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

TODD R. LEWIS^{1,6*}, STEVEN PIGGOTT², ROWLAND GRIFFIN³, PAUL GREIG-SMITH⁴, GERALD MARTIN⁵, GREG BARRETTO⁵, KAUSHIK BAJIBAB⁵, JOHN THORPE-DIXON, PETER PRODROMOU, MICHEAL FORDHAM, DAVID WILLIS, JACQUI TURNER, ADAM RADOVANOVIC, DANIEL HOLLOWAY, REECE WOOD, NIGEL HAND, STEVE LLOYD, MICHAELA CLAPSON, JAMES HENNESY and GREG OLDHAM

¹ Westfield, 4 Worgret Road, Wareham, Dorset, BH20 4PJ. UK.

² 92 Northfleet Road, Peelgreen, Eccles, Manchester, M30 7PQ. UK.

³ Amphibian and Reptile Conservation, 655a Christchurch Rd, Bournemouth, BH1 4AP. UK.

⁴ Partnership Travel Ltd, Whitelion House, 64A Highgate High Street, London, N6 5HX. UK.

⁵ C/o Agumbe Rainforest Research Station, Suralihalla, Agumbe, Thirthahalli Taluk, Shivamogga Karnataka 577411, India. www.agumbe.com and www.gerrymartin.in

⁶ Corresponding author: ecolewis@gmail.com

* The above authorship is open and its order does not denote authority.

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 Tapi 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 km²). 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 Nagarhole 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 Nagarhole 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.

Wilderness 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-made 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 near 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. ►

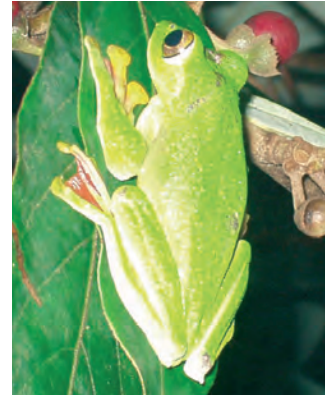


Figure 8. *Rhacophorus malabaricus*. © Todd Lewis 2008. ►



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

CROCODYLIA; 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 Wilderrest 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 Nagarhole 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 Wilderrest 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 become 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, Kavar 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 *Argyrola 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.

Xenochrophis 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, Uttar 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 pharmacokinetic 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 maculatus*. *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., Seneviratne, 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 Limited, 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.