lizards: the significance of foraging and predator escape modes. *Herpetologica* **39**, 151-162.
Vitt, L.J. Congdon, J.D. & Dickson, N.A. (1977). Adaptive strategies and energetics of tail autotomy in lizards. *Ecology* **58**, 326-337.
Zar, J.H. (1999). Biostatistical Analysis. New Jersey: Prentice Hall. 663 pp.

Predation of adult freshwater turtles in a protected area in southernmost Brazil

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Predation has a major influence on population dynamics and distribution (Heithaus et al., 2002). In chelonia predation is particularly critical in the early stages of life, when eggs and hatchlings are consumed by birds, mammals and reptiles (Gonçalves et al., 2007). Adult females are also vulnerable to terrestrial predators while seeking and digging nests and laying eggs (Spencer, 2002).

Adult freshwater turtles are predated by jaguars *P. onca*, cougars *Puma concolor* and black caimans *Melanosuchus niger* (Salera Junior et al., 2009a; 2009b). In addition, there are records of Brazilian radiolated swamp turtle *Acanthochelys radiolata* and Brazilian giant tortoise *Chelonoidis denticulata* predation by *P. onca* (Garla et al., 2001). This study provides data regarding predation on specific adult limnic species of chelonia, *Trachemis dorbigni, Phrynops hilarii* and *Hydromedusa tectifera*, in a protected federal area in southernmost Brazil.

The Taim Ecological Station (ESEC Taim) and the Mangueira Lake are located within the Coastal Plain, in southernmost Rio Grande do Sul State. It is a low-lying, flat land and predominantly wetland area, composed of swamps, dunes, sand and peat restinga forests (Waechter & Jarenkow, 1998).

In two different situations we observed the predation of *T. dorbigni* adults by small rodents and hawks, while *H. tectifera* and *P. hilarii* were exclusively predated by hawks.

The first predation events occurred in the Caçapava Farm, located on the shores of the Mangueira Lake (32º50' S, 52º38' W), in September 1997 and 1998. Gravid females of *T. dorbigni, P. hilarii*, and *H. tectifera* were predated by *Caracara plancus* hawks and other unidentified species. The hawks captured female turtles as they left the water to excavate nests. The hawks immobilized the turtles with attacks to the head, turned them over, putting their plastron face up, and pierced the epithelial tissue between the carapace and hind limbs, consuming only the eggs (Fig. 1). There are records of hawk predation on chelonian eggs (Ferreira et al., 2003; Gonçalves et al., 2007), but none in which the eggs were still inside the females.

The second situation occurred during August 2002 in the Taim wetland (32º32' S, 52º32' W). During the winter *T. dorbigni* becomes inactive, remaining buried in silt and organic matter at the bottom of lakes and swamps. In this month the average temperature was 14°C and rainfall was unusually heavy. Strong winds increased water turbulence and wave formation. Hundreds of *T. dorbigni* were carried by waves to the shoreline where they remained static, making them an easy prey for unidentified small rodents. The attacks resulted in forelimb injuries (Fig. 2) and several died. During a single day, 221 individuals were gathered and 33 died due to predation. There are records of hatchling and juvenile chelonia predation (Draud et al., 2004; Caut et al., 2008), but we have no knowledge of mass predation of adult freshwater turtles by small rodents.

Most chelonia predation studies focus on nests and hatchlings (e.g. Gonçalves et al., 2007). The early life stages do not determine a population's survival rate, although the low recruitment of juveniles may alter population sizes in the long term (Course et al., 1987). Likewise, the predation of adults may affect population conservation status due to low replacement rates and increasing extinction risks (Pough et al., 1993).

We believe that the predation by small rodents that we observed was an isolated and opportunistic event. Predation by hawks may be more common, providing predators with a protein-rich food resource (Ferreira et al., 2003; Gonçalves et al., 2007). Both types of predation provide important information towards conservation efforts and population management, especially when reflecting

Figure 1. *Trachemys dorbigni, Phrynops hilarii* and *Hydromedusa tectifera* females predated by hawks.

Figure 2. *Trachemys dorbigni* individuals with forelimb injuries due to predation by small rodents.

alterations in food habits.

REFERENCES

Caut, S., Angulo, E. & Courchamp, F. (2008). Dietary shift of an invasive predator: rats, seabirds and sea turtles. *J. Appl. Ecol.* **45**, 428-437.

Course, D.T., Crownder, L.B. & Caswell, H. (1987). A stage-based population model for loggerhead sea turtle and implications for conservation. *Ecology* **68**, 1412-1423.

Draud, M., Bossert, M. & Zimnavoda, S. (2004). Predation on hatchling and juvenile diamondback terrapins (*Malaclemys terrapin*) by the Norway rat (*Rattus norvegicus*). *J. Herpetol.* **38**, 467-470.

Ferreira, J.R., Malvásio, A. & Guimarães, O.S. (2003). Influence of geological factors on reproductive aspects of *Podocnemis unifilis* (Testudines, Pelomedusidae) on the Javaés Rivers, Araguaia National Park, Brazil. *Chel. Conserv. Biol.* **4**, 626-634.

Garla, R.C., Setz, E.Z.F. & Gobbi, N. (2001). Jaguar (*Panthera onca*) food habits in Atlantic Rain Forest of Southeastern Brazil. *Biotropica* **33**, 691-696.

Gonçalves, F.A., Cechin, S.Z. & Bager, A. (2007). Predação de ninhos de *Trachemys dorbigni* (Duméril e Bibron) (Testudines, Emydidae) no extremo sul do Brasil. *Rev. Bras. Zool.* **24**, 1063-1070.

Heithaus, M.R., Frid, A., Wirsing, A.J., Dill, L.M., Fourqurean, J.W., Burkholder, D., Thomson, J. & Bejder, L. (2002). State-dependent risk-taking by green sea turtles mediates top-down effects of tiger shark intimidation in a marine ecosystem. *J. Anim. Ecol*. **76**, 837-844.

Pough, F.H, Heiser, J.B. & McFarland, W.N. (1993). A vida dos vertebrados. Atheneu Editora. São Paulo (SP), 839 pp.

Salera Junior, G., Malvasio, A. & Portelinha, T.C.G. (2009a). Avaliação e predação de Podocnemis expansa e Podocnemis unifilis (Testudines, Podocnemididae) no rio Javaés, Tocantins. Acta Amaz. **39** (1), 207-214.

Salera Junior, G., Portelinha, T.C.G. & Malvasio, A. (2009b). Predação de fêmeas adultas de Podocnemis expansa Schweigger (Testudines, Podocnemididae) por Panthera onca Linnaeus (Carnivora, Felidae), no Estado do Tocantins. Biota Neotrop. **9** (3), 387-391.

Spencer, J.R. (2002). Experimentally testing nest site selection: fitness trade-offs and predation risk in turtles. Ecology **83** (8), 2136-2144.

Waechter, J.L. & Jarenkow, J.A. (1998). Composição e estrutura do componente arbóreo nas matas turfosas do Taim, Rio Grande do Sul. Biotemas **11** (1), 45-69.

Low survivorship of *Rana dalmatina* embryos during pond surface freezing

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In western France one of the earliest breeding anurans is the agile frog (*Rana dalmatina*), which arrives at ponds during the first weeks of February depositing spawn soon after. The spawn may be laid on the bottom of ponds or attached to the stems of water plants or fallen twigs although most clumps gradually float to the surface and remain there until the tadpoles emerge (Fig 1a). This takes advantage of the warmer surface temperatures for increased speed of embryo development (Anacona & Capietti, 1996) but during February freezing conditions are not uncommon and spawn may be at least partially enclosed in ice. A mild local climate (46º27`N) inevitably results in the ice melting the following day and hence the impact is usually minimal. The present note was prompted by the occurrence of abnormally low temperatures beginning February 2nd 2012 that lasted for around 10 days when daily air temperatures of around –9°C were experienced. This resulted in spawn clumps already present on the surface of ditches being encased in ice (Fig 1b).

To examine if the prolonged freezing impacted on embryo survivorship, two of three spawn clumps that were deposited previous to the cold spell were cut out of the ice on 9th February. These had been deposited in a ditch at a distance of around 100 metres from woodland. The third clump was laid in a large pond and had not yet moved to the water surface. The two clumps were placed in aquaria with water temperatures of around 10-12°C where after 5 days the first tadpoles emerged and began to swim freely. To estimate any mortalities that might have occurred due to freezing, approximate volumes of the spawn clumps were first calculated using a measuring beaker and gave spawn volumes of 308 & 360ml. Egg number per spawn clump was then estimated using $N = 2.35V+127.45$, where N is egg number and V spawn volume (Ponsero & Joly, 1998) giving 851 and 973 eggs respectively. Mortalities were then determined by calculating the number of surviving embryos that emerged successfully as a percentage of the total egg estimate for each spawn clump (n = 29 & 26). This gave 3.4% and 2.7% respectively. The embryos that survived appeared have been positioned at the centre/bottom regions of the spawn clumps and hence may have received a degree of insulation from the ice. Their development proceeded normally with no unusual defects except in two individuals from the same clump that began swimming abnormally in circles. A further sample of 16 spawn clumps deposited in the large pond nearby after the cold spell was examined for empty egg sacks and indicated around 95% hatching success.

Arriving early to deposit eggs is assumed to gain an advantage for the offspring by increasing the time available for growth (Lyapkov et al., 2000), which enhances survivorship potential during the first winter (Ryser, 1996). If most *R. dalmatina* females only reproduce once during their lifetime (Guarino et al., 1995) they are risking potential loss of reproduction if the embryos freeze. Fixing egg clumps to plant stems or fallen twigs has been cited as a method of preventing the spawn floating to the surface (Ficetola et al., 2006). However, most clumps in the study locality broke from the fixing plant and slowly moved to the surface (Fig 1c). This suggests the potential benefit of shortening development time when spawn floats on the water surface is adaptive and outweighs the risks from doing so.

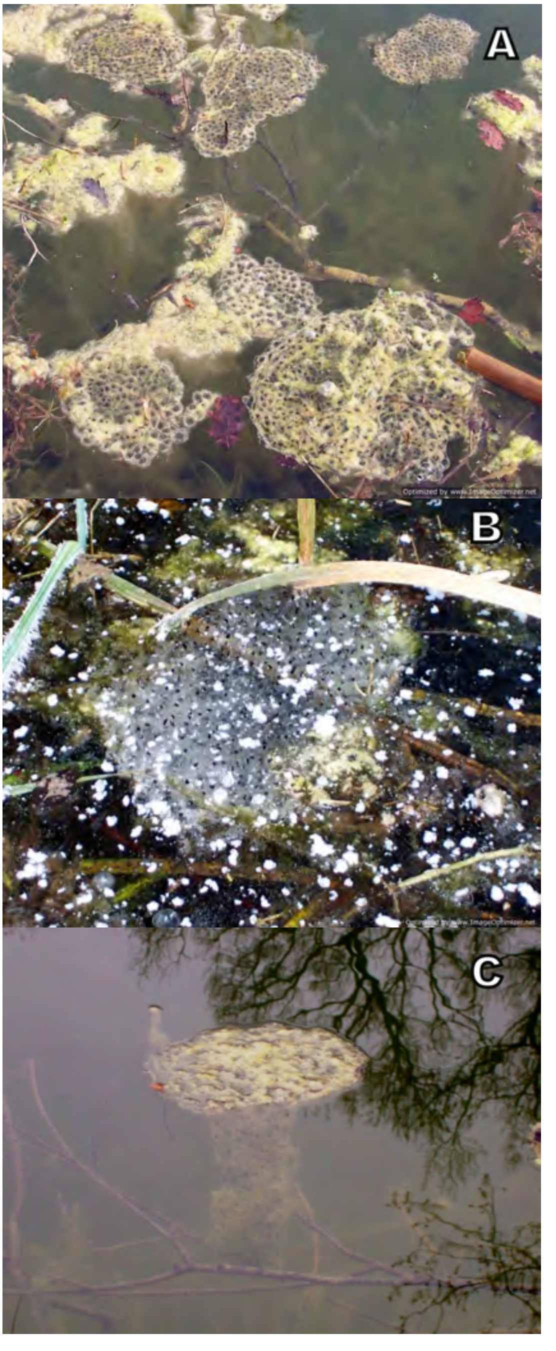

Figure 1. Typical location of *R. dalmatina* spawn on pond surface during development (A). Spawn clump encased in ice is shown in (B) and a spawn clump in the process of moving to the pond surface after breaking from a broken tree twig on which it had been deposited in (C).

REFERENCES

Anacona, N. & Capietti, A. (1996). Osservazioni sulla disposizione di uova e girini di *Rana temporaria* e *R. dalmatina* in un`area prealpina. *Studi Trdentini di Scienze Naturali – Acta Biologica* **71**, 177 – 181.

Ficetola, G. F., Valota, M. & De Bernardi, F. (2006). Within-pond spawning site selection in *Rana dalmatina*. In, *Atti del Congresso Nazionale Societas Herpetologica Italica*. Zuffi, M.A.L. (Ed) Firenze, Firenzi University Press.

Gaurino, F. M., Anelini, F & Cammota, M. (1995). A skeletochronological analysis of three syntopic amphibian species from Southern Italy. *Amphibia–Reptilia* **16**, 297-302.

Ponsero, A. & Joly, P. (1998). Clutch size, egg survival and migration distance in the agile frog (*Rana dalmatina*) in a floodplain. *Arch. Hydrobiol.* **142**, 343-352.

Ryser, J. (1996). Comparative life histories of a low- and a high-elevation population of the common frog *Rana temporaria*. *Amphibia–Reptilia* **17**, 183-195.

Lyapkov, C. M., Cherdanteseva, V.G., Cherdanteseva Y.M. & Severtsov, A. S. (2000). Survival and growth of brown frog juveniles dispersing from breeding pond. *Entomol. Rev.* **80**, (Suppl.1) 167-180.

NATURAL HISTORY NOTES

ANGUIS FRAGILIS (slow-worm): PREDATION. As part of a mitigation exercise relating to quarry works at Burnt Hill, Ringwood Forest, Hampshire (SU 122 091) 891 reptiles were captured and translocated to an allocated receptor site nearby: a clear-felled area of Plumley Wood (SU 116 097). Upon releasing some of the reptiles on 8 May 2010, an adult male slow-worm was found to have its jaws firmly clamped around a yearling viviparous lizard *Zootoca vivipara*. The slow-worm released the lizard soon afterwards, but it seems very likely that it was attempting to predate the lizard, opportunistically.

The animals had been held together for up to two hours in a cloth bag. It is not known how long this behaviour had been occurring within the bag. The lizard showed no signs of life while gripped by the slow-worm, and its eyes were closed as if dead. The slow-worm had its jaws clamped around the lizard's abdomen, but did not attempt to manoeuvre it in order to swallow it. After about two minutes, the slow-worm released the lizard, and seemingly revived, it ran away. The lizard was recaptured and examined briefly, but did not show any external signs of injury around the abdomen, and was released, apparently unharmed.

It is common practice for ecologists translocating reptiles to hold them, sometimes several species, temporarily in a cloth bag or other container. Viviparous lizards and slow-worms can normally be held together safely; slow-worms are typically much larger than common lizards, but are rarely aggressive. On this occasion, however, an apparent predation attempt was made. It is likely that this situation was brought about by the close proximity of around 20 captive reptiles in one bag.

Figure 1. Male slow-worm attempting to feed on a yearling common lizard.

This is the only time I have encountered a slow-worm preying upon another reptile, despite having captured and translocated thousands of reptiles in this way. Street (1979) cited examples of slow-worms eating an adult common lizard, a juvenile grass snake, and even one cannibalising its own young. However, these are rare examples, and slow-worms typically restrict their diet to slugs, worms and other invertebrates.

REFERENCES

Street, D. (1979). *The Reptiles of Northern and Central Europe.* London: B.T. Batsford Ltd.

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ANGUIS FRAGILIS (slow-worm): MELANISM. During a commercial capture and translocation exercise in Dorset, southern England, on 2 July 2008, an entirely black adult slow-worm was captured. It was around 30cm total length, with an intact tail. Its markings were not at all clear, but the relatively large head indicated that it was a male.

The location was a clear-felled area within a conifer plantation at Avon Common (SZ 135 983) near Christchurch, Dorset. Reptiles were removed from the area as mitigation for future mineral extraction. Between 20 May 2008 and 18 July 2008 18 viviparous lizards *Zootoca vivipara* and 47 slow-worms were captured (during 38 site visits) from approximately 0.3ha of heathy ride remnants (supporting heather, grass and moss). All captured reptiles were translocated to a 5-ha designated receptor area at the northern edge of the original site, where conifer clear-felling had removed shading from heather, tussocky grass and scrub areas.

The melanistic slow-worm was captured under a small roofing felt refuge and later released at the receptor area. Monitoring each subsequent year has not rediscovered the same slow-worm.

Figure 1. Melanistic slow-worm from Dorset.

Whilst melanism is not uncommon in adders *Vipera berus* or viviparous lizards, it seems rarer in the other British reptiles. Street (1979) described melanism in slow-worms as 'rare', Frazer (1983) acknowledged its occurrence and Inns (2009) described it as 'extremely rare'; but none cited specific examples. I am aware of only a few other observations of melanistic slow-worms: one from south London captured in 2008 and one from Witley Common, Surrey (John Gaughan, pers. comm.) and a several individuals captured from a single site in Reading by Adam Egglesfield in 2008 (Jon Cranfield, pers. comm.).

Figure 2. Melanistic slow-worm showing left-hand side view of head.

Figure 3. Melanistic slow-worm showing lack of obvious dorsal markings.

REFERENCES

Frazer, D. (1983). *Reptiles and Amphibians in Britain.*London: Collins New Naturalist Series.

Inns, H. (2009).*Britain's Reptiles and Amphibians.* Old Basing: Wild Guides Ltd.

Street, D. (1979). *The Reptiles of Northern and Central Europe.* London: B.T. Batsford Ltd.

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ZOOTOCA VIVIPARA (common or viviparous lizard): INJURY OR PATHOLOGY?

During a commercial capture and translocation exercise in Dorset on 1 July 2008, a male common lizard with unusual leg and facial damage was captured. Its left foreleg was reduced to bone, with the radius and ulna exposed, capped by the withered remains of its left hand. Its right arm was cleanly truncated at the wrist. Both stumps seemed to be healing or healed. Its nasal area was also damaged by soft tissue degeneration around the nasal area, with blackened skin, possibly covering healed lesions. It was not obvious whether these afflictions were due to injury or pathology. The lizard was bright and active, with full mobility, and otherwise seemingly unaffected by the damage.

The location was a clear-felled part of a conifer plantation at Avon Common (SZ 135 983) near Christchurch, Dorset, formerly under Forestry Commission management consented for sand and gravel extraction. Protected species mitigation measures included capture and translocation of

Figure 1. Common lizard showing left foreleg damage.

Figure 2. Common lizard showing right foreleg damage.

Figure 3. Common lizard showing damage to nasal area.

reptiles (viviparous lizards and slow-worms *Anguis fragilis*). Between 20 May 2008 and 18 July 2008, 18 common lizards and 47 slow-worms were captured (during 38 site visits), from an area that would become the quarry 'plant area'.

The 'injured' common lizard was captured under a felt refuge on 1 July 2008, exhibiting normal thermoregulatory behaviour, and showing no obvious signs of suffering. It was released at a receptor area soon afterwards. Figures 1-3 show its injuries. Ongoing monitoring each year since then has not rediscovered the same lizard.

Consideration of these 'injuries' throws up several possible explanations. Pathology is one possibility; perhaps an infection that causes necrosis of the extremities, or a parasitic organism. The nasal damage was superficially reminiscent of the effects of toadfly *Lucilia bufonivora* on common toads *Bufo bufo*, but the lesions seemed to be healed. Frost damage is another possibility. The restriction of necrosis to the anterior extremities, with none evident elsewhere on the body, suggests only partial exposure to frost, however. Another explanation may be partial predation by small rodents, or invertebrates such as ants, consuming parts of the lizard while it hibernated. Alternatively, forestry operations could have caused injuries, which the lizard survived but then became infected or necrotic. Traumatic injury such as this would have probably resulted in less subtle injuries though, and outright death.

Healed head lesions covered with black skin were recently reported from male sand lizards *Lacerta agilis* from Wareham, by Sainsbury *et al.* (2011), but the authors attributed them to male-male combat.

REFERENCES

Sainsbury, A.W., Foster, J., Bird, D., Moulton, N., Molenaar, F., Vaughan, R., Peniche, G., Marschang, R. (2011). Evaluating the threat to the conservation of the sand lizard, *Lacertaagilis*, from parasites harboured by the introduced wall lizard, *Podarcismuralis*. Unpublished Report. Institute of Zoology, London.

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DRYMOLUBER DICHROUS (northern woodland racer) and ***ANOLIS FUSCOAURATUS*** (slender anole): PREDATION.

Drymoluber dichrous (Peters, 1863) is a ground-dwelling colubrid from northern South America found in both primary and secondary forest (Borges-Nojosa & Lima, 2001). It is active during the day, sleeping in low vegetation at night (Duellman, 1978; Martins & Oliveira, 1998). Stomach contents indicate that the diet of *D. dichrous* is mainly composed of Leptodactylid frogs and lizards of both Sphaerodactylidae and Gymnophthalmidae families (Martins & Oliveira, 1998; Borges-Nojosa & Lima, 2001). It also preys on teiid lizards (e.g. *Ameiva ameiva* and *Kentropyx calcarata*), other snakes and reptile eggs (Martins & Oliveira, 1998; Pinto, 2006). Thus, these studies indicate that *D. dichrous* preys predominantly upon ground dwelling species (but see Duellman [1978]).

The slender anole *Anolis fuscoauratus* has a wide geographic distribution in the Amazon and Atlantic Forest biomes, within which it is the most common anole (Vitt et al., 2003). This diurnal, lizard inhabits primary and secondary forests but can also be found in forested patches of urban areas, where it is often seen on low vegetation, or occasionally climbing tree trunks into the canopy (Duellman, 1978; Vitt et al., 2003). Records of predators of this species are relatively scarce and no detailed descriptions of predatory episodes have been documented.

On the 27 October 2010 an individual of *D. dichrous* was sighted at approximately 1140 hours in the proximity of the Santo Antônio water spring (07°24’49”S, 39°12’46”W, 807 m a.s.l.) located in the central slopes of the Chapada do Araripe, Municipality of Missão Velha. The snake (TL approximately 110 cm) was seen and photographed moving amongst the leaf litter at the edge of the southern bank of the canal, about 20 m downstream from the spring. After some minutes of observation during which time the snake moved slowly through the vegetation, in a burst of speed it took to chasing an individual of *A. fuscoauratus* (SVL approximately 5 cm), until then unnoticed by the team. The chase occurred over a distance of approximately six metres, towards the centre of the canal, with both the snake and lizard having passed between the feet one of the observers (D. Veríssimo) and finally finishing on top of the backpacks used by the field team. The *D. dichrous* seized the lizard by its upper body (Fig. 1A) and started slowly, whilst making repeated chewing motions, moving back into vegetation. The anole gaped and presented signs of respiratory distress (Fig. 1B), stopping all movement after a few seconds (Fig. 1C). While firmly held, the lizard did not show any sign of movement or struggle, and the snake did

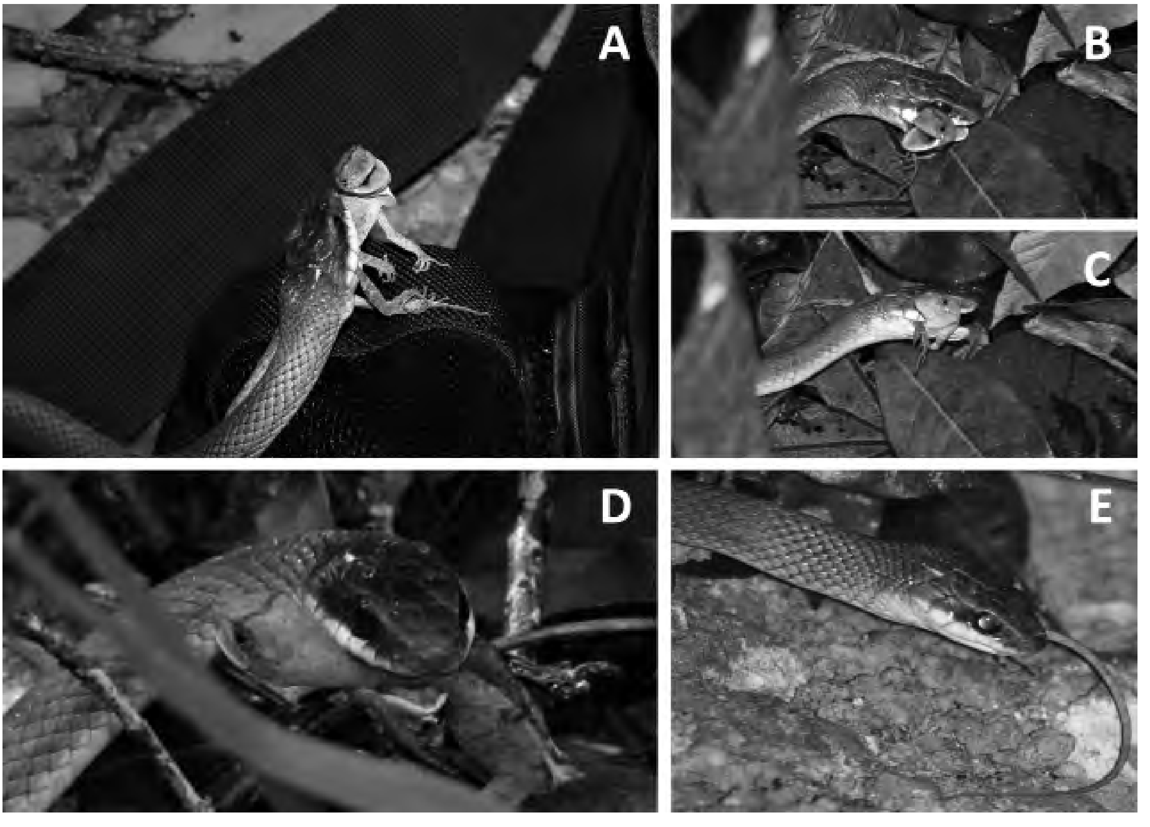

Figure 1. *Drymoluber dichrous* predation of *Anolis fuscoauratus*: A. snake seizing the lizard, B. lizard gaping, C. lizard immobilized, D. snake preparing to swallow lizard, E**.** tip of lizard’s tail hanging from the snake’s mouth. Photographs by A. Campos, except D by D. Veríssimo.

not constrict or use its body to restrain its prey (Fig. 1D). The prey was then handled and adjusted to be ingested from the head and swallowing ensued quickly. After three minutes, only the tip of the tail of the anole was visible, hanging from the snake's mouth (Fig. 1E).

Our observation confirms the suspicion by Martins (1994) that active search for prey is a strategy employed by this species. On the other hand, despite *A. fuscoauratus* being an abundant species (Borges-Nojosa & Lima, 2001), its predominantly arboreal habits appear to make it unlikely prey for this snake. This might explain why episodes involving both species have not been documented in the wild.

The lack of struggle by the lizard may have been death feigning, which has been documented in other neotropical lizards (Gomes et al., 2004), or the result of envenomation. We suggest the latter given that, although the presence of Duvernoy's glands has not yet been documented for the genus *Drymoluber,* it has been described for its closest relative, the genus *Mastigodryas*, (Serapicos & Merusse 2006; Pyron et al., 2011).

This report represents a new prey species for *D. dichrous* and a newly confirmed predator of *A. fuscoauratus*.

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REFERENCES

Borges-Nojosa, D.M. & Lima, D.C. (2001). Dieta de *Drymoluber dichrous* (Peter, 1863) dos Brejos-de-altitude do Estado do Ceararaá, Brasil (Serpentes, Colubridae). *Bol. Museu N. Zool.* **468**, 1-5.

Duellman, W.E. (1978). The biology of an Equatorial Herpetofauna in Amazonian Ecuador. *Misc. P. Mus. Nat. Hist.*, *University of Kansas* **65**, 352.

Gomes, F.R., Kohlsdorf, T., Navas, C.A. (2004). Death-feigning in *Eurolophosaurus divaricatus*: Temperature and habituation effects. *Amphibia-Reptilia* **25**, 321-325.

Martins, M. (1994). História natural e ecologia de uma taxocenose de serpentes em mata ripária na região de Manaus, Amazônia Central, Brasil. Ph.D thesis. Universidade Estadual de Campinas, Brazil.

Martins, M. & Oliveira, M.E. (1998). Natural history of snakes in forests of the Manaus region, Central Amazonia, Brazil. *Herpetol. Nat. Hist.* **6**, 78-150.

Pinto, R.R. (2006). *Drymoluber dichrous* (NCN). Ophiophagy. *Herpetol. Rev.* **37**, 231-231.

Pyron, R.A., Burbrink, F.T., Colli, G.R., de Oca, A.N.M., Vitt, L.J., Kuczynski, C.A. & Wiens, J.J. (2011). The phylogeny of advanced snakes (Colubroidea), with discovery of a new subfamily and comparison of support methods for likelihood trees. *Mol. Phylogenet. Evol.* **58** (2), 329-342

Serapicos, E.O., Merusse, J.L.B. (2006) Morfologia e histoquímica das glândulas de Duvernoy e supralabial de seis espécies de colubrídeos opistoglifodontes (Serpentes, Colubridae). *Pap. Avul. Zool.* (São Paulo) **46**, 187-195.

Vitt, L.J., Ávila-Pires, T.C.S., Zani, P.A., Sartorius, S.S. & Espósito, M.C. (2003). Life above ground: Ecology of *Anolis fuscoauratus* in the Amazon rain forest, and comparisons with its nearest relatives. *Can. J. Zool.* **81**, 142-156.

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CYCLORAMPHUS ELEUTHERODACTYLUS (alto button frog): CALLING AMONG ROCKS AND CAVES.

Cycloramphus eleutherodactylus (Miranda-Ribeiro, 1920) is the most widespread species in the genus, found in the states of Minas Gerais, Rio de Janeiro, São Paulo, and Paraná among the mountainous region of the Atlantic forest of southeast and south Brazil (Heyer, 1983a; Heyer & Maxon, 1983; Frost, 2010). Its natural history is poorly known and there are still some taxonomic and systematic issues to be resolved (Lutz, 1954; Heyer, 1983a; Verdade, 2005). Only one previous study mentioned the calling of *C. eleutherodactylus* in which it is said to be rarely heard in rock crevices (Lutz, 1954). Advertisement and territorial calls have been described from data gathered in 1991 from the Serra de Paranapiacaba mountain range, municipality of Santo André, state of São Paulo (23º46'S, 46º18'W; Fig. 1, site 1) (Brasileiro et al., 2007). However, the calling sites were not cited by Brasileiro et al. (2007) and were described as: two males heard calling sheltered in rock crevices inside a cave, approximately 2 m from the entrance (C.F.B. Haddad, pers. comm.). Like several other species within this genus, the IUCN Red List and others consider this species to be data deficient (Verdade & Heyer, 2004; Mikichi & Bérnils, 2004) and it is also classed as near threatened in the state of Rio de Janeiro (Bergallo et al., 2000). Herein we describe some features of calling behaviour and locations of *C. eleutherodactylus* from south and southeast Brazil. Voucher specimens were collected and deposited at the Museu de História Natural Capão da Imbuia, state of Paraná (MHNCI 6584), Coleção de Anfíbios CFBH, Instituto de Biociências, Universidade Estadual Paulista "Júlio de Mesquita Filho", campus de Rio Claro, state of São Paulo (CFBH 25678-25680; 28026-28036) and Instituto de Biociências, Universidade de São Paulo, state of São Paulo (MCL 127; MTR 11687).

We collected information of the frogs from three locations: The Estação Biológica de Boracéia (EBB), municipality of Salesópolis, state of São Paulo (23º38'S, 45º50'W); Parque Estadual

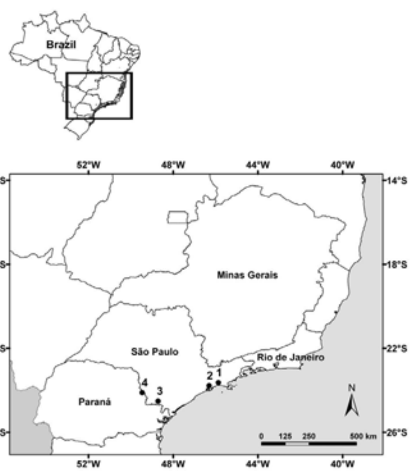

Figure 1. Study sites in the states of São Paulo, and Paraná, Brazil. Black dots show the surveyed localities: 1 - Estação Biológica do Alto da Serra de Paranapiacaba (municipality of Santo André); 2 - Estação Biológica de Boracéia (EBB, municipality of Salesópolis); 3 – Parque Estadual Turístico do Alto Ribeira (PETAR, municipalities of Iporanga and Apiaí); 4 - Morungava Farm (municipality of Sengés).

Turístico do Alto Ribeira (PETAR), municipalities of Apiaí and Iporanga, state of São Paulo (24º17'S, 48º27'W), and Morungava Farm, municipality of Sengés, state of Paraná (24º6´S, 49º27´W, Fig. 1). The EBB was surveyed monthly from April 2003 to November 2005 by researchers and students while under the auspices of M.T. Rodrigues' Herpetological Laboratory, University of São Paulo. During these surveys, *C. eleutherodactylus* was seen twice displaying reproductive behaviour. One male was found calling over a rock near a stream (November 2003), and one female was found under a humid rock close to a stream, laying over a clutch of eggs (November 2005) (V.K. Verdade, pers. comm.).

PETAR was visited from October to December 2009 and surveyed both near and within nine caves (Fig. 2, A-B) and along forest trails (Araujo et al., 2010). Eighteen individuals of *C. eleutherodactylus* were found in November and December. Of these, seven males, five females with eggs, and one juvenile (N = 13 individuals) were found in seven different caves. During the same time period, one male was heard calling from near the entrance of one of these caves (Fig. 2, C-D) and another four males were heard calling from crevices in large rocks in the forest.

More observations at the Morungava Farm, during two days in both November 2007 and 2008, found several more calling males. Calling males were found in one cave of 20 m in height by 150 m length (Fig. 2, E). A total of 23 males of *C. eleutherodactylus* were found calling and 17 call sites were measured (Fig. 3). Six of these sites were used in both years. Males were heard calling constantly at any time of day from 8:30 – 22:00, apparently increasing call rates at dusk (around 19:00). Only one male was found at the entrance to the cave and the remainders were found within the cave in similar locations (Fig. 2, F-G). Generally, *C. eleutherodactylus* were calling from several heights from the ground and always hidden in rock crevices, usually in dark areas far from the entrance of the cave (Fig. 3). Additionally, three juveniles were found in the cave (35, 55, and 70 m away from the cave entrance; Fig. 2, H). Neither eggs nor tadpoles were found.

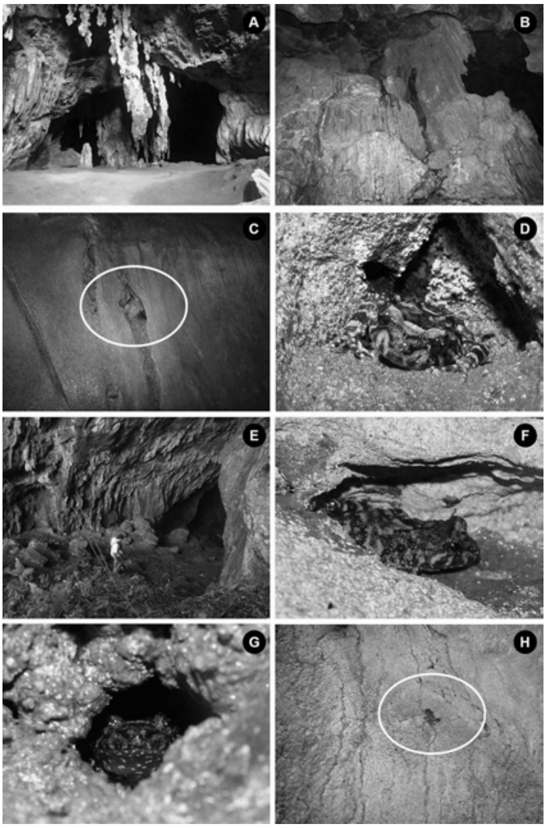

Figure 2. (A) Entrance of the Morro Preto cave at Parque Estadual Turístico do Alto Ribeira (PETAR), municipality of Iporanga, state of São Paulo, Brazil; (B) internal view of Cafezal cave (PETAR); (C) adult male of *Cycloramphus eleutherodactylus* sheltered in humid rock crevices in Cafezal cave; (D) detail of observed male in Cafezal cave; (E) entrance of the cave at Morungava Farm, municipality Sengés, state of Paraná; (F-G) males at calling sites in the cave at Morungava Farm; (H) a juvenile found climbing in the cave at Morungava Farm. Photos: T. H. Condez (A); F. C. Centeno (B-D); A. M. X. Lima (E-H).

C. eleutherodactylus uses rocky formations as reproductive sites. If rocks and caves are important to the reproduction of this frog, then their availability may in part determine the distribution of this species. While we did not exhaustively search other possible calling locations, such as under logs or among roots in the forest, it is possible that the frogs could prefer rocks and caves. This apparent association with rocky formations is common within the genus, especially for the stream dwellers *Cycloramphus* (Giaretta & Cardoso, 1995; Giaretta & Facure, 2003; Lima et al., 2010). Forest litter species may also shelter under logs, or use leaf litter for reproduction (Heyer & Crombie, 1979; Brasileiro et al., 2007; V.K. Verdade, pers. comm.). In Brazil, other frogs have been found in caves but the implications of such an association have not been fully explored (Pinto-da-Rocha & Sessegolo, 2001). No other species has been reported to consistently call from within caves, with the exception of the cave-dwelling frog *Litoria cavernicola*, in Australia (Tyler & Davis, 1979). We suggest that it is likely that while caves are not necessary the only place where these frogs can be found, they could occur in higher abundance within caves. We therefore recommend that caves are searched systematically for this species and that attention be drawn to the acoustic quality of caves, a factor that may be important for courtship behaviour.

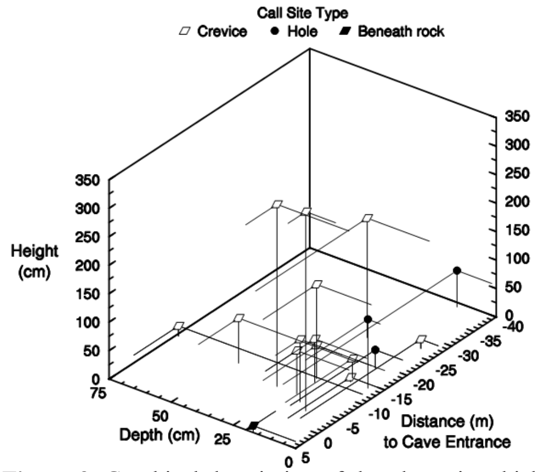

Figure 3. Graphical description of the places in which male frogs were observed vocalizing in the cave in Morungava Farm, municipality of Sengés, state of Paraná, Brazil. In this three-dimensional representation, the lines connect the individual to the zero points of the three axes (height from the ground, distance from the cave entrance and depth in the calling site), thus allowing comparison and visualization of their positions within the cave.

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REFERENCES

Araujo, C.O., Condez, T.H., Bovo, R.P., Centeno, F.C. & Luiz, A.M. (2010). Amphibians and reptiles of the Parque Estadual Turístico do Alto Ribeira (PETAR), SP: an Atlantic Forest remnant of southeastern Brazil. Biota Neotrop. 10 (4), 257-274.

Bergallo, H.G., Rocha, C.F.D., Alves, M.A.S. & Sluys, M.V. (2000). A Fauna Ameaçada de Extinção do Estado do Rio de Janeiro. Rio de Janeiro: Editora da Universidade do Estado do Rio de Janeiro.

Brasileiro, C.A., Haddad, C. F. B., Sawaya, R. J., & Sazima, I. (2007). A new and threatened island dwelling species of Cycloramphus (Anura: Cycloramphidae) from southeastern Brazil. Herpetologica 63, 501-510.

Frost, D.R. (2010). Amphibian species of the world: an online reference. Version 5.4. <http://research.amnh.org/herpetology/amphibia/index.php.> New York: American Museum of Natural History.

Giaretta, A.A. & Cardoso, A. (1995). Reproductive behaviour of *Cycloramphus dubius* Miranda-Ribeiro (Amphibia, Anura, Leptodactylidae). *Rev. Bras. Zool*. **12**, 229-232.

Giaretta, A.A. & Facure, K.G. (2003). Clutch attendance: *Cycloramphus boraceiensis. Herpetol. Rev.* **34**, 50.

Heyer, W.R. (1983a). Variations and systematics of frogs of the genus *Cycloramphus* (Anura, Leptodactilidae). *Arq. Zool*. **30**, 235–339.

Heyer, W. R. & Maxon, L. R. (1983). Relationships, Zoogeography, and Speciation mechanisms of frogs of the genus *Cycloramphus* (Anura, Leptodactilidae). *Arq. Zool*. **30**, 341–373.

Heyer, W.R. & Crombie, R.I. (1979). Natural history notes on *Craspedoglossa stejnegeri* and Thoropa petropolitana (Amphibia: Salientia, Leptodactylidae). *J. Wash. Ac. Sci.* **69**, 17–20.

Lima, A.M.X., Garey, M.V., Noleto R.B. & Verdade, V.K. (2010). Natural history of the Lutz's Frog *Cycloramphus lutzorum* Heyer 1983 (Anura: Cycloramphidae) in the Brazilian Atlantic Forest: description of the advertisement call, tadpole and karyotype. *J. Herpetol.* **44**, 360-371.

Lutz, B. (1954). Anfibios anuros do Distrito Federal. *Mem. Inst. Oswaldo Cruz* **52**, 155–238.

Mikich, S.B. & Bernils, R.S. (2004). Livro Vermelho da Fauna Ameaçada no Estado do Paraná. Curitiba: Instituto Ambiental do Paraná.

Pinto-da-Rocha, R. & Sessegolo, G.C. (2001).

Estudo da fauna da Gruta de São Miguel I, Serra da Bodoquena (MS), como subsídio para o plano de manejo. In *Conservando cavernas. Quinze anos de espeleologia* , 123-134 . Rocha, L.F.S., Oliveira, K.L. & Sessegolo, G.C. (eds). Curitiba: GEEP-Açungui.

Tyler, M.J. & Davies, M. (1979). A new species of cave-dwelling, hylid frog from Mitchell Plateau, Western Australia. *T. Roy. Soc. South Aust.* **103**:149-153.

Verdade, V.K. & Heyer, W.R. (2004). *Cycloramphus eleutherodactylus*. In: *IUCN 2010. IUCN Red List of Threatened Species.* Version 2010.4. <www.iucnredlist.org> , [Accessed: 2010].

Verdade, V.K. (2005). Relações filogenéticas entre as espécies dos gêneros *Cycloramphus* Tschudi 1838 e Zachaenus Cope 1866 (Anura, Leptodactylidae). Ph..D. Thesis, São Paulo: Universidade de São Paulo.

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PEDIOPLANIS HUSABENSIS Berger-Dell'Mour & Mayer, 1989. (Husab Sand Lizard) (Sauria Lacertidae): MAXIMUM SIZE. On 12 June 2009 a large specimen of *Pedioplanis husabensis* was collected from the rocky substrate of the Schieferberg, Langer Heinriech Uranium Mine, Namibia (22°49'26.9"S; 15°18'48.0"E; 2215CD, 631 m a.s.l), by W. Conradie and M. Matengu. The male specimen (Port Elizabeth Museum, PEM R18138) measures 61.23 mm snout-vent length (SVL) and has a tail length (partly regenerated) of 132.96 mm (Fig. 1). Branch (1998) gave the average size range of this species as 45-55 mm SVL, with a maximum size of 58 mm. The holotype described by Berger-Dell'Mour & Mayer (1989) measured 59.3 mm SVL and has a tail length of 112 mm. The new specimen

Figure 1. *Pedioplanis husabensis.*

represents a 3.3 % increase in maximum length from the holotype. Specimens were collected under the Namibian Ministry of Environmental and Tourism Permit (#1367/2009).

REFERENCES

Berger-Dell'Mour, H.A.E. & Mayer, W. (1989). On the parapatric existence of two species of the *Pedioplanis undata* group (Reptilia: Sauria: Lacertidae) in the central Namib Desert (Southwest Africa) with description of the new species *Pedioplanis husabensis*. Herpetozoa 1(3/4): 83-95.

Branch, W. R. (1998). Field Guide to the Snakes and Other Reptiles. Struik Publishers, Cape Town. 399 pp.

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PEDIOPLANIS LINEOOCELLATA LINEOOCELLATA (Duméril and Bibron, 1839) (Spotted Sand Lizard) (Sauria, Lacertidae): MAXIMUM SIZE. On 17 February 2010 an exceptionally large specimen of *Pedioplanis l. linecoocellata* was collected on semi-compacted calcrete sands with scattered thorny bushes near a dried-out pan in the Tswalu Kalahari Game Reserve, Northern Cape Province, South Africa (27°17'52.5"S; 22°13'51.0"E; 2722AC, 1034 m. a.s.l). The male specimen (Port Elizabeth Museum, PEM R18605) measures 64.10 mm snout-vent length (SVL) and has a tail length (partly regenerated) of 141.42 mm (Fig. 2).

Figure 2. *Pedioplanis lineoocellata.*

Branch (1998) gave the average size range of this species as 45-55 mm SVL, with a maximum size of 58 mm. Wasiolka et al. (2010) gave the maximum size of males used in their study as 63.6 mm SVL and tail length of 148.75 mm. This specimen itself is an increase 9.7% increase on the maximum size reported by Branch (1998). Taking this new maximum size in consideration the specimen from Tswalu represents a 1.5% increase in maximum length. The largest female (PEM R18608) from the same collection site measured 60.1 mm SVL and tail length of 92.68 mm. Bauer & Branch (1999) reported that the body size of *Cordylosaurus subtesselatus* (Dwarf Plated Lizard) shows a South to North cline in increasing body size. This seems true in this species also, but further investigation is needed.

REFERENCES

Bauer, A.M., Lamb, T. & Branch, W. R. (1999). *Cordylosaurus subtessellatus*, Dwarf Plated Lizard. Maximum size. *Afr. Herp. News*. **30**, 30.

Branch, W. R. (1998). *Field Guide to the Snakes and Other Reptiles.* Struik Publishers, Cape Town. 399 pp.

Wasiolka, B., Jeltsch, F., Henschel, J. & Blaum, N. (2010). Space use of the spotted sand lizard (*Pedioplanis l. lineoocellata*) under different degradation states. Afr. J. Ecol. **48**, 96-104.

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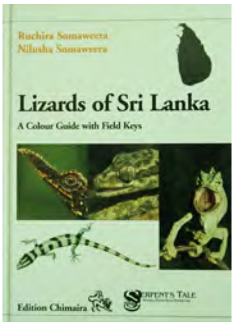
Book Review

Lizards of Sri Lanka: A Colour Guide with Field Keys

Somaweera, N. & Somaweera R. (2009). Edition Chimaira, Frankfurt am Main, Germany. 304 pages



The island of Sri Lanka is well known for its biodiversity and its high levels of endemicity, especially amongst reptiles and amphibians. My first visit to this lovely country was over a decade and a half ago and I was enthralled by the immense diversity of herpetofauna in such a small geographic space. There are lizards from tiny geckos to giant water monitor lizards everywhere in Sri Lanka! This field guide is conceivably one of the best written on reptiles of South Asia and is obviously written by field herpers and is laid out in a way that makes it very user friendly. Sri Lanka is rich in reptile diversity and some of the lizard species are truly spectacular. The first image in the book is of the hump-nosed lizard (*Lyriocepphalus scutatus*) and this helps create an excitement towards this diverse group of reptiles. With seventy endemic species of the ninety-six species of lizards known from this tiny island, this book provides valuable guidance to the identification, natural history and conservation.

The introductory part of the book covers the geography of Sri Lanka, identifies the various habitats lizards are found in, cultural aspects, conservation issues and a history of herpetology in Sri Lanka. The field guide section itself is incredibly well laid out and explicit enough to appeal and be useful to people of varying experience and skill levels. Multiple pictures of each species from different angles and illustrating different aspects and taxonomic characters add to the ease of identification. There are also multiple pictures showing colour variations, ontogenic variations and morphs of many of the species. The ‘Morphology & Scalation’ section on pages 39 and 40 are a good example of how the authors have removed ambiguity and subjectivity. Again, in the Key to the Families, the photographic keys enable the user to easily and confidently put most lizards into the relevant family, greatly cutting down the time taken in the process of identifying a species in the field. The table detailing the external morphological details of the seven species of Sri Lankan *Calotes*, is tremendously useful as this is one of the most visible genus around urban and rural areas. Quick identification in the field will also enable a lot of ecological work and study.

The range maps are easy to read and the topographical outlines make it easy to place a species in a particular habitat or altitude range. The text provides details on global distribution of species along with their ranges within the country. The specific diagnosis helps to establish clarity, in particular taxonomic characteristics along with details of length. The natural history notes provided are elaborate and interesting and will help the field biologist or naturalist immensely. Aside from its focus on the biology of these lizards, the book also succeeds at exciting the naturalist about the various species while also engaging him/ her in the diversity of lizard fauna on this tiny island nation. Leafing through the various species descriptions and pictures might have just inspired my next Sri Lankan visit!

All in all, this book is the perfect field guide. It will succeed in developing interest in the subject, assist in fieldwork, help budding herpetologists get a head start and set a standard for this type of book that will be hard to surpass. As a herpetologist living in India where field guides are few and far between, I would love to have people like the Somaweeras exercising the rigour to come out with a book like this one.

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