The HERPETOLOGICAL BULLETIN

Number 112 – Summer 2010

PUBLISHED BY THE

BRITISH HERPETOLOGICAL SOCIETY

Contents

- Registered Charity No. 205666 -

THE HERPETOLOGICAL BULLETIN

The Herpetological Bulletin is produced quarterly and publishes, in English, a range of articles concerned with herpetology. These include society news, selected news reports, full-length papers of a semi-technical nature, new methodologies, natural history notes, book reviews, letters from readers and other items of general herpetological interest. Emphasis is placed on natural history, conservation, captive breeding and husbandry, veterinary and behavioural aspects. Articles reporting the results of experimental research, descriptions of new taxa, or taxonomic revisions should be submitted to *The Herpetological Journal* (see inside back cover for Editor's address).

ISSN 1473-0928

Printed by: Bruce Clark (Printers), Units 7-8, Marybank Lane, Dundee, DD2 3DY.

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Front cover illustration. *Naja naja* © Rowland Griffin. See article on page 17.

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Letters

BOX TURTLE (*TERRAPENE CAROLINA CAROLINA*) CARAPACE COLOUR DEVELOPMENT

We have long been working on the presentation of our novel findings, on Box Turtle (*Terrapene carolina carolina*) carapace colour development, that serendipitously emerged during our long-term repatriation field studies for this species.

To properly present the phenomenon, we wanted to provide readers with numerous colour images documenting the various aspects of carapacial colour development and changes that we observed (a goal which faced prohibitive paper-publishing costs). But, thanks to Mark Miller (President and special publications editor), the Philadelphia Herpetological Society provided the peer review for our article, and then prepared it for posting as a special publication (#2009_02) of the Society on the web site, to obviate our financial obstacles and enable the work to be easily available to the herpetology community.

Mark has spent many months on the project and we are happy to inform you that, thanks to his kind help and unstinting effort, you can now examine our report {Photo-dependent localized colour development in the Eastern Box Turtle carapace. 2010. William Belzer and Susan Seibert. PHS Special Publication #2009_02 (permanent archive) at http://herpetology.com/belzer2/colorintro.htm. The article can also be accessed from the revelvant "Research link" provided at www.ebtct.org

Bill Belzer & Sue Seibert, Box Turtle Conservation Trust, Oil City, Pennsyvania 16301, USA.

Research Abstracts

NEW TAXONOMY FOR *LAMPROPELTIS GETULA* GROUP.

This study presents a systematic revision of the *Lampropeltis getula* group, based on a recent range wide phylogeographic analysis. The study investigated and defined theoretical and operational concepts of species delimitation, and provided full diagnoses based on mitochondrial DNA evidence, ecological niche modelling, morphology, and historical precedence. The study used these advanced techniques to recognise five distinct species, which bear the name of the nominate subspecies found primarily within the range of each phylogeographic lineage: the Eastern lineage (*Lampropeltis getula*, Eastern Kingsnake), the Mississippi lineage (*L. nigra*, Black Kingsnake), the Central lineage (*L. holbrooki*, Speckled Kingsnake), the Desert lineage (*L. splendida*, Desert Kingsnake) and the Western lineage (*L. californiae*, California Kingsnake). Interestingly, all of these taxa had originally been described as distinct species and recognized as such for over 100 years (in the case of *L. californiae*) before being demoted to subspecies level. The study discusses the impact that increasingly detailed genetic information from phylogeographic analyses may have on traditional taxonomy.

Pyron, A.R. & Burbrink, F.T. (2009). Systematics of the Common Kingsnake (*Lampropeltis getula*; Serpentes: Colubridae) and the burden of heritage in taxonomy. *Zootaxa* **2241**, 22-32.

HABITAT FRAGMENTATION AS CAUSE OF LOCAL AMPHIBIAN DECLINE.

Most amphibian species have biphasic life histories and undergo an ontogenetic shift from aquatic to terrestrial habitats. In deforested landscapes, streams and forest fragments are frequently disjunct, jeopardizing the life cycle of forest-associated amphibians with aquatic larvae. In this recent and well documented research the authors tested the impact of “habitat split”, defined as human-induced dissection between habitats, used by different life-history stages of a species on four forest-associated amphibians in a severely

fragmented landscape of Brazilian Atlantic Forest.

Amphibians were surveyed in forest fragments with and without streams (referred to as wet and dry fragments), including grass-field matricies. The comparison of capture rates in dry fragments and nearby streams in the matrix allowed evaluation of the number of individuals that engaged in high-risk migrations through nonforested habitats. Adult amphibians moved from dry fragments to matrix streams at the beginning of the rainy season, reproduced, and returned at the end of the breeding period. Juveniles of the year moved to dry fragments along with adults.

These risky reproductive migrations through nonforested habitats that expose individual amphibians to dehydration, predation, and other hazards may cause population declines in dry fragments. Indeed, capture rates were significantly lower in dry fragments compared with wet fragments. Declining amphibians would strongly benefit from investments in the conservation and restoration of riparian vegetation and corridors linking breeding and nonbreeding areas. Becker et al. (2010) is the sort of study that could be replicated in a number of locations. It could well serve as a model example of a habitat degradation study that coupled with micro-climatic change can exhibit the pressures faced by amphibians in pressured landscapes.

Becker, C.G., Fonseca, C.R., Haddad, C.F.B. & Prado, P.I. (2010). Habitat split as a cause of local population declines of amphibians with aquatic larvae. *Cons. Biol.* **24** (1), 287-294.

RED-EYED TREEFROG EMBRYOS USE TWO FEATURES OF RAIN VIBRATIONS TO AVOID EVASIVE HATCHING FALSE ALARMS.

Prey use predator cues to inform defensive decisions. Detecting these cues is often complicated by benign stimuli that resemble and can be mistaken for predators, leading prey to display costly defences incorrectly. One strategy that prey have evolved to reduce these 'false alarms' is to respond only to stimuli with characteristics consistent with predator cues. Decision errors might still be frequent, however, in cases where the probability distributions of benign stimulus properties completely overlap those of predator cues.

Figure 1. *Agalychnis callidryas* (Top) and snake attack on embryos, triggering hatching (Below). © Michael S. Caldwell.

In such cases, inhibition of defensive responses by characteristic features of benign stimuli could

further improve discrimination. Red-eyed Treefrog embryos, *Agalychnis callidryas* (Fig. 1), hatch prematurely to escape egg predators. They detect predators using vibrations generated during attacks. However, common benign disturbances such as rainstorms generate vibrations with property probability distributions that largely overlap those of predators. In this study Michael Caldwell and colleagues used vibration playbacks to test the hypotheses that embryos use two features of rainstorm vibrations not shared by predator attacks, characteristic high frequencies and an initial period of intensity buildup, to avoid hatching in response to this benign stimulus. The escape-hatching response to otherwise stimulatory vibrations is reduced in the presence of either features characteristic of rainstorms. Either *A. callidryas* embryos use rainstorm features to inform their hatching decision or these features alter their perception of predator cues. Identifying likely sources of potential false alarms and comparing their stimulus characteristics to predator cues and prey decision rules will improve our understanding of both the information processing challenges facing prey and the ways they solve them.

Caldwell, M.S., McDaniel, J.G. & Warkentin, K.M. (2009). Is it safe? Red-eyed treefrog embryos assessing predation risk use two features of rain vibrations to avoid false alarms. *Animal Behaviour* **79** (2), 255-260.

METAPOPULATION DYNAMICS AND CLIMATE IMPACTS OF A DECLINING GREAT CRESTED NEWT METAPOPULATION.

Climate can interact with population dynamics in complex ways. In this study Richard Griffiths and colleagues describe how climatic factors influenced the dynamics of an amphibian metapopulation over 12 years through interactions with survival, recruitment and dispersal. Low annual survival of Great Crested Newts (*Triturus cristatus*) was related to mild winters and heavy rainfall, which impacted the metapopulation at a regional level. Consequently, survival varied between years but not between sub-populations. Despite this regional effect, the four sub-populations were largely asynchronous in their dynamics. Three out of the four sub-populations suffered reproductive failure in most years, and recruitment to the metapopulation relied on one source. Variation in recruitment and juvenile dispersal was therefore probably driving asynchrony in population dynamics. At least one sub-population went extinct over the '12 year' period. These trends are consistent with simulations of the system, which predicted that two sub-populations had an extinction risk of >50% if adult survival fell below 30% in combination with low juvenile survival. Intermittent recruitment may therefore only result in population persistence if compensated for by relatively high adult survival. Mild winters may consequently reduce the viability of amphibian metapopulations. In the face of climate change, conservation actions may be needed at the local scale to compensate for reduced adult survival. These would need to include management to enhance recruitment, connectivity and dispersal. Griffiths et al. (2009) study is a good model example of how to gather and apply climate and metapopulation data.

Griffiths, R.A., Sewell, D. & McCrea, R.S. (2009). Dynamics of a declining amphibian metapopulation: survival, dispersal and the impact of climate. *Biol. Cons.* **143**, 485-491.

Figure 1. *Triturus cristatus* (Great Crested Newt). © Gareth Blockley.

Thermoregulation of *Craugastor berkenbuschii* (Peters, 1870)

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ABSTRACT - Many physiological and behavioural processes are temperature dependent in ectothermic organisms. In this study, we evaluated the influence of environmental temperature on the thermoregulation of *Craugastor berkenbuschii* in a remnant of tropical evergreen forest in southeastern México. Mean body temperature was 22.02 ± 1.55°C (range: 19.5-25.5°C). Body temperature was correlated with air and substrate temperature. It requires more complex studies involving other aspects of the thermal ecology, together with consideration of other biological characteristics, to purposefully conclude specific conservation strategies for this species.

THE family Craugastoridae comprises 114 species of frogs, of which 39 inhabit Mexico. The family represents 10.4% of the total Mexican amphibian fauna. Specifically the genus *Craugastor* occurs from southern Arizona to central Texas (USA) and south through tropical and subtropical habitats to northwestern Ecuador, Colombia and eastern Brazil (Frost, 2009). In Mexico the genus occurs from southeastern San Luis Potosi and northern Veracruz to northern Oaxaca, and to the Isthmus of Tehuantepec at 400-1,900 m ASL. Although these frogs are widely distributed, their ecology is still poorly known.

Craugastor berkenbuschii (Berkenbusch's Stream Frog) (Fig. 1 and 2) is endemic to Mexico. It inhabitats rocky streams in premontane and lower montane wet forests, has an insectivorous diet, and is a species with direct development (Pough et al., 2004). The frog is protected by Mexican law under the "Special Protection" category (Pr). The IUCN list the species as "Near Threatened" although it is still relatively widely distributed. It depends on areas of cloud forest habitat and thus its area of occupancy is probably not much greater than 2,000 km^2. The extent and quality of its habitat is rapidly declining, making this species close to qualifying as "Vulnerable" (Santos-Barrera & Flores-Villela, 2004).

Thermoregulation in amphibians is both behavioural (emergence, retreat, temperature selection and basking, etc.) and physiological (acclimation, evaporative cooling, etc.) (Brattstrom, 1963). Behavioural thermoregulation enables ectotherms to use thermally diverse environments and yet control temperature-sensitive physiological processes (Feder, 1982). In this paper we analyze the thermoregulation of *C. berkenbuschii* and describe the relationship of body temperature with substrate, air temperature and microhabitat for this frog.

METHODS AND MATERIALS

This study was carried out 6 km southestern of Paso del Moral locality, in municipality of Uxpanapa, Veracruz, México, (17º10´50" N, 94º35´0.8" W; 225 elev.). The climate of the study area is tropical

Figure 1. *Craugastor berkenbuschii* on the forest floor. Photograph © Uri Omar García-Vázquez. ◄

Figure 2. *Craugastor berkenbuschii* in a communal shelter hole. Photograph © Uri Omar García-Vázquez. ▲

with a mean annual temperature of 25°C and a mean annual rainfall of 2900 mm (García, 1973). Vegetation is tropical evergreen forest (Secretaría de Gobernación, 2005). We collected 21 frogs between 20:00 to 02:00 from 22 to 24 February 2009. Organisms were captured by hand and returned to their habitat after data collection. Body temperature (Tb to the nearest 0.2°C), air (Ta at 5 cm) and substrate temperatures (Ts on the site where the frog was first observed) were obtained using a Miller & Weber® (0-50 ± 0.2 °C) quick reading thermometer. We also recorded microhabitat type for each captured specimen. Snout-vent length (SVL) was measured with an electronic caliper to 0.1 mm and body mass measured using a Pesola® scale to 0.2 g.

We assessed normality and homocedasticity with Kolmogorov-Smirnov and Bartlett tests, respectively. Parametric statistical analyses were performed with JMP Statistical Software Package Version 7® (SAS, Institute Inc. 2007). We calculated residuals from the relationship of Tb to SVL to produce Tb adjusted variables which maintained variation of extrinsic factors and minimized the compounding effect of size related individual variation in SVL. We performed a multiple regression analysis to analyze the relationship among Tb, Ta, and Ts. All measurements are reported as mean ± standard deviation. Statistical significance (α) was set at 0.05.

RESULTS

The mean SVL of all frogs was 50.39 ± 11.05 (n = 21; range 30.9-69.5 mm) and the weight was 12.84 ± 8.54 (n = 21; range 2.2-29 mm). Overall mean Tb of *C. berkenbuschii* was 22.02 ± 1.55°C (19.5-25.5°C; n = 23). There was no significant relationship between SVL and Tb (y = 25.329 + 0.064 SVL, r^2 = 0.195, F = 4.387, P = 0.05) so we used the original data set on the analysis. Air temperature in the locality fluctuated between 20.6°C to 23.3°C (Ta = 22 ± 0.77°C, n = 23) and substrate temperature had an average of Ts = 20.36 ± 1.27°C, n = 23, with extremes of 19°C to 25.5°C. There was a significant relationship between Tb with both Ta and Ts (r^2 = 0.436, F = 7.349, P =

0.0043). Most frogs were found on the ground (n = 10) and among rocks (n = 8), the remainder were found on trunks (n = 3) and vegetation (n = 2).

DISCUSSION

Amphibian diversity is threatened by direct factors such as diseases, pesticides and habitat loss, and indirect factors like climate change and invasive species, which reduce their population viability, and increase their vulnerability to extinction (Semlitch, 2003). Among these risk factors, habitat loss and local environmental climate change are some of the most important factors causing tropical amphibian decline. The former creates a semi-natural landscape composed principally of forest fragments, immersed in an agricultural matrix (Saunders et al., 1991). The latter (climate change) alters the temperature and precipitation pattern and results in changes at the macro and micro climate level that may influence amphibian behaviours, such reproductive phenology, hibernation, aestivation and foraging (Blaustein et al., 2001). It could also potentially affect a frog's thermoregulatory behaviour. Some *Craugastor* species have been identified as habitat quality indicators in tropical rain forest fragments. Urbina-Cordona (2006) found that *Craugastor vulcani* is a truly forest interior/edge-avoiding species due to it requirement for living in forest fragments with high habitat quality (e.g., high leaf-litter cover, good understorey density, high relative humidity, but with lower temperatures) in order to reproduce and survive. The effect of decline factors, together with the highly specialized habitat use by *C. berkenbuschii* could lead to body/environment temperature change. Therefore, more complex studies, involving other aspects of thermal ecology of Berkenbusch´s Stream Frog, may prove useful. Such studies might include consideration of habitat composition and other biological characteristics that could aid development of specific conservation strategies for the species.

REFERENCES

Blaustein, A.R., Belden, L.K., Olson, D.H., Green, D.M., Root, T.L. & Kiesecker, J.M. (2001). Amphibian breeding and climate change. *Cons. Biol.* **15**, 1804-1809.

Brattstrom, B.H. (1963). A preliminary review of the thermal requirements of amphibians. *Ecology* **44**, 238-255.

Feder, M.E. (1982). Thermal ecology of neotropical lungless salamanders (Amphibia: Plethodontidae): Environmental temperatures and behavioral responses. *Ecology* **63**, 1665-1674.

Frost, D.R. (2009). Amphibian species of the world: an online reference. Version 5.3. <http://research.amnh.org/herpetology/amphibia/index.html>. Amer. Mus. Nat. Hist., New York. [Accessed: 12 February 2009].

García, E. (1973). *Modificaciones al Sistema de Clasificación Climática de Koppen. Segunda Edición*. Mexico: Instituto de Geografía, Universidad Nacional Autónoma de México. 246 pp.

Pough, F.H., Andrews, R.M., Cadle, J.E., Crump, M.L., Savitzky, A.L. & Wells, K.D. (2004). *Herpetology, Third Edition.* New York: Prentice Hall. 726 pp.

Santos-Barrera, G. & Flores-Villela, O. (2004). *Craugastor berkenbuschii*. In: IUCN Red List of Threatened Species. Version 2009.1. <www.iucnredlist.org>. [Accessed: February 2009].

Saunders, D., Hobbs, R. & Margules, C. (1991). Biological consequences of ecosystem fragmentation: a review. *Cons. Biol.* **5**, 18-32.

Secretaría de Gobernación (2005). Enciclopedia de los Municipios de México, Veracruz. <www.e-local.gob.mx>. [Accessed: 2009].

Semlitsch, R.D. (2003). *Amphibian Conservation.* Washington: Smithsonian Institution Press.

Urbina-Cardona, J.N. (2006). Tropical amphibian diversity and edge effect. *Froglog* **77**, 1-2.

A herpetofaunal survey of Southern Jordan

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ABSTRACT - A total of 70 herpetofauna species from 3 Orders and 18 Families were surveyed during a period of two years (2005-2007) in Southern Jordan. The Ophidia included Leptotyphlopidae, Typhlopidae, Boidae, Colubdridae, Atractaspididae, Elapidae and Viperidae. The Sauria included Gekkonidae, Chamaeleonidae, Agamidae, Lacertidae, Sincidae, Anguidae and Varanidae. Testudines included Cheloniidae, Dermochelyidae, Emydidae and Testudinidae. The species listed were all resident and mostly found throughout the year. The diversity of terrestrial and aquatic ecosystems in the study area likely encouraged species presence. The results reinforce the necessity for long-term inventory planning in order to understand the ecology and the dynamics of herpetofauna and other wildlife communities in the study area. The increasing human impact on the existing natural resources in Southern Jordan has threatened the ecology and diversity of wildlife species to such a degree that populations of anurans and many reptiles are declining in diversity, status and abundance. The author recommends improving cooperation of different parties to enhance public awareness and to implement environmental laws and legislation to conserve sensitive and rare species of herpetofauna.

SOUTHERN Jordan lies at the juncture of the Levantine and Arabian regions of the Near East. Four main physiographic regions are recognised; (1) Rift Valley, (2) Mountain ranges, (3) Southeastern desert and (4) Marine environment of the Gulf of Aqabah. This affords Southern Jordan a diversified morphology that is reflected in the diversity of its herpetofauna (Amr & Amr, 1983; Arnold, 1983; Disi, 1983; Arnold 1984; Joger, 1984; Disi, 1985; Disi, 1987; Amr, 1988; Amr & Woodbury, 1988; Disi et al., 1988; Arnold 1989; Disi, 1991, 1993; Al-Oran et al., 1994; Amr et al., 1994; Al-Oran & Amr, 1995; Disi, 1996; Al-Oran et al., 1997; Amr et al., 1997; Al-Oran et al., 1998; Amr et al., 1998; Disi et al., 1998).

Southern Jordanian territory, due to its geographical position, creates a crossroad of different zoogeographic realms (Afrotropical, Saharo-Sindian, Oriental and Palearctic), which influence the composition of the Jordanian herpetofauna. Distribution of these biogeographical regions is at its most diverse in the west of Jordan where it is influenced by altitude (Leviton et al., 1992; Werner, 1986, 1988, 1991, 1992; Wittenberg, 1992). The complex mosaic of high mountains, steep slopes and deep wadis has lead to the formation of narrow borders or overlap between individual eco-zones and causes mixing of floral and faunal elements with different biogeographical affinities in individual localities.

Within these eco-zones there are apparent declines and extinction of herpetofauna at a local community level creating a requirement for knowledge of distribution and presence data. The causes of these declines may include habitat loss and degradation, unsustainable use, invasive species, environmental pollution, disease and global climate change (Sindaco et al., 1995; Modry et al., 1998, 1999). Habitat loss appears to be the most serious threat to the herpetofauna of Jordan. Habitat degradation of wetlands by draining and/or pollution also threatens amphibian populations in Jordan.

A variety of herpetological surveys and studies have been conducted in neighbouring countries on species that occur in Jordan. These comparable studies showed that lizards were the most common group of reptiles in terms of species identified or caught. Three anuran species (*Bufo viridis*, *Rana ridibunda* and *Hyla arborea*) that were investigated in the different areas of Turkey also have a wide distribution throughout the Middle East countries (Amr & Amr, 1983; Amr, 1988; Amr & Woodbury, 1988; Amr et al., 1994; Amr et al., 1997; Al-Oran

et al., 1998). In Southern Jordan a number of reptile species are recognized (Disi, 1983; Joger, 1984; Disi, 1985, 1987; Disi et al., 1988, Disi, 1991, 1993, 1996; Disi et al., 1998).

Two species of turtles, the Caspian Terrapin *Mauremys caspica rivulata* and the Terrestrial Spur-thighed Tortoise *Testudo graeca terrestris*, occur in most of the Mediterranean basin and the Middle East, including Jordan (Werner, 1986, 1988, 1991; Leviton et al., 1992; Werner, 1992; Wittenberg, 1992). In spite of the threats facing freshwater turtles worldwide, both species have a reasonably good distribution in Jordan.

Ten species of venomous snakes occur in Israel and Jordan belonging to three families. The most dangerous, and most common, is the Palestine Viper *Vipera palaestinae*. All venomous snake species in Jordan seem to pose a serious threat to humans with several hundred bites being reported every year in Israel and Jordan (Werner, 1986, 1988, 1991; Leviton et al., 1992; Werner, 1992; Wittenberg, 1992).

Data on wildlife species indicate that approximately 500 birds, 100-120 mammals, 400 fish and 120 herpetofauna species are also known from Jordan (Amr & Amr, 1983; Arnold, 1983; Disi, 1983; Arnold 1984; Joger, 1984; Disi, 1985; Disi, 1987; Amr, 1988; Amr & Woodbury, 1988; Disi et al., 1988; Arnold 1989; Disi, 1991, 1993; Al-Oran et al., 1994; Amr et al., 1994; Al-Oran & Amr, 1995; Disi, 1996; Al-Oran et al., 1997; Amr et al., 1997; Al-Oran et al., 1998; Amr et al., 1998; Disi et al., 1998).

METHODS AND MATERIALS

The sites in this study are wide ranging. The study area comprised Aqaba wetland (site I), Ras Al Naqab mountainous land (site II) and Araba Irano-turanian valley land (site III). In the wetland habitat typical vegetation was bordered by tall emergent plants like *Phragmites australis* and *Arundo donax. Tamarix nilotica* covered considerable maritime areas. In the Ras Al Naqab mountainous land vegetation comprised trees and shrubs such as *Juniperus phoenicea, Sarcopoterium spinosa* and *Daphne linearifolium.* In the Araba Valley the vegetation comrpised *Calotrops procera, Salvadora persica* and *Acacia* spp.

Field methodologies used in this study were divided into two occasions;

(1) The main survey period, covering two years (October 2005-September 2007); and
(2) Additional visits that have been conducted after the study period.

Data collected in the field were recorded on survey sheets designed specifically for the purpose. Live traps and aquatic nets were used. Frequent visits and discussions with local people were also used to determine presence and identification of herpetofauna, and their ecological importance in the study area. Visits were carried out both diurnally and nocturnally to detect all species. Examination of amphibian and reptile eggs, their parts and identification was completed in situ. Acoustics and tracks were also used to supplement visual encounter survey. Road kills were also utilised for presence and absence.

Voucher specimens were deposited in the Jordanian Natural History Museum at both Yarmouk and Mutah Universities, and in the Zoologic Museum at Jordan University. A long range of international, regional and even local literature was used to identify species (Amr & Amr, 1983; Arnold, 1983; Disi, 1983; Arnold, 1984; Joger, 1984; Wittenberg, 1984; Disi, 1985; Werner, 1986; Disi, 1987; Werner, 1988; Arnold, 1989; Amr, 1988; Amr & Woodbury, 1988; Disi et al., 1988; Disi, 1991; Werner, 1991; Leviton et al., 1992; Werner, 1992; Wittenberg, 1992; Disi, 1993; Al-Oran et al., 1994; Amr et al., 1994; Al-Oran & Amr, 1995; Sindaco et al., 1995; Disi, 1996; Al-Oran et al., 1997; Amr et al., 1997; Al-Oran et al., 1998; Amr et al., 1998; Disi et al., 1998; Modry et al., 1998, 1999).

Following previous author's style we used a bird recording status and abundance technique that is approximate and qualitative. We adapted it to record herpetofaunal species as follows (Bibby & Marsden, 1998):

1. Resident (R): Generally present all year round.
2. Winter Visitor (WV): Present in winter.
3. Summer Visitor (SV): Present in summer.

4. Passage Migrant (PM): Only present in spring and/or autumn migration periods.
5. Vagrant (V): Migratory species that swerved from normal migratory routes.
6. Unknown (UN): Status unknown.

1. Very Rare (VR): The species seen once or twice.
2. Rare (R): The species seen in very low numbers
3. Uncommon (UC): The species seen in small numbers but more than R.
4. Common (C): The species seen in relatively large numbers.
5. Very Common (VC): The species seen in large numbers.

RESULTS

A total of 70 herpetofaunal species belonging to 3 Orders and 18 Families were recorded in Southern Jordan. The three Orders were; (1) Ophidia - has 7 Families, Leptotyphlopidae (1 species), Typhlopidae (2 species), Boidae (1 species), Colubridae (17 species), Atractaspididae (1 species), Elapidae (1 species) and Viperidae (5 species); (2) Sauria - has 7 Families, Gekkonidae (12 species), Chamaeleonidae (1 species), Agamidae (8 species), Lacertidae (3 species), Sincidae (8 species), Anguidae (1 species), Varanidae (1 species); (3) Testudines - has 4 Families, Cheloniidae (2 species), Dermochelyidae (1 species), Emydidae (1 species) and Testudinidae (1 species).

All the taxonomic categories with their species are listed in Table 1 (Appendix) with their status recognition. The three amphibians belong to a single order and three Families. All were noted to inhabit wetlands, seasonal rainwater pools, rainwater harvesting areas, irrigated canals and wastewater ponds in the study area.

DISCUSSION

The isolated relict natural ecosystems of Jordan are mostly found in the southeastern desert on the border with Saudi Arabia but also in high elevations and deep valleys of the Rum Mountains. The majority of herpetofauna in the Mediterranean eco-zone are of Palearctic origin. Most amphibians and reptiles that inhabit this eco-zone are widely distributed in the eastern Mediterranean region, namely *Rana bedriagae*, *Hyla savignyi*, *Testudo graeca*, *Hemidactylus turcicus*, *Lacerta laevis*, *Typhlops vermicularis*, *Eryx jaculus*, *Malpolon monspessulanus* and several others. However, some of the local reptiles can be considered as endemics, namely *Chalcides guentheri*, *Rhinotyphlops simoni* and *Micrelaps muelleri.*

It is clear that the Mediterranean eco-zone of the Southern Jordan is generally confined to the southwestern highlands, that is typically identified by having the highest rainfall in the region. The vegetation used to be dominated mostly by pine forests at higher altitudes and oak forests at lower elevation. Grazing of numerous herds of domestic animals has lead to secondary, heavily disturbed and rather dry Steppe vegetation. The Irano-Turanian eco-zone is defined mainly phytogeographically and forms a strip of mostly Steppe habitat surrounding the Mediterranean. It is often considered to be a transitional zone between drier parts of the Mediterranean and surrounding eco-zones. Afrotropical (or Sudanian) eco-zone (often referred to as Afrotropical penetration) extends from Al Karama region in the north through the Rift Valley to Aqabah and also to the east, including the sea shore. This zone is typically recognized by the presence of African flora and fauna and by the presence of Arabian herpetofauna. *Phrynocephalus arabicus*, *Coluber elegantissimus*, *Atractaspis engaddensis* are typically confined to this eco-zone.

Relatively humid regions of southwest parts of the Jordanian highlands in Southern Jordan represent the centre of amphibian diversity in Jordan. Unfortunately, this region is also widely affected by urbanisation, agriculture and industry. The distribution of some amphibians, chiefly *Pelobates syriacus* and *Triturus vittatus* is limited in this region and the current occurrence of these species is questionable. *P. syriacus* has not been reported since 1973 and the occurrence of *T. vittatus* still requires confirmation.

The above mentioned overlap of the Jordanian territories hosts surprisingly rich reptile fauna compared to that of neighbouring countries, even at a regional level in the Middle East. Thus far, more than 70 species are known to occur in

Southern Jordan. Interestingly, the occurrence of several reptile species was secured only recently. Among the most recent additions, the presence of *Phrynocephalus maculatus* near Wadi Araba and discovery of a new form of *Lacerta* in Wadi Rum are notable. It is still probable that the list of Southern Jordanian reptiles, as shown in Table 1 (Appendix), is incomplete and thus awaits further additions and revisions. However, despite this it is evident, that our knowledge about the distribution and biology of several species is essentially anecdotal and requires more intense field research.

The overview of typical habitats mentioned herein is not definitive. The eco-zones surveyed during this study can, however, help identify herpetofauna found in certain areas; e.g. prevailing Steppe habitats favour *Trapelus ruderatus* and *Acanthodactylus tristrami.* Also, the Saharo-Arabian eco-zone (Badyiah), covers a major part of the Southern Jordanian inland and depending on the geology, geomorphology, latitude and altitude, can form arid semi-deserts and desert habitats that may limit distribution of certain species because permanent natural water resources are so rare. Various reptile taxa are typical of this eco-zone; e.g. *Trapelus pallidus agnetae*, *Acanthodactylus robustus*, *A. grandis*, *Malpolon moilensis* and *Pseudocerastes persicus.*

The results from this survey reinforce the necessity of long-term inventories in order to understand the dynamics of animal communities in the study area. It is expected that increasing human population, residential and agricultural expansions, intensive and extensive infrastructure, development projects, and poor implementation of environmental legislation are major factors contributing to the gradual decline of biodiversity in the area. The arid to semi-arid environment of Southern Jordan hosts reptile populations comprising desert species that are also found in neighbouring countries, especially on the Sinai Peninsula. Many reptiles recorded in this study resemble species assemblages recorded in other studies from different Middle East countries. These similarities could be attributed to the fact that these countries lie in the east Mediterranean basin where climatic conditions are fairly similar.

The diversity of agro-environments and wetland habitats in Southern Jordan also attracts more insects and other micro-fauna which in turn constitute a major trophic level in the food chain of lizards. The Desert Monitor *Varanus griseus* is among the largest lizards occurring in the area and would need a substantial trophic food chain to support it. Venomous and non-venomous snakes play an ecological role in eliminating pests and harmful animals from the environment. However, this role is not generally acknowledged by many people in the region and often snakes are still persecuted. Solutions to this problem lie in improving education of local communities and in enforcing laws regarding wildlife protection. Ten species of venomous snake belonging to three Families (Viperidae, Elapidae and Atractaspididae) occur in Southern Jordan and much is still to be known about their ecology.

The strategic position of the study area, at the terrestrial meeting point between Asia, Europe and Africa, coupled with its climate and topography means that Jordan receives interaction and spread of flora and fauna from all three continental masses. The diversity of ecological habitats in particular contributes to species diversity. The various ecosystems, including wetlands, sand dunes, natural vegetation and agricultural orchards provide reptiles and amphibians with all their habitat needs for shelter, food and reproduction.

However, the increasing human impact on existing natural resources in Southern Jordan threaten wildlife including herpetofauna. Populations of frogs and many reptiles are potentially declining, with virtually no data to monitor such losses. The current deterioration and drainage of wetland habitats will seriously threaten the existence of wildlife. Human intervention by habitat alteration, drainage of riparian wetlands, water pollution and turtle collection has been reported to endanger the existence of certain populations of herpetofauna. With this in mind, the author recommends improving cooperation of different government and non governmental organisations to enhance the public awareness and to implement environmental laws and legislation to conserve nature and to protect wildlife, especially that of the sensitive and rare herpetofauna of Southern Jordan. Finally, the author recommends

carrying out more field studies on the biodiversity in Southern Jordan.

REFERENCES

Al-Oran, M., Disi, A.M., Al-Melhim, W. & Amr, Z. (1997). Reptiles of Wadi Araba. *Mutah* **12** (4), 45-67.

Al-Oran, R. & Amr, Z.S. (1995). First record of the Mole Viper, *Atractaspis microlepidota engaddensis*, from Jordan. *Zool. Middle East* **11**, 47-49.

Al-Oran, R. Al-Melhem, W. & Amr, Z.S. (1994). Snakes of Southern Jordan. *Boll. Zool.* **61** (4), 359-367.

Al-Oran, R., Rostum, S., Joger, U. & Amr, Z. (1998). First record of the Levantine viper, *Macrovipera lebetina*, from Jordan. *Zool. Middle East* **16**, 65-70.

Amr, Z.S. & Amr, S.S. (1983). Snakebite in Jordan. *The Snake* **15** (1), 81-85.

Amr, Z.S. & Woodbury, S. (1988). History of zoological expedition and studies on Jordan. *Korean J. Zool.* **31** (1), 71-79.

Amr, Z.S. (1988). Recovery of *Prosthodendrium obtusum* (Looss, 1896) from *Chamaeleo chamaeleon* collected from Jordan. *Japanese J. Parasitol.* **37** (5), 371-372.

Amr, Z.S., Al-Oran, R & Al-Melhem, W. (1997). Aggregation behavior in two Jordanian snakes: *Coluber rubriceps* and *Typhlops vermicularis. Herpetol. Rev.* **28**, 130-131.

Amr, Z.S., Al-Oran, R. & Disi, A. (1994). Reptiles of Southern Jordan. *The Snake* **26** (2), 41-49.

Amr, Z.S., Al-Oran, R. & Shwyat, S. (1994). Snakebites in Jordan. *The Snake* **26**, 111-115.

Amr, Z.S., Disi, A.M. & Al-Melhim, W. (1997). Distribution of Mueller's snake, *Micrelaps muelleri* Böettger, 1880 (Reptilia, Serpentes, Colubridae). *Herpetozoa* **10** (3/4), 163-168.

Amr, Z.S. & Disi, A.M. (1998). Diet of some snakes from Jordan. *Amphibia-Reptilia* **19**, 436-439.

Arnold, E.N. (1983). Osteology, genitalia and the relationships of *Acanthodactylus. Bull. Brit. Mus.* (*Nat. Hist*.)*, Zool.* **44**, 291-339.

Arnold, E.N. (1984). Ecology of lowland lizards in the eastern United Arab Emirates. *J. Zool.* **204**, 329-354.

Arnold, E.N. (1989). Towards a phylogeny and biogeography of the Lacertidae: relationships within an Old-World family of lizards derived from morphology. *Bull. Brit. Mus.* (*Nat. Hist*.)*, Zool.* **55** (2), 209-257.

Disi, A.M. (1983). Contribution to the herpetofauna of Jordan. 1. Venomous snakes. *Dirasat* **10** (2), 167-180.

Disi, A.M. (1985). Contribution to the herpetofauna of Jordan. II. New records and systematic list of snakes from Jordan. *The Snake* **17**, 31-42.

Disi, A.M. (1987). Environmental factors affecting snake distribution in Jordan. In: *Proceedings of the Symposium on the and Zoogeography of the middle east, Mainz, 1985.* Pp. 296-310. Krupp, F., Schneider, W. & Kinzelbach, R. (Eds). Beihefte zum TAFO A. Wiesbaden, 28.

Disi, A.M. (1991). A contribution to the herpetofauna of Jordan. 4. Lizards of Jordan. *Zool. Middle East* **5**, 25-35.

Disi, A.M. (1993). A contribution to the herpetofauna of Jordan. V. New records of three Colubrid snakes from Jordan. *The Snake* **25**, 109-113.

Disi, A.M. (1996). A contribution to the knowledge of the herpetofauna of Jordan. VI. The Jordanian herpetofauna as a zoogeographic indicator. *Herpetozoa* **9**, 71-81.

Disi, A.M. & Amr, Z.S. (1998). Distribution and ecology of lizards in Jordan (Reptilia: Sauria). *Faun. Abh. Mus. Tierkd. Dresden*, 21 (Suppl. Fritz, U., Obst, F.J. & Andreas, B. (Eds.). Contribution to a "Herpetologia arabica", **6**, 43-66.

Disi, A.M., Amr, Z.S. & Defosse, D. (1988). Contribution to the herpetofauna of Jordan. III. Snakes of Jordan. *The Snake* **20** (1), 40-51.

Joger, U. (1984). The venomous snakes of the Near and Middle East. Beih. Tübing. *Atlas Vorder. Orients, Ser. A*. **12**, 1-115.

Leviton, A.E., Anderson, S.C., Adler, K. & Minton, S.A. (1992). *Handbook of Middle East Amphibians and Reptiles.* Utah: Society for the Study of Amphibians & Reptiles. 252 pp.

Modry, D., Al-Oran, R.M., Amr, Z.S. & Necas, P. (1999). A new record of the Tilbury´s spiny-footed lizard, *Acanthodactylus tilburyi* Arnold, 1986 (Reptilia: Lacertidae) from the Hashemite

Kingdom of Jordan. *Casopis Národního muzea, Rada prirodovedná* **168** (1-4), 121-124.

Modry, D., Koudela, B., Al-Oran, R. & Amr, Z.S. (1999). *Carysospora maxima* sp. n. (Apicomplexa: Eimeriidae), new coccidium from Forskäl's sand snake, *Psammophis shokari* (Serpentes: Colubridae) from lava desert of Jordan. *Folia Parasitol.* **46** (2), 96-98.

Modry, D., Koudela, B., Al-Oran, R., Amr, Z.S. & Dolezel, D. (1998). *Isospora ptyodactyli* sp. n. (Apicomplexa: Eimeriidae) - New coccidian parasite from the Fan-footed Gecko *Ptyodactylus puiseuxi* (Reptilia: Gekkonidae) from Jordan. *Syst. Parasitol.* **39** (1), 45-48.

Sindaco, R., Fedrighini, N. & Venchi, A. (1995). Contribution to the herpetology of Jordan. *Bull. Mus. Reg. Sci. Nat. Torino.* **13** (2), 389-405.

Werner, Y.L. (1986). Geographic sympatry of *Acanthodactylus opheodurus* with *A. boskianus* in the Levant. *Zool. Middle East* **1**, 92-95.

Werner, Y.L. (1988). Herpetofaunal survey of Israel (1950-85), with comments on Sinai and Jordan and on zoogeographical heterogeneity. In: *Zoogeography of Israel.* Pp. 355-388. Yom-Tov, Y. & Tchernov, E. (Eds.). Monographiae Biologicae, 62.

Werner, Y.L. (1991). Notable herpetofaunal records from Transjordan. *Zool. Middle East* **5**, 37-42.

Werner, Y.L. (1992). Identity and distribution of *Agama stellio picea* Parker (Sauria: Agamidae), endemic to the volcanic desert of Jordan. *Zool. Middle East* **6**, 41-44.

Wittenberg, J. (1992). First records of Arabian Toad-headed Agamid (*Phrynocephalus arabicus*) (Sauria: Agamidae) in Jordan. *Zool. Middle East* **7**, 59-63.

APPENDIX

Table 1. List of Reptilia from Southern Jordan.

	Family	Scientific Name	Status	Abundance
OPHIDIA				
	Leptotyphlopidae	*Leptotyphlops macrorhynchus*	R	R
	Typhlopidae	*Typhlops vermicularis*	V	U
		Typhlops simoni	R	C
	Boidae	*Eryx jaculus*	V	C
	Colubdridae	*Coluber elegantissimus*	R	C
		Coluber jugularis asianus	R	C
		Coluber nummifer	R	VC
		Coluber ravergieri	PM	VC
		Coluber rhodorachis	R	R
		Coluber rogersi	R	VR
		Coluber rubriceps	SV	VC
		Coluber schmidti	R	VR
		Coluber ventromaculatus	V	R
		Eirenis coronella	R	C
		Eirenis decemlineata	R	C
		Eirenis lineomaculata	R	VC
		Eirenis rothi	WV	C
		Lytrorhynchus diadema	R	R
		Lytrorhynchus kennedyi	UN	R
		Natrix tessellata	R	VR
		Rhynchocalamus melanocephalus	R	VC
		Spalerosophis diadema cliffordi	UN	VC
		Malpolon monspessulanus insignitus	V	C
		Psammophis schokari	R	C
		Telescopus dhara	V	C
		Telescopus fallax syriacus	R	C
		Telescopus nigriceps	R	R

	Atractaspididae	*Atractaspis microlepidota engaddensis*	R	R
	Elapidae	*Walterinnesia aegyptia*	R	UC
	Viperidae	*Cerastes cersates*	R	C
		Macrovipera lebatina	R	C
		Echis colorarus	R	C
		Pseudocerastes persicus fieldi	R	R
		Vipera palaestinae	PM	VR
SAURIA				
	Gekkonidae	*Bunopus tuberculatus*	R	UC
		Cyrtodactylus scaber	V	C
		Cyrtodactylus kotschyi	R	C
		Hemidactylus turcicus turcicus	R	C
		Pristurus rupestris	R	VC
		Ptyodactylus hasselquistii	V	C
		Ptyodactylus guttatus	R	VC
		Ptyodactylus puiseuxi	R	UC
		Stenodactylus doriae	UN	C
		Stenodactylus grandiceps	R	C
		Stenodactylus sthenodactylus	WV	C
		Tropiocolotes nattereri	R	UC
	Chamaeleonidae	*Chamaeleo chamaeleon recticrista*	UN	VC
	Agamidae	*Laudakia stellio stellio*	PM	UC
		Laudakia stellio brachydactyla	R	C
		Laudakia stellio picea	R	C
		Pseudotrapelus sinaita	R	C
		Trapelus blanfordi fieldi	R	C
		Trapelus pallda haasi	R	C
		Phyrnocephalus arabicus	R	C
		Uromastyx aegyptius microlepis	R	C
	Lacertidae	*Acanthodactylus grandis*	V	C
		Mesalina olivieri schmidti	R	R
		Ophisops elegans	R	C
		Lacerta laevis	R	VR
		Lacerta trilineata israelica	R	R
	Sincidae	*Ablepharus rueppellii*	R	C
		Chalcides ocellatus	R	C
		Chalcides guentheri	R	VC
		Eumeces schneideri pavimentatus	R	C
		Eumeces schneideri schneideri	R	C
		Mabuya vittata	SV	UC
		Ophiomorus latastii	V	VC
		Sphenops sepsoides	R	VC
	Anguidae	*Ophisaurus apodus*	R	C
	Varanidae	*Varanus griseus*	R	UC
TESTUDINES				
	Cheloniidae	*Chelonia mydas*	R	UC
		Eretmochelys imbricata	PM	C
	Dermochelyidae	*Dermochelys coriacea*	R	C
	Emydidae	*Mauremys caspica rivulata*	R	C
	Testudinidae	*Testudo graeca terrestris*	R	C

Helminths of *Anolis nitens* (Squamata, Polychrotidae), from Brazil and Ecuador, South America

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ANOLIS nitens (Wagler, 1830) is known to occur in Brazil, northern Peru, Ecuador, Suriname, French Guiana, Venezuela and Trinidad (Uetz & Hallermann, 2009). We know of no helminth records for *A. nitens*. The purpose of this note is to establish the initial helminth list for *A. nitens* as part of an ongoing investigation of helminths in South American lizards.

METHODS AND MATERIALS

Eighteen individuals of *Anolis nitens* collected by LJV were borrowed from the Department of Herpetology, Sam Noble Museum of Natural History (OMNH), University of Oklahoma, Norman, Oklahoma, USA. Eight were from Brazil (mean snout-vent length, SVL = 51.0 mm ± 12.2 SD, range = 30-60 mm, Acre State, OMNH 37000-37007, 5.0 km N Porto Walter, inland from the Rio Jurúa, 8°15'S, 72°46'W, collected February-April, 1996); ten were from Ecuador (mean SVL = 70.7 mm ± 6.7 SD, range = 60-80 mm, Sucumbíos Province, OMNH 40392-40401, Reserva Faunistica Cuyabeno, Neotropic Turis, 00°00', 76°00'W, collected February-April, 1994). Lizards were field fixed in 10% formalin and preserved in 70% ethanol. The stomachs had previously been removed for an ecological study (Vitt et al., 2001). Small and large intestines, lungs, liver and body cavities were examined for helminths under a dissecting microscope. Nematodes were cleared in glycerol on a glass slide under a coverslip and examined with a compound microscope. Acanthocephalans were stained in hematoxylin, mounted in Canada balsam and studied as whole-mounts. Terminology is in accordance with Bush et al. (1997).

RESULTS

Number of helminths, prevalence (number of infected hosts divided by number of hosts examined), mean intensity (mean number of helminths per infected host and range (lowest and highest intensities) are presented in Table 1. Found in *A. nitens* were five species of Nematoda, *Cosmocercoides variabilis* (Harwood, 1930) (small, large intestines), *Oswaldocruzia bainae*, Ben Slimane and Durette-Desset. 1996 (small intestine), *Piratuba digiticaudata*, Lent and Freitas, 1941 (body cavity), *Strongyluris oscari*, Travassos, 1923 (small, large intestines), *Rhabdias* sp. (lung) and one species of Acanthocephala, *Acanthocephalus saurius*, Bursey and Goldberg, 2003 (small intestine). Voucher helminths were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland as *A. nitens* Brazil: *Cosmocercoides variabilis* (USNPC 102067), *Piratuba digiticaudata* (USNPC 102068), *Rhabdias* sp. (USNPC 102069), *Acanthocephalus saurius* (USNPC 102070); Ecuador: *Cosmocercoides variabilis* (USNPC 102071), *Oswaldocruzia bainae* (USNPC 102072), *Piratuba digiticaudata* (USNPC 102073), *Strongyluris oscari* (USNPC 102074).

DISCUSSION

Cosmocercoides variabilis is well known in salamanders, toads, frogs, lizards, snakes and turtles of Central and North America; a host list can be read in Bursey et al. (2007). *Anolis nitens*

Collection Locality Helminth species	Number	Prevalence	Mean intensity	Range
Acre State, Brazil				
Cosmocercoides variabilis	2	25%	1.0 ± 0.0	1
Piratuba digiticaudata	2	13%	2.0 ± 0.0	2
Rhabdias sp.	2	25%	1.0 ± 0.0	1
Acanthocephalus saurius	2	13%	2.0 ±0.0	2
Sucumbios Prov. Ecuador				
Cosmocercoides variabilis	1	10%	1.0±0.0	1
Oswaldocruzia bainae	65	90%	7.2±4.8	2-14
Piratuba digiticaudata	1	10%	1.0±0.0	1
Strongyluris oscari	36	100%	3.6±3.2	1-12

Table 1. Number of helminths, prevalence, mean intensity and range of infection for six species of helminths in eight *Anolis nitens* from Brazil and ten from Ecuador.

represents a new host record and Brazil and Ecuador are new locality records for *C. variabilis*.

Oswaldocruzia bainae was described from *Anolis chrysolepis* and *Anolis fuscoauratus* from Ecuador by Ben Slimane & Durette-Desset (1996). It also was reported in *Anolis biporcatus* from Panama by (Bursey et al., 2003). *Anolis nitens* represents a new host record for *Oswaldocruzia bainae*. Brazil is a new locality record.

Piratuba digiticaudata has wide distribution in the New World tropics and has been reported from *Anolis baracoae*, *A. equestris* and *A. luteogularis* from Cuba (Barus & Coy Otero, 1969; Coy Otero & Barus, 1979), *Tropidurus torquatus* (Vicente & Jardim, 1980; Vicente, 1981), *T. spinulosus* (Vicente & Jardim, 1980; Vicente, 1981) from Brazil and *T. guarani* from Paraguay (Bursey & Goldberg, 2004a). *Anolis nitens* represents a new host record for *Piratuba digiticaudata*. Ecuador is a new locality record.

Strongyluris oscari is widespread in South America and has been found in *Anolis fuscoauratus* from Brazil, Ecuador and Peru (Bursey et al., 2005; Goldberg et al., 2006a). Hosts are summarized in Bursey et al. (2005). To that list should be added, *Eurolophosaurus nanuzae* (Fontes et al., 2003), *Tropidurus guarani* from Paraguay (Bursey & Goldberg, 2004a), and *Enyalius iheringii* and *E. perditus* from Brazil (Vrcibradic et al., 2008). *Anolis nitens* represents a new host record for *Strongyluris oscari*.

Three species of *Rhabdias* are currently known as parasites of Neotropical lizards, namely *R. anolis*, *R. leonae* and *R. nicaraguensis*. *Rhabdias* of undetermined species has been reported from several species of lizards in tropical South American and the Caribbean (Torres-Ortiz, 1980; Bundy et al., 1987; Dobson et al., 1992; Goldberg et al., 2006a, 2006b; Vrcibradic et al., 2008).

Acanthocephalus saurius was described from *Anolis limifrons* from Costa Rica by Bursey & Goldberg (2003). It has previously been found in *Anolis capito* from Nicaragua and *Prionodactylus oshaughnessyi* from Brazil (Bursey & Goldberg, 2004b; Bursey et al., 2007). *Anolis nitens* represents a new host record for *Acanthocephalus saurius*; Ecuador is a new locality record.

In conclusion, published data indicates *Anolis* lizards are infected by a variety of generalist helminths which infect a wide spectrum of lizards.

ACKNOWLEDGEMENTS

Lizards were collected under collaborative projects in Brazil (through T.C.S. Avila-Pires) and Ecuador (through L. Cooma). Brazilian permits were issued by Conselho Nacional de Desenovolvimento Cientifico e Tecnológico (CNPq.Portaria MCT no. 170. De 28/09/94), the Instituto Renováveis (IBAMA, permit no. 073/94-DIFAS). Ecuadorian permits were issued by the Ministry of Agriculture and Livestock of the Republic of Ecuador. All animals were treated in accordance with federal, state and university regulations (Animal Care Assurance 73-R-100, approved 8 November 1994). NSF grants DEB-9200779 and DEB-9505518 to L.J. Vitt and J.P. Caldwell supported collection of lizards. We also thank Sarah Goldsberry (Whittier College) for assistance with dissections.

REFERENCES

Barus, V. & Coy Otero, A. (1969). Systematic survey of nematodes parasitizing lizards (Sauria) in Cuba. *Helminthologia* **10**, 329-346.

Ben Slimane, B. & Durette-Desset, M-C. (1996). Four new species of *Oswaldocruzia* (Nematoda: Trichostrongylina, Molineoidea) parasitizing amphibians and lizards from Ecuador. *Mem. Institut. Oswaldo Cruz* **91**, 317-328.

Bundy, D.A.P. Vogel, P. & Harris, E.A. (1987). Helminth parasites of Jamaican Anoles (Reptilia: Iguanidae): a comparison of the helminth fauna of 6 Anolis species. *J. Helminthol.* **61**, 77-83.

Bursey, C.R. & Goldberg, S.R. (2003). *Acanthocephalus saurius* n. sp. (Acanthocephala: Echinorhynchidae) and other helminths from the lizard *Norops limifrons* (Sauria: Polychrotidae) from Costa Rica. *J. Parasitol.* **89**, 573-576.

Bursey, C.R. & Goldberg, S.R. (2004a). Helminths of *Tropidurus guarani* (Sauria: Tropiduridae) from Paraguay. *Comp. Parasitol.* **71**, 203-207.

Bursey, C.R. &. Goldberg, S.R. (2004b). *Cosmocerca vrcibradici* n. sp. (Ascaridida: Cosmocercidae), *Oswaldocruzia vitti* n. sp. (Strongylida: Molineoidae), and other helminths from *Prionodactylus eigenmanni* and *Prionodactylus oshaughnessyi* (Sauria: Gymnophthalmidae) from Brazil and Ecuador. *J. Parasitol.* **90**, 140-145.

Bursey, C.R., Goldberg, S.R. & Parmelee, J.R. (2005). Gastrointestinal helminths from 13 species of lizards from Reserva Cuzco Amazónico, Peru. *Comp. Parasitol.* **72**, 50-68.

Bursey, C.R., Goldberg, S.R. & Telford, Jr. S.R. (2003). *Strongyluris panamaensis* n. sp. (Nematoda: Heterakidae) and other helminths from the lizard, *Anolis biporcatus* (Sauria: Polychrotidae), from Panama. *J. Parasitol.* **89**, 118-123.

Bursey, C.R., Goldberg, S.R. & Telford, Jr. S.R. (2007). Gastrointestinal helminths of 14 species of lizards from Panama with descriptions of five new species. *Comp. Parasitol.* **74**, 108-140.

Bush, A.O., Lafferty, K.D., Lotz, J.M. & Shostak, A.W. (1997). Parasitology meets ecology on its own terms: Margolis et al. revisited. *J. Parasitol.* **83**, 575-583.

Coy Otero, A. & Barus. V. (1979). Nematodes parasitizing Cuban reptiles. *Acta Scient. Nat. Brno* **13**, 1-43.

Dobson, A.P., Pacala, S.V., Roughgarden, J.D., Carper, E.R. & Harris, E.A. (1992). The parasites of Anolis Lizards in the northern Lesser Antilles. I. Patterns of distribution and abundance. *Oecologia* **91**, 110-117.

Fontes, A.F., Vicente, J.J.. Kiefer, M.C. & Van Sluys, M. (2003). Parasitism by helminths in *Eurolophosaurus nanuzae* (Lacertilia: Tropiduridae) in an area of rocky outgroups in Minas Gerais State, Southeastern Brazil. *J. Herpetol.* **37**, 736-741.

Goldberg, S.R., Bursey, C.R. & Vitt, L.J. (2006a). Helminths of the Brown-eared Anole, *Norops fuscoauratus* (Squamata, Polychrotidae), from Brazil and Ecuador, South America. *Phyllomedusa* **5**, 83-86.

Goldberg, S.R., Bursey, C.R. & Vitt, L.J. (2006b). Helminths of two lizard species, *Anolis punctatus* and *Anolis transversalis* (Squamata: Polychrotidae) from Brazil and Ecuador. *Amphibia-Reptilia* **27**, 575-579.

Torres Ortiz, R.A. (1980). Otro hospedador final para *Rhabdias* sp. (Nematoda) e implicaciones evolutivas de las especies del hospedador. *Carib. J. Sci.* **16**, 109-114.

Uetz, P. & Hallermann, J. (2009). The Reptile Database. <www.reptile-database.org>. [2009].

Vicente, J.J. (1981). Helmintos de Tropidurus (Lacertilia, Iguanidae da coleção helmintológica do Instituto Oswaldo Cruz. II. Nematoda. *Atas Soc. Biol. Rio de Janeiro* **22**, 7-18.

Vicente, J.J. & Jardim. C.R. (1980). Filarideos da coleção helmintológica do Instituto Oswaldo Cruz. I. Peixes, anfibios e répteis. *Atas Soc. Biol. Rio de Janeiro* **21**, 47-57.

Vitt, L.J., Sartorius, S.S., Avila-Pires, T.C.S. & Espósito, M.C. (2001). Life on the leaf litter: the ecology of *Anolis nitens tandai* in the Brazilian Amazon. *Copeia* **2001**, 401-412.

Vrcibradic, D., Anjos, L.A., Vicente, J.J. & Bursey, C.R. (2008). Helminth parasites of two sympatric lizards, *Enyalius iheringii* and *E. perditus* (Leiosauridae), from an Atlantic rainforest area of southeastern Brazil. *Acta Parasitol.* **53**, 222-225.

Herpetological observations from field expeditions to North Karnataka and Southwest Maharashtra, India

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ABSTRACT - The Western Ghats of India are one of the 34 global hotspots of biodiversity. They are one of the most important large natural areas in the world and are fast becoming recognised for their biological importance. The herpetofauna of the Western Ghats is hugely diverse, with many species exhibiting rare, endemic styles of autecology and niche preference that could equal that of countries such as Borneo and Madagascar. In this report we detail 18 amphibian and 37 reptile species from eight sites following three expeditions to the Western Ghats from 2007-2009. The report details species descriptions, habitat, ecology and conservation to alert the herpetological community to the importance of future research to address the lack of knowledge in species ecology. It also presents new information on species distribution and behaviour.

THE Western Ghats are an expanse of hills along the south western side of peninsular India. They extend approximately 1600 km from the Tapti River south to the Arabian Sea. They rise from a narrow coastal strip and form a barrier between the Deccan Plateau and the coast. They cover 4.8% of India's land mass (160,000 km^2). The mountainous forests have two gaps which divide its description and habitats into northern and southern types. The northern section, in which most of this study was conducted, is distinct in character and is named Sahyadris (Kadur & Bawa, 2005).

The highest point across the Sahyadris range is 2695 m ASL and elevation averages 1200 m. The northern section is 700-1000 m. As most herpetofauna is found between 0-1200 m in the ranges, with the greatest diversity between 800 and 1000 m, the majority of the Western Ghats provide amphibian and reptile montane habitats of significant biological importance. In this study we surveyed the following nine locations over two years;

Kadamane Estate, Sakleshpur, north Karnataka – This estate, located 7-800 m ASL, is comprised of 7000 acres of Tropical Moist Evergreen forest (Holdridge, 1967). One thousand acres of the estate are monocultures of tea (Fig. 3). The estate is located centrally in the Western Ghats. Annual temperatures vary between 14-30°C. The Western Ghats receive the brunt of the southwest monsoon rains as they arrive from the Indian Ocean. During monsoon up to 2000 mm of rain can fall and temperatures are lower than in the dry season. The southwest monsoon typically lasts through October with the northeast monsoon bringing dry cool winds from the end of October/ November until February/March. Natural habitats

on this estate were characterised by high canopy tree species with patchy understorey pools. The Kadamane estate was visited in June 2008.

Agumbe Rainforest Research Station (ARRS), Agumbe, north Karnataka – This privately owned biological station was set up in 2002 by Romulus Whitaker following years of renowned research on *Ophiophagus hannah* (King Cobra) that led to successful televised portrayal of the species for National Geographic. The reserve comprises eight acres at 700 m ASL that is bordered by primary tropical deciduous rainforest (Fig. 1). Agumbe boasts a similar climatic regime to the Kadamane Estate with temperatures between 14-35°C and up to 4000 mm of rainfall p/a. Agumbe was visited in June 2008 and September 2009.

Devbagh Island Resort, Karwar – Devbagh is a jungle lodge island resort two hours drive from Goa, north Karnataka. It is off the mainland of Karwar. Devbagh is accessible from Karwar by boat. Karwar lies on a strip of tropical sand bounded by the Western Ghats on its east and the Arabian Sea on its west. Its forests comprise secondary coastal forest, pine plantation and mangrove. Devbagh was visited in June 2008.

Hunsur Farm, Rathnapuri – This quiet and picturesque farm in Hunsur covers ten acres that is mostly cultivated land. Crops include Mangoes, Arecanut, Sapota, Rice, Corn, Tomatoes and Coconut. The farm overlooks a large ephemeral lake that is a migratory passage for wading birds. The lake is also home to various raptors including Indian Buzzards (*Buteo buteo*) and Brahminy Kites (*Haliastur indus*). Wild scrub covers one acre and Bamboo groves cover half a further acre. We visited in February and September 2009.

Ranganthittu Bird Sanctuary, Mandya, Karnataka – This small reserve (0.67 km²) comprises six islets on the Kaveri River. The islets formed when a dam across the Kaveri River was built in the 1700s. The ornithologist Dr. Salim Ali discovered the islets' importance for nesting ground birds and persuaded the Wodeyar Kings of Mysore to declare the area a wildlife sanctuary in 1940. The area has been managed as a reserve since 1972 and is a major migratory bird passage (IUCN, 2005). The habitat of the area is 'Indomalaya Riparian Ecozone'. Typical habitats include riverine reed beds, broadleaf forests with Arjun Tree (*Terminalia arjun*), *Pandanus* spp., *Eucalyptus* spp. and *Acacia* spp. The rare endemic lily *Iphigenia mysorensis* (Colchicaceae) also grows here. The reserve was visited in February and September 2009.

Hongod Farm, near Nagarahole National Park, Mysore, Karnataka – This relatively small farm covers ten acres and is surrounded by reserve forest. The farm grows Banana, Rice, Groundnut, Mango, Coconut and Cashew. The surrounding forest is primarily thorn scrub and Bamboo with dry deciduous forest toward the core of the national park. Within these areas, there are ravines that are filled by rainwater runoff. These ravines hold puddles of water through the dry season. The farm was visited in February and September 2009.

Brahmagiri Wildlife Sanctuary, Kodagu district (near Irrupu falls), Coorg, Karnataka - This sanctuary is approximately 950 m ASL. It has evergreen and semi-evergreen forests, as well as Shola-grassland habitat (Fig. 4). The Sanctuary is bordered by agricultural fields and coffee plantations. The eastern tip of the Sanctuary at Nagarahole National Park is separated by coffee plantations. The sanctuary derives its name from the Brahmagiri Peak (1607 m). Temperatures range from 5-32°C and mean annual rainfall varies from 2500-6000 mm. The Sholas are made up of dwarf evergreen trees or 'Krummholz' that are stunted from strong winds. The part of sanctuary we visited was last felled more than 80 years ago. The forest comprised dry to moist deciduous forest with Bamboo and hardwood species. Numerous lianas, tree saplings (< 2m), shrubs (< 1m) and grass species (Graminae) were also present. Decaying logs were liberally scattered across the forest floor. We visited in February 2009.

Wildernest Lodge, Chorla Ghats, Goa – This small and beautifully presented eco-lodge is nestled in the Swapnagandha valley among forest at 800 m ASL. Its forests consist of deciduous,

Figure 1. Primary tropical deciduous Rainforest bordering ARRS. Photograph by Todd Lewis 2008. ▲

Figure 2. Semi-evergreen forest habitat at Wildernest. Photograph by Steve Lloyd and Michaela Clapson 2008. ▲ ►

Figure 3. Tea plantation with mixed forest. Photograph by Todd Lewis 2008. ▲

Figure 4. Montane evergreen forest with and Chorla grassland habitat. Photograph by Rowland Griffin 2008. ▲

secondary semi-evergreen and wet deciduous types (Fig. 2). The Nature Conservation Facility has been established at Chorla Ghats to assist research and long-term monitoring of the Western Ghats of the Sahyadris region. The project is providing a platform for ecologists and wildlife biologists working in the Chorla Ghats and is a fully equipped field station. Wildernest was visited in June 2008.

Mojo Rainforest Retreat Madikeri, Karnataka – The Rainforest Retreat at Mojo, 10 km northwest of Madikeri is a sustainable eco-lodge. Its plantation is a unique project that combines eco-tourism with sustainable agriculture and environmental education. It has a plantation that is forested with native trees and intercropped organic Cardamom, Coffee, Black Pepper, Vanilla, Kokam, fruit trees and spices. Mojo Plantation was founded in 1996 by Drs. Sujata and Anurag Goel and provides opportunity for research and ecotourism. The eco-lodge was visited in September 2009.

SPECIES DESCRIPTIONS

AMPHIBIA

ANURA: Bufonidae

Duttaphrynus melanostictus (Schneider 1799). Common or Indian Toad. - This medium sized toad

(measured at 76.2 mm SVL) (Daniel, 2002) was found in wet grassland areas at Agumbe and on a concrete bridge on Hongod farm. Specimens had red, yellow and tan mottled dorsum with cream/white ventral coloration. The skin was tuberculate with black tipped warts. Specimens had large glands on the nape. Juveniles of < 20 mm SVL may be mistaken for other Bufonids due to a lack of cranial ridging (Daniel, 2002). This species is very common and ubiquitous in India.

Dicroglossidae

Fejervarya cf *brevipalmata* (Peters, 1871). - *F. brevipalmata* is a small brown leaf-litter frog with a pointed snout and well developed toes that are almost entirely webbed. The frog is distinguished from other *Fejervarya* spp. by prominent sub-articular tubercles and an oval shaped metatarsal tubercle. Males have two internal vocal sacs. This species is prominent across the Western Ghats in wet evergreen forest where it breeds in temporary ponds (Biju et al., 2007). Some limb abnormalities have been recorded, possibly in relation to chemical agriculture (Gurushankara et al., 2007). Specimens were seen at Agumbe in 2008 and 2009.

Fejervarya kudremukhensis Kuramoto, Joshy, Kurabayashi & Sumida, 2007. - Like *F. brevipalmata* this species has a brown/grey non-descript body that is granulate. Its nose is typically pointed. This species is not as common as other *Fejervarya* spp. We found specimens at Agumbe among evergreen wet forest in 2008.

Fejervarya caperata, Kuramoto, Joshy, Kurabayashi & Sumida, 2007. - *F. caperata* (previously *F. limnocharis*) was encountered in Kunupatti in natural and man-man water bodies. This small (20-22 mm SVL) frog had a warty, light mottled grey/brown dorsum with dark brown stripes on its limbs and digits (Fig. 6). *F. caperata* can be distinguished from other Ranids by half webbing on the toes and by the first three phalanges that are free of webbing (Daniel, 2002). During the breeding season males can be distinguished by a black vocal sac. Populations of *F. caperata* are threatened by pollution from pesticides in tea plantations (Daniels, 2003).

Fejervarya rufescens (Jerdon, 1853). - Another non-descript *Fejervarya* frog with a brown granulate body. The genus as a whole is suspected to be paraphyletic. However, too few species are sufficiently documented to draw a clear taxonomic boundary at present. The dividing line runs mostly between South Asian and Southeast Asian species, but there are molecular anomalies (e.g. *F. nicobariensis*) (Islam et al., 2008). The widespread *F. limnocharis* has been suspected to be a cryptic species complex and a number of populations have undescribed species (Islam et al., 2008). Kuramoto et al. (2007) proposed *Minervarya* as a synonym of *Fejervarya* based on previous molecular work by Kurabayashi et al. (2005). Kurabayashi et al. (2005) included species from Southern India and Sri Lanka for the South Asian clade of *Fejervarya* but did not include *Minervarya sahyadris* (previously *Fejervarya*). If phylogeny proposed by Kuramoto et al. (2007) is confirmed then this small frog will change its terminal position in the phylogenetic tree and may influence other *Fejervarya* taxonomy.

In the *Fejervarya-Minervarya* complex, frogs appear almost miniaturized with stumpy body proportions. This physiological modification is a manifestation of niche driven adaptation. This factor supports an argument for distinct generic allocation. Also, their choice of habitat, cryptic coloration and behaviour may cause them to be mistaken in identity of larger common species' progeny (Clarke, 1989). *Minervarya sahyadris* was misidentified as *Fejervarya syhadrensis*, a sympatric small sized species (Kuramoto & Joshy 2001; Kadadevaru et al., 2002; Daniels 2005). It is possible therefore that *Minervarya* spp. might be present in other populations in India and misidentified as young *Fejervarya*. Future researchers in India should be attentive in the field where the *Fejervarya-Minervarya* complex exists as new species may await discovery (Ohler et al., 2009; Radhakrishnan, 2009).

Hoplobatrachus tigerinus (Daudin, 1803). Indian Bullfrog. - The *H. tigerinus* we encountered was a juvenile (89 mm SVL). It was mottled brown with black and tan patches and flashes of bright green on the dorsum. Adults have either a smooth dorsum or longitudinal glandular folds and vary from brown

to olive. The snout is pointed and the tympanum distinct. Toes are webbed. *H. tigerinus* is found throughout India and Sri Lanka from 0-2000 m (Daniels, 2002). The juvenile was encountered in Kunupatti in a shallow paddy field. The specimens we encountered were at Brahmagiri in June 2008 in an open field on the periphery of secondary forest.

Microhylidae

Kaloula taprobanica Parker, 1934. Painted Kaloula. - This medium sized frog (40 mm SVL) has distinct dilation of the toe ends into discs. It has a small rounded snout, stubby head and distinct canthus rostralis. The toes have developed discs, which are webbed. *K. taprobanica* has a black/brown and red patched dorsum (Fig. 10). Breeding males have black throats. It is found in Bihar, Tamil Nadu, Sri Lanka, Karnataka, Gujarat, Assam and Bengal (Daniel, 2005). We found individuals in coastal plantation forest on Devbagh in June 2008. Several specimens were observed at perch heights of 2.0 m in tree crevices. The tree the frogs had climbed had limited footholds and we surmise that the frogs may have crossed the canopy as well as moving between trees terrestrially. *K. taprobanica* is a fossorial species, but is recorded as scansorial and a good climber (Dutta & Manamendra-Arachchi, 1996). It is found hear human settlement, rice fields and water storage ponds. Mating begins when the rains start and males call in aggregations. Eggs float in a single layer on the surface of ponds. The tadpoles are black. This species is nocturnal and feeds on insects (De Silva & De Silva, 1995).

Ramanella triangularis (Günther, 1876). Malabar Narrow-Mouthed Frog. - One specimen was found at Brahmagiri in February 2009. It was excavated from a hole behind a large stone. This species is a small, plump frog with a short, rounded snout. The specimens we found measured 25 mm SVL. They had a black dorsum with two wide irregular dorsal stripes. The forelimbs had orange blotches. *R. triangularis* is rarely encountered at Brahmagiri (G. Martin, pers. comm.).

Nyctibatrachidae

Nyctibatrachus major Boulenger, 1882. Wrinkled Frog. - This small species of frog (25.4 mm SVL) was mottled tan/brown with a stout body and short rounded snout. *N. major* has large prominent eyes indicative of its nocturnal habits (Gururaja et al., 2003). It can be confused with *N. humayuni* but is distinguished by its circum-marginal grooves (Daniel, 2002). *N. major* ranges from Kerala to the Kalakkad forests in Tamil Nadu. It is becoming rare from habitat reduction (Gururaja et al., 2003). The specimens we found were in a trickling stream at Brahmagiri in February 2009.

Ranidae

Clinotarsus curtipes (Jerdon, 1853). Bicoloured frog. - *C. curtipes* has a distinctive light grey/brown dorsum and black belly with dorsolateral folds. This medium sized frog (74 mm SVL in females) has smooth skin, a pointed snout, and depressed head with canthus rostralis. It has a concave loreal and its first digit is longer than the second (Daniel, 2005). *C. curtipes* is found in Karnataka, Malabar, Kerala, Tamil Nadu, Papanasam and Tirunelveli (Daniel, 2002). We encountered a number of specimens at Brahmagiri in June 2008. Tadpoles were well developed, large (up to 70 mm TL), and strong swimmers that frequented nearby streams.

Hylarana aurantiaca (Boulenger, 1904). Trivandrum Frog. - *H. aurantiaca* (previously *Rana*) is endemic to the Western Ghats. It has a golden brown dorsum with light flecks and a cream underside. It has a light coloured mask through the eye and a distinct light coloured lip. This species is gracile with long legs and a pointed snout. It typifies a Ranid body type and has prominent dorsolateral folds. It is a semi-arboreal and semi-aquatic frog, associated with wetlands in tropical moist, swamp, and coastal forest regions. In India, larvae are reported from streams. Adults can also be found in tea and coffee plantations, but only at the forest edge. We found several individuals at Agumbe during rains in June 2008.

Hylarana temporalis (Günther, 1864). Bronze Frog. - This ranid has a bronze dorsum and a cream venter. It has a white dorsolateral stripe, and a dark brown lateral wash. Adults have a depressed head with an elongate snout, and a white upper labial. A specimen (50 mm SVL) was encountered in a

rock pool bordering a river in Brahmagiri Wildlife Sanctuary in February 2009.

Ranixalidae

Indirana beddomii (Günther, 1875). Leaping Frog. - This fairly abundant frog is found in the northern Western Ghats and Tamhini areas (Dahanukar & Padhye, 2005). It has a dark mottled brown body with black horizontal lines on limbs and digits, short stout body (38.1mm SVL), large head and prominent glandular folds on the dorsum. The specimens we found were on the edge of a shallow river, in a pool between rocks at Brahmagiri in June 2008. *I. beddomii* populations are seriously threatened by pesticide use (Daniels, 2003).

Rhacophoridae

Philautus wynaadensis (Jerdon, 1853). - This small yet vocal species has exhibits variation in colour from light to dark greys, browns, and caramel. Although widespread in the Western Ghats it is an endangered species threatened by habitat degradation and conversion (Biju et al., 2009a).

We found and heard a variety of *Philautus* spp. at every site visited in all years but were unable to identify most to species. Most were small bodied (< 3.9 cm) shrub dwelling frogs with grey/brown bodies and small toe-pads. Nearly all were found at perch heights of > 1.0 m among edge and deep forest. Some *Philautus* spp. are considered extinct by IUCN, while others are widespread and abundant, such as the recently-described *P. abundus*, named for this fact. The taxonomy of the group is unclear and many species are poorly described (Karthikeyan Vasudevan et al., 2007). Recently, Biju et al. (2009b) revised much of the genus with new species. The genus is unique due to direct development of young inside the egg and no free swimming tadpole stage (Biju, 2003) (similar to Eleutherodactylines in South America [Savage, 2002]). Some species have been found to bury their eggs in soil, although adults are generally arboreal, and others attach their eggs to leaves (Bahir et al., 2005). *Philautus* continues to inspire herpetologists. With over 145 species and new species being revised, discovered and rediscovered it will likely remain one of the most speciose amphibian genera in Asia (Manamendra-Arachchi & Pethiyagoda, 2005; Meegaskumbura & Manamendra-Arachchi, 2005; Gururaja et al., 2007a; 2007b).

Polypedates maculatus (J. E. Gray, 1830). Chunam or Indian Treefrog (Fig. 5). - *P. maculatus* is found throughout India, Nepal, Bhutan, Sri Lanka, and parts of Bangladesh (Daniels, 2005). It has been reported up to 1,500 m ASL. It is a welcome indicator of a near-pollution free habitat. The species frequents communal day roosts with both adults and sub-adults. The call is a sudden short and rapid series of rattling rat-tats. When temperatures are high it secretes moisture from the skin, pants and adopts lighter skin colours. It has been recorded from tropical dry and moist forests, grasslands, agricultural areas, and human habitation. It is largely arboreal, although can be found in walls and under rocks and leaves. Males have been reported calling from the ground. It breeds in temporary pools and paddy fields.

Rhacophorus malabaricus Jerdon, 1870. Malabar Gliding Frog. - *R. malabaricus* is a large Tree-frog (67-78 mm SVL), endemic to the Western Ghats (Kadadevaru & Kanamadi 2000; Daniels, 2002). The dorsum is bright green with black and white dots (Fig. 8). The ventral surface is white. The toes are yellow and have bright red/orange webbing (Kadadevaru & Kanamadi, 2000; Daniel, 2002). *R. malabaricus* has a short sharply pointed snout, obtuse canthus rostralis and a concave loreal region. *R. malabaricus* was encountered at Kadamane (N = 3) and Agumbe (N = 4) in June 2008. All specimens were found on the edge of small running streams among overhanging tree branches. The species is known for its gliding escape behaviour.

GYMNOPHIONA (APODA); Caeciliidae

Gegeneophis cf. *danieli* Wilkinson, Gower, Giri 2003. Amboli or Daniel's Caecilian. - *G. danieli* is a recently discovered species first documented from near Amboli, in the Western Ghats of Maharashtra (Giri et al., 2003). It is distinguished from other Indian caeciliids in having more numerous secondary annuli that are not restricted to the posterior. Within the genus, *G. danieli* has the most externally visible eyes and is postulated to live in the surface soil due to enhanced eyesight

Figure 5. *Polypedates maculatus.* © Jacqui Turner 2008. ▲

Figure 6. *Fejervarya caperata.* © K.V. Gururaja 2006. ▲

Figure 7. *Gegeneophis* cf. *danieli.* © John Thorpe-Dixon 2008. ►

Figure 8. *Rhacophorus malabaricus.* © Todd Lewis 2008. ►

Figure 9. *Ichthyophis beddomei.* © Steve Lloyd & Michaela Clapson 2008. ▲

Figure 10. *Kaloula taprobanica.* © Steve Lloyd & Michaela Clapson 2008. ▲

Figure 12. *Geckoella deccanensis.* © Rowland Griffin 2008. ▲

Figure 11. *Hemidactylus maculatus hunae.* © Jacqui Turner & Rowland Griffin 2008. ◄

Figure 13. *Calotes versicolor.* © Steve Lloyd & Michaela Clapson 2008. ▲

Figure 15. *Draco dussumieri.* © Paul Greig-Smith 2009. ▲

Figure 14. *Eutropis macularia* © J.M. Garg 2008. ▲

Figure 16. *Hemidactylus maculatus.* © Jacqui Turner and David Willis 2008. ▲

Figure 17. *Trimeresurus malabaricus.* © Steve Lloyd & Michaela Clapson 2008. ▲

Figure 18. *Hypnale hypnale.* © John Thorpe-Dixon 2008. ▲

Figure 19. *Ahaetulla nasuta.* © Steve Lloyd & Michaela Clapson 2008. ▲

Figure 20. *Lycodon aulicus.* © Rowland Griffin 2008. ◄ ▲

Figure 21. *Calliophis bibroni.* © Daniel Holloway 2008. ►

Figure 22. *Amphiesma beddomei.* © Rowland Griffin 2008. ◄

Figure 23. *Ophiophagus hannah.* © Todd Lewis 2008. ▲

(Giri et al., 2003). It is generally a grey to lavender colour in life, however our specimen was almost dark blue-purple in shade on the underside (Fig. 7). The specimen we found was resting under a rock next to a pathway around the Wildernest hostel.

Ichthyophiidae

Ichthyophis beddomei Peters, 1879. Nilgherries or Beddome's Caecilian. - This caecilian has a dark violet-brown body. There is a yellow lateral stripe from head to tail tip (Fig. 9). Its upper lip and lower jaw are also yellow. Eyes are distinct. Its tentacles are placed very close to the lip and almost equidistant from eye and nostril. Nostrils are positioned at the tip of the snout but visible from above. The upper jaw slightly overhangs the lower jaw. *I. beddomei* reaches 17.0-24.9 cm. This species is widely distributed in the Western Ghats (Bhatta, 1998). We found two specimens at ARRS in a small, shallow, babbling stream on the fringe of an area of secondary forest.

Ichthyophis longicephalus Pillai, 1986. - *I. longicephalus* reaches 270 mm when adult. This caecilian has 438 primary and secondary annuli, with eight of these on the tail (Pillai, 1986). It has long, conical tentacles with the aperture close to the lip (Bhatta, 1998). Its nostrils are terminally positioned and can be seen from above (Bhatta 1998). The snout extends slightly further than the mouth, giving them the long head referred to in its name '*longicephalus*'. The second collar has two incomplete dorsal folds (Bhatta 1998). The tail is short and pointed, and the vent longitudinal with a white spot (Bhatta 1998). Dorsal coloration is a uniform dark violet brown. A yellow lateral stripe runs from the edge of the second nuchal collar (Bhatta 1998). These caecilians are thought to be endemic to the Western Ghats in wet evergreen forest habitat (Pillai, 1986; Bhatta, 1998; Pillai & Ravichandran, 1999). Three other small bodied species of caecilian were also discovered in the Chorla Ghats, near Wildernest but were unidentifiable, even to genus, in the field. They were found in the same habitats as giant centipedes and scorpions (*Mesobuthus tamulus*).

REPTILIA

CROCODILIA; Crocodylidae

Crocodylus palustris Lesson, 1834. Mugger Crocodile. - This relatively large crocodilian (4.0-4.5 m TL) has an olive dorsum, with black speckles. The ventral colour is cream/yellow. The back of the head has four raised post-occipitals. Protective scutes are present on the dorsum and the toes are webbed (Daniel, 2002). This is a widely distributed and recognizable crocodile in India and it inhabits many rivers and tributaries. *C. palustris* occurs from 0-600 m. It is found from Baluchistan to Assam (west to east) of India and from Nepal to Tamil Nadu (north to south). It is often confused with *C. porosus* (Estuarine or Salt-water Crocodile) and although hard to distinguish they are rarely present together. One female and two male *C. palustris* were encountered in a small river in the Ranganthittu Bird Sanctuary in February 2009.

LEPIDOSAURIA; Agamidae

Calotes ellioti Günther, 1864. Elliot's Forest Lizard. - This typically shaped agamid has an olive/brown lichenous pattern with darker chevron markings along the spine. It has keeled dorsal scales and a black triangular mark behind the ear. In the breeding season males change colour and are somewhat blackish with patches. It also has strong oblique fold or pit in front of the shoulder and a transverse gular fold that distinguishes it from other *Calotes* spp. *C. ellioti* is endemic to the Western Ghats. It is an arboreal lizard found in forest glades up to 1800 m ASL. We found this species on the edge of tea plantations and evergreen forest at Agumbe and Devbagh in 2008.

Calotes versicolor Daudin, 1802. Oriental Garden Lizard (Fig. 13). - This agamid is famous for being polychromatic. The dorsum ground-colour is generally a light brownish olive, but the lizard can change it to bright red, black and a mixture of both. During the breeding season the male's anterior turns bright orange to crimson and his throat black. Males also turn red-headed after a successful battle with rivals (Tiwaru & Schiavina, 1990). This species is widely distributed from Afghanistan to China and Thailand. It is mostly insectivorous but has been known to eat small rodents and lizards. Males

become highly territorial during breeding season. They discourage intruding males by brightening their red heads and performing "push-up" displays. Each tries to attract a female by inflating the throat. About 10-20 eggs are laid and they hatch in 6-7 weeks. Progeny are able to breed at approximately one year old (Asana, 1931). We found this species around the lodges at Devbagh in 2008.

Draco dussumieri Duméril & Bibron, 1837. Western Ghats Flying Lizard (Fig. 15). - *D. dussumieri* is endemic to southern India and is the sole representative of the genus west of Assam in India. The recorded range of *D. dussumieri* shows a wide distribution along the Western Ghats in the states of Goa, Karnataka, Tamil Nadu and Kerala (Daniels, 2002). It occurs in a diverse range of habitats including evergreen forests, moist and dry deciduous forests as well as teak, coconut and arecanut plantations (Smith, 1935). The species is characterized by a lateral wing-membrane (patagium) formed by the skin, which is supported by the last five to seven elongated ribs. The patagium enables gliding for up to 20 m (Herre, 1958). *D. dussumieri* also possess an elongate dewlap. Interestingly males and females are dimorphic with respect to dewlap length and colour of the patagium. Habitat fragmentation in the Western Ghats has had a negative impact on populations of this species (Ishwar et al., 2003).

Gekkonidae

Cnemaspis littoralis Jerdon 1854. Coastal Day Gecko. - A small bodied gecko with a mottled brown dorsum and tan specks. Three tan lines are visible from cheek to nape with a triangular pointed snout. *C. littoralis* has reduced toe pads, reduced webbing and circular pupils (Rösler, 2000; Manamendra-Arachchi et al., 2007). The ventral scales are hexagonal, imbricate and smooth. *C. littoralis* is distributed from Malabar, Nilambur, Nellakota and on the west side of the Nilgiris (Smith, 1935). It is an uncommon species usually found on trees in dry teak forests. One individual (63.5 mm SVL/350-400 mm TL) was encountered at Brahmagiri in February 2009 in a rotting log.

Geckoella deccanensis Günther 1864. Deccan Banded Gecko (Fig. 12). - Two nominal species of Indian geckos, *G. deccanensis* and *G. albofasciata*, appear similar and have previously been regarded as conspecific. The two forms differ in dorsal scalation and juvenile colour. *G. deccanensis* has large, flattened, juxtaposed dorsal scales and a series of yellow cross-bands on a dark body. *G. albofasciata* has smaller, heterogeneous, conical dorsal scales. Its juveniles have a white dorsal trunk bands and a yellow nape band (Bauer & Giri, 2004). We found *G. deccanensis* at Wildernest lodge in June 2008 among a pile of cut tree branches. The species is also found at Bhimashankar Wildlife sanctuary, Phansad Wildlife sanctuary and a few other select forests in Maharashtra.

Hemidactylus frenatus Dumeril & Bibron, 1836. Southern House Gecko. - The four specimens of this small and vocal gecko (ca. 63 mm SVL) were found at Hongod Farm (near Nagarahole National Park) in February 2009. *H. frenatus* is mottled brown/grey in coloration. The tail is striped with large lateral tubercles. This species has a large, triangular head and variable toe webbing (Das, 2008). Even though this species is known to frequent manmade structures three of the four *H. frenatus* we found were behind peeling tree bark at approximately 75 cm perch height in forest.

Hemidactylus maculatus Dumeril & Bibron, 1836. Rock Gecko (Fig. 16). - The three specimens we found (76-101 mm SVL) had cream/grey bodies with parallel black dorsal spots. The toes of this species are clawed with small pads. All three specimens were found on scrubland among short grass close to Hongod farm in February 2009. *H. maculatus* is well distributed in southern India, but is restricted to the foothills of the Western Ghats (Daniel, 2002; Das, 2008). At Kadamane in June 2008, we also encountered the sub-species *H. maculatus hunae* (Giant Leaf-toed Gecko) (Duméril & Bibron) (Fig. 11). These were large (up to 11.0 cm SVL) and had a golden yellow dorsum with contrasting white spots. *H. m. hunae* also has granular scales and a distinctive golden iris. The '*hunae*' race is only found in India at Malabar, Tirunelveli, Salem and Madras.

Scincidae
Eutropis macularia (Blyth, 1853). Bronze Grass Skink (Fig. 14). - This small bodied skink had a light bronze dorsum and cream imbricate ventral scales. The dorsum scales of this species has 5-9 keels (Daniel, 2002; Das, 2008). *E. macularia* (previously *Mabuya*) is characterized by two symmetrical dark brown stripes from the nape to the tail. The specimen we encountered was found at Hongod Farm in February 2009 among low-lying Horn Scrub and short grass. *E. macularia* is widely distributed in India and mainland Southeast Asia (Das, 2008).

Lygosoma punctata (Gmelin, 1799). - This small bodied (< 4 cm SVL) species is found in India and Sri Lanka. It has a brown body with a dark basal spot on each scale. It also has a yellowish dorsolateral streak. Juveniles are recognized by their bright red tails (a feature lost in adulthood). We encountered specimens at Devbagh in June 2008 among leaf-litter near the lodges.

SERPENTES; Boidae
Eryx whitakeri Das, 1991. Whitaker's Boa. - This sand boa, named after Romulus Whitaker, is a medium sized snake (79 cm TL). It has a brown body with dark brown blotches. *E. whitakeri* resembles *Gongylophis conicus*. It differs by having a smooth scaled body, whereas *G. conicus* has prominent keels (Whitaker & Captain, 2004). The behaviour and natural history of *E. whitakeri* is poorly known, but it seems to be an excellent climber and is nocturnal (Whitaker & Captain, 2004). *E. whitakeri* is restricted to coastal areas of the Western Ghats, Kerala, Maharashtra and Goa, from 0-60 m. One specimen was encountered climbing up a wall in daylight at the Kadamane Tea Estate in June 2008.

Gongylophis conicus (Schneider, 1801). Rough Scaled or Common Sand Boa. - *G. conicus* is found throughout India. It is a medium sized snake (50-100 cm TL), with a body that is short, cylindrical and thick. The tail is short and ends with an acute point. The dorsum colour can vary from brown/black to red/brown, with irregular dark brown/black body blotches in a zigzag pattern. Juveniles of this species can look similar to Saw-scaled Vipers and the adults can be mistaken for Russell's Vipers and Whitakers Boas. *G. conicus* is nocturnal (Whitaker & Captain, 2004). One specimen was encountered at Agumbe in late 2009.

Colubridae
Ahaetulla dispar (Günther, 1864). Günther's Vine Snake. - *A. dispar* is a medium sized, rear-fanged, arboreal snake (78 cm TL). It is endemic to the southern Western Ghats and restricted in range to hills in Tamil Nadu and Kerala (Whitaker & Captain, 2004). It has a long slender body with a pointed elongate head. The eyes, which are large with horizontal pupils, face forward following a pre-ocular groove to the snout which gives this genus its characteristic look. *Ahaetulla* spp. appear similar to the neotropical genera *Oxybelis* and *Xenoxybelis* (Savage, 2002; Duellman, 2005). This snake can be green or brown and is distinguished from *A. nasuta* by its shorter snout. One individual was found at Kadamane Tea Estate in June 2008.

Ahaetulla nasuta (Lacepède, 1789). Common Vine Snake (Fig. 19). - This large arboreal snake (max. 2 m TL) is widespread throughout India, excluding the extreme north. It has a long slender body with a pointed elongate head. The rostral scale extends beyond the mouth which distinguishes it from *A. dispar*. This species is uniform bright green with a yellow stripe separating the lateral from the ventral scales. *A. nasuta* was the most abundant snake encountered in June 2008, with multiple specimens found at every site except Devbagh. Only recently has ARRS observed its ophiophagus habits.

Amphiesma beddomei (Günther, 1864). Bedomme's or Nilgiri Keelback (Fig. 22). - This ornately marked, medium sized, snake (70 cm TL) has a slender body and keeled scales. Adults have a brown ground colour. The first third of the body has a chequered pattern of alternate black and white squares both laterally and on the dorsum. It has a dark postocular stripe and white labials with black stripes. *A. beddomei* is endemic to the Western Ghats and prefers riparian stream edges where it is a significant predator of anurans. One individual was encountered at Wildernest in June 2008.

Amphiesma stolatum Linnaeus, 1758. Buff-Striped Keelback. - This Keelback is widespread in India. It is slender bodied (40-80 cm TL), with strongly keeled scales (Whitaker & Captain, 2004; Das, 2008). The dorsum colour is brown/grey with two longitudinal yellow stripes running from the neck to the tail. The anterior third of the body has black/brown spots or bars. The head is light yellow/olive, and the throat, lips and snout are orange/yellow. Three black stripes are present on the supralabials. *A. stolatum* is diurnal and found within bushes, thick grass, paddy fields and ponds (Whitaker & Captain, 2004). One specimen was seen at Kadamane in 2008.

Boiga beddomei (Wall, 1909). Beddome's Cat Snake. - This arboreal cat snake has chevron shaped brown/black body markings on a toffee brown background. It has bulging eyes and nocturnal vertical pupils. Its body is laterally compressed with enlarged vertebral scales. Most specimens have a dark postocular stripe. Average lengths are 120 cm. *B. beddomei* is rear fanged and has a mild venom. The species appears similar to neotropical *Imantodes* spp. (Savage, 2002; Duellman, 2005). Its diet consists mainly of lizards (Whitaker & Captain, 2004). It is found mostly in the Western Ghats in India. Two individuals were encountered in June 2008, one at Kadamane and one at Wildernest.

Boiga ceylonensis (Günther, 1858). Ceylon/Sri Lankan Cat Snake. - This long species (132 cm TL) has a laterally compressed body with smooth body scales and a long tail. Dorsum coloration is a light tan to grey with dark brown/black patches in series down the vertebral line. The head has a black streak on the nape and a postocular stripe. This species is found in the west of India including the Western Ghats and Tamil Nadu. It looks very similar to *B. beddomei* but is differentiated by ventral (214-235 *B. ceylonensis*/248-266 *B. beddomei*) and sub-caudal scalation (98-108 *B. ceylonensis*/113-127 *B. beddomei*) (Whitaker & Captain, 2004).

Coelognathus helena helena (Daudin, 1803). Common/Indian Trinket Snake. - *C. helena* (previously *Elaphe*) is currently recognized as two subspecies *C. helena helena* and *C. helena monticollaris*. The species is medium sized (700-1680 cm TL) with a relatively slender body. Scales are smooth anteriorly and weakly keeled posteriorly. The dorsum colour is light or dark tan with two prominent black lines on the neck that becomed chequered. The anterior pattern smoothly leads into two large brown or black lines that reach the tip of the tail (Daniel, 2002; Whitaker & Captain, 2004; Abyerami & Sivashanthini 2008; Das, 2008). *C. h. helena* is active both diurnally and nocturnally and is common throughout India from as far north as Jammu and Kashmir. *C. h. monticollaris* is endemic to the Western Ghats (Das, 2008).

Lycodon aulicus (Linnaeus, 1758). Common Wolf Snake (Fig. 20). - Wolf snakes are aptly named because of their fierce dentition. *Lycodon* spp. have enlarged upper front incisors. *L. aulicus* is a small (adults to 80 cm) snake with an ox-blood ground colour and narrow white dorsal bands that widen ventrally and blend into a white underside. Its head is slightly flattened and broader than the neck. This species is often mistaken for *Bungarus* spp. *L. aulicus* is strictly nocturnal and often found around houses, walls, stone piles and hollows of trees. It lays a small clutch of 5-7 eggs in December/January in Chennai region but lays in March-July in northern India. It is ubiquitous across India. Care must be taken when handling because of its nervous disposition and potential to cause bad lacerations when it bites. One individual was encountered at Devbagh Island resort, Kawar in June 2008.

Lycodon travancorensis (Beddome,1870). Travancore Wolf Snake. - This small (74 cm) Wolf Snake has a dark brown/black ground colour with an iridescent sheen. It has thin (two scale rows) yellow bands that separate into two ventrally along the entire body. These bands can appear white in the beam of a flashlight at night and lead to confusing this species with *Bungarus* spp. (Whitaker & Captain, 2004). *L. travancorensis* is endemic to India and has a disjunct and limited range. We encountered this species under a plank of wood at Wildernest in June 2008. The species was also encountered in September 2009 at the Mojo Rainforest Retreat, Madikeri.

Oligodon arnensis (Shaw, 1802). Common Kukri Snake. - *O. arnensis* can be distinguished from other Kukri Snakes by the divided anal shields and from other Indian plain snakes from the 17:17:15 scale rows (Daniel, 2002). This relatively small snake (35-66 cm TL) has a depressed head with a short blunt snout. Three distinct dark brown/black 'V' shaped markings are present on the head. The dorsum is brown with 10-20 dark brown/black bands. *O. arnensis* is found throughout India, Pakistan, Sri Lanka Nepal, with the exception of the Andaman & Nicobar Islands. It can be mistaken in the field for *Bungarus* spp. (Whitaker & Captain, 2004). We found this species at Devbagh in 2008 on the edge of a shallow lake in 2008.

Ptyas mucosa (Linnaeus, 1758). Common Indian Rat Snake. - This species has a bronze/brown ground colour, though it can vary from yellow to black. The species has large eyes and round pupils with vertical black lines that separate the lip scales. Adult *P. mucosa* can resemble *Naja naja* (Spectacled Cobra) and *Argyorena fasciolata* (Banded Racer). It is distributed throughout Southeast Asia and can be found up to 4000 m ASL (Daniel, 2002; Whitaker & Captain, 2004; Das, 2008). *P. mucosa* has been seen at Kadamane and Agumbe on all expeditions.

Xenochropis piscator (Schneider, 1799). Chequered Keelback. - *X. piscator* is a medium sized and robust species (60-170 cm TL) with strongly keeled scales. It can be identified by 19 costals at mid body, supralabials touching the eye and undivided anal shields (Daniel, 2002). The head is broad, slightly rounded and has prominent eyes with circular pupils. The dorsum colour is olive brown/green, grey or black and can sometimes show some yellow. The chequered body pattern is produced by rows of black spots covering the body, which become less conspicuous toward the tail. *X. piscator* is a common water snake in India. It was encountered at Kadamane and Agumbe in 2008 and 2009.

Elapidae

Bungarus caeruleus Schneider, 1801. Indian Krait. - *B. caeruleus* is identified by enlarged hexagonal vertebral scales. This feature distinguishes it from *Lycodon* spp. (Daniel, 2002; Whitaker & Captain, 2004; Das, 2008). *B. caeruleus* is a medium sized snake (100-170 cm TL), with a slightly broader head than the neck. It has smooth glossy black, blue/grey or brown/black dorsum scales, with white bands that are usually paired to the tip of the tail. It is mostly nocturnal and encountered throughout India up to 1700 m ASL. *B. caeruleus* is highly venomous and one of India's most dangerous snakes. Its venom causes serious morbidity and fatalities within India and has a high affinity for pre-synaptic neuromuscular receptors. However, the bite is not painful like other elapid and Viper bites (Bawaskar & Bawaskar, 2004; Whitaker & Captain, 2004). This species was found near Agumbe and Hunsur Farm in September 2009.

Calliophis bibroni (Jan, 1858). Bibron's Coral Snake (Fig. 21). - *C. bibroni* is a coral snake endemic to the Western Ghats. It is dark purplish above with black bands that continue onto the ventral region which is bright coral red. This species is small (up to 64 cm) and terrestrial in habit. It prefers moist deciduous forests at 900-1000 m ASL. Its distribution records are fragmented from four localities; Muthanza, Wyanad wildlife sanctuary, Kannur district - Silent Valley, and Agumbe - Karnataka. The IUCN status for this species is Endangered (EN). The Indian Wildlife (Protection) Act, 1972, lists the species in Schedule IV (Anonymous, 2001). This species is known from the Western Ghats as far north as Coorg (Smith, 1943). Shankar & Ganesh (2009) produced the first known photographs of the species. Although not encountered as part of the investigations herein, we were privy fortunate to be shown a rare specimen at Agumbe in June 2008.

Calliophis melanurus (Shaw, 1802). Indian Coral Snake. - This relatively small species (35 cm TL) has an extremely slender, smooth scaled, brown body with two distinct black rings. It is blue on the underside. The colour of the head is jet black with white or yellow spots haphazardly arranged on the head and nape. The dorsum colour is light brown and the ventral scales are bright red. *C. melanurus* can be mistaken for *Sibynophis subpunctatus* (Duméril's Black-headed Snake) (Whitaker & Captain, 2004). Information on this species is

meagre and its distribution has not been clearly defined. There have been records from Tamil Nadu, West Bengal, Karnataka, Gujarat and Maharashtra (Whitaker & Captain, 2004). This species was found at Agumbe in 2008.

Naja naja (Linnaeus, 1758). Spectacled Cobra. - *N. naja* is a relatively large snake (100-200 cm TL) and is one of the big four venomous snakes in India. This species is identified by the famous spectacled marking on the hood. The dorsum coloration can vary considerably, but browns, dark yellows, greys and blacks are most common with a speckled or a banding pattern. The hood is produced from the elongation of the ribs from the third and the following 27 vertebrate and markings on this can vary. This is a common snake found throughout mainland India, Sri Lanka, Nepal, Bangladesh and Pakistan (Whitaker & Captain, 2004). This species has many look-alikes which include *Argyrogena fasciolata* (Banded Racer), *Ptyas mucosa* and *Coronella brachyuran* (Indian Smooth Snake) (Whitaker & Captain, 2004). *N. naja* can be distinguished from these species by the presence of a small 'cuneate' scale between the fourth and fifth infralabials and the presence of the hood (Daniel, 2002). We found specimens at all locations except Devbagh.

Ophiophagus hannah Cantor, 1836. King Cobra (Fig. 23). - *O. hannah* is the third largest snake in India and is the largest species of venomous snake in the world (558 cm TL) (Daniel, 2002; Das, 2008). The colour within this species can vary from black/ olive green, to brown, with 32-43 stripes of white/ yellow (Daniel, 2002). Hatchlings emerge with bluish black coloration and pure white banding. The head is relatively flat, with the hood being less profound and longer than cobras of the genus *Naja*. The venom of *O. hannah* is not as toxic as *N. naja* but the volume of venom injected during an attack is considerably more (approx. 7 ml). Attacks on humans are very rare. Antivenom for *O. hannah* is manufactured only in Thailand. *O. hannah* can be found in the Western Ghats, Goa, Utter Pradesh, West Bengal, and in the northeast Indian province of Arunachal Pradesh and as far as the Philippines (Whitaker & Captain, 2004; Das, 2008). We were fortunate to see two specimens at Agumbe in 2008. The first was a female that had been rescued nearby from persecution. We released it at Agumbe. The second, a male, was a specimen that was part of a radio-tracking study undertaken by researchers at ARRS. During our stay at Agumbe in 2008 the male was found and then tracked visually from approx. 10 m for about 1 minute before it retreated into undergrowth. The specimen was possibly 12 feet with a healthy girth. Recently, ARRS presented video footage of a King Cobra tracking down and preying on a *Trimesurus malabaricus* (Malabar Pit-viper). The selected prey species was a first for *O. hannah* and the predation was observed for over an hour. The specimen had followed a scent up a tree and chased the viper where it fell to the ground. The cobra continued to follow it, temporarily slowing down when the viper entered a stream. It then followed the vipers trail exactly and even tried attacking a small rock, which the viper had rested on, acting upon its olfactory senses. It eventually found the viper's and consumed it. The viper's attempt to defend itself proved futile.

Viperidae

Daboia russelii (Shaw & Nodder, 1797). Russell's Viper. - *D. russelii* is a robust snake with a short, thin tail (120-150 TL), triangular head and strongly keeled body scales. It has a slightly elevated snout and the head has dark triangular postocular markings. The dorsum colour is light brown or grey with a series of dark brown or black oval markings with white margins that run longitudinally on the body. The fangs of *D. russelii* are the biggest of the Indian vipers but this species will only strike when aggravated. Cases of bites occur more frequently than for Cobras. Ariaratnam et al. (1999) showed that up to 73% of all bites in Anuradhapura were by Russell's Viper. They are found throughout India up to 2700 m ASL (Daniel, 2002; Whitaker & Captain, 2004; Das, 2008). *D. russelii* was found near Hongod Farm and Agumbe in 2009.

Echis carinatus (Schneider, 1801). Saw-Scaled Viper. - *E. carinatus* is one of the leading causes of snakebite morbidity and mortality in the world (Warrell et al., 1974). It is a relatively small species (30-100 cm TL). The head is slightly broader than

the neck with large eyes and vertical pupils. It has a stout body with a short tail. Several colour forms are present within the species. The general dorsum colour can range from light or dark brown, grey and brick reds, with distinctive zigzag patterns. The head is usually marked with a distinct arrow shape. *E. carinatus* is one of the big four venomous species in India. Its vernacular name is given from the rasping sound produced by scraping its highly keeled scales together when acting defensively. *E. carinatus* has a boisterous temperament and is quick to strike. The species has a wide distribution that includes Africa, the Middle East, India, Pakistan and Sri Lanka (Warrell et al., 1974; Daniel, 2002; Whitaker & Captain, 2004; Das, 2008). Two specimens were encountered on a high plateau close to Wildernest in 2008. Interestingly, it is only Northern Indian specimens of *E. carinatus* that can reach sizes of 1 m (G. Martin pers. comm.). As yet there are few explanations for this but it is possibly a prey related phenomenon.

Hypnale hypnale (Merrem, 1820). Hump-Nosed Pit-viper. - This nocturnal snake (28-55 cm TL) has a lance shaped head with a pointed snout. The head is reddish brown with a dark brown or black jaw that is separated by a thin white line (Fig. 18). It has a stout body and often a brown/reddish dorsum with black triangles or circles on the flanks. Ventral scales can be yellow, grey or even light brown. The tail is short and white in juveniles and used as a caudal lure (Daniel, 2002; Whitaker & Captain, 2004; Das, 2008). This species has heat-sensing pits situated between the nostril and the eyes. *H. hypnale* is found in India only in the Western Ghats from 300-600 m ASL. It is moderately venomous when compared to *Daboia russelii* and *Naja naja*. The bite of *H. hypnale* causes acute pain and swelling but is rarely fatal. Only two reports of mortality exist from *H. hypnale* bites (Premawardena et al., 1998). The individual of this mostly terrestrial species was encountered at Agumbe in June 2008. Unusually it was found in scrub at a height of 1 m.

Trimeresurus gramineus (Shaw, 1802). Bamboo Pit-viper. - This medium sized snake (40-110 cm TL) can be distinguished from other green pit-vipers by differences in the costal scales (Daniel, 2002; Whitaker & Captain, 2004). The neck of this species is constricted giving the appearance of a lance shaped head. This species has heat sensitive pits between the nostril and eye and a prehensile tail. The dorsum is bright green with a light brown/yellow irregular line running down the vertebrae. The labial scales are yellow and it has a dark postocular stripe. *T. gramineus* is endemic to India and is found within the Western and Eastern Ghats, with northern limits of its range extending to the Dangs in Gujarat. It is sedentary and remains in the same bush for several months during the dry season (Daniel, 2002; Whitaker & Captain, 2004). The bite of *T. gramineus* can cause swelling and pain. One specimen was seen at Agumbe in 2008.

Trimeresurus malabaricus (Jerdon, 1854). Malabar Rock Pit-viper (Fig. 17). - *T. malabaricus* exhibits great variation in marking both ontogenetically and between individuals. Adults have weakly keeled body scales, a strongly lance shaped head and short prehensile tails. They have prominent zigzag patterns of green, browns and olive with dark and/or yellow dorsal spots. Two specimens we found at Brahmagiri were encountered within a deep, narrow valley. A juvenile was coiled in a tree sapling approximately 2 m in perch height. The second specimen, an adult female, was found next to a streambed, sheltered between two rocks. The habitat of this species varies considerably from deep forest to edge vegetation. The neotropical *Bothriechis schlegelii* (Eyelash Viper) also exhibits such variability in habitat and trophic layer (Savage, 2002). It is possible that habitat selection in *T. malabaricus*, like *B. schlegelii*, is based upon prey availability (Seigel et al., 2002). Further behavioural study may reveal this. *T. malabaricus* is a species of medical significance and has been recorded to cause 500 bites per annum (Simpson & Norris, 2007). It is endemic to the Western Ghats. In June 2008 *T. malabaricus* was one of the most frequently observed snake species with multiple individuals encountered at Kadamane, Agumbe and Wildernest.

Uropeltidae

Uropeltis ellioti (Gray, 1858). Elliot's Shield-tail. - This small snake (25 cm TL) has a slender smooth

scaled body, narrow head and sharp pointed snout. It has a short tail that is slanted, appearing identical to the head. The tail has two spines at the end. Dorsum and ventral scales are a gloss brown with small yellow spots. Yellow lines are present on the head and tail. *U. ellioti* is endemic to India, being present within the Western and Eastern Ghats, with some records from Gujarat, Maharashtra, Bangalore, and Madhya Pradesh (Whitaker & Captain, 2004). This species is semi-fossorial and was encountered during a travel break on the main road near the city of Mysore in 2008.

TESTUDINES; Geoemydidae

Melanochelys trijuga (Schweigger, 1812). Indian Black Turtle. - *M. trijuga* is an abundant and widespread freshwater turtle in India (22-38 cm carapace length). The carapace in juveniles is a light brown, which darkens and then becomes almost black in adults (Daniel, 2002; Das, 2008). The plastron is bordered by yellow which is more prominent in juveniles. The head is grey or olive, with yellow or pink reticulation. The carapace is only slightly convex and has one median and two lateral keels. The margin of the shell flares outwards as it progresses to the hind limbs and curves inwards laterally and behind. The tail of *M. trijuga* is short and the skin of the head is divided into large shields (Daniel, 2002). We saw a number of specimens at Devbagh in 2008 and 2009 among vegetation and around a shallow lake.

Trionychidae

Aspideretes leithii (Gray, 1872). Leith's Softshell Turtle. - This Softshell Turtle has an oval to rounded carapace (to 63.5 cm) with olive/yellow vermiculations in adults. In juveniles four to six dark-centered, light-bordered ocelli are present on the grey carapace, but these fade with age. Juveniles have several longitudinal rows of tubercles on the carapace. The skull has a narrow pointed bony snout that is longer than the diameter of the orbit. The outer surface of the limbs is green and its underside cream. Males have long, thick tails with the vent near the tip; females have short tails. *A. leithii* occurs in the Bhavani, Godaveri, and Moyer rivers of peninsular India (Moll & Vijaya, 1986). This turtle lives in reservoirs and shallow, mud-bottomed stretches of streams and rivers. It is sometimes maintained in tanks within cities and villages. Possibly two clutches of round, hard-shelled eggs (29.8-31.1 mm) are laid each year (Das, 1995). Its diet comprises worms, snails, prawns, crabs, fish, and tadpoles, but also some plant material (Das, 1995). We found multiple specimens in a shallow lake in Devbagh in 2008.

DISCUSSION

In 1992 India was identified as one of the 12 global mega bio-diverse countries at the Convention of Biological Diversity. The same convention led the Indian Government to classify the Western Ghats as a 'Biodiversity Hotspot' in June 1999 in its policy document. This document also recognised the need for education and development to conserve biodiversity.

The increasing population of India has produced increased development and road networks that have brought worrying pressure on populations of flora and fauna in its biodiversity hotspots. The Western Ghats has experienced massive changes over the last century with the development of plantations and towns. This has led to increased vehicle traffic and the subsequent increase in mortality of reptiles and amphibians on roads (Vijayakumar et al., 2001). The Western Ghats are also under threat from habitat loss and fragmentation, as well as intensive harvesting of non timber products, hunting, invasive species and grazing by livestock (Vasudevan et al., 2001; Davidar et al. 2007; Gunawardene et al., 2007). Between 1973 and 1995 the Western Ghats suffered a 25.6% loss of forest cover (Gunawardene et al., 2007).

A number of new initiatives are being tried in India to engage its local population and international visitors in ecological education. The Indian Wildlife Institute has launched a number of sustainability and research projects that span the length and breadth of the country and include programmes for many taxa. Many of the national universities also have environment related degree programmes and a wealth of professionals contributing to herpetological research. Private research stations like ARRS and eco-lodges are also playing a valuable part in the process. What will be important for these in coming years is

the correct and sustainable use of eco-tourism to support changes that local people make in conversion from agriculture. We believe it is vital for international visitors to be careful about their choice in following only sustainable and conscientious eco-tourism programs that promote sustainable values for local people. In a generation where eco-tourism is a dominant source of income in a number of tropical countries we, as researchers and visitors, must choose an ethical tour operator or scientific research direction.

Currently only 9% of the Western Ghats are protected (Gunawardene et al., 2007). In 2006 an application to UNESCO was made by the Nature Conservation Foundation and the Ashoka Trust for Research, Ecology and Environment that proposed to designate a chain of sites across the Western Ghats as of World Heritage Status (WHS). Although UNESCO entered these sites onto a 'tentative list', the Western Ghats have yet to be confirmed as a WHS. The Western Ghats has already been recognised as one of the Worlds biodiversity hotspots due to its extensive endemic biota. Approximately 75% of amphibians that are endemic to India are found in this region (Oommen et al., 2000). As scientific interest in the Western Ghats grows, so does the number of newly described species. Again amphibians provide a good example of this with several species being described in the last eight years (Bossuyt, 2002; Aggarwal, 2004; Bhatta & Srinivasa, 2004; Giri et al., 2004; Biju & Bossuyt, 2005a; Biju & Bossuyt, 2005b; Gururaja & Ramachandra, 2005; Biju & Bossuyt, 2006; Biju et al., 2007; Molur, 2008).

The large number of species known from the Western Ghats, some of which are described in this paper, combined with the large numbers of species still being described, highlight the need for a more concerted scientific study of the Sahyadris region as well as a need for greater protection of the habitat that remains.

ACKNOWLEDGEMENTS

We express thanks to many people who organised logistics and funding that made these field trips possible. We thank Paul Greig-Smith (International Herpetologist) and Gerry Martin (National Geographic) for leadership on all aspects of fieldwork, and for teaching us about venomous and non-venomous snakes of India. Kaushik Bajibab (Wishbone Conservation) and Greg Barretto (Indian Herpetological Researcher) provided strong field support, logistical action, species identification and language translation. Mark Wilkinson (British Museum Natural History, BMNH) and David J. Gower (BMNH) helped to decipher species identification of caecilians. Dr. K.V. Gururaja (Indian Institute of Science), J.M. Garg and Rowland Griffin (Amphibian and Reptile Conservation Trust) reviewed taxonomy, draft manuscripts and generously granted use of photographs. We thank Romulus Whitaker and the staff of ARRS for a friendly welcome, generous hospitality and sumptuous meals. We thank Nirmal Kulkarni (Director of Ecology, Wildernest) for the essential off-road transport and for wonderful food in an idyllic setting. We thank Partnership Travel and Pioneer Travel for their contacts and organisation. Thanks also to the many drivers, cooks and entourage who accompanied our groups. Importantly, our final thanks are to the Irula Tribes who gave freely their knowledge and assistance in finding many of the species in these expeditions.

REFERENCES

Abyerami, S. & Sivashanthini, K. (2008). Diversity of snakes from Jaffna Peninsula, Sri Lanka. Pakistan. *J. Biol. Sci.* **11**, 1969-1978.

Aggarwal., R. (2004). Ancient frog could spearhead conservation efforts. *Nature* **428**, 467.

Anonymous. (2001). Note book for Reptiles. CAMP. CBSG South Asian Reptile Special Interest Group / South Asian Reptile Network, Taxon Data Sheets, 1998, 226 pp.

Ariaratnam, C.A., Meyer, W.P., Perera, G., Eddleston, M., Kuleratne, S.A.M., Attapattu, W., Sheriff, R., Richards, A.M., Theakston, R.D.G. & Warrell, D.A. (1999). A new monospecific ovine fab fragment anti-venom for treatment of envenoming by the Sri Lankan Russell's viper (*Daboia russelii russelii*): A preliminary dose-finding and pharmaco-kinetic study. *Amer. J. Trop. Med. Hyg.* **61**, 259-265.

Asana, J. (1931). The natural history of *Calotes*

versicolor, the Common Blood Sucker. *J. Bombay Nat. Hist. Soc.* **34**, 1041-1047.

Bahir, M.M., Meegaskumbura, M., Manamendra-Arachchi, K., Schneider, C.J. & Pethiyagoda, R. (2005). Reproduction and terrestrial direct development in Sri Lankan shrub frogs (Ranidae: Rhacophorinae: *Philautus*). *Raffles Bull. Zool.* **12**, 339-350.

Bauer, A.M. & Giri, V. (2004). On the systematic status of *Gecoella deccanensis* (Gunther, 1864) and *G. albofasciata* (Boulenger, 1885) (Squamata: Gekkonidae). *Hamadryad* **28**, 51-58.

Bawaskar, H.S. & Bawaskar, P.H. (2004). Envenoming by the Common Krait (*Bungarus caeruleus*) and Asian Cobra (*Naja naja*): Clinical manifestations and their management in a rural setting. *Wilder. & Enviro. Medi.* **15**, 257–266.

Bhatta, G. (1998). A field guide to caecilians of the Western Ghats, India. *J. Biosci.* **23** (1), 73-85.

Bhatta, G., & Srinivasa, R. (2004). A new species of *Gegeneophis* Peters (Amphibia: Gymnophiona: Caeciliidae) from the surroundings of Mookambika Wildlife Sanctuary, Karnataka, India. *Zootaxa* **644**, 1-8.

Biju, S.D. (2003). Reproductive mode in the shrub frog *Philautus glandulosus* (Jerdon, 1853) (Anura:Rhacophoridae). *Curr. Sci.* **84**, 283-284.

Biju, S.D., Dutta, S. & Ravichandran, M.S. (2004). *Fejervarya keralensis*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. [Accessed: 07/01/10].

Biju, S.D. & Bossuyt, F. (2005a). Two new *Philautus* (Anura: Ranidae: Rhacophorinae) from Ponmudi Hill in the Western Ghats of India. *Copeia* **2005**, 29-37.

Biju, S.D. & Bossuyt, F. (2005b). A new species of frog (Ranidae, Rhacophorinae, *Philautus*) from the rainforest canopy in the Western Ghats, India. *Curr. Sci.* **88**, 175-178.

Biju, S.D. & Bossuyt, F. (2006). Two new species of *Philautus* (Anura, Ranidae, Rhacophorinae) from the Western Ghats, India. *Amphibia-Reptilia* **27**, 1-9.

Biju, S.D., Van Bocxlaer, I., Giri, V.B., Roelants, K., Nagaraju, J. & Bossuyt, F. (2007) A new night-frog, *Nyctibatrachus minimus* sp. (Anura, Nyctibatrachidae): the smallest frog from India. *Curr. Sci.* **93**, 854-858.

Biju, S.D. Bhuddhe, G.D., Dutta, S., Vasudevan, K., Srinivasulu, C. & Vijayakumar, S.P. (2009a). *Philautus wynaadensis*. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. [Accessed: 17/0110].

Biju, S.D. & Bossuyt, F. (2009). Systematics and phylogeny of *Philautus* Gistel, 1848 (Anura, Rhacophoridae) in the Western Ghats of India,with descriptions of 12 new species. *Zool. J. Linn. Soc.* **155**, 374-444.

Bossuyt, F. (2002). A new species of *Philautus* (Anura: Ranidae) from the Western Ghats of India. *J. Herpetol.* **36**, 656-661.

Clarke, B.T. (1989). Real vs apparent distribution of dwarf amphibians: *Bufo lindneri* Mertens 1955 a case in point. Amphibia-Reptilia **10**, 297–306.

Dahanukar, N. & Padhye, A. (2005). Amphibian diversity and distribution in Tamhini northern Western Ghats, India. *Curr. Sci.* **88**, 1496-1501.

Daniel, J.C. (2002). *The Book of Indian Reptiles and Amphibians.* Oxford: Oxford University Press, 238 pp.

Daniels, R.J.R. (2003). Impact of tea cultivation on anurans in the Western Ghats. *Curr. Sci.* **85**, 1415-1422.

Daniels, R.J.R. (2005). *Amphibians of Peninsular India.* Indian Academy of Sciences, Orient Blackswan, 268 pp.

Das, I. (1995). *Turtles and Tortoises of India.* Bombay: Oxford Univ. Press. 179 pp.

Das, I. (2008). *A Photographic Guide to Snakes and Other Reptiles of India.* London: New Holland Publishers, 144 pp.

Davidar, P., Arjunan, M., Mammen, P.C., Garrigues, J.P., Puyravaud, J.P., & Roessingh, K. (2007). Forest degradation in the Western Ghats biodiversity hotspot: resource collection, livelihood concerns and sustainability. *Curr. Sci.* **93**, 1573-1578.

De Silva, A. & De Silva, P. (1995). Some observations on *Kaloula taprobanica* (Amphibia: Anura: Microhylidae) in Sri Lanka. *Lyriocephalus* 1 (1-2), 48-51.

Duellman, W.E. (2005). *Cuzco Amazónico: The Lives of Amphibians and Reptiles in an*

Amazonian Rainforest. Ithaca, New York: Comstock, Cornell University Press. 433 pp.

Dutta, S.K. & Manamendra-Arachchi, K. (1996). *The Amphibian Fauna of Sri Lanka.* Colombo: Wildlife Heritage Trust of Sri Lanka.

Giri, V. Wilkinson, M. & Gower, D.J. (2003) A new species of *Gegeneophis* Peters (Amphibia: Gymnophiona: Caeciliidae) from southern Maharashtra, India, with a key to the species of the genus. *Zootaxa* **351**, 1-10.

Giri, V., Gower, D.J. & Wilkinson, M. (2004). A new species of *Indotyphlus* Taylor (Amphibia: Gymnophiona: Caeciliidae) from the Western Ghats, India. *Zootaxa* **739**, 1-19.

Girish, S. & Saidapur, S.K. (1999). Mating, nesting behaviour and early development in the tree frog *Polypedates maculates*. *Curr. Sci.* **76**, 91-92.

Gunawardene, N.R., Dulip Daniels, A.E., Gunatilleke, I.A.U.N., Gunatilleke, C.V.S., Karunakaran, P. V., Geetha Nayak, K., Prasad, S., Puyravaud, P., Ramesh, B.R., Subramanian, K.A. & Vasanthy, G. (2007). Brief overview of the Western Ghats - Lanka biodiversity hotspot. *Curr. Sci.* **93**, 1567-1572.

Gururaja, K.V., Manjunatha Reddy, A.H., Keshavayya, J. & Krishnamurthy, S.V. (2003). Habitat occupancy and influence of abiotic factors on the occurrence of *Nyctibatrachus major* (Boulenger) in central Western Ghats, India. *J. Herpetol.* **10**, 87-92.

Gururaja, K.V. & Ramachandra, T.V. (2005). Integrated approaches to minimise ambiguities in anuran description. Indian Institute of Science, Bangalore.

Gururaja, K.V., Aravind, N., Ali, S., Ramachandra, T.V., Velavan, T.P., Krishnakumar, V. & Aggarwal, R.K, (2007a). A new frog species from the central Western Ghats of India and its phylogenetic position. *Zool. Sci.* **24**, 525-534.

Gururaja, K.V., Dinesh, K.P., Palot, M.J., Radhakrishnan, C. & Ramachandra, T.V. (2007b). A new species of *Philautus* Gistel (Anura: Rhacophoridae) from southern Western Ghats, India. *Zootaxa* **1621**, 1-16.

Gurushankara, H.P., Krishnamurthy, S.V. & Vasudev, V. (2007). Morphological abnormalities in natural populations of common frogs inhabiting agroecosystems of central Western Ghats. *Appl. Herpetol*. **4**, 39-45.

Herre, A.W. (1958). On the gliding of flying lizards genus *Draco. Copeia* **4**, 338-339.

Ishwar, N.M., Chellam, R., Kumar, A. & Rao, B.R. (2003). The response of agamid lizards to rainforest fragmentation in the Southern Western Ghats, India. *Cons. and Society* **1** (2), 69-86.

Islam, M.M., Kurose, N., Rahman K., Md. Mukhlesur, Nishizawa, T., Kuramoto, M., Alam, M.S., Hasan, M., Kurniawan, N., Nishioka, M. & Sumida, M. (2008). Genetic divergence and reproductive isolation in the genus *Fejervarya* (Amphibia: Anura) from Bangladesh inferred from morphological observations, crossing experiments, and molecular analyses. *Zool. Sci.* **25** (11), 1084-1105.

IUCN (2005). Category IV (Habitat/Species Management Area) by the World Conservation Union/International Union for Conservation of Nature and Natural Resources (IUCN). [Accessed: July 2008].

Kadur, S. & Bawa, K.S. (2005). *Sahyadris: India's Western Ghats.* Bangalore: Ashoka Trust for Research in Ecology and Environment, 245 pp.

Kadadevaru, G.G. & Kanamadi, R.D. (2000). Courtship and nesting behaviour of the Malabar Gliding Frog, *Rhacophorus malabaricus* (Jerdon, 1870). *Curr. Sci.* **79**, 377-380.

Kadadevaru, G.G., Kanamadi, R.D. & Schneider, H. (2002). Advertisement call, courtship and mating behaviour of the frog, *Limnonectes syhadrensis* from Western Ghats, India. *Curr. Sci.* **82**, 503-505.

Karthikeyan Vasudevan, M., Chaitra, S. & Aggarwal, R.K. (2007). Pernicious descriptions of 'new' frogs from the Western Ghats, India. *Curr. Sci.* **92** (3), 281-282.

Khan, M.S. (1997). A new subspecies of Common Skittering Frog *Euphlyctis cyanophlyctis* (Schneider, 1799) from Balochistan, Pakistan. *J. Zool.* **29**, 107-112.

Kurabayashi, A., Kuramoto, M., Joshy, H. & Sumida, M. (2005). Molecular phylogeny of the ranid frogs from Southwest India based on the mitochondrial ribosomal RNA gene sequences. *Zool. Sci.* **22** (5), 525-534.

Kuramoto, M. & Joshy, S.H. (2001). Advertisement call structures of frogs from Southwestern India,

with some ecological and taxonomic notes. *Curr. Herpetol.* **20**, 85-95.

Kuramoto, M., Joshy, S.H., Kurabayashi, A. & Sumida, M. (2007). The genus *Fejervarya* (Anura: Ranidae) in central Western Ghats, India, with descriptions of four new cryptic species. *Curr. Herpetol.* **26** (2), 81-105.

Manamendra-Arachchi, K., Batuwita, S. & Pethiyagoda, R. (2007). A taxonomic revision of the Sri Lankan Day-geckos (Reptilia: Gekkonidae: *Cnemaspis*), with description of new species from Sri Lanka and southern India. *Zeylanica* **7**, 9-122.

Meegaskumbura, M. & Manamendra-Arachchi, K. (2005). Description of eight new species of shrub-frogs (Ranidae: Rhacophorinae: *Philautus*) from Sri Lanka. *Raff. Bull. Zool.* **12**, 305-338.

Manamendra-Arachchi, K. & Pethiyagoda, R. (2005). The Sri Lankan shrub-frogs of the genus *Philautus* Gistel, 1848 (Ranidae: Rhacophorinae), with description of 27 new species. *Raffles Bull. Zool.* **12**, 163-303.

Moll, E.O. & Vijaya, J. (1986). Distributional records for some Indian turtles. *J. Bombay Nat. Hist. Soc.* **83**, 57-62.

Molur, S. (2008). South Asian amphibians: taxonomy, diversity and conservation status. *Int. Zoo Yb.* **42**, 143-157.

Ohler, A., Deuti, K., Grosjean, S., Paul, S., Ayyaswamy, A. K., Ahmed, M. F. & Dutta, S.K. (2009). Small-sized dicroglossids from India, with the description of a new species from West Bengal, India. *Zootaxa* **2209**, 43-56.

Oommen, O.V., Measey, G.J. Gower, D.J. & Wilkinson, M.D. (2000). Distribution and abundance of the caecilian *Gegeneophis ramaswamii* (Amphibia: Gymnophiona) in southern Kerala. *Curr. Sci.* **79** (9), 1386-1389.

Pillai, R.S. (1986). Amphibian fauna of Silent Valley, Kerala, South India. *Rec. Zool. Sur. India* **84**, 229-242.

Pillai, R.S. & Ravichandran, M.S. (1999). Gymnophiona (Amphibia) of India, a taxonomic study. *Rec. Zool. Sur. India* **72**, 1-117.

Premawardena, A.P., Seneviratine, S.L., Gunatilake, S.B., & De Silva, H.J. (1998). Excessive fibrinolysis: the coagulopathy following Merrem's Hump-nosed Viper (*Hypnale hypnale*) bites. *J. Trop. Med. Hyg.* **58**, 821-823.

Radhakrishnan, C. (2009). Kolkata News: Zoological Survey of India. *E-News* **1** (9), 17.

Rösler, H. (2000). Kommentierte liste der rezent, subrezent und fossil bekannten Geckotaxa (Gekkonomorpha). *Gekkota* **2**, 28-153.

Savage, J.M. (2002). *The Amphibians and Reptiles of Costa Rica: A Herpetofauna Between Two Continents, Between Two Seas.* Chicago: The University of Chicago Press, 934 pp.

Seigel R.A., Collins, J.T. & Novak, S.S. (2002). *Snakes: Ecology and Evolutionary Biology.* New Jersey: The Blackburn Press.

Shankar, P.G. & Ganesh, S.R. (2009). Sighting record and range extension of *Calliophis bibroni* Jan, 1858 (Reptilia, Squamata, Serpentes, Elapidae). *Herpetol. Bull.* **108**, 10-13.

Simpson, I.D. & Norris, R.L. (2007). Snakes of medical importance in India: is the concept of the "Big 4" still relevant and useful? *Wild & Environ. Med.* **18**, 2-9.

Smith, M.A. (1935). *The Fauna of British India, Including Ceylon and Burma. Vol. I.* London: Taylor & Francis, 40 pp.

Smith, M.A. (1943). *Fauna of British India, including Ceylon and Burma, Vol. II Serpentes.* London: Taylor & Francis Limted, 583 pp.

Tiwaru, M. & Schiavina, A. (1990). Biology of the Indian garden lizard *Calotes versicolor* (Daudin). Pt I: Morphometrics. *Hamadryad* **15**, 30-33.

Whitaker, R. & Captain, A. (2004). *Snakes of India, The Field Guide.* Tamil Nadu, India: Draco Books, Chengalpattu, 385 pp.

Warrell, D.A., McDavidson, N., Omerod, L.D., Pope, H.M., Watkins, B.J., Greenwood, B.M., & Ried, H.A. (1974). Bites by the Saw-scaled Viper (*Echis carinatus*): trial of two specific anti-venoms. *Brit. Med. Jour.* **4**, 437-440.

Vijayakumar, S.P., Vasudevan, K., & Ishwar, N.M. (2001). Herpetofaunal mortality on roads in the Anamalai hills, southern Western Ghats. *Hamadryad* **26**, 265-272.

Vasudevan, K., Kumar, A. & Chellam, R. (2001). Structure and composition of rainforest floor amphibian communities in Kalakad–Mundanthurai Tiger Reserve. *Curr. Sci.* **80**, 10.

VARANUS FLAVESCENS (Yellow Monitor): DISTRIBUTION AND REPRODUCTION. *Varanus flavescens* was first described in 1827 by Hardwicke and Gray as *Monitor flavescens* from its type locality, India. The current range for the species in southern Asia includes the floodplains of Indus, Ganges, and Brahmaputra rivers of Pakistan, Northern India, Nepal, Myanmar, and Bangladesh (Auffenberg et al., 1989; Zug et al., 2003; Visser, 2004; Islam 2009). The species is highly secretive and has proved to be difficult to locate (Visser, 2004). *V. flavescens* has been described as widely distributed in Bangladesh (IUCN, 2000; Khan, 2008). However, very few specific locations have been known due to its unclear distribution within the country and because virtually no published natural history information is available on the Bangladesh population. The species is categorized nationally as 'Endangered' (IUCN, 2000). This note confirms the distribution of a breeding pair in the Netrokona District of northern Bangladesh and is the first confirmed record for the Dhaka Division. The report also describes some reproductive activities of a breeding pair.

On 15 June 2009, a brightly coloured breeding pair of *V. flavescens* was observed displaying courtship behaviour at the entrance of a burrow close to a seasonally flooded water body (Fig.1). The site is in Chandpur Village (24º57'48" N, 90º52'21" E; WGS 84) of Netrokona District under Dhaka Division. The nearest records were from the hill forests of Sylhet (> 200 km east of the present locality) and Chittagong (> 450 km south) Divisions (Islam, 2009). No voucher specimen was collected because of the species' endangered status. Several photographs were taken as reference. Identification was verified by Bryan Stuart and photographs have been deposited at the USDZ, Raffles Museum of Biodiversity Research, National University of Singapore. The photographs are catalogued as ZRC [IMG] 2.122.

V. flavescens is a diurnal species active in the summer months between April and September (Ali Reza pers. obs.). The breeding pair in Chandpur Village was found on a mid June afternoon (14:00) close to a burrow. Breeding activity was observed for approximately one hour. Chandpur Village in Netrokona District is situated in the northern part of Bangladesh on the foothills of the Himalayas. Seasonal flooding is common in the area but most of the plains are used for agriculture. Natural vegetation is altered by garden allotments, orchards and commercial plantations.

Figure 1. *Varanus flavescens* at the entrance of the burrow. © M.S.H. Sourav.

The male was observed mating with the female for about fifteen minutes. The male was differentiated from the females due to its slightly bigger body size and bright coloration. Although common in other varanids, this breeding pair of *V. flavescens* did not show any biting activity during courtship. The pair was calm and unaggressive when they engaged in copulation. When approached to take photographs, the pair remained alert and the female retreated into the burrow while the male stayed outside carefully observing us (Fig.1). After several minutes, the male followed the female into the burrow. Visser (2004) reported that courtship and mating in *V. flavescens* occurs in June and July, at the beginning of the wet season. This has also been documented for captive animals. The specimens observed herein displayed a similar seasonal breeding phenology.

ACKNOWLEDGEMENTS

Part of this work was supported by the Cleveland Metroparks Zoo, Columbus Zoo and Aquarium, and Rufford Small Grants Foundation awarded to Ali Reza. Jahangirnagar University in Bangladesh and Texas Tech University in the USA provided administrative support.

REFERENCES

Auffenberg, W., Rahman, H., Iffat, F. & Perveen, Z. (1989). A Study of *Varanus flavescens* Hardwicke and Gray (Sauria Varanidae). *J. Bombay Nat. Hist. Soc.* **86** (3), 286-307.

Islam, M.A. (2009). *Varanus flavescens*. In: *Encyclopedia of Flora and Fauna of Bangladesh, Vol. 25. Amphibians and Reptiles*. Pp. 103-104. Kabir, S.M.H., Ahmad, M., Ahmed, A.T.A., Rahman, A.K.A., Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A. & Khondker, M. (Eds.). Dhaka, Bangladesh: Asiatic Society of Bangladesh.

IUCN (2000). *Red Book of Threatened Amphibians and Reptiles of Bangladesh.* IUCN-The World Conservation Union. Bangladesh Country Office. Xii + 95 pp.

Khan, M.M.H. (2008). *Protected Areas of Bangladesh - A Guide to Wildlife*. Dhaka, Bangladesh: Nishorgo Program.

Visser, G. (2004). *Varanus flavescens*. In: *Varanoid Lizards of the World*. Pp. 179-183. Pianka, E. & King, D.R. (Eds.). Indiana: Indiana University Press.

Zug G.R., Leviton, A.E., Vindum, J.V., Wogan, G.O.U. & Koo, M.S. (2003). Checklist of the Myanmar Herpetofauna from the Myanmar Herpetological Survey Project. <www.calacademy.org/research/herpetology/myanmar>. [Accessed: 2009].

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XENOCHROPHIS PISCATOR (Checkered Keelback): PREDATION. All snakes are predators, and as a whole, they prey on a very large variety of organisms (Mattison, 1995). But since some are generalists, while others are opportunists, and because there may be a variation between different populations of the same species (Mattison, 1995), it is important to state the locality, as well as the prey species in snake diet reports. Additionally, prey should be identified to the lowest taxonomical classification possible to develop not only an understanding of the ecology of the snake species in question, but also to provide information which could contribute to the understanding of the ecology of the prey species. Here, we report on Checkered Keelback, (*Xenochrophis piscator* [Schneider, 1799], formerly *Natrix piscator*) predation on a Heymonsi's Narrow-mouthed Toad (*Microhyletta heymonsi* [Vogt, 1911], formerly *Microhyla heymonsi*), and Asian Snake-head Fish (*Channa asiatica* [Linnaeus, 1758]).

At ca. 10:30 on 07 July 2006, a male *X. piscator* (197 mm SVL, 89 mm tail length, 8.3 g) was observed moving along the bottom of the fence on the inside of a 6 x 6 m enclosure, constructed of 3 mm plastic mesh, erected in a Betelnut Palm (*Areca catechu*) plantation in Santzepu, Sheishan District, Chiayi County, Taiwan (23º28'23"N, 120º29'15"E; datum: WGS84). The vegetation on the inside of the enclosure was very dense and consisted of *Ageratum catechu*, *A. conyzoides*, *Bidens pilosa* var. *radiata*, *Ipomoea cairica*, *I. obscura*, *Ludwigia octovalvis*, *Mikania micrantha* and *Panicum maximum*. The *Xenochropis piscator* was captured and it was noted that the mid-body was greatly enlarged. After gentle palpation of the enlarged area of the mid-body, the snake regurgitated an anuran, along with a large number of anuran ova. The prey item was identified as a female *Microhyletta heymonsi* (ca. 25mm SVL, 1.6 g). Since it was regurgitated head and forelimbs first, combined by the fact that parts of the hind limbs were already partly digested, it is believed it was ingested in a vent first position. Although *M. heymonsi* is a common species in lowlands and foothills of central and southern Taiwan, it is listed under the Wildlife Conservation Laws of Taiwan as a protected species due to the destruction of its

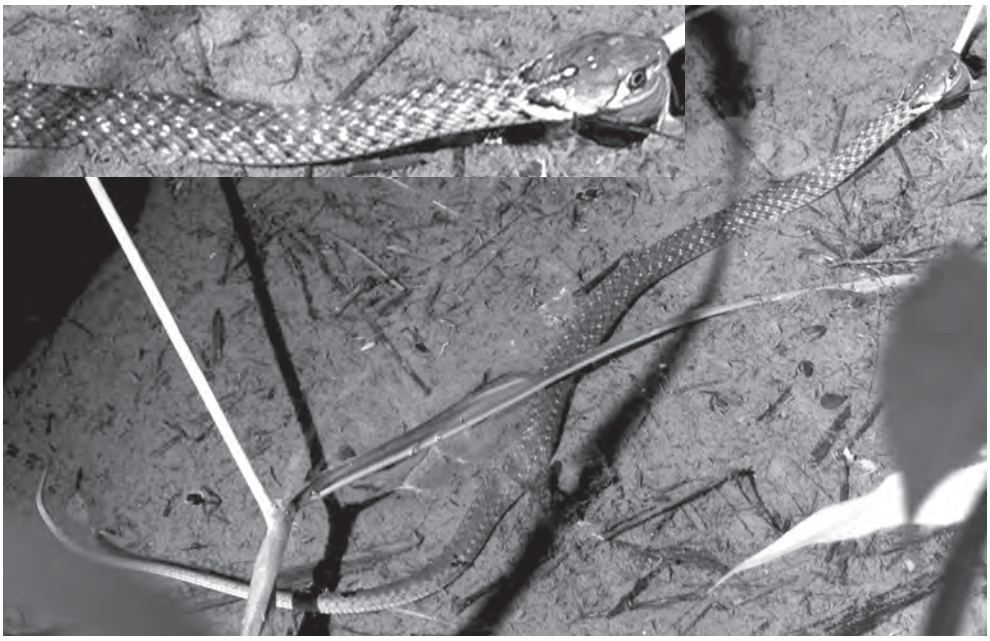

Figure 1. *Xenochrophis piscator* in a drainage ditch in an *Areca catechu* plantation in Santzepu, Sheishan District, Chiayi County, Taiwan (Photographed by G. Norval).

habitats (Yang, 1998). During the breeding season (March to September), males usually call from within vegetation or leaf-litter along the edges of pools and marshes (Yang, 1998). In the *A. catechu* plantations in Santzepu, *X. piscator* can often be seen in drainage ditches and puddles (G. Norval, pers. obs.) (Fig.1). Since *M. heymonsi* is mostly terrestrial and only enters water for oviposition, and because the *M. heymonsi* described herein still contained ova, it is likely that the predation event took place on land. This is consistent with earlier observations that *X. piscator* tends to capture anuran prey on land (Mao, pers. obs.).

On 3 October 2006, a female *X. piscator* (655 mm SVL, 200 mm tail length, 209.7 g) was collected by Mao from a wetland at the Youth Industrial Park, Taoyuan County, Northern Taiwan, where he is conducting wildlife monitoring. Soon after being captured, the snake regurgitated a *Channa asiatica* (182mm TL [total length], 52 g) tail first and it was noted that the head was partially digested. Snakehead Fish (Genus *Channa*) are well known aquatic predators in Asia and are considered to be exotic invasive species of serious concern in the U.S.A. (Courtenay & Williams, 2004). In a previous study, it was found that the presence or absence of the alien *Channa striata* affected the abundance of sympatric Chinese Water Snakes (*Enhydris chinensis*) in several fishponds in northern Taiwan (Mao, unpubl. data). However, in some of our field observations we found that the large semi-aquatic snakes of Taiwan (e.g. *Sinonatrix annularis* and *S. percarinata suriki* [Mao, 2003]) seem to prey on the indigenous Snakehead Fish (e.g. *C. asiatica*). In captivity, *C. asiatica* has been observed to spontaneously approach, and even attempt to attack, the small water snakes in neighboring tanks. There is thus a possibility that Snakehead Fish and water snakes in natural conditions in Taiwan have prey/predator switching interactions.

Xenochrophis piscator, is a common species in the areas where it occurs, which extends over most of sub-Himalayan Asia (Kuntz, 1963; Cox et al., 1998; Das, 2002; Das & De Silva, 2005). Although it has been stated that *X. piscator* occasionally preys on smaller snakes (Kuntz, 1963) and mice (Cox et al., 1998), our observations differ. Instead, we have found that these snakes prey on amphibians and fish, as reported by Pope (1929), Das (2002) and Das

& De Silva (2005). As well as some unidentified amphibians and fish, Pope (1929) reported *Barbus snyderi*, Rhodein Carp (*Rhodeus spinalis*), and *Rana limnocharis* as prey of *X. piscator*.

Colubrids commonly prey on creatures about 20% of their own mass (Greene, 1997), and the prey/predator weight-ratios for the *M. heymonsi* and *C. asiatica* described herein were 19.28% and 24.80% respectively. Even though the prey sizes were not out of the ordinary for this type of snake, to our knowledge, this is the first description of *X. piscator* preying on *M. heymonsi* and *C. asiatica*.

REFERENCES

Cox, M.J., van Dijk, P.P, Nabhitabhata, J. & Thirakhupt, K. (1998). *A Photographic Guide to Snakes and Other Reptiles of Peninsular Malaysia, Singapore and Thailand.* London: New Holland Publishers (UK) Ltd.

Courtenay, Jr., W.R. & Williams, J.D. (2004). Snakeheads (Pisces, Channidae): A Biological Synopsis and Risk Assessment. U.S. Geological Survey circular; 1251.

Das, I. (2002). *A Photographic Guide to Snakes and Other Reptiles of India*. London: New Holland Publishers (UK) Ltd.

Das, I. & De Silva, A. (2005). *A Photographic Guide to Snakes and Other Reptiles of Sri Lanka*. London: New Holland Publishers Ltd.

Ernst, C.H. & Zug, G.R. (1996). *Snakes in Question: The Smithsonian Answer Book.* Washington: Smithsonian Institute Press.

Greene, H.W. (1997). *Snakes: the evolution of mystery in nature.* California: University of California Press.

Kuntz, R.E. (1963). Snakes of Taiwan. *Quart. J. Taiwan Mus.* **16**, 15-17.

Lee, W.J. & Lue, K.Y. (1996). The preliminary study on the food habits of snakes in Taiwan. *Biol. Bull. NTNU.* **31** (2), 119-121. (In Chinese)

Lue, K.Y., Tu, M.C. & Shang, G.S. (2002). *The Transition World - Guidebook of Amphibians and Reptiles of Taiwan*. Taipei: SWAN.

Mao, J.J. (2003). Population ecology of genus *Sinonatrix* in Taiwan. Ph.D. Thesis in Biogeography, Trier University, Germany.

Mattison, C. (1995). *The Encyclopedia of Snakes*. New York: Checkmark Books.

Pope, C. H. (1929). Notes on reptiles from Fukien and other Chinese provinces. *Bull. Amer. Mus. Nat. Hist.* **58** (8), 335-487.

Yang, Y.J. (1998). *A Field Guide to the Frogs and Toads of Taiwan*. Taipei: Nature and Ecology Photographer's Society.

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LEPTODACTYLUS OCELLATUS (Butter Frog): DIET. *Leptodactylus ocellatus* is a large anuran, widely distributed throughout South America, east of the Andes (Cei, 1980). It inhabits a wide variety of aquatic habitats, being found even in altered areas (Solé et al., 2009). It has a generalist diet (Teixeira & Vrcibradic, 2003; Solé et al., 2009), with adults preying upon small vertebrates and other anurans, although the latter prey item comprises a minor part of its diet (Gallardo, 1964; Solé et al., 2009). Here we report an event of predation on another species of *Leptodactylus* by *L. ocellatus* from a locality in the Southeast of Brazil.

During a field expedition near the urban area of the municipality of Carangola (20°42'35"S, 42°01' 54"W), State of Minas Gerais, Brazil, on 25 November 2009, at 20:42, we witnessed an adult female *L. ocellatus* (SVL 93.90 mm) preying upon an adult female *Leptodactylus* aff. *mystaceus* (SVL 44.82 mm) that was hidden among grass (Fig. 1) near a small temporary pond. The frogs were located by the distress calls emitted by the prey. After approximately 10 minutes the predator attempted to escape. We then collected both frogs. The specimens were housed at the collection

Figure 1. A female *Leptodactylus ocellatus* (MZUFV 10187) attempting to ingest a female *Leptodactylus* aff. *mystaceus* (MZUFV 10188). Photo by R. C. Heitor.

of Amphibians at the Museu de Zoologia João Moojen (MZUFV), Universidade Federal de Viçosa, Viçosa municipality, State of Minas Gerais, Brazil, under the registration MZUFV 10187 (*Leptodactylus ocellatus*) and 10188 (*Leptodactylus* aff. *mystaceus*). Besides the occurrence of cannibalism (Teixeira & Vrcibradic, 2003; Kokobum & Rodrigues, 2005), the only other *Leptodactylus* spp. previously reported as prey of *L. ocellatus* was *Leptodactylus furnarius* (França et al., 2004).

We are grateful to Faculdades Vale do Carangola, Universidade do Estado de Minas Gerais (UEMG) for logistical support and IBAMA for collection permits (number 17310-1).

REFERENCES

Cei, J.M. (1980). Amphibians of Argentina. *Mon. Zool. Ita. N. S. Mon.* **2**, 1-609.

França, L.F., Facure, K.G. & Giaretta, A.A. (2004). Trophic and spatial niches of two large-sized species of *Leptodactylus* (Anura) in South-eastern Brazil. *Stud. Neo.trop. Fau. Env.* **39** (3), 243-248.

Gallardo, J.M. (1964). Consideraciones sobre *Leptodactylus ocellatus* (L.) (Amphibia, Anura) y especies aliadas. *Physis Tomo* XXIV (68), 373-384.

Kokobum, M.N.C. & Rodrigues, A.P. (2005). *Leptodactylus ocellatus* (Rã-manteiga). Cannibalism. *Herpetol. Rev.* **36** (3), 303.

Solé, M., Dias, I.R., Rodrigues, E.A.S., Marciano-Jr, E., Branco, S.M.J., Cavalcante, K.P. & Rödder, D. (2009). Diet of *Leptodactylus ocellatus* (Anura: Leptodactylidae) from a cacao plantation in southern Bahia, Brazil. *Herpetol. Notes* **2**, 9-15.

Teixeira, R. & Vrcibradic, D. (2003). Diet of *Leptodactylus ocellatus* (Anura; Leptodactylidae) from coastal lagoons of Southeastern Brazil. *Cuad. Herpetol.* **17** (1-2), 113-120.

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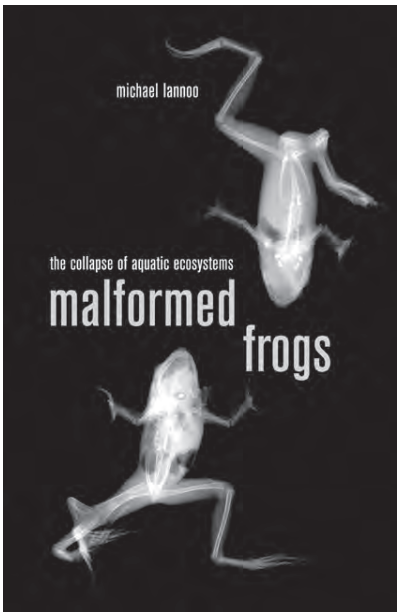
Malformed Frogs: The Collapse of Aquatic Ecosystems

Michael Lannoo

2008. University of California Press, Berkeley, Los Angeles, London. 768 pp.



Malformed frogs have been prominent within the issue of amphibian declines. They underline one of the original key concerns stemming from the phenomenon that amphibians may, like the now overworked canary in the coalmine, be warning of hitherto unrecognised environmental degradation. Apparently amphibian malformations have been documented from as long as 300 years ago, but it was the more recent discovery of malformed Northern Leopard Frogs by junior high school students in Minnesota, in 1995, that raised awareness of amphibian malformations among both the public and research communities.

This book provides a readable summary of the research into amphibian malformations in North America. It includes a thorough catalogue, which the author summarises as 'parts missing, parts present but abnormal, and parts extra'. Sixty-three radiographs of frogs (by far the majority of malformations have been reported from anurans rather than urodeles), form the basis of the catalogue which provides a reference for researchers and, in some cases, indications of the underlying causes of the malformations themselves. The book also gives descriptions of some well-known malformation hotspots, defined as sites where peak counts of malformed amphibians are at least 5% of the population sampled.

In spite of the attention given to the issue of malformed frogs, Mike Lannoo's account has an air of frustration and disappointment. Unusually, for a scientist, he concludes that we do not need further research to unravel the causal factors. In fact, Lannoo's view is that progress has been hampered by disputes over causes and that, overall, the issue has been a scientific failure, because of the lack of focus on remediation. Lannoo notes that no malformed frog hotspot has been restored to ecological health as a result of research.

The factors that have been found to cause malformations are examined with particular attention given to the trematode parasite *Ribeiroia ondatrae* and agro-chemicals. Lannoo comes to the conclusion that no single factor satisfactorily explains the full range of malformations documented but he proposes that the practical solution may be simply to reduce agricultural inputs into aquatic systems. Not only does this redress problems caused by direct impact of agro-chemicals on amphibian development, but it is also likely to reduce the numbers of *Ribeiroia*, which tend to increase in nutrient-enriched water.

A chapter on malformations in humans concludes that, in general, these differ from those in amphibians, as the former tend to have a genetic basis, whereas in amphibians they tend to be environmentally induced. Nevertheless, Lannoo stresses the potential significance of findings of Lowcock et al. (1997) that chromosomal damage has been detected in malformed frogs. Whilst, this is the exception rather than the rule, Lannoo urges that if genetic abnormalities are involved at all, then we should be concerned about potential effects in humans, too.

'Malformed Amphibians' is something of a hybrid between a scientific detective story and a reference book – but it does the job of both well.

REFERENCES

Lowcock, L.A., Sharbel, T.F., Bonin ,M., Ouellet, M., Rodrigue, J. and DesGranges, J.-L. (1997). Flow cytometric assay for in vivo genotoxic effects of pesticides in green frogs (*Rana clamitans*). *Aquatic Toxicology* **38**, 241-255.

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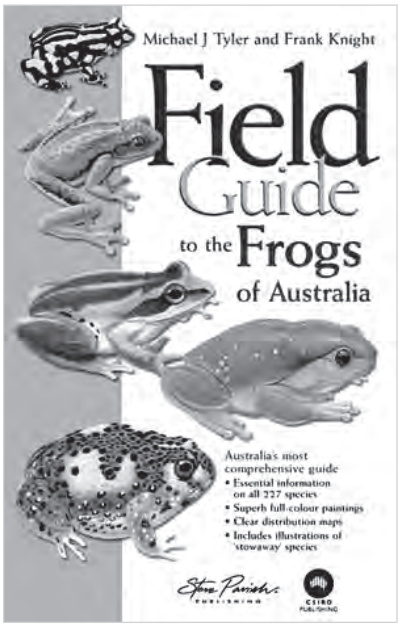
Field Guide to the Frogs of Australia

Mike Tyler and Frank Knight.

2009. CSIRO Publishing, Australia, 200 pp.



When first receiving the 'Field Guide to the Frogs of Australia' I was impressed by the aesthetics of the front cover, with its brightly coloured illustrations. This, coupled with a brief peruse through the book reinforced the sheer skill and attention to detail of the workmanship. The practicality of the book is recognisable by the plasticized cover that could protect the pages during periods of rain or accidental tea spillage.

Pages one to three of the field guide present a varied and busy introduction, including the use of Latin names, common or colloquial names and stowaways. The author highlights the swiftness of using an illustrated and mapped guide for species identification that only becomes inadequate when the species is differentiated by its call. The author provides 227 species accounts, with the exception of new species of *Litoria*, *Uperoleia* and *Crinia* yet to be described, and with the possibility of more to be discovered.

Latin nomenclature is a stable process, however, the change in stability for anurans is mentioned. In 2006 Daryl Frost and team reassessed anuran families, such as the change of *Bufo marinus* to *Rhinella marinus* but the former is retained by the author pending further information. The misuse of common names for a number of species such as 'Bullfrog' and 'Green Tree Frog' is mentioned due to the many species that look alike have sympatric distributions. The author states that Latin is preferred and only refers to the most popular common names in the guide.

The stowaway section is significant due to the Cane Toad (*Bufo marinus*) problem. Species accidentally entering Australia in cargo is a fascinating yet deeply concerning problem and thankfully the book holds a special illustrated section for the readers' interest and for future reference in this. The author highlights the main stowaways established including *Litoria fallax* into Guam. A very nice but simplified sketch of an anuran is shown on page two, illustrating the main morphological measurements taken in the field.

I found that one of the most important areas of the book is within pages four to nine; that encapsulate a comprehensive review of the six families, Hylidae, Limnodynastidae, Microhylidae, Myobatrachidae, Ranidae and Bufonidae, and their genera. The sheer detail given in such a small section will provide the reader with a vital preface to lead them smoothly through the book. One pleasing snippet is the addition of unique behavioural aspects, for instance the genera *Assa* (Myobatrachidae), in

which males carry tadpoles in paired hip pouches and *Notaden* spp. (Limnodynastidae) that exude a dermal secretion that oxidises to form a solid mass (currently being investigated for medical use).

Two simplified sketches are presented very nicely of the two variants in constricted pupil shape (horizontal and vertical) that can help characterise species. By far the most vital part of this introduction is the accounts of taxon change; for example, Myobatrachidae and Limnodynastidae were united at one time under Leptodactylidae, however, Myobatrachidae was retained, and the possibility that *Litoria* may be split into numerous genera in the future. Cane Toads (Bufonidae) are presented as *Bufo marinus* and the intentional introduction and problems with eradication are briefly discussed.

Micheal J Tyler and Frank Knight excellently portray the basic biology of anurans on pages ten to fourteen with simple but accurate sketches backed with precise information. The biological introduction has some attention grabbing information; for example, *Rheobatrachus* spp. swallow fertilised eggs, retain them in their stomach, and give birth via their mouth. Illustrations show how to identify the sexes, the vocal sac found only in males, the nuptual pads produced by different species to clasp the female during amplexus (breeding season only) and that males are smaller on average. One of the finest parts in the section is the detailed illustration of skin glands and foot/hand diversity. The sketches are simple but give good insight into species specific characters.

Page fourteen presents a brief but vital summary on the current problem in Australia with chytridiomycosis. On pages fifteen and eighteen, habitats of Australia are portrayed with a brief introduction. Again the photos by Mike Tyler, M. Davies, and R. Kerton give clarity to the diverse habitats within the country.

As one would expect within a field guide, the majority of the book is taken up by illustrations and information on the species, totalling a grand 146 pages. In each description the reader is greeted by aesthetic pages with hand drawn sketches of each species. The pertinent information is presented with a small scale but detailed map. The map shows in green, where the species are distributed throughout Australia. The detailed illustrations on the right hand page are of a very high standard, and praise should be given to Frank Knight for the effort and skill at producing over 200 hand painted illustrations with such clarity.

Hylidae represents by far the biggest section. Readers will discover some delightful species such as *Litoria chloris*, *L. xanthomera* and *L. gracilenta* (p. 30-31) that show the varying groin and thigh colours between them. My favourite sketch was that of *Litoria splendida*. Frank Knight seems to capture the frog in a pose whereby it appears to leap out of the page! The information on *Litoria infrafrenata* (68-68), gives the reader some great information on the species' tadpole identification, which would enhance any search or survey for it.

The transition onto Limnodynastidae (Myobatrachidae) on page seventy-two and on the rest of the families is quite confusing at first due to the lack of a bold heading, however, this is a minor annoyance. Within the Limnodynastidae section, the illustrations and 'key-like' guide on *Limnodynastes dumerilli* (84-85) allows readers to interpret the specifics needed to identify species and subspecies. Illustrations of *Limnodynestes dorsalis*, *L. interioris* and *L. terraereginae* (88-89) show species differences with varying groin coloration. For *Neobatrachus pictus* (92-93), the distribution is detailed specifically so identification by geographical range can help.

Microhylidae species are covered in a small part of the book (100-109), however the reader is presented with detailed accounts of all species. Myobatrachidae reveals how diverse a family can be with examples such as *Crinia* spp. that are extremely difficult to differentiate from one another. Again though Tyler and Knight provide the varying colour patterns and skin textures for simpler identification. The Myobatrachidae holds one of the more bizarre species, *Myobatrachus gouldii* (122-123), a strange looking frog that on first inspection may not be recognised as an anuran. It is a head-first burrower. Myobatrachidae also includes Ranidae (126-127); this is a very small but detailed section, as is the Bufonidae (158-159), however, it gives

valuable information on how these species are causing problems within Australia.

An insightful section is the Stowaways. I found this interesting with its details on how species get into Australia and with detailed illustrations provided alongside.

The book is finished off with checklists of genera and species, common names and a helpful glossary of words to guide readers in difficult areas. The citable work is accurately utilised throughout the guide and will allow the reader to undertake further reading.

A worrying point that I realised from reading the guide was the dire need for research on the anurans of Australia. Thirty-nine species in the guide are probably extinct, or have not been seen for many years or are unknown as their status and behaviour is vaguely documented. Two prime examples are *Litoria cavernicola* and *Uperoleia orientalis*.

Although well-written, 'Field Guide to the Frogs of Australia' is not without a few minor omissions. On page 13 *Cyclorana australis* foot adaptation is shown within the four diagrams. However, the use of this adaptation is not explained. On page 58, *Litoria phyllochroa*, explains that *L. pearsoniana* is a similar species but not the same in geographical distribution. However, within both species distribution information and mapping, they appear sympatric in distribution. Moreover, on page 100, *Austrochaperina robusta* claims to have only *A. pluvialis* within its geographic range, but *A. fryi* (page 102) explains that both *A. robusta* and *A. pluvialis* are similar species and exist in the same geographic distribution.

The field guide has a UK price averaging £35 to £40. Therefore, for anyone about to buy this book they would have to have a penchant for Australian anurans. That said, any field guide that attempts to decipher taxonomic and field characteristics in a purposeful and clear manner should be celebrated. On this account alone I would recommend the book to those interested in Australia's batrachology.

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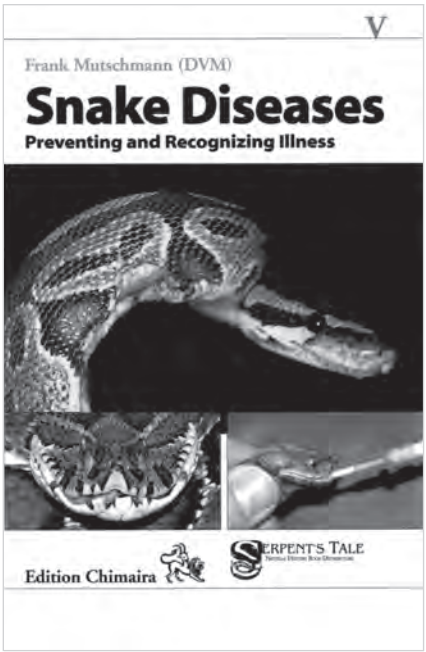
Snake Diseases: Preventing and Recognizing Illness

Frank Mutschmann

2008, Edition Chimaira, Frankfurt am Main, 306 pp.



When this book arrived, I eagerly looked forward to reading and reviewing it. Snake diseases is a topic that has always interested me as my background is a reptile keeper in a zoological society.

'Snake Diseases' is a hardback book covering a wide range of snake ailments. It specialises in recognising symptoms of disease and hopefully preventing them from ever occurring. I would like to make it clear to anybody who may want to purchase this book that it does not include any information pertaining to the treatment of diseases so as not to encourage readers to experiment with technical veterinary procedures.

As one would expect from Edition Chimaira the book is very reader friendly. At 306 pages, it is crammed full of information. There are lots of colour plates and photos to peruse through at your leisure. These are much needed in such a book in order to help recognise symptoms of illness.

Information relating to the numerous diseases is often presented in detailed tables, which are very useful to use at a glance and help to separate areas of importance. The author has highlighted points of interest (in a yellow background with black text) and key elements of the chapters throughout the text. This assists in recognizing key points if a reader decides to merely glance through the book during a spare half-hour.

The book opens with a contents page and a preface. The preface gives a great background into the author's love and knowledge of snakes gained through many years of experience as a practicing veterinarian. The first main chapter in the book (actually chapter 2) is called 'What Are Snakes' and gives a brief history of reptile evolution and snake biology. There is a whole page dedicated to the systematics of reptile (particularly snake) classification and by this point, I thought I was reading an encyclopaedia of snakes and not a book about snake diseases.

Chapter 3 is one of my favourites because it covers a lot of ground when discussing 'preventing illness' in snakes, with sections on vivarium set ups and requirements for enclosures, which is further broken down into sections on water, humidity, temperature, substrates, cleaning, disinfecting and quarantine. The section on 'responding to bites' will be of interest to anyone who keeps venomous snakes. Throughout this book there are a lot of references and photos of venomous snakes, presumably as a result of the large numbers of amateur and professionals who are now keeping them in captivity whether in zoological collections or in the home.

Another favourite section in this book is chapter 5. It is certainly the largest and one of the most important chapters - entitled 'Special Section on Diseases'. Subjects that are discussed in the chapter include; illness caused by inappropriate husbandry, improper diet, malnutrition, foreign bodies, poisoning and medical abuse. These sections are short and concise and I learned a great deal of valuable information from them. In particular, the section on improper diet has lots of information about related issues such as vitamin deficiencies, whether a lack or excess of. There is some much needed information here for any Garter Snake (*Thamnophis* spp.) keepers that highlights the need for vitamin B1 and thiamine. Preventing the lack of this vitamin is very well explained.

The chapter then gets more in depth about bacterial, viral and fungal infections, as well as endo and ecto-parasites. I was particularly excited about the section on viruses. Now don't get me wrong, I'm not a virus lover but there is a virus out there called ophidian paramyxovirus. I know only too well that this is a horrific viral infection as one of my Green Tree Pythons (*Morelia viridis*) was diagnosed with it. I was ecstatic to finally see the mention of this virus in a book. There was good information about the symptoms and the outcomes that are almost always fatal, and can threaten an entire collection of snakes. However, I did consider the information on it to be a bit rushed. I wanted to know more and think it needed to be made clear to people who are going to read this book, that ophidian paramyxovirus is one of the most serious viral infections. I also expected a mention about quarantine procedures with such a prolific virus. However, this may be an artefact of the lack of knowledge surrounding the subject. I found it misleading that the author stated that ophidian paramyxovirus affects 'giant snakes' and brackets the family (Boidae), since not all members of this group are classed as 'giant snakes' (my specimen of *M. viridis* being a case in point).

This is certainly not a book that one would want to read whilst having a bite to eat as it may make a reader feel nauseous due to the large number of graphic photographs. Four in particular that shocked me were: 1) a Royal Python (*Python regius*) that had been savagely attacked by a rodent that had been left in the enclosure for the snake to eat; 2) another Royal Python that had died from stomach and intestinal obstruction from eating its cage mate during a feeding session; 3) a case showing the advanced stages of mouth rot in which the snake's mouth is deformed and heavily inflamed. The mouth is so deformed in fact that without the caption it would have been nearly impossible to identify it as a Boa; and 4) a Corn Snake (*Elaphe guttata*) with a destroyed cloacal area and no tail as result of inflammation of the hemipenes caused by incorrect probing. The most shocking thing about

these examples is that they are all easily avoidable and should never have occurred in the first place.

'Snake Diseases' is a book for amateur reptile keepers and professional herpetologists as well as student or qualified veterinarians. The book is very reasonably priced at around £40/£45, particularly when considering the quality of the content. This book will probably not interest people who just keep the one snake as a pet but I think it is extremely valuable to anybody who has a large collection of snakes and who may want to gain knowledge in helping to safeguard it. 'Snake Diseases' has aided me and my veterinarian (who incidentally has since purchased this book) in the last couple of months. It is a welcome addition to my ever growing herpetological library, and one that I will use in the future.

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