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Cover

Emerald Gecko (*Phelsuma andamanense*)

A small (5 inches) bright green, day-active gecko endemic to Andaman islands. Tree-dwelling, but often found in and around houses. Insectivorous. The genus is largely distributed in Africa and Madagascar.

Photo: R. Deepak.

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A SURVEY OF HERPETOFAUNA OF ANDAMAN AND NICOBAR ISLANDS, WITH ISLAND-WISE CHECKLIST AND DIVERSITIES

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Abstract:

The Andaman and Nicobar Islands are known for their rich biodiversity. This archipelago comprises 572 islands extending over 800 km. Surveys were carried out from 2008 to 2010 to assess the species richness and abundance of herpetofauna in some representative islands, namely, Mount Harriet National Park, Neil, Havelock, Inglis, Outram, John Lawrence, Henry Lawrence, North Button, Little Andaman, Car Nicobar and Great Nicobar. Quadrat sampling method was used for estimating abundance and diversity indices were later calculated. A total of 32 species of herpetofauna belonging to 21 genera and 11 families were recorded. Of these, 6 species belonging to 4 genera and 3 families were amphibians, and 26 species belonging to 17 genera and 8 families were reptiles. Of the recorded species, highest number of species recorded was from Mount Harriet National Park (23) followed by Havelock (18), John Lawrence (16), Car Nicobar (16), Great Nicobar (16), Neil (15), Inglis (13), Henry Lawrence (13), Outram (12), North Button (11) and Little Andaman (11). The species richness and abundance significantly varied in the different islands. This study emphasizes the importance of herpetofauna conservation in this region.

Keywords: Abundance, Andaman, Diversity, Herpetofauna, Nicobars

Introduction

The herpetofauna of Andaman and Nicobar Island is one of the least studied group in the Indian subcontinent (Das, 1999). The early herpetological studies in these islands date back to 19th Century (Das, 1999). Regarding the evolutionary affinities of the herpetofauna, their primary colonization source is thought to be Indochina for the Andamans and Indonesia for the Nicobars (Das, 1999). The present study provides a checklist of herpetofauna in Andaman and Nicobar group of Islands, based on fresh field surveys in some representative islands of both the Andaman and the Nicobar groups.

Several studies have been done on the herpetofauna on Andaman and Nicobar islands including new species descriptions, new geographic / provincial range records, new synthesis of checklists and taxonomic revisions (Andrews & Ghodke, 2001; Biswas & Sanyal, 1977; 1978; 1980; Chandi, 2003; Daniels & David, 1996; Das, 1994; 1997; 1998; Ghodke, 2000; Ghodke & Andrews, 2000 a & b; Murthy & Chakrapani, 1983; Smith, 1940; Tiwari & Biswas, 1973; Tiwari 1992; Vijayakumar, 2005; Vijayakumar and David, 2006; Wall, 1914; Whitaker, 1978).

Study Area

The Andaman and Nicobar Islands comprises of 572 islands extending over 800 km. These can be broadly divided into two groups, namely, the Andamans and the Nicobars, which are separated by the Ten-degree Channel that is about 150 km wide 400 fathoms deep. The region has tropical evergreen, semi-evergreen and moist monsoon forest types. The dominant species is *Dipterocarpus grandiflorus* in hilly areas, while *Dipterocarpus kerrii* is dominant on some islands in the southern parts of the archipelago. The monsoon forests of the Andamans are dominated by *Pterocarpus dalbergioides* and *Terminalia* spp. (Mani, 1974). The study was carried out in the following islands of the Andaman and Nicobar archipelago (Figure 1 & Table 1).

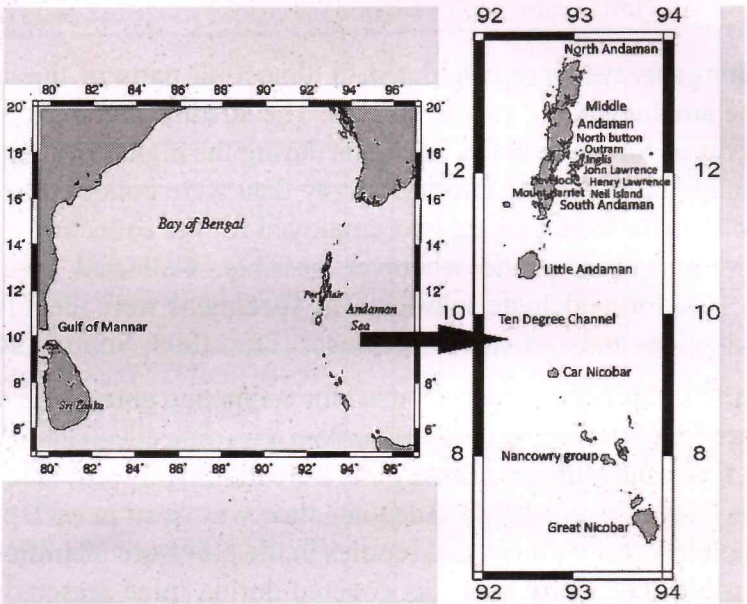

Fig. 1. Map of Andaman and Nicobar Islands

Table 1. List of surveyed locations with GPS coordinates

Sl.No.	Place	Coordinates	
1.	Mount Harriet NP	11° 52. 052' N	92° 46. 012' E
2.	Neil Island	11° 51. 941' N	93° 00. 667' E
3.	Havelock Island	12° 00. 005' N	92° 56.808' E
4.	Inglis Island WLS	12° 08. 639' N	93° 06.786' E
5.	Outram Island	12° 00. 574' N	92° 56.808' E
6.	John Lawrence Island	12° 04. 075' N	93° 00.398' E
7.	Henry Lawrence Island	12° 05. 000' N	93° 06.312' E
8.	North Button Island	12° 18. 974' N	92° 03.826' E
9.	Little Andaman Island	10° 35. 419' N	92° 33.066' E
10.	Car Nicobar Island	09° 10. 490' N	92° 49.714' E
11.	Great Nicobar Island	06° 59. 749' N	93° 56.718' E

Methods

Random surveys were conducted in almost all parts of the study area to document the amphibian and reptile species. The streams and marshy areas were specially surveyed for amphibians. The calls during the night time helped to locate and collect amphibian species. Diurnal survey data were collected between dawn and mid-day. Usually hand picking was employed for the collection of specimens. Night observations were made wherever possible. Collected specimens were preserved in 10% formaldehyde solution. The specimens were identified based on standard field guides and systematic references (Das, 1999; Smith, 1940).

Quadrat sampling method was used for estimating abundance and diversity indices. Plots of 8 x 8m size were laid at random, ensuring adequate representations of all habitat types and altitudes. These plots were thoroughly searched by a team of three persons (Heyer, *et al.,* 1984). Adequate time was spent in each plot to search the area completely. Amphibians and reptiles in the plot were identified in the field as far as possible. The study area was covered during three seasons viz. summer (February-May), monsoon (June-August) and post monsoon (September -January). The diversity indices were calculated using the computer program SPDIVERS of STATECOL (Ludwig and Reynolds, 1988).

Results and Discussion

A total of 29 species of herpetofauna belonging to 22 genera and 12 families were recorded during the period of study (Tables 2 and 3). Of these, 23 species belonging to 17 genera and 8 families were reptiles and 6 species belonging to 4 genera and 3 families were amphibians. Highest number of species were recorded from Mount Harriet National Park (23) followed by Havelock Island (18), John Lawrence Island (16), Car Nicobar Island (16),Great Nicobar Island (16), Neil Island (15), Inglis Island (13), Henry Lawrence Island (13), Outram Island (12), North Button Island (11) and Little Andaman Island (11).

Table 2. List of reptiles recorded in the select study sites

Sl. No.	Name of the species	1	2	3	4	5	6	7	8	9	10	11
	Gekkonidae											
1.	*Cnemaspis* cf. *wicksi* (Stolizcka, 1873)	+	+	-	-	-	+	+	-	-	+	+
2.	*Cosymbotus platyurus* (Schneider, 1792)	+	-	-	-	+	-	+	-	-	+	+
3.	*Gekko verreauxi* (Tytler, 1865)	+	+	-	-	+	-	+	-	-	-	-
4.	*Gekko smithii* (Gray, 1842)	-	-	-	-	-	-	-	-	-	+	+
5.	*Hemidactylus frenatus* Schlegel, 1836	+	+	+	+	+	+	+	+	+	+	+
6.	*Phelsuma andamanense* (Blyth, 1860)	+	+	+	+	-	+	+	-	-	-	-
	Agamidae											
7.	*Pseudocalotes andamanensis* (Boulenger, 1891)	+	+	+	+	-	-	-	-	-	+	-
8.	*Coryphophylax subcristatus* (Blyth, 1860)	+	+	+	+	+	+	-	+	+	+	+
9.	*Calotes versicolor* (Daudin, 1802)	+	+	+	+	+	+	+	+	+	+	+
	Scincidae											
10.	*Dasia olivacea* (Gray, 1838)	+	-	+	-	-	-	-	+	+	+	+
11.	*Eutropis andamanensis* (Smith, 1935)	+	+	+	+	+	+	+	+	+	-	-
12.	*Eutropis tytleri* (Theobald, 1868)	-	+	-	+	-	+	-	-	-	-	-
13.	*Eutropis rudis* (Boulenger, 1887)	-	-	-	-	-	-	-	-	-	+	+
14.	*Eutropis rugifera* (Stolizcka, 1870)	-	-	-	-	-	-	-	-	-	+	+
15.	*Eutropis multifasciata* (Kuhl, 1820)	-	-	-	-	-	-	-	-	-	+	+

	Varanidae											
16.	*Varanus salvator* (Laurenti, 1768)	+	-	-	-	-	+	-	-	+	+	+
	Typhlopidae											
17.	*Indotyphlops braminus* (Daudin, 1803)	+	-	+	+	-	-	-	-	-	-	+
	Gerrhopilidae											
18.	*Gerrhopilus andamanensis* (Laurenti, 1768)	-	-	+	-	+	+	-	+	-	-	-
	Colubridae											
19.	*Dendrelaphis andamanensis* (Anderson, 1871)	+	-	+	-	-	+	-	-	-	-	-
	Elapidae											
20.	*Bungarus andamanensis* Biswas & Sanyal, 1978	+	-	+	-	-	+	-	-	-	-	-
21.	*Ophiophagus hannah* (Cantor, 1836)	+	+	-	-	-	+	-	-	-	-	-
22.	*Naja sagittifera* Wall, 1913	+	+	-	+	+	-	+	-	-	-	-
	Viperidae										-	-
23.	*Trimeresurus andersoni* (Theobald, 1868)	+	+	+	+	+	-	+	+	+	-	-

(1 - Mount Harriet; 2 - Neil; 3 - Havelock; 4 - Inglis; 5 - Outram; 6 - John Lawrence; 7 - Henry Lawrence; 8 - North Button; 9 - Little Andaman; 10 - Car Nicobar; 11- Great Nicobar)

Table 3. List of amphibians recorded in the select study sites

Sl. No.	Name of the species	1	2	3	4	5	6	7	8	9	10	11
	Dicroglossidae											
1.	*Fejervarya andamanensis* (Stolicka, 1870)	+	+	+	-	+	-	+	+	+	-	-
2.	*Fejervarya cancrivora* (Gravenhorst, 1829)	-	-	-	-	-	-	-	-	-	+	+
3.	*Fejervarya nicobariensis* (Stolicka, 1870)	-	-	-	-	-	-	-	-	-	+	+
4.	*Limnonectus* sp.	+	-	+	+	-	+	+	+	+	-	-
	Ranidae											
5.	*Hylarana erythraea* (Schlegal, 1837)	-	-	-	-	-	-	-	-	-	+	+
	Bufonidae											
6.	*Duttaphrynus melanostictus* (Schneider, 1799)	+	+	+	+	+	+	+	+	+	+	+

(1 - Mount Harriet; 2 - Neil; 3 - Havelock; 4 - Inglis; 5 - Outram; 6 - John Lawrence; 7 - Henry Lawrence; 8 - North Button; 9 - Little Andaman; 10 - Car Nicobar; 11- Great Nicobar)

Highest diversity (H') of reptiles was observed in Mount Harriet National Park (2.78), followed by John Lawrence island (2.56) and lowest from South Button island and Little Andaman Islands (2.04). Similarly richness index (R1) was also highest in Mount Harriet National Park (5.22) and lowest in South Button island (Table 4).

Table 4. Diversity indices of reptiles recorded in the select study sites

Location	Richness index		Diversity index		Hill's Number		Evenness index	
	R1	R2	λ	H'	N1	N2	E1	E2
Mount Harriet	5.22	3.24	0.05	2.78	16.12	20.04	0.93	0.81
Neil	3.38	2.20	0.05	2.53	12.55	18.55	0.99	0.97
Havelock	4.16	2.79	0.04	2.63	13.82	23.33	0.97	0.92
Inglis	3.00	2.08	0.08	2.26	9.54	12.63	0.94	0.87
Outram	2.91	2.13	0.06	2.29	9.85	17.25	0.99	0.98
John Lawrence	3.46	2.13	0.06	2.56	12.89	16.80	0.97	0.92
Henry Lawrence	2.76	1.96	0.07	2.27	9.69	14.67	0.99	0.97
South Button	2.34	1.79	0.09	2.04	7.71	11.74	0.98	0.96
Little Andaman	3.19	2.67	0.03	2.04	7.72	40.00	0.98	0.96
Car Nicobar	4.17	3.21	0.02	2.44	11.48	48.75	0.98	0.96
Great Nicobar	3.42	2.40	0.05	2.46	11.66	20.80	0.99	0.97

The diversity (H') of Amphibians showed that highest in Little Andaman islands (1.67) and lowest in Inglis Island Wildlife Sanctuary (0.69). Similarly, the richness index (R1) also varied in different locations and highest in Little Andaman (1.95) and lowest in Inglis island Wildlife Sanctuary (0.72) (Table 5).

Table 5. Diversity indices of amphibians recorded in the select study sites

Location	Richness index		Diversity index		Hill's Number		Evenness index	
	R1	R2	λ	H'	N1	N2	E1	E2
Mount Harriet	1.03	1.13	0.21	1.08	2.94	4.80	0.98	0.98
Neil	1.12	1.22	0.23	1.01	2.75	4.38	0.92	0.92
Havelock	1.24	1.34	0.17	1.05	2.87	6.00	0.96	0.96
Inglis	0.72	1.00	0.27	0.69	2.00	3.75	1.00	1.00
Outram	1.12	1.22	0.23	1.01	2.75	4.38	0.92	0.92
John Lawrence	0.56	0.82	0.40	0.64	1.89	2.50	0.92	0.94
Henry Lawrence	1.03	1.13	0.21	1.08	2.94	4.80	0.98	0.98

South Button	1.44	1.50	0.13	1.04	2.83	7.50	0.95	0.94
Little Andaman	1.95	1.66	0.13	1.67	5.32	7.64	0.93	0.89
Car Nicobar	1.67	1.63	0.11	1.33	3.78	8.75	0.96	0.94
Great Nicobar	1.54	1.51	0.13	1.35	3.86	8.00	0.98	0.97

Our results show that the richness and distribution of the herpetofauna, in general, followed similar trends at different islands. Of the recorded species, only three were observed from all locations namely *Hemidactylus frenatus*, *Calotes versicolor* and *Duttaphrynus melanostictus*. It is noteworthy that these three species are human commensally in nature everywhere. *Gecko smithi, Eutropis rudis, Eutropis rugifera, Eutropis multifaciata, Fejervarya cancrivora, Fejervarya nicobariensis* and *Hylarana erythraea* were recorded only in two sites.

The differences in species richness reported from a locality and that of our records from the same area probably reflect our sampling effort. Greater sampling efforts allowed to search more localities and more habitats. The reason for the significantly greater species diversity and higher species richness of reptiles in the Mount Harriet National Park and John Lawrence, is that both the areas are covered with evergreen forest and presence of different microhabitats. Among the islands studied, the Havelock Island and Great Nicobar Island are facing more problems. The road networks were major disturbance factors in these areas. Accidental killings of reptiles and amphibians along the road were observed and annual clearings of road edges were also noticed.

In spite of the protection provided to these islands, the herpetofauna still faces considerable pressures due to increasing human population and other developmental activities. Since, this study was carried out for a short period for inventory purpose, it could not estimate complete species occurrence and populations. Hence, a detailed study of herpetofaunal assemblage and their habitat preferences should be carried out in these islands.

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HERPETOFAUNAL ROAD MORTALITIES BY VEHICULAR MOVEMENTS IN VELACHERY, CHENNAI, TAMIL NADU

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Introduction

Population of herpetofauna existing in and around rural / urban areas is drastically affected by human activities, particularly vehicular movements (Row et al., 2007; Shwiff *et al.*, 2007). Vehicles on the roads create adverse effects on herpetofauna including regulation of movements, degeneration of home-ranges, impact on activity patterns, direct assault or mortality and, in the longer run, even genetic bottlenecks (Hourdequin, 2000). There are several studies on the vehicular mortalities of herpetofauna in various regions in India, such as Anaimalais (Vijayakumar *et al.*, 2001), Megamalai (Bhupathy *et al.*, 2009), Mudumalai (Gokula, 1997; Kannan, 2007), Sharavathi (Seshadri *et al.*, 2009), Pune (Ghadage, 2013), and Kaziranga (Das *et al.*, 2007). However, most of these studies worked on mortalities in forest areas but not townships and suburbs. In this work, a detailed account has been made to quantify the herpetofaunal mortalities in a suburb of Chennai city.

Study Area

Velachery (12.976' N 80.221'E; 14 m asl), is located towards the southern boundary of the Chennai city, abutting Guindy National Park. Originally many areas in this town were lakes, ponds and cultivated lands. At present much of these have got urbanised. It is well connected by road networks including highways, with very busy traffic (Cushman & Wakefield, 2011). The area experiences maritime climate, being present on the East coastal plains of southern India. The region has alluvial soil. Four seasons prevail, namely: cold season (Jan-Feb.), summer / dry season (March-May), pre-monsoon (June-Sep.) and monsoon / rainy season (Oct.-Dec.). General accounts on species richness and distribution of herpetofauna of this region can be found in Kalaiarasan & Kanakasabai (1999), a long-term survey that also included places near Velachery town.

Methodology

The observations on roadkills at the study area were made using visual count method. The study took place on the 100 feet road from Vijay Nagar terminus (Velachery) to Gurunanak College a distance of 3 km. Since the observation took place by traversing the road twice, onward on one side of the road and return journey on the other, a total of 6 km distance was covered on each survey up and down. Surveys were conducted between January, 2007 and December, 2012 for a total of 6 years. Some specimens, particularly snakes, seemingly killed out of fear by people with signs such as smashed head and rather intact body, were found on roads during the surveys. However, as one cannot be sure of the mode of death, all such dead specimens were considered as road kills, and added in the present data. All dead specimens, including young ones and adults of herpetofauna found on the roads were recorded and identified to the extent possible. A few specimens were also photographed.

Results

The present observation reveals a total of 407 road kills consisting of 20 species during the study period. The amphibians are the major victims with a total mortality of 216 specimens belonging to five species. Common toad, *Duttaphrynus melanostictus* was the most affected amphibian species with 85 records. Among the 189 dead specimens of reptiles, 15 species were identified. A higher number of observations of 36 records were made for the worm snake *Indotyphlops braminus* and among the lizards and turtles they were *Hemidactylus frenatus* with 20 roadkills and the pond turtle *Lissemys punctata* with 16 roadkills respectively. The least number of deaths were recorded during the summer or the dry season (March to May). Conversely, the highest road kill mortalitites were observed during the rainy season (October to December) followed by the pre-monsoon season (July to September). Annually, the road kill records ranged from 38 in the year 2008 to a maximum of 106 in the year 2010.

Table 1. Herpetofaunal road mortalities during January 2007–December 2012

Species	2007	2008	2009	2010	2011	2012	Total
Duttaphrynus melanostictus (Schneider, 1799)	10	6	12	26	12	19	85
Euphlyctis cyanophlyctis (Schneider, 1799)	5	4	7	16	12	11	55
Euphlyctis hexadactylus (Lesson, 1834)	2	2	8	1	2	1	16
Kaloula taprobanica (Parker, 1934)	5	6	5	5	6	3	30
Polypedates maculatus (Gray, 1834)	4	3	-	7	5	11	30
Total amphibians	**26**	**21**	**32**	**55**	**37**	**45**	**216**
Melanochelys trijuga (Schwaigger,1812)	1	2	3	2	1	2	11
Lissemys punctata (Bonnaterre, 1789)	2	1	1	6	1	5	16
Total turtles	**3**	**3**	**4**	**8**	**2**	**7**	**27**
Hemidactylus brookii Gray, 1842	3	-	-	5	6	3	17
Hemidactylus frenatus Schlegel, 1836	5	2	-	9	-	4	20
Hemidactylus leschenaultii Dum. & Bibr., 1836	4	-	-	7	-	2	13
Hemidactylus triedrus (Daudin, 1802)	-	-	-	3	-	2	5
Calotes versicolor (Daudin, 1802)	3	4	6	5	-	-	18
Eutropis carinata (Schneider,1801)	-	-	2	2	-	2	6
Total lizards	**15**	**6**	**8**	**31**	**6**	**13**	**79**

Indotyphlops braminus (Daudin, 1803)	5	4	6	2	11	8	36
Ahaetulla nasuta (Bonnaterre, 1790)	1	2	2	-	-	-	5
Ptyas mucosa (Linnaeus, 1758)	1	2	-	3	1	2	9
Lycodon aulicus (Linnaeus, 1758)	3	-	-	-	1	1	5
Oligodon taeniolatus (Jerdon, 1854)	-	-	2	-	-	-	2
Amphiesma stolatum (Linnaeus, 1758)	3	-	4	3	-	2	12
Xenochrophis piscator (Schneider, 1799)	4	-	6	4	-	2	16
Total snakes	**17**	**8**	**20**	**12**	**13**	**15**	**85**
All species	**61**	**38**	**64**	**106**	**58**	**80**	**407**

The herpetological population in Chennai city, was greatly reduced when compared to past records several decades ago (personal communication by local farmers). They are commonly found in the forest adjacent to Guindy National park, Palikaranai Marsh, Velachery lake and the adjacent cultivated areas. Trees like *Azadirachta indica, Albizia lebbeck, Cocos nucifera, Carica papaya, Annona squamosa* and bushes of *Prosopis juliflora* were common in this area and now they have been destroyed for urbanisation. Local population of many species of herpetofauna has alarmingly decreasing due to various impacts of human activities all over the study area, as is the case with other faunal groups too. Herpetofauna are more susceptible to road kill mortality due their sluggish activity pattern and movement during the dark especially during the rainy season.

Discussion

The present study is more similar to studies by Gokula (1997) and Kannan (2007) when compared to those of others (Bhupathy *et al.*, 2009; Seshadri *et al.*, 2009; Vijayakumar *et al.*, 2001), mainly due to the similarities between the habitat and herpetofaunal assemblages of the two regions. This difference is because of the great variations in the species-composition of the various regions previously studied. Among the few co-occurring widespread species, some preliminary comparisons

between the many studies can be made. Thus, Vijayakumar *et al.,* (2001) reported that among the amphibian road kills recorded, *Duttaphrynus melanostictus* was the most affected in the Anamalais. A study on road mortalities of snakes in Mudumalai carried out over six months (Gokula, 1997) shows that out of seven species of snakes, the common vine snake *Ahaetulla nasuta* was the most affected (12 out of 23 snake road kills) and estimated at 0.25 snakes/km in 24 hours.

Since most studies were done in the rainforest regions including biodiversity hotspot such as the Western Ghats (Bhupathy *et al.*, 2009; Gokula, 1997; Ghadage, 2013; Kannan, 2007; Seshadri *et al.*, 2009; Vijayakumar *et al.*, 2001) and the northeast India (Das *et al.*, 2007), the records and no. of species of herpetofauna reported in each study will vastly vary between the many works.

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A COMPARITIVE STUDY ON MICROHABITAT USE, ACTIVITIES AND THERMOREGULATION OF TWO INDIAN, DIURNAL TREE SNAKES (*DENDRELAPHIS TRISTIS* & *AHAETULLA NASUTA*) IN CAPTIVITY

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Introduction

Habitat usage, morphology and behavior in animals are inextricably inter-related, with distinct morphological adaptations enabling peculiar habitat usage and behavioral displays in several life forms. Snakes are a diverse assemblage of vertebrates which have complex life-history traits (Blouin-Demers *et al.*, 2000, 2001, 2002; Goin & Goin, 1978; Porter, 1972). Ecological traits of animals impose certain constrains on their morphology and habits. In snakes, arboreality imposes morphological constraints on body form and habits profoundly and result in habits that differ distinctly from their terrestrial counterparts, including those that share many traits in common. Arboreality in snakes over-exposes them to predators and prey, which in turn, induce certain adaptive traits such as cryptic colouration, or agility, or both (Henderson, 1974, 1982; Krysko, 2010; Mattison, 2007; Martins *et al.*, 2008).

In the present study, the comparison of microhabitat use, activities and thermoregulation of two species of snakes–the Indian bronzeback tree snake (*Dendrelaphis tristis*) and the green vine snake (*Ahaetulla nasuta*) was carried out in captive conditions. The bronzeback is a non-venomous, oviparous, diurnal, fast-moving tree snake found throughout peninsular India. It is a long, slender, smooth-scaled snake that is brownish in colour resembling a dried-out twig. The vine snake is a green-coloured, diurnal, ovoviviparous, mildly-venomous tree snake which is found throughout India (except the extreme northwest). It relies on its camouflage for protection from predators and foraging. These two ecologically similar tree snakes co-occur widely in many parts of the Indian subcontinent (Daniel, 2002; Das, 2002; Whitaker & Captain, 2008).

Materials and Methods

Observations on the study animals were recorded for 20 hrs, for each species at the Chennai Snake Park, where they were housed in glass-fronted enclosures. The period of observation was November to December. The enclosure size of bronzeback tree snake was 2.95ft x 2.7 ft. and that of the vine snake was 2.95 ft x 2.6 ft. Bronzeback snake enclosure was furnished with a water trough, two plants, one heat pot, a resting pot, four stones and window-like ventilators. Vine snake enclosure was furnished with a water trough, a heat pot, one stone, one plant. The observations were made from 1 m distance from the glass-fronted enclosures and the activities were observed by naked eye. Duration (time in seconds) and the frequency (no. of times a behaviour occurred) were noted. The time was noted by using a stop watch. Temperature and humidity were recorded using a Thermo-hygrometer. The glass-front of the enclosure was clear enough to accurately watch and score the activities of the captive snakes. Mean comparison of temperature and humidity were calculated on the basis of a two-hour time interval between 9:00-17:00h hrs.

Results

In the bronzeback enclosure, temperature ranged between 22 and 27°C in the forenoon (09:00– 13:00 hrs.) and 24 and 30°C in the afternoon (13:00-17:00 hrs.). Humidity level (in %) ranged between 57 and 71% in forenoon and 43 and 71% in afternoon. The bronzeback tree snake spent 750 seconds in neck waving, for 167 times; 105 seconds in head movement, for 55 times; 5671 seconds in body movement, for 152 times; 293 seconds in tongue flickering for 293 times; 17 seconds in yawning, for 13 times; 10 seconds in drinking, for 2 times 256 seconds in climbing, for 44 times; 10 seconds in swimming, for 1 time.

In the vines snake enclosure, temperature ranged between 22 and 28°C in the forenoon (09:00– 13:00 hrs.) and 25 and 29°C in the afternoon (13:00-17:00 hrs.). Humidity level (in %) ranged between 58 and 70% in forenoon and 48 and 71% in afternoon. The vine snake spent 1498 seconds in neck waving, for 179 times; 185 seconds in head movement, for 165 times; 65 seconds in body movement for 33 times; 14 seconds in yawning for 11 times; 31 seconds in climbing for 4 times.

Table 1. Duration (in sec) and frequency of occurrence of resting substrate associations in captive Indian bronzeback and vine snakes.

Location	*D. tristis*	*A. nasuta*	*D. tristis*	*A. nasuta*
Plant	11690	32390	8	10
Heat pot	3720	0	12	0
Ground	24910	30960	22	11
Stone	4500	1450	3	2
Window	27040	7200	12	2
Water	240	0	1	0

Table 2. Duration (in sec) and frequency of occurrence of behaviours in captive Indian bronzeback and vine snakes.

Behaviour	*D. tristis*	*A. nasuta*	*D. tristis*	*A. nasuta*
Neck waving	750	1498	167	179
Head movement	105	185	77	162
Body movement	5671	65	152	33
Tongue flickering	293	0	293	0
Yawning	17	14	13	11
Drinking	10	0	2	0
Climbing	256	31	44	4
Swimming	10	0	1	0

Table 3. Thermal settings (temperature in Celsius and humidity in percentage) of the enclosures and duration (in sec) and frequency of occurrence of contact with heat-pot in captive (heat exposure) Indian bronzeback and vine snakes.

Time (hrs.)	*D. tristis*	*A. nasuta*	*D. tristis*	*A. nasuta*	*D. tristis*	*A. nasuta*
09:00-11:00	24.4°C 64%	23.5°C 64%	0	7200	0	2
11:00-13:00	26.7°C 62%	26.7°C 63%	2040	7200	6	2
13:00-15:00	26.5°C 60%	27.3°C 54%	1680	3600	6	1
15:00-17:00	25°C 51%	27°C 56%	0	0	0	0

Discussion

Thermoregulation is considered to be an important factor influencing habitat selection by arboreal snakes (Mattison 2007). Activities such as neck waving, head movement, body movements, tongue flicking, yawning, climbing, drinking and swimming were observed. Neck waving and head movement denotes the focus of the animals on to any surrounding factors like visitors and prey. Body movement, both localized to a body part and complete displacement of the entire animal from one place to another, including climbing, denotes response towards prey, thermoregulation and may also be due to visitors. Yawning denotes the relaxing and adjustment of jaws, and often happened shortly after drinking.

Lin *et al.* (2007) reported that the height of the daytime perch sites in arboreal snakes was influenced by the ambient temperature. Snakes perched on lower layers of vegetation seeking cooler condition when the ambient temperature within the enclosure was high. Additionally, Lin *et al.* (2007) report that tree vipers in low temperature environments exhibited no preference for vegetation structures in terms of density, except for an apparent avoidance of vegetation with bare branches devoid of leaves. In our study on *D. tritis* and *A. nasuta* the ambient temperature fluctuation was not large enough (23.5°–27.0°C) to cause deliberate movements of the snakes within its enclosure vegetation. The fact that our preliminary study was not long enough to accommodate for diel or seasonal fluctuations is also responsible for lack of such data in our work.

Defensive displays such as neck waving and head movement were higher in *A. nasuta*. Previous studies indicate that the defensive displays are associated with habitat use in snakes; visual defenses correlate better with habitat than with phylogeny and arboreal snakes are more exposed to predators than terrestrial species (Martins *et al.*, 2008). Compared to terrestrial snakes, arboreal ones display more visual defensive tactics like frontal display, gaping, gular inflation, head elevation, neck-coiling, and head triangulation (Martins *et al.*, 2008; Mattison, 2007). Peculiarities of the arboreal microhabitat, such as the prevalence of a green background, a likely higher exposition to predators, and the variety of directions from which a predator would approach may have led to the evolution of peculiar visual defensive tactics in arboreal species (Martins *et al.*, 2008).

With regard to time of activity, the number of visual tactics was not different between diurnal and nocturnal species or genera. However, frontal display, gaping,

gular inflation, and crypsis were prevalent in diurnal snakes, whereas mimicry and, apparently, head triangulation were more frequent in nocturnal forms. Furthermore, green was significantly more frequent in diurnal species, whereas contrasting colour patterns were more frequent in nocturnal species.

Arboreal snakes are efficient predators hunting in the tropical forests canopy and on the ground, using visual and chemical cues (Campbell *et al.,* 2008). Most tree snakes selected temperature around 28°C if these levels were available within retreat-sites, but rarely basked (Flank, 1999; Goin & Goin, 1978). In the present study both *D. tritis* and *A. nasuta* experienced 25°C - 30°C of ambient air temperature. Among the many habitats available to arboreal snakes, bush edges had the highest thermal quality, retreat sites and the interiors were intermediate, and open habitats had the lowest thermal quality (Blouin-Demers and Weatherhead, 2002). In our study, *D. tritis* and *A. nasuta* alternatively used both the ground and the plants present inside the enclosure.

During daylight hours when the snakes were active, ambient temperatures generally is hypothesized to be higher on the ground than on trees; but this thermal cline is said to reverse after the ground was cooled by rain showers (Shine *et al.*, 2004). Arboreality was most common during those thermal reversals. Experimentally stimulating rain in the field, induced climbing behavior and in the laboratory enclosures, snakes climbed to avoid a cold substrate (Shine *et al*, 2004). However, in our study, we did not attempt to create any rain showers to stimulate or record any such activities. As ambush hunters, arboreal snakes disproportionally used trees / branches that were on the edge of a vegetation, reaching out towards the clearing, often at an angle slightly above horizontal (Shine and Li-xin, 2001), whereas the bushy interiors were not preferred. Since our study on captive snakes did not attempt to describe their foraging and hunting strategies, our work did not fetch out those data.

Body temperatures of snakes sheltering under rocks were reported to be determined by the degree of shading and the thickness of the rocks (Webb and Shine, 1997). In our study, despite the presence of suitably large rocks inside the enclosure, no snake was observed to shelter under it during our observation period, i.e., the daytime (09:00-17:00 hrs). Nocturnal observations are needed to test if these snakes used rock shelters for night-time retreats, although it is known that *A. nasuta* and *D. tristis* sleep coiled on tree branches at night (Whitaker, 1978).

Webb and Shine (1997; 1998) observed the snake's striking speed to maximize at 30°C and prey capturing ability increased at higher body temperatures over the range of 20°-30°C. Webb & Shine (1998), mention their laboratory thermal gradients to range around 28.1°-31.1°C. In our study, *D. tritis* and *A. nasuta* experienced a thermal cline of 25°-30°C. Anderson *et al.* (2004) reported that the tree snakes thermoregulated around two distinct temperature ranges (21.3°-24.9°C; 28.1°-31.3°C). In the gradient, tree snakes exhibited elevated body temperature into the higher range only in the evening. We too found our measurements of ambient air temperature to rise during the evenings, however, in this work we could not prove that the captive snakes approached or avoided heat-pots (to thermoregulate) around the two spikes in temperature, as mentioned by Anderson *et al.* (2004). Moreover, such 'peak activity' values are, understandably, species- and area-specific.

The seasonal movements of tree snakes showed the fast active movements occurred only in the high range of temperature (Tobin *et al*, 1999). The climatic change in the forenoon and afternoon session showed that the raised temperature caused fast movements of the snakes.

Due allowance should be made to the fact that these observations were made in captive conditions in cages especially considering that the two species are arboreal and behavior in the wild (Aengals 1999) open may not always be the same.

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INDIAN GERBIL (*TATERA INDICA*) BURROWS USED AS RETREAT SITES BY BROOK'S GECKO *HEMIDACTYLUS BROOKII* GRAY

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As a part of pest-control activities in Sajjangarh Wildlife Sanctuary, Rajasthan, a team of Kathodi tribals was brought from the forests of Ogna-Kotra to eradicate rats in the area. Kathodi tribesmen are considered as one of the best rat and monkey catcher tribes in Rajasthan (Joshi 1993, 1995). They started rat-hole digging operation and excavated as many as 45 holes but no rats came out. Interestingly, out of 45 holes, seven Brook's geckoes (*Hemidactylus brookii*) were recovered from seven holes (one gecko from each hole). Nearly 15.55 % holes were found occupied by the Brook's gecko. It is one of the common geckos of India which is widely distributed in Asia, Africa and other tropical parts of the world (Daniel 2002, Smith 1935, Tikadar & Sharma 1992).

Three Cutch rat (*Cremynomys cutchius*) and 13 Indian gerbil (*Tatera indica*) were captured. This suggests that the Brook's geckoes take refuge in the holes of *T. indica* to avoid vagaries of environment, sun light and predation pressure. Probably, they also hibernate in the hole of *I. indica* during winter. Indian gerbil is a common nocturnal rodent of the area which is found throughout India (Menon 2014, Prater 1980, Roberts 1997).

There was no termitorium in the immediate vicinity. A good number of wild young trees of *Acacia senegal, Acacia leucophloea, Commiphara wightii* and bushes of *Capparis sepiaria* were present in the region. Being young trees, their

barks were quite smooth and there were no cracks on the bark to provide retreat space to the Brook's geckos. Rat holes are more safe than tree trunks hence geckos spend their day time inside the rat holes and the geckoes venture out at night for their activities.

According to Daniel (2002) and Tikader and Sharma (1992) Brook's gecko lives in a variety of habitats, on trees, rocks, under stones, beneath the dry bark of the wooden logs and on buildings. Rat holes being used as retreat sites are thus far unreported for *H. brookii*, and is worth placing on record.

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RANDOM HARVEST

Two additional reptile species from the Deccan:

Two more reptile species have been added recently to the comparatively little-known reptile fauna of the dry forests of Deccan, India.

The first is the Sri Lankan flying snake (*Chrysopelea taprobanica*), that was so far considered endemic to Sri Lanka, reported recently from the Tirupathy hills in Andhra Pradesh, India. This species was first described from Sri Lanka by Malcolm A. Smith in his *Fauna of British India* series in 1943. Now, after over half-a-century, two scientific articles have reported its presence in India. The first one published in the journal *Checklist* vol. 11, no.1, in January 2015 authored by Bubesh Guptha *et al.* report on fieldwork-based record of a voucher specimen from Tirupathy. The second one authored by Ruchira Somaweera *et al.* in *Zootaxa*, no. 3947 April 2015, compiles some 'forgotten records' of this species from India, based on existing collections in international museums such as the Museum of Comparative Zoology (MCZ), Harvard University, USA Coleção Herpetológica do Butantan, São Paulo, Brazil and the Natural History Museum of Vienna.

The second species is the newly described Adi's day gecko (*Cnemaspis adii*) described by Srinivasulu *et al.* in *Zootaxa*, no. 3947 in April 2015. This new lizard species occurs in rocky hillocks of Hampi in the Bellary district of Karnataka. The authors, based on their field work and collections in Hampi fort ruins, describe this species. As is typical of most Indian day geckoes, the new species is a small (< 3 inches), dull brown, insectivorous lizard that lives camouflaged among the rock formations that abound in Hampi.

* * * *

On tool use and luring by crocodiles:

Not many animals are known to be clever enough to use tools or lure to hunt prey. The famous examples include chimpanzees using sticks to extract termites from their mounds and *Neophron* vultures using stones to break open egg-shells. Of luring, we know the cases of angler fishes and some pit vipers. And now crocodiles too join this list of 'clever' animals. A study by Vladimir Dinets *et al.*, published this year in vol. 27 of *Ethology, Ecology and Evolution* is the first record of tool use by any reptile, and also the first known case of predators timing the use of lures to a seasonal behavior of the prey. Dinet and team studied the behavior of two species of crocodilians in captivity — the marsh crocodile (*Crocodylus palustris*) in Madras Crocodile Bank, India, and the American alligator (*Alligator mississippiensis*) in St. Augustine Alligator Farm, Florida, USA. The scientists noticed the captive crocodiles slowly amassing sticks and twigs on their snouts and remaining motionless in ambush. The targeted prey is the water-birds nesting in heronries in and around the crocodile pools. The crocodiles displayed this behaviour only when the seasonally-migrating water birds were observed to be engaged in nest-building activities. The scientists term it the 'stick-displaying behaviour', wherein the crocodiles deliberately amass and 'offer' sticks and twigs to the water birds for nest-building, leading to the birds unwarily falling prey to the crocodiles.

* * * *

Bizarre!

If crocodiles are bizarre creatures, a technique used to hunt them sounds even more bizarre.

A research article by Anslem de Silva and Ruchira Somaweera published in *The Journal of Threatened Taxa*, vol. 7, no.1, in January 2015 recounts the use of human babies as baits in hunting crocodiles, by Europeans in colonial Sri Lanka. The authors have compiled evidence in the form of texts and illustrations explaining this. The authors reproduce and / or quote published excerpts (texts and illustrations) from up to nine European dailies / periodicals between 1888 and 1896 and up to six American and Australian dailies between 1907 and 1911. Additionally, the authors remark that these instances have been depicted in early twentieth century American movies (*Alligator Bait*, *The Gator and the Pickaninny* and *Untamed Fury*), and also on postcards. The sport-hunter would approach native public and the mothers would flock to rent their babies for money. The baby would

be tied to a peg near the lake shore, and the armed hunter would lie hidden nearby. The cry of the baby would lure crocodiles in the vicinity and the hunter would kill the approaching crocodile(s) before their 'baits' are grabbed. The babies are returned to their parents unharmed. As can be expected, in rare cases, the crocodiles manage to snatch away their 'baits' before being killed by the hunter. The authors conclude that although use of live animals like dogs as baits in sport-hunting is not uncommon, the use of humans is poorly documented.

* * * *

Common krait envenoming signs:

A 2014 study by Bawaskar *et al.* (medical doctors well-known for scorpion sting treatment) published in *Tropical Doctor*, analysed 141 krait-bite cases admitted to their hospital. Since krait bites produce little or no pain, bleeding or swelling at the bite-site or other body parts in general, symptoms of envenomation need detailed studies. In this study, the authors elaborate on their observations on premonitory signs and symptoms. The authors summarise that most patients experienced bite at night-time between 00:00 and 05:00 hrs, abdominal colic (85%), chest pain (72%), vomiting (42%), sweating (17%), excessive salivation (35%) and later on arrival at the hospital, pooling of saliva (78%), heavy and drooping eyelids (89%). Some victims died en route to hospital (12.5%) or during treatment (13.47%) in the hospital, while most (74.46%) recovered, among which almost half (48%) required artificial respiration. As a study by practicing doctors based on their reasonably large, first-hand data, this study is a significant addition to the little-known information on krait-bite complications and treatment in India.

* * * *

An overview on colour abnormalities in Indian reptiles:

In a paper authored by Mahabal and Thakur, published last year, in vol.21, no.2 of *Russian Journal of Herpetology*, the authors present an overview of published information on colour abnormalities in Indian reptiles. The authors have painstakingly compiled publications amounting to a total of 70 cases reported over a period of 120 years. They report the addition of four species namely the saltwater crocodile (*Crocodylus porosus*), the beaked worm snake (*Grypotyphlops acutus*), the green vine snake (*Ahaetulla nasuta*) and the king cobra (*Ophiophagus hannah*) to the records known so far. The authors state that color aberrations occur more frequently in certain species such as the sand boas (*Eryx conicus, E. johnii*), the

green keelback (*Macropisthodon plumbicolor*), the trinket snake (*Coelognathus helena*), the krait (*Bungarus caeruleus*) and the spectacled cobra (*Naja naja*) from across several Indian states, across the length and breadth of the country. The authors say that compared to albinism (63 cases), melanism (7 cases) is far less common. The authors emphasize that in species such as the royal snakes (*Spalerosophis atriceps, S. diadema*), the banded krait (*Bungarus fasciatus*), and the king cobra, only melanism (but not albinism) was noticed, whereas in trinkets particularly, both albinism and melanism were reported. In all other remaining species mentioned, only albinism was reported. Among these cases, 40 cases are total albinos, 8 are incomplete albinos, 2 are partial albinos and 13 are unclassified albinos, depending on the extent and intensity of albinism. Incomplete albinism impacts either the skin or eye melanophores but not both. Partial albinism refers to the dominant presence of achromatic areas on the animal's skin. The authors have also come across individuals that do not readily fit into these schemes, and call for further studies on colour observations.

* * * *

New frog from Sulawesi that gives birth to froglets:

In a paper published in *PLoS One*, dated 31st Dec 2014, Iskander *et al.*, describe a new species of fanged frog (*Limnonectes larvaepartus*) that is unique among frogs and toads, in that it undergoes internal fertilization and gives birth to froglets. Out of nearly 6455 species of frogs in the world, fewer than a dozen species are reported to have internal fertilization, none except the new species would deposit fertilized egg or could give birth to froglets. The new species is endemic to the Indonesian island of Sulawesi, where it is found in and around streams and watercourses having rocky substratum and dense vegetation. The new species is aptly named '*larvaepartus*' in Latin, from '*larvae*' the early form of an animal, and '*partus*', to give birth to. The females that the authors studied, produced around 50-100 non-pigmented eggs, many of which could stem from one single oviduct. Unlike most frog eggs, the eggs of the new species that measure 3 mm across, do not have a jelly-like coating. These eggs develop within the female's body, inside the oviducts and transform into dark tadpoles with visible limb- and tail-buds before their birth. This discovery is a milestone in amphibian evolutionary history studies.

* * * *

Oldest snake fossils discovered:

While previous estimates of oldest known fossil snakes date back to only a 100 million years, Caldwell *et al.*, in a paper published on 1st Dec 2014, in *Nature*, newly describe four extinct snakes based on their fossils that are 70 million years older, taking back the age of snakes to Middle Jurassic-Lower Cretaceous boundary (i.e., 140-170 million years ago). These snakes are named: *Eophis underwoodi*, *Portugalophis lignites*, *Diablophis gilmorei*, *Parviraptor estesi* and are from the northern hemisphere (Europe and N. America). These are reported to share characters typical of both snakes and lizards, as evidenced by their dentition. Commenting on the fossils, the authors state that though ancient, they were already quite diverse and complex, indicating that they had undergone habitat differentiation and geographic radiation by the mid-Jurassic. The scientists found from their studies that these snakes formed the most basal lineages among all known snakes, both living and extinct, with the closest relative being *Najash rionegrina* [a 90-million-year-old fossil reported from the Patagonia region of Argentina, according to a 2006 report in *Nature*].

* * * *

The 'how' of colour-change in chameleons:

Chameleons are, perhaps, the least understood group of lizards. Their many oddities like very long sticky tongue, independently movable eyes, a 360° range of vision, opposable digits, prehensile tail and active, dramatic colour-changing ability have puzzled us. Even after years of research, the active principle behind the colour-changing ability of chameleons remains little-understood. Much of the previous studies on this posit that the colour-change is due to the 'dispersion-aggregation' dynamics of 'pigment-containing organelles' within the 'chromatophores' embedded in the skin layers. A recent study on Madagascar's Panther chameleon (*Furcifer pardalis*), published by Teyssier *et al.* in *Nature*, 2nd Mar. 2015, gives us some insights, by examining the lizard's skin ultra-structure. The scientists found that chameleons change their skin colour by actively tuning a 'lattice of guanine nanocrystals' within a superficially thick layer of particles called dermal iridophores. And, additionally, a deeper iridophore layer with much larger crystal particles reflects reasonably large amount of incident sunlight, particularly in the near-infrared range. This formation of iridophore particles into two superposed

layers is what is responsible for the chameleon's ability to change skin colour so radically within seconds. These, so far unknown, complex skin features enable chameleons to effectively indulge in camouflage, behavioual colour-change display and also thermoregulation simultaneously.

-- B. Vijayaraghavan

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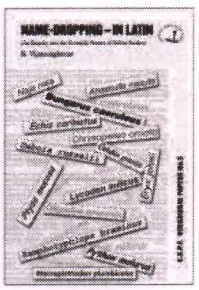

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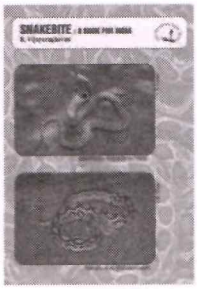

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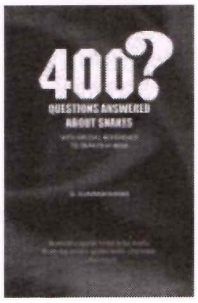

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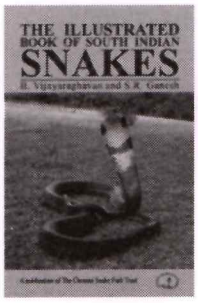

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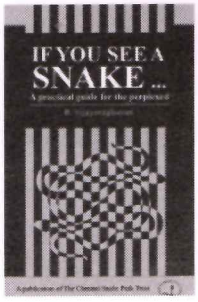

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ii) To promote knowledge among the public on reptiles and amphibians and dispel the widespread erroneous beliefs about snakes in particular and, to this end, conduct awareness programmes targeting school children primarily and bring out low-priced publications with technical, semi-technical and popular contents on reptiles and amphibians.

iii) To aid and assist research on reptiles and amphibians including the conduct of surveys to assess their status and distribution.

iv) To undertake captive breeding of endangered species of snakes and other reptiles.

v) To canvass public support for the protection and conservation of reptiles and amphibians.

* * * * *

FORM IV

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