



REPTILE DIVERSITY OF A FRAGMENTED LOWLAND RAIN FOREST PATCH IN KUKULUGALA, RATNAPURA DISTRICT, SRI LANKA

Sectional Editor: John Rudge

Submitted: 20 April 2010, Accepted: 13 February 2011

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Abstract

A four month survey was undertaken to document the diversity and abundance of reptiles in the Kukulugala forest (KF) in the Ratnapura District, Sri Lanka. A total of 708 individuals belonging to 41 genera (~50%) and 13 families (~55%) were recorded. KF had high species diversity with 58 species, representing about ~28% of the total diversity of known reptiles of Sri Lanka. Of the recorded species, 11 (~19%) were threatened and 24 (~44%) are endemic to Sri Lanka. Endemic relict genera including *Aspidura*, *Balanophis*, *Cercaspis*, *Lyriocephalus*, *Ceratophora*, *Lankascincus* and *Nessia* were also recorded during the survey. Availability of varied microhabitats may be responsible for the observed high species diversity. Anthropogenic activities, particularly illegal logging and man-made forest fires, is threatening these habitats leading to reduction in reptile population and diversity.

Keywords: Conservation, endemic, reptiles, threatened, wet-zone, Ratnapura, Sri Lanka

Introduction

Sri Lanka, despite its small area of 65,610 km², has an estimated population of 18.7 million people (IUCN SL, 2005). It is among the biologically richest countries in South Asia and is considered as a global biodiversity hotspot along with the Western-Ghats (Bossuyt *et al.*, 2004; Gunatilleke *et al.*, 1995; Gunawardene *et al.*, 2007; Meegaskumbura *et al.*, 2002). Its natural forest

areas still constitute a little over 12% of the total land area (Tan, 2005) and favorable environmental factors such as high rainfall, humidity, and high density of undergrowth found in these areas support a rich diversity of herpetofauna (Karunarathna *et al.*, 2008). However, the natural forests in the island are rapidly diminishing as a result of the expansion of settlements and agricultural land, leading to

adverse impacts on the rich biodiversity (Bambaradeniya *et al.*, 2003; Giri & Chaturvedi, 2001). The loss of natural forests and other causes over the past 100 years, has led to the extinction of nineteen species of the frog genus *Pseudophilautus*, and one species each from the genera *Adenomus* and *Nannophrys* (Manamendra-Arachchi & Pethiyagoda, 2005; Meegaskumbura *et al.*, 2007).

According to the IUCN SL & MENR (2007) 16 species of reptiles in Sri Lanka (including 12 endemics) are critically endangered, 23 (including 16 endemics) are endangered, 17 (including 9 endemics) are vulnerable, 25 (including 15 endemics) are near threatened and 47 (including 37 endemics) are data deficient. Based on published sources, a total of 208 species of reptiles are recorded from Sri Lanka and 118 (56.7 %) are known to be endemic to the island (De Silva, 2006; Maduwage *et al.*, 2009; Manamendra-Arachchi *et al.*, 2007; Wickramasinghe & Munindradasa, 2007; Wickramasinghe *et al.*, 2007).

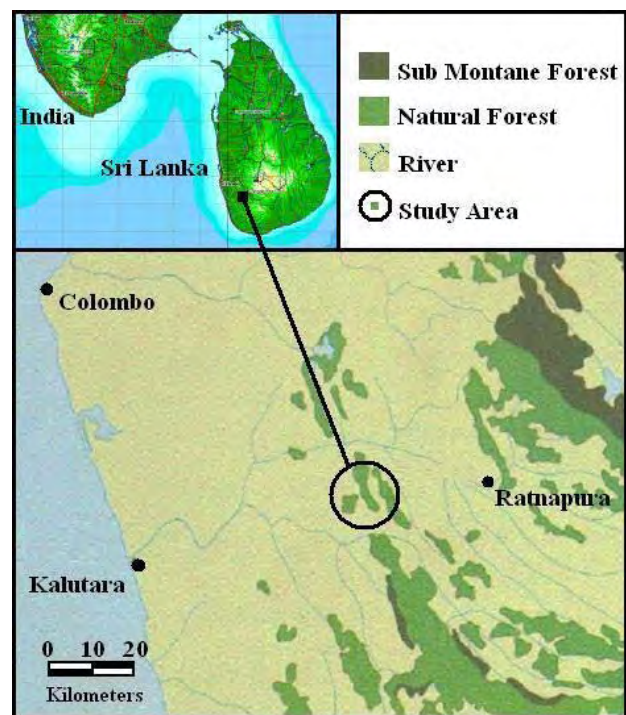
The Wet Zone forests of Sri Lanka harbor more than 60% of the indigenous herpetofauna of Sri Lanka (Bambaradeniya, 2006; De Silva, 1996). Furthermore, a high percentage of endemism can be seen in the southwest lowland forests where almost 90% of the endemic vertebrates are concentrated (Bambaradeniya *et al.*, 2003; IUCN SL & MENR, 2007; Senanayake *et al.*, 1977; Wijesinghe & Dayawansa, 2002). Previous studies have focused on the avian, butterfly and fish diversity of Kukulugala Forest, one of the fragmented forest patches in lowland Wet Zone Sri Lanka (Jayaneththi & Maduranga, 2004; Sirimanna, 2005). This study reports some preliminary data on herpetological diversity and the threats posed to the reptiles of Kukulugala. Its aim is to enhance the current knowledge of the biodiversity and conservation implications in this unique forest habitat.

Study Area

The Kukulugala Forest (KF) is situated within the Western boundary of Ratnapura District in Sabaragamuwa Province (Map 1); it is located 15 km away from Bulatsinhala town. The study area is located between 6° 38' 30.52" – 6° 40' 51.00" N and 80° 15' 07.39" – 80° 17' 35.25" E. The forest ecosystem, which also forms an important part of the forest cover of the Dumbara-Manana village (Sirimanna, 2005), covers an area of more than 600 acres within the Ayagama secretariat division and can be categorized as a lowland evergreen rain

forest (Gunatilleke & Gunatilleke, 1990). This lowland wet forest consists of dominant tree species such as *Dipterocarpus* sp., *Mesua* sp., *Doona* sp., *Schumacheria castaneifolia*, *Artocarpus nobilis*, *Calophyllum inophyllum*, *Mangifera zeylanica*, *Humboldtia laurifolia*, *Oncosperma fasciculatum*, *Canarium zeylanicum* and *Shorea* sp. (Karunarathna & Amarasinghe, 2007).

The general forest floor is covered with cascading large boulders and leaf litter. Kukulugala Mountain, also known as “Horanae Kanda” (Horana = traditional bugle, Kanda = mountain) in Sinhala language, is situated at an elevation of 705m a.s.l. The area supports a rich network of waterways which includes two waterfalls called “Ritigas Ella” and “Miyunu Ella” (Ella = fall). Among the number of small streams which start from this mountain, “Thaberum ela” and “Era-Handapana ela” (Ela = stream) are the major tributaries that flow throughout the year (Jayaneththi & Maduranga, 2004; Karunarathna *et al.*, 2004). The average annual rainfall is around 3849 mm, with most rainfall occurring from December to May. The weather gradually becomes dry from July to October when the highest temperatures are recorded. The mean annual temperature in the KF is 28.7 °C with a maximum of 32 °C and a minimum of 24.3 °C. The study area is accessible via the Horana – Bulathsinhala road or via the Rathnapura – Panadura road (Jayaneththi & Maduranga, 2004).



Map 1: Study Area, Kukulugala Forest

Materials and Methods

The present study was carried out during the period of November 2001 to February 2002. Fieldwork was conducted for a total of 20 days (9 hrs / day) over the 4 month study period. Each field visit comprised of four night and two day surveys per week (two field visits per month x 3 habitat). General area surveys were carried out in three elevation types (below <200m, between 200m – 400m and >400m) and were sampled using 100 X 2 m transects (Table 1). Approximately an hour was spent at each of the 72 randomly selected transects that were located within the several habitat types found in the area. Surveys were conducted by both day and night. Flashlights were used at night.

The surveys were conducted by visual encounter survey (VES). All habitats such as water bodies, rock crevices, logs, trees, decaying vegetation and bushes up to 5 m, were thoroughly searched for the presence of reptiles and amphibians. All collected specimens were examined carefully and recorded before being released back into the same habitat. Specimens were examined using a 10× Triplet® hand lens and all species and color morphs were photographed alive using a digital camera (Sony DHC H9). The species were identified using keys and guides provided by Deraniyagala (1953, 1955), Das & De Silva (2005), De Silva (1980), De Silva (1990), Greer (1991), and Wickramasinghe & Somaweera (2003). Afterwards the same species were verified using keys and guides provided by Bahir & Maduwage (2005), Bahir & Silva (2005), Bauer *et al.* (2010), Maduwage *et al.* (2009), Manamendra-Arachchi *et al.* (2007), Rooijen & Vogel (2008), Vidal *et al.* (2009), Vogel & David (2006) and Wickramasinghe & Munindradasa (2007). Abundance was assessed according to the total number of individuals of each species recorded throughout the study period.

Results

During the present survey a total of 58 (27.8%) species of reptiles, representing 33 (57%) species of the Sri Lankan serpentoid reptiles and 25 (43%) of the Sri Lankan species of tetrapod reptiles were recorded from the main ecosystems of the KF (Table 2). They belong to 13 (54.1%) families, 41 (50.6%) genera and include 24 (41.3%) endemic species (13 - serpentoid reptiles and 11 - tetrapod reptiles). The endemic relict genera; *Aspidura* (1 sp.), *Balanophis* (1 sp.), *Cercaspis* (1 sp.), *Nessia* (1 sp.), *Lyriocephalus* (1 sp.), *Ceratophora* (1 sp.) and *Lankascincus* (2 sp.) were found in KF. Out of the 58 species recorded in KF, 11 (18.9%) were

Threatened species, 4 (6.8%) were Endangered species and 7 (12.1%) were Vulnerable species according to IUCN SL & MENR (2007). The reptile fauna of the KF is composed of 2 tortoise, 23 lizards and 33 snake species. The relationships of these species are diverse. Some, such as *Geckoella triedrus*, *Aspidura guentheri*, *Balanophis ceylonensis*, *Oligodon calamarius*, *Lankascincus gansi* and *Otocryptis wiegmanni* occur in the same habitat at the same elevation. Different families recorded a different number of species as follows (proportional representation); Bataguridae (1 sp.) 1.7%, Trionychidae (1 sp.) 1.7%, Agamidae (6 sp.) 10.3%, Gekkonidae (9 sp.) 15.5%, Varanidae (2 sp.) 3.4%, Pythonidae (1 sp.) 1.7%, Typhlopidae (1 sp.) 1.7%, Cyndrophidae (1 sp.) 1.7%, Elapidae (2 sp.) 3.4%, Viperidae (4 sp.) 6.9%, Scincidae (6 sp.) 10.3%, Colubridae (18 sp.) 31.0% and Natricidae (6 sp.) 10.3%.

Discussion

According to the present survey the most abundant families were Colubridae (167 individuals, 23.6%) and Gekkonidae (140) 19.8%, while other families Cyndrophidae (10) 1.4%, Trionychidae (11) 1.6%, Bataguridae (13) 1.8%, Pythonidae (13) 1.8% and Varanidae (20) 2.8% were the least abundant. The lower diversity of the upper forest habitats (>400 m) may be due to the open canopy resulting in the exposure of the forest floor to high temperature and winds, resulting in increased disturbance, desiccation and predation. *Melanochelys trijuga*, *Lissemys punctata*, *Varanus salvator*, *Atretium schistosum*, *Xenochrophis asperrimus* and *Xenochrophis cf. piscator* species were not recorded in the upper part of the forest area. This may be due to the lack of large water bodies. *Chrysopelea ornata* and *Liopeltis calamaria* snake species were recorded only once during the study period.

Hemiphyllodactylus typus and *Lepidodactylus lugubris* are parthenogenetic geckos that are restricted to large boulders and crevices of old houses in the KF. *Cnemaspis molligodai*, *C. silvula* and *Hemidactylus depressus* are distributed moderately both inside the forest and in the houses of the human inhabitants. *Geckoella triedrus* was only observed under large logs on the forest floor. The second most recorded species, *Hemidactylus parvimaculatus*, was found occupying every conceivable niche (terrestrial and arboreal) within the KF. Several gecko eggs were observed in rock crevices in the middle area of the forest. The villagers in the study area have an aversion to

geckos, whether through superstition or squeamishness.

Melanochelys trijuga and *Lissemys punctata* are generally active during the rainy season and found in the vicinity of temporary water bodies. *Calotes liolepis* and *Lyriocephalus scutatus* are diurnal, arboreal lizards commonly found in undisturbed closed canopy forest. The litter dwelling *Ceratophora aspera* is easily camouflaged by the dark brown leaf litter in very shaded areas and is generally found in couples but during this survey only a single specimen was recorded. *Otocryptis wiegmanni* was generally found in shady places near streams, where some egg clutches were also recorded. They generally dig holes in the sandy soil into which they lay 3 – 6 eggs at a time. During some night surveys groups of *Cercaspis carinatus* were observed digging the soil and feeding on the eggs of *Otocryptis wiegmanni*. This indicates that *Cercaspis carinatus* are social feeders. This behavior was also observed during a previous survey at Beraliya Mukalana forest (Karunarathna *et al.*, 2008).

Shortcomings of the study

Most of the species were recorded after a shower of rain, particularly in the well-shaded canopy covered areas. Several species were also recorded within the well-wooded home gardens that were dominated by native plant species. As most of the sampling was conducted during the day time, the data collection was biased towards lizards. Had we spent equal time at these sites at night the snake species recorded would probably have been higher. Even diurnal snakes are most easily found at night while sleeping in vegetation where their camouflage is less effective in torch light.

Threats and Recommendations

It is evident that the KF provides suitable habitat, particularly for reptiles. Habitat loss and deterioration remain the dominant threat to KF reptile populations at the present time. Some areas of the KF are being felled to clear land for tea and rubber plantations. This poses a major threat not only for reptiles but also for the other flora and fauna of the area and its surrounds. In addition, the villagers kill snakes that have been incorrectly identified. This preliminary survey indicates that the KF has a high reptilian diversity. However, this study was conducted over a short period of time and therefore, it is recommended that further surveys are conducted over longer periods to truly assess the reptilian diversity in the area.

Based on IUCN SL & MENR (2007) criteria 4 (~7%) Endangered and 7 (~12%) Vulnerable species have been recorded in this study. This is a critical finding of KF. The slash and burn technique of shift cultivation involves intermittent clearing of a forest patch for agricultural practices, which destroys the habitat of several endemic and relict reptile genera (Gunatilleke *et al.*, 1995). This and other human activities involving cutting of trees inside the forest will contribute to the decline of tree-dwelling reptiles, particularly those belonging to the genera *Boiga*, *Calotes*, *Cnemaspis*, *Hemiphyllodactylus* and *Lyriocephalus* that already show irregular distribution due to their habitat specificity.

It is recommended that awareness programs on managing the forest and its resources are conducted for the local communities that will in turn contribute to the protection of these species. An advantage of using members of the local communities in future monitoring is that it will help to raise awareness of the value of species and habitats. If this awareness can be integrated into conservation and management efforts, then the likelihood of its success will be higher than otherwise might be the case. Measures should also be taken to declare the KF as a Forest Reserve under the Forest Department due to its high diversity of endemic and threatened species.

Acknowledgements

The authors wish to thank Sujana Maduranga (North Dhakota University), Asha De Vos (IUCN) for reviewing the manuscript and Jayantha Wattevidanage (OUSL) for guidance. We also like to thank Mendis Wickramasinghe (HFS) and Naalin Perera, (IUCN) for giving us literature and more comments. Finally we thank Thalagala Dhamma Gaveshi Thera, Ramyanath Sirimanna, Anushka Kumarasinghe, Tiran Abeywardena, Panduka Silva, late Sirikumara, Niranjana Karunarathna and Bandula Jayaneththi (YZA) for the helps during the field work in KF area in different ways.

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Table 1: Description of the habitat types in three study areas of KF in Ratnapura District, Sri Lanka [Based on the Ashton *et al.* (1997); Gunatilleke & Gunatilleke (1990) and Senaratna (2001)].

Study Area	Description of Habitat
Lower area of KF (below 200m)	Mixed cropping with woody and non woody plants like <i>Mangifera indika</i> , <i>Artocarpus heterophyllus</i> , <i>Dipterocarpus</i> sp., <i>Chaetocarpus</i> sp., <i>Myristica</i> sp. and <i>Cinnamomun</i> sp. trees growing up to 25 m, shade is about 60%, and leaf litter content is high and moderately wet. Among the most abundant understorey tree species are <i>Garcinia</i> spp and <i>Gyrinops</i> spp. In the lowland forest area of KF are perennial flowing water bodies, 1m to 10m wide. Home garden also included rarely.
Middle area of KF (between 200m–400m)	Plants such as <i>Dipterocarpus</i> sp., <i>Chaetocarpus</i> sp., <i>Mesua</i> sp., <i>Myristica</i> sp., <i>Shorea</i> sp. and <i>Calophyllum</i> sp. trees very dominant, growing up to 40 m, shade is about 80%, and leaf litter content is very high and wet. Flowing water bodies, 1m to 4m wide, visibility high, and turbidity low. Large rock boulder areas with seasonally moist cascade habitats
Upper area of KF (above 400m)	Plants such as <i>Strobilanthes</i> sp. are very dominant. Rock boulders and grassy areas with seasonally moist cascade habitats. Shade is 30% with small trees. Bushes and trees 1m to 5m tall are randomly distributed on open soil. Bamboo species along with those of <i>Eriocaulon</i> sp. and <i>Osbeckia</i> sp. are also common in the open grasslands near rocky outcrops. Leaf litter content is very low and dry, flowing water bodies, 1m or 2 m wide

Table 2: Checklist of the reptile fauna recorded from KF. (Abbreviation: TR – threatened / † endemic genus / * endemic species / VR – very rare / R – rare / UC – uncommon / C – common / VC – very common) species. (Source: IUCN, 2000; IUCN & MENR, 2007).

Family and Scientific Name	Common Name	Status IUCN (2000)	Status IUCN & MENR (2007)	Total Individuals with %	Species Abundance
Tortoises and Turtles					
Bataguridae					
<i>Melanochelys trijuga</i>	Black Turtle	TR		13 (1.83)	C
Trionychidae					
<i>Lissemys punctata</i>	Flapshell Turtle	TR	VU	11 (1.55)	C
Lizards					
Agamidae					
<i>Calotes calotes</i>	Green Garden Lizard			24 (3.38)	VC
<i>Calotes liolepis</i>	Whistling Lizard *	TR	VU	3 (0.42)	R
<i>Calotes versicolor</i>	Common Garden Lizard			31 (4.37)	VC
<i>Ceratophora aspera</i>	Rough Horn Lizard *†	TR	EN	3 (0.42)	R
<i>Lyriocephalus scutatus</i>	Hump Snout Lizard *†	TR		5 (0.70)	R
<i>Otocryptis wiegmanni</i>	Sri Lankan kangaroo Lizard *	TR		13 (1.83)	C

REPTILE DIVERSITY IN KUKULUGALA RAIN FOREST

Gekkonidae

<i>Cnemaspis molligodai</i>	Molligoda's Day Gecko *			18 (2.54)	VC
<i>Cnemaspis silvula</i>	Lowland Day Gecko*		EN	29 (4.09)	VC
<i>Geckoella triedrus</i>	Spotted Bowfinger gecko *	TR		2 (0.28)	VR
<i>Gehyra mutilata</i>	Four-Claw Gecko			11 (1.55)	C
<i>Hemidactylus parvimaculatus</i>	Spotted House Gecko			38 (5.36)	VC
<i>Hemidactylus depressus</i>	Kandyan Gecko *	TR		10 (1.41)	UC
<i>Hemidactylus frenatus</i>	Common House Gecko			22 (3.10)	VC
<i>Hemiphyllodactylus typus</i>	Slender Gecko		EN	3 (0.42)	R
<i>Lepidodactylus lugubris</i>	Scaly Finger Gecko		EN	7 (0.98)	UC

Scincidae

<i>Lankascincus fallax</i>	Common Lanka Skink *†			56 (7.90)	VC
<i>Lankascincus gansi</i>	Gans's Lanka Skink *†	TR		6 (0.84)	UC
<i>Lygosoma punctatus</i>	Dotted Skink			16 (2.25)	VC
<i>Eutropis carinata</i>	Common Skink			18 (2.54)	VC
<i>Eutropis macularia</i>	Bronzegreen Little Skink			10 (1.41)	UC
<i>Nessia burtonii</i>	Threetoe Snake Skink *†	TR		3 (0.42)	R

Varanidae

<i>Varanus bengalensis</i>	Land Monitor			12 (1.69)	C
<i>Varanus salvator</i>	Water Monitor			8 (1.12)	UC

Snakes

Pythonidae

<i>Python molurus</i>	Indian Python	TR		13 (1.83)	C
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Typhlopidae

<i>Ramphotyphlops braminus</i>	Common Blind Snake			24 (3.38)	VC
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Cylindrophidae

<i>Cylindrophis maculatus</i>	Sri Lanka Pipe Snake *	TR		10 (1.41)	UC
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Colubridae

<i>Ahaetulla nasuta</i>	Green Vine Snake			16 (2.25)	VC
<i>Ahaetulla pulverulenta</i>	Brown Vine Snake			2 (0.28)	VR
<i>Boiga ceylonensis</i>	Sri Lanka Cat Snake			6 (0.84)	UC
<i>Boiga forsteni</i>	Forsten's Cat Snake			4 (0.56)	R
<i>Cercaspis carinatus</i>	The Sri Lanka Wolf Snake *†	TR	VU	11 (1.55)	C
<i>Chrysopelea ornata</i>	Ornate Flying Snake	TR		1 (0.14)	VR
<i>Coelognathus helena</i>	Trinket Snake			19 (2.68)	VC
<i>Dendrelaphis bifrenalis</i>	Boulenger's Bronze Back *			7 (0.98)	UC
<i>Dendrelaphis caudolineolatus</i>	Gunther's Bronze Back		VU	4 (0.56)	R
<i>Dendrelaphis schokari</i>	Common Bronze Back			15 (2.11)	C
<i>Liopeltis calamaria</i>	Gunther's Reed Snake		VU	1 (0.14)	VR
<i>Lycodon aulicus</i>	Common Wolf Snake			13 (1.83)	C

<i>Lycodon osmanhilli</i>	Flowery Wolf Snake *	TR		9 (1.27)	UC
<i>Oligodon arnensis</i>	Common Kukri Snake			11 (1.55)	C
<i>Oligodon calamarius</i>	Templeton's Kukri Snake *	TR	VU	5 (0.70)	R
<i>Oligodon sublineatus</i>	Dumerul's Kuki Snake *	TR		5 (0.70)	R
<i>Ptyas mucosa</i>	Common Rat Snake			28 (3.95)	VC
<i>Sibynophis subpunctatus</i>	Jerdon's Polydent			10 (1.41)	UC
Natricidae					
<i>Amphiesma stolatum</i>	Buff Striped Keelback			13 (1.83)	C
<i>Aspidura guentheri</i>	Ferguson's Roughside *†	TR		4 (0.56)	R
<i>Atretium schistosum</i>	Olive Keelback Watersnake			14 (1.97)	C
<i>Balanophis ceylonensis</i>	Sri Lanka Keelback *†	TR	VU	3 (0.42)	R
<i>Xenochrophis asperrimus</i>	Sri Lanka checkered Keelback *	TR		16 (2.25)	VC
<i>Xenochrophis cf. piscator</i>	Checkered Keelback *			12 (1.69)	C
Elapidae					
<i>Bungarus ceylonicus</i>	Sri Lankan Krait *	TR		3 (0.42)	R
<i>Naja naja</i>	Common Cobra			22 (3.10)	VC
Viperidae					
<i>Hypnale hypnale</i>	Merrem's Hump Nosed Viper			11 (1.55)	C
<i>Hypnale zara</i>	Lowland Hump Nosed Viper *			5 (0.70)	UC
<i>Trimeresurus trigonocephalus</i>	Green Pit Viper *	TR		7 (0.98)	UC
<i>Daboia russelli</i>	Russell's Viper			12 (1.69)	C

PLATE 05



Fig. 01: Kukulugala Mountain



Fig. 02: *Geckoella triedrus*



Fig. 03: *Lepidodactylus lugubris*



Fig. 04: *Calotes calotes*



Fig. 05: *Ceratophora aspera*



Fig. 06: *Balanophis ceylonensis*



Fig. 07: *Trimeresurus trigonocephalus*



Fig. 08: Field work in Kukulugala forest