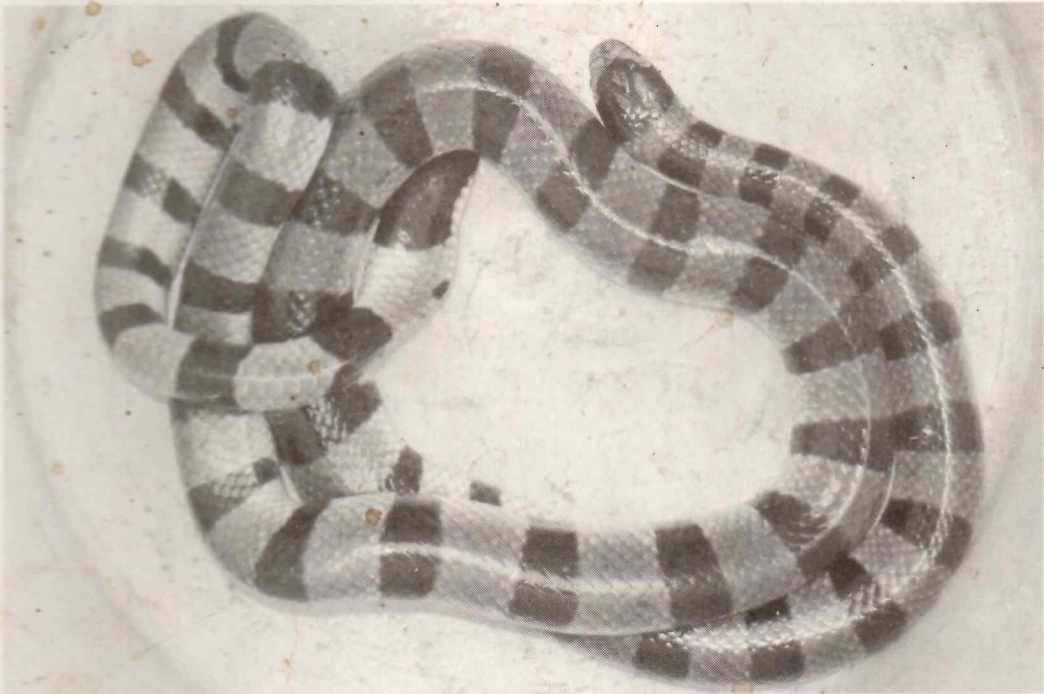


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Cover

Yellow-lipped sea krait (*Laticauda colubrina*)

Sea-kraits are venomous estuarine snakes which, unlike most true sea snakes, are less aquatic, need fresh water, lay eggs, have broad ventral scales and move well on land. They occur in warm tropical coastlines. In India, the yellow-lipped sea krait occurs on Andaman & Nicobar coasts.

Photo: S.R. Ganesh

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Edward O. Wilson, in the prologue to his book *Letters to a Young Scientist* (2013) addressed to young biologists, says:

“First and foremost,
I urge you to stay on the path
you’ve chosen,
and to travel on it as far as you can.
The world needs you—badly.”

HERPETOFAUNA OF BELGAUM CITY, NORTH KARNATAKA, INDIA

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Introduction

The Western Ghats biodiversity hotspot harbors 171 species of amphibians and 187 species of reptiles (Daniels, 2011) and more species are being discovered every now and then. Of these, no less than 85% of amphibians and 58% of reptiles are endemic to the Western Ghats (Daniels, 2011). Belgaum (15°52'N, 74°34'E; 762 m asl) in western part of Karnataka state is situated at the foothills of the Central Western Ghats. Recently, Ganesh *et al.* (2013) described the reptile fauna of the Central Western Ghats. However, due to lack of published report on herpetofauna of Belgaum, I present field survey results from this region.

Study area

Belgaum city, in Karnataka state receives > 1000 mm annual rainfall, largely during the southwest monsoon. The diurnal air temperature here ranges from 10 to 34°C. Three small rivers namely, Bellary Nala (53.35 % area coverage), Markhandeya River (31.65 %) and Mongetri Nala (14.98 %) flow past Belgaum. Several crops, both food and cash crops are extensively grown in this region and there are thick human settlements all throughout.

Methods

Visual encounter surveys and acoustic / call surveys (anurans only) were done day and night from for a period of 20 months from May 2010 to December 2011. Surveys were conducted in all the habitats types in the region, including anthropogenic habitats, cultivations, etc. Species were identified using field guides (Daniel 2002; Daniels, 1997a,b,c; 2005).

Results and Discussion

During the said period, a total of 31 species of herpetofauna, comprising 14 species of amphibians belonging to 4 families and 9 genera and 17 species of reptiles belonging to 8 families and 14 genera were recorded in Belgaum city. Of these, 14 were anurans: Bufonidae (3 species), Dicroglossidae and Microhylidae (5 species each) and Rhacophoridae (1 species). The rest of the 17 reptiles : Agamidae (1 species), Gekkonidae (3 species), Scincidae (1 species), Viperidae (1 species), Elapidae (2 species), Colubridae (6 species), Boidae (2 species) and Geomydidae (1 species). It is inferred from the checklist that all of the species inhabiting Belgaum are widespread, common ones found throughout India (Daniel, 2002; Daniels, 2005).

Karnataka state harbors a total of 291 herpetofauna species of which 135 are amphibians and 156 are reptiles (<http://www.indiaenvironmentportal.org.in>). The present study reveals that, Belgaum city hardly represents around 10% of amphibians and 11% of reptiles found in Karnataka. In the last 5 years, BUDA (Belgaum Urban Development Authority) and KHB (Karnataka Housing Board Belgaum) acquired 397 and 260 acres of land respectively for residential colonies. On the other hand, builders have been converting every year around 130 acres of agricultural land into non-agricultural land for educational and residential buildings, industrial purposes and, for real estate business. Around 1300 acres of agricultural land was converted into non-agricultural land. BUDA and KHB are further planning to acquire another 1775 acres of agricultural land for development of housing colonies in Belgaum city. Due to these activities several temporary ponds, agricultural fields and microhabitats for herpetofauna are disappearing forever, severely affecting the herpetofauna.

Checklist of herpetofauna of Belgaum City

BUFONIDAE

1. Common Indian toad *Duttaphrynus melanostictus* (Schneider, 1799)
2. Ferguson's toad *D. scaber* (Schneider, 1799)
3. Marbled toad *Duttaphrynus cf. stomaticus* (Lütken, 1862)

DICROGLOSSIDAE

4. Cricket frog *Fejervarya cf. limnocharis* (Gravenhorst, 1829)
5. Jerdon's bull frog *Hoplobatrachus crassus* (Jerdon, 1854)
6. Indian bull frog *H. tigerinus* (Daudin, 1802)
7. Skipper frog *Euphlyctis cyanophlyctis* (Schneider, 1799)
8. Indian burrowing frog *Sphaerotheca breviceps* (Schneider, 1799)

MICROHYLIDAE

9. Indian painted frog *Kaloula taprobanica* Parker, 1934
10. Ornate narrow-mouthed frog *Microhyla ornata* (Dumeril & Bibron, 1841)
11. Red narrow-mouthed frog *M. rubra* (Jerdon, 1854)
12. Indian balloon frog *Uperodon globulosum* (Günther, 1864)
13. Marbled balloon frog *U. systoma* (Schneider, 1799)

RHACOPHORIDAE

14. Common tree frog *Polypedates maculatus* (Gray, 1834)

AGAMIDAE

15. Indian garden lizard *Calotes versicolor* (Daudin, 1802)

GEKKONIDAE

16. Brook's house gecko *Hemidactylus brookii* (Gray, 1845)
17. Asian house gecko *H. flaviviridis* (Rüppell, 1835)
18. Southern house gecko *H. frenatus* Schlegel, 1836

SCINCIDAE

19. Common / keeled skink *Eutropis carinata* (Schneider, 1801)

- BOIDAE
20. Common sand boa *Gongylophis conicus* (Schneider, 1801)
21. Red sand boa *Eryx johnii* (Russell, 1801)
- COLUBRIDAE
22. Indian rat snake *Ptyas mucosa* (Linnaeus, 1758)
23. Common trinket *Coelognathus helena helena* (Daudin, 1803)
24. Checkered keelback *Xenochrophis piscator* (Schneider, 1799)
25. Striped keelback *Amphiesma stolatum* (Linnaeus, 1758)
26. Green keelback *Macropisthodon plumbicolor* (Cantor, 1839)
27. Green vine snake *Ahaetulla nasuta* (Bonnaterre, 1790)
- ELAPIDAE
28. Spectacled cobra *Naja naja* (Linnaeus, 1758)
29. Common krait *Bungarus caeruleus* (Schneider, 1801)
- VIPERIDAE
30. Russell's viper *Daboia russelii* (Shaw & Nodder, 1797)
- GEOEMYDIDAE
31. Black pond turtle *Melanochelys trijuga* (Schweigger, 1812)

Acknowledgements

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AMPHIBIAN COMMUNITY AND MICROHABITAT ASSOCIATION IN AGARAKEERAGUDI AGRO-ECOSYSTEM, MAYILADUTHURAI, TAMILNADU

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Introduction

Global biodiversity loss is currently a major international concern, with some estimates suggesting that the current rate of extinction is greater than any known in the last 100 000 years (Eldridge, 1998). Amphibians are declining worldwide (Wake, 1991; Alford and Richards, 1999; Houlahan *et al.*, 2000; Blaustein & Kiesecker, 2002) due to pollution (Alford & Richards, 1999; Blaustein & Kiesecker, 2002; Blaustein & Wake 1990; Blaustein *et al.*, 1994, Lannoo, 1998). Being bio-indicators, their decline is of ominous significance (Wyman, 1990; Lips, 1998).

Many studies in India have raised concerns about decline of forest-dwelling amphibians, like the many endemic species of the Western Ghats and Northeast India, but few studies have attempted to assess the current status of frog populations in and around human habitations. Here, we present our study of common, widespread amphibian species inhabiting agro-ecosystems of southeastern India.

Methods

The present study was carried out from Jan to March 2009. Visual Encounter surveys for detecting amphibians were conducted in three habitats, namely: cultivated land, non-cultivated land and pond. Amphibians were identified using Daniel (2002) and Daniels (2005). The sampling was done morning and evening. During the sampling we intensively searched all the microhabitats for detecting frogs. Microhabitat preference was scored and categorized for each sighting. Shannon-Weiner Index (H') was used for calculating amphibian diversity on a MS Office Excel sheet.

Study Area

Agarakeeragudi is a farmland-dominated village 3 kms south of Mayiladuthurai Taluk, Nagapattinam district, Tamil Nadu. The study area is covered by agriculture lands and human settlements. Mainly paddy, banana, beans, soya, sugarcane, coconut and are the common produces here. Six ponds namely Agarakeeragudi (0.234 acre), Bullet (0.166 acre), Ayyanar koil (0.22 acre), Ammakulam (1.38 acre) and Therkkku street ponds (0.741 acre) were studied.

Table.1. Amphibian sighting frequencies in various land-use patterns in Agarakeeragudi village, Nagai district, during the study period from January (2009) to March (2009).

Species	No. sightings in non-cultivate habitat	(%)	No. sightings in Cultivate habitat	(%)	No. sightings in pond habitat	(%)	Total sightings in all three habitats	(%)
<i>Duttaphrynus melanostictus</i>	395	81.3	20	4.4	0	0	413	39.6
<i>Euphlyctis cyanophlyctis</i>	25	5.1	356	78.8	50	46.2	431	41.3
<i>Euphlyctis hexadactyla</i>	0	0	10	2.2	40	37.1	50	4.7
<i>Hoplobatrachus tigerinus</i>	10	2.1	51	11.3	18	16.7	79	7.5
<i>Polypedates maculatus</i>	26	5.3	10	2.2	0	0	36	3.4
<i>Fejervarya cf. limnocharis</i>	30	6.2	5	1.1	0	0	35	3.5
Total	486	100	452	100	108	100	1044	100
Diversity (H)	0.3068		0.3433		0.2547		0.2547	

Table.2. Amphibians recorded from different microhabitats during the study period from January (2009) to March (2009) at Agarakeeragudi village.

Species	Under logs	Under stones	Under leaves	Floor	Leaves	Leaf litters	Bank edges	Grass beds	Trees	Total
<i>Duttaphrynus melanostictus</i>	115	150	54	45	43	0	6	0	0	413
<i>Euphlyctis cyanophlyctis</i>	0	0	0	0	0	0	385	46	0	431
<i>Euphlyctis hexadactylus</i>	0	0	0	0	0	0	50	0	0	50
<i>Hoplobatrachus tigerinus</i>	0	0	0	0	21	48	10	0	0	79
<i>Polypedates maculatus</i>	1	0	5	8	0	0	0	12	10	36
<i>Fejervarya cf. limnocharis</i>	2	0	0	18	0	0	0	0	15	35
	117	150	57	71	64	48	451	58	25	1044

Results

Out of the 16 species of amphibians reported from Mayiladuthurai (Ganesh & Chandramouli, 2007), six species viz. one bufonid, the common toad *Duttaphrynus melanostictus*, four dicroglossids, the skipper frog *Euphlyctis cyanophlyctis*, the green frog *E. hexadactylus*, the cricket frog *Fejervarya cf. limnocharis* and the bull frog *Hoplobatrachus tigerinus* and one rhacophorid, the tree frog *Polypedates maculatus* were recorded by us during the study (Tables 1 and 2).

In non-cultivable habitat, a total of 486 amphibian sightings were obtained. The highest percentage of amphibian encountered was *Duttaphrynus melanostictus* (81.3%). In cultivable habitat, a total of 452 amphibian sightings were obtained. *Euphlyctis cyanophlyctis* (78.8%) was found to be the most dominant species. In ponds, a total of 108 amphibian sightings were obtained. *Euphlyctis cyanophlyctis* (46.2%) was the most common amphibians.

A total of 1044 amphibian sightings were obtained in cultivable, non-cultivable habitats and ponds. The overall highest sighting frequency was obtained for *Euphlyctis cyanophlyctis* (41.3%) in the study area (Table 1). Shannon–Weiner index (H') revealed a diversity of 0.3433, 0.3068, 0.2547 across the three land use

types respectively. Cultivable land had more diversity (0.3433), then followed by non-cultivable lands (0.3068) but in ponds, the amphibians diversity was very low (0.2547) (Table 1).

Our results indicate close relationship between the habitat and microhabitat occupancy and the frog diversity. Research on pond-dwelling frogs is needed to assess the effect of factors such as water temperature, air temperature, pH, water conductivity, dissolved oxygen and pond size on frog population.

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PRELIMINARY OBSERVATIONS ON DIURNAL ACTIVITY PATTERNS OF SOME CAPTIVE CROCODILIANS

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Introduction

Activity patterns of animals are an essential part of their natural history. Knowing the activities of a species is crucial in designing conservation measures for that species (Allen, 1972; Broadhurst, 1963). Reptiles have evolved complex life histories by several adaptations. Thermoregulation, foraging, feeding, resting, inter-and intra-specific interactions, all form an integral part of a reptile's life (Goin & Goin, 1962; Porter, 1972; Huey, 1982). Most ectothermic animals spend a good deal of time for acquiring optimum temperature, as much as they would, to acquire food. They rest for long and move about only when absolutely necessary (Diwan & Arora, 1995; Goin & Goin, 1962; Huey, 1982).

Crocodylians are an ancient lineage of reptiles, dating back to the age of the dinosaurs (Alderton, 1998; Levy, 1991; Rossa, 2002). Living crocodylians are found mostly in the world's tropics and subtropics, split into 23 species, among three families (Brazaities, 1974; Rossa, 2002). Their lifestyle is for the most part sluggish but when they are active, they are capable of fast movements. Crocodylians are consensually considered to be the apex predators in riverine and wetland ecosystems worldwide. Therefore, monitoring crocodylians in any ecosystem would yield information on the health of the entire ecosystem (Anonymous, 2000; Levy, 1991). Since many crocodylian species have been hunted by man for their skin, most species worldwide are now threatened or endangered (Anonymous, 2000; Bostids, 1983). Captive breeding and rearing has been adopted as one of the best means of studying and saving many species of crocodylians (Alderton, 1998; Anonymous,

2000; Rossa, 2002). In this paper, we describe one such study on activity patterns of some species of captive crocodilians.

Materials & Methods

The study was conducted in Chennai Snake Park, in Chennai, Tamilnadu, for a period of ten days between 3rd and 13th September 2012. During the study period, ambient air and water temperatures ranged from 30.6-33.7°C and 27.6-29.8°C respectively and the relative humidity ranged from 49-62%. There were 2-6 (mean = 4) trees and 1-2 plants in and around each enclosure, offering shade to the crocodilian pits. About 50-70% the enclosure area was water. Approximate total lengths of the crocodilians were visually estimated in meter. The sub-adult or young ones ranged in size from 1-1.5 m total length while most adults were over 2 m in total length. The largest crocodilian we observed was an adult male saltwater crocodile that was nearly 3.5 m long while the smallest crocodilian was a young Siamese crocodile that was only 1 m long.

We visually observed the crocodilians as a group of 2-3 members, for 2.5 hrs a day, totaling to 15 hrs per species, throughout the study period. We used scan sampling method to collect the raw data. While one of us would be watching the crocodilian continuously, the other would write down notes of all activities, told as and when it occurs by the one who was watching. Time in minutes (min.) was noted down for all such activities. In other words, the activities were plotted against time in minutes. Since these captive crocodilians are well-acquainted to being seen by people, as they had been living in public display cages, we observed them from just outside the parapet wall of the enclosure. As the study period was during the northeast monsoon season, we chose the hottest part of the day i.e., forenoon from 10:30-13:00 hrs, to observe their activity patterns.

A total of six species of crocodilians, three native to India namely the marsh crocodile (*Crocodylus palustris*), the saltwater crocodile (*Crocodylus porosus*) and the gharial (*Gavialis gangeticus*) and three exotic species namely the Nile crocodile (*Crocodylus niloticus*) of Africa, the spectacled caiman (*Caiman crocodilus*) of South America and the Siamese crocodile (*Crocodylus siamensis*) of South East Asia were studied. Different parameters like enclosure size, ambient air temperature in sunlight and shade as well as water temperature, humidity in sunlight and shade, area of water body, number of individuals, their maturity and sex as well as enclosure ornamentation were all noted down. The species, number of individuals, their maturity and sex, are given in Table 1.

Results

Among the six species of captive crocodylians under observation, the gharial showed highest basking rate (497 min.), followed by marsh (320 min.), salt water (199 min.), Siamese (93 min.), caiman (23 min.), and Nile crocodile (15 min.). The movement of different body parts was highest in marsh crocodile (720 min.), followed by Nile crocodile (320 min.), gharial (178 min.), saltwater crocodile (149 min.), Siamese crocodile (90 min.) and spectacled caiman (75 min.) respectively. Feeding behavior was seen only in the gharial (192 min.), and Marsh crocodile (24 min.). Locomotion or displacement from one place to another was highest in the gharial (354 min.), followed by marsh crocodile (350 min.), Nile crocodile (48 min.), Siamese crocodile (37 min.), spectacled caiman (26 min.) and saltwater crocodile (10 min.). Vocalization was only for 16 min. and 15 min. in saltwater crocodile and the gharial respectively. This implies that the gharial was the most active species of crocodylian among those studied and the least active species is the spectacled caiman.

When categorized activity-wise, our results show that the activities moving (1532 min.), basking (1144 min.) and locomotion (825 min.) were much more predominant and time-consuming when compared to feeding (216 min.) and vocalization (31 min.).

Likewise, all the activities of a single species put together Nile crocodile (n=5) exhibited 383 min. of activities, i.e., on an average 1 individual exhibited 76 min.; Spectacled Caiman (n=2) exhibited 124 min. of activities, i.e., on an average 1 individual exhibited 62 min. of activities; Siamese crocodile (n=4) exhibited 236 min. of activities, i.e., on an average 1 individual exhibited 59 min. of activities; Salt water crocodile (n=2) exhibited 358 min. of activities, i.e., on an average 1 individual exhibited 149 min. of activities; marsh crocodile (n=8) exhibited 1414 min. of activities, i.e., on an average 1 individual exhibited 177 min. of activities; gharial (n=6) exhibited 1236 min. of activities, i.e., on an average 1 individual exhibited 206 min. of activities.

Table 1. Activity patterns of captive crocodylians in Chennai Snake Park.

SPECIES	NO. OF INDIVIDUALS	TIME DURATION (IN MINUTES) OF ACTIVITIES (n = 15 hrs or 900 min / SPECIES)				
		BASKING	MOVING	FEEDING	LOCOMOTION	VOCALIZATION
Nile crocodile	5 young ones	15 (1.6%)	320 (35%)	Nil	48 (5.3%)	Nil
Spectacled caiman	1 adult male 1 adult female	23 (2.5%)	75 (8.3%)	Nil	26 (2.8%)	Nil
Siamese crocodile	1 adult male 1 adult female 2 young ones	93 (10.3%)	90 (10%)	Nil	37 (4.1%)	16 (1.7%)
Salt water crocodile	1 adult male 1 adult female	199 (22.1%)	149 (16.5%)	Nil	10 (1.1%)	Nil
Marsh crocodile	3 adults 5 young ones	320 (35.5%)	720 (80%)	24 (2.6%)	350 (38.8%)	Nil
Gharial	5 adult females 1 adult male	497 (55.2%)	178 (19.7%)	192 (21.3%)	354 (39.3%)	15 (1.6%)

Discussions

Our observations on the activity patterns of captive crocodylians are consistent with published literature (Alderton, 1998; Anonymous, 2000; Bostids, 1983; Rossa, 2002) in that crocodylians spend more time on basking, movement and locomotion compared to either feeding or vocalization. There are several studies on the three species of Indian crocodylians on various aspects including status surveys, population dynamics, activity patterns and thermoregulation. Bustard & Choudhry (1980) and Whitaker & Whitaker (1978) studied the status and conservation of salt-water crocodile in India. Gupta & Hari (1989), Tibbo (1991) and Whitaker & Whitaker (1979) studied the conservation status, thermoregulatory and social behaviour in wild and captive marsh crocodiles. Kumar (1998) and Singh & Bustard (1977) studied the basking behaviour of gharials in captivity. Grig *et al.* (1998) studied the thermoregulation and activity patterns of salt-water crocodile. Some natural history aspects of those exotic species studied here were previously studied by Brandt & Mazzotti (1980), Schaller & Crawshaw (1982) (spectacled caiman), Modha (1968) (Nile crocodile) and Platt *et al.* (2011) (Siamese crocodile)

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**A PRELIMINARY STUDY ON SURFACING - DIVING
DYNAMICS OF THREE AQUATIC REPTILES
(*CERBERUS RYNCHOPS*, *MELANOCHELYS TRIJUGA*,
LISSEMYS PUNCTATA) IN CAPTIVITY**

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Abstract: In most vertebrates, pulmonary respiration is generally the major mode. In aquatic reptiles, respiration rate differs based on the environmental conditions such as climatic factors and temperature, etc. Three captive aquatic reptiles, one brackish water snake *Cerberus rynchops* (n=2, adults) and two freshwater turtles *Melanochelys trijuga* (n=5, young ones) and *Lissemys punctata* (n=2, adult & sub adult) were visually observed for 20 h per species, for scoring surfacing-diving dynamics. The snakes were observed submerged under water for 16.2h (81.25%), surfaced for 62 times and the time intervals between two surfacing events averaged 4.40 min. In *Lissemys punctata* the surfacing duration was 1.77h (8.85%) surfaced for 367.5 times, time intervals between two surfacing events averaged 1.35min, *Melanochelys trijuga* the surfacing was 1.96h (9.83%), the time intervals between two surfacing events averaged 1.62 min and surfaced for 130 times.

Key words: Surfacing duration, frequency of surfacing, surfacing time intervals, fresh water turtles, brackish water snake, visual observation.

Introduction

Reptiles in general are more terrestrial compared to amphibians and spend most of the time on land rather than in water. However some reptiles are aquatic, most live in freshwater habitats, some live in marine environment (e.g. sea snakes, sea turtles, marine iguana) and some others live in brackish water (e.g. file snakes. estuarine crocodile). As is well known, even aquatic reptiles largely rely on breathing through lungs, supplemented by cutaneous route, cloacal bursae and so on. Respiration, water balance (Osmosis) and thermoregulation of reptiles. including aquatic species have been well studied (Bellairs, 1969, Goin and Goin,

1971, Porter, 1972, Vitt and Caldwell, 2009, Cloudsley-Thomson, 1971, Lenfant *et al.* 1970, Kramer, 1988, Shelton and Boutilier, 1982, Ultsch *et al.* 2004).

In this work we studied the surfacing-diving dynamics of three species of aquatic reptiles in captive conditions. We observed two species of aquatic turtles (fresh water) and one species of aquatic snake (brackish water) to find out their surfacing duration, time interval between two surfacing events and surfacing frequency.

Review of literature

Belkin (1968) studied the aquatic respiration and underwater survival of two freshwater turtle species *Sternothaerus minor* and *Pseudemys scripta*. Kramer (1988) studied the behavioral ecology of air breathing by aquatic animals and found out that the breathing of aquatic animals depends on optimal exploitation of resource gain in the environment. Lenfant *et al.* (1970) studied respiration in the fresh water turtle *Chelys fimbriata* and examined the exchange of oxygen by blood. Shelton and Boutilier (1982) studied apnoea in amphibians and reptiles and found out the responses that occur to decreasing PO₂ and increasing PCO₂ tensions in inspired air, alveolar air, and arterial blood.

Ultsch *et al.* (2004) studied lung collapse among aquatic reptiles and amphibians during long-term diving and found out that infrequent air breathing does not serve an immediate gas exchange function under normoxic condition and lung deflation is routine in hibernating aquatic reptiles and amphibians in the northern portions of their ranges, where ice cover prevents surfacing for extended periods. FitzGibbon *et al.* (2010) studied the importance of the cloacal bursae as the primary site of aquatic respiration in the freshwater turtle *Elseya albagula*.

Vitalis and Milsom (1986) studied pulmonary mechanics in the turtle *Pseudemys scripta* and found out the static pulmonary mechanics of the total respiratory system of *Pseudemys scripta* are the primary mechanics of the body wall rather than those of the lungs and the majority of the forces to be overcome in the body wall are elastic in nature. Heatwole and Seymore (1978) studied cutaneous oxygen uptake in three groups of aquatic snakes namely true sea snakes (*Hydrophis*), sea kraits (*Laticauda*) and homalopsine colubrid species *Cerberus rynchops* and found out the rate of cutaneous oxygen uptake increases with physical activities of the snakes.

Seymour *et al.* (1981) studied respiratory and cardiovascular physiology of the aquatic snake *Acrochordus arafuræ* and found out that pulmonary blood flow increases during ventilation and the duration of the episode ensures that almost the entire blood volume passes through the lung. Lutz and Bentley (1985) studied respiration physiology of diving in the sea turtle *Caretta caretta* and found out the duration of respiration was high because of their large lung size and oxygen storage capacity. Gatten (1975) studied aerial and aquatic oxygen uptake by freely-diving snapping turtles *Chelydra serpentina* and found out that aquatic consumption of oxygen is low in moderate temperature.

Materials and Methods

Study species: Dog-faced water snake (*Cerberus rynchops*): An estuarine water snake found in mangroves and coastlines of tropical Asia. Egg-laying; feeds on crustaceans and fishes; lives in crab-holes (Daniel, 2002, Whitaker and Captain, 2004); our enclosure contained two adults that were not in ecdysis during the study period.

Black pond turtle (*Melanochelys trijuga*): A semi-aquatic turtle found in Indian subcontinent; has hard, domed carapace; inhabits freshwater bodies; egg-laying; omnivorous (Daniel, 2002, Das, 1986); our enclosure contained five young ones.

Flap-shell turtle (*Lissemys punctata*): An aquatic turtle found in Indian subcontinent; has soft, leathery flattened carapace; inhabits freshwater bodies; egg-laying; omnivorous (Daniel, 2002, Das, 1986); our enclosure contained one adult and one sub-adult.

Study methods: We made 20 hours of observations on the study animals in Chennai snake park, where they were housed in 2ft x 4ft sized glass-fronted enclosures filled with fresh water and stony gravel. We maintained a distance of 1m and visually observed their activities by naked eye. Time was noted using stop watch. The water was clear and transparent enabling our proper scoring of respiratory activities.

The three activities observed, of interest to this paper, are defined as follows:

Surfacing duration: Time in minutes spent by the animal with at least its nostrils above the water surface.

Time interval: Time in minutes between two surfacing events.

Surfacing frequency: Number of times the animal was observed surfacing.

Results

Out of the 20h of observations a total of 3.75 h (18.75%) was spent by dog faced water snake on surfacing i.e., the snakes were submerged in the water for 16.25 h (81.25%) ; the snakes (n=2) surfaced about 62 times and the time interval between two surfacing events averaged 4.40 min.

Out of the 20h of observations a total of 1.96 h (9.83%) was spent by black pond turtle on surfacing i.e., the turtles were submerged in the water for 18.04 h (90.17%) ; the turtles (n=5) surfaced about 130 times and the time interval between two surfacing events averaged 1.62 min.

Out of the 20h of observations a total of 1.77 h (8.85%) was spent by flap shell turtle on surfacing i.e., the turtles were submerged in the water for 18.23 h (91.15%); the turtles (n=2) surfaced about 367.5 times and the time interval between two surfacing events averaged 1.35 min.

The above activities are summarized and presented in Table 1.

Table 1. Surfacing-diving activities observed in three captive aquatic reptiles studied

Species studied	Surfacing duration (in minutes)	Sum of time interval (in minutes)	Surfacing frequency
Dog faced water snake	226.5	273	62
Black pond turtle	118	211.5	130
Flap shell turtle	106.25	499	367.5

Discussions

In the references studied (Fitz Gibbon *et al.* 2010, Gatten, 1975, Glass and Jogansen, 1976, Heatwole and Seymore 1975, 1978, Lenfant *et al.* 1970, Lutz and Bentley, 1985, Seymour *et al.* 1981, Ultsch *et al.* 2004, Vitalis and Milesom, 1986). the aspects worked upon were cloacal bursae, pulmonary respiration. cutaneous respiration, temperature regulation, arterial blood oxygen uptake of both wild and captive aquatic reptiles, including marine, brackish and freshwater turtles and snakes.

In our study we observed the pulmonary respiration rate (surfacing duration, time interval between two surfacing events and frequency of surfacing) in captive fresh water turtle and brackish water snake. While the studies cited are highly specific with deep substantiation, ours is a preliminary study aimed only at an estimation of pulmonary respiration rate by visual observations. More detailed studies are needed to learn further about specific physiological changes during respiration in these three species.

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DIURNAL BEHAVIOURAL PROFILE OF CAPTIVE INDIAN COBRAS *Naja naja* (LINNAEUS, 1758) DURING THE DRY SEASON

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Introduction

Over a million people are estimated to be bitten by snakes each year in India and fatality guesstimates range from 10,000 to 50,000. Four snake species, collectively known as the “big four”, namely, Indian cobra *Naja naja*, common krait *Bungarus caeruleus*, Russell’s viper *Daboia russelii* and saw-scaled viper *Echis carinatus* are responsible for most snakebite (Whitaker & Captain, 2008).

Unlike the nocturnal kraits and vipers, cobras are reported to be active during daytime which potentially increases the chances of them being seen by people. Cobra’s venom is neurotoxic, causing rapid paralysis and, if untreated, death. Knowledge on the behavior of this widespread and potentially dangerous species is still scarce. In this paper, we aim to understand and quantify the diurnal behavior of Indian cobra in captivity.

Materials and Methods

We made visual observations without binoculars or video tapes on captive cobras housed in glass-fronted enclosures from a distance of 1-1.5 m. Twenty hours of observations using focal animal sampling (Altmann, 1974), on the captive cobras were made between 10:00 – 16:00 hrs, over a period of 12 days during the winter and summer months (i.e.) from January 2013 to May 2013 at Chennai Snake Park.

The observation was based on 6 adult snakes, such that there were not more than two individuals in an enclosure at any given time. Different behaviours of the snakes, such as movement (localised body motion), displacement (complete transfer of snake from one place to another), resting (immobile), tongue-flicking and drinking were recorded. Temperature and humidity of both the enclosures were measured using a digital thermohygrometer. Temperature and humidity were recorded between 09:00–17:00 h.

Study species: Indian or spectacled cobra (*Naja naja*) is a species of front-fanged venomous snake found throughout the Indian subcontinent. It inhabits many habitat types except deserts and in hills above 1,800 m. Feeds on rats, frogs, and toads and occasionally birds, lizards and even other snakes. Breeds in January through March, lays eggs in April or May, which hatch in August. Its venom is neurotoxic (Das, 2002; Daniel, 2002; Whitaker and Captain, 2008).

Enclosures: Cage I, housing one adult measures : 90 x 90 x 100 cm length x breadth x height, and a water bowl of 30 cm diameter. Cage II, housing two adults measures: 230 x 150 x 140 cm length x breadth x height; and a water bowl of 57 cm diameter. Both the cages contain sand of 7 cm thickness as the substrate, branches for the snake to climb on and small rocks to facilitate moulting.

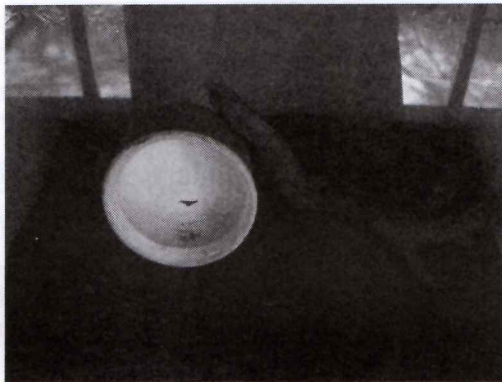


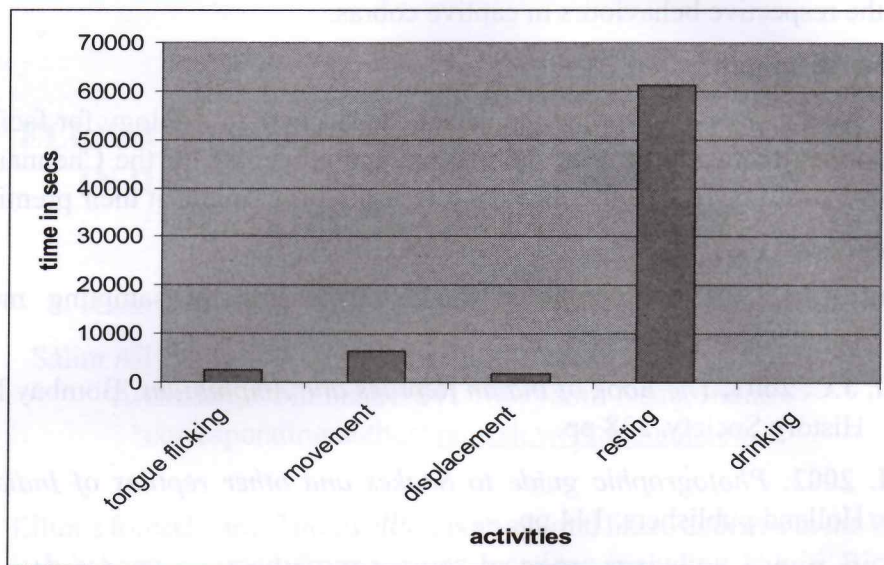
Fig.1. Enclosures 1 and 2 (left to right) housing captive cobras that were observed

Results

On an average the captive cobras spent 61,258 seconds (1021 minutes or 17 hours) 85% in resting, 2537 s (42 m or 0.75 h) 3.5% in tongue flicking, 6320 s (105 m or 1.75 h) 8.7% in movement, 1920 s (32 m or 0.5 h) 2.3% in displacement and 47 s 0.06% in drinking (Fig. 2.). Drinking was observed only once although the snakes had access to water all the time.

Temperature in both the cages housing the snakes ranged between 31.8°C and 33.5°C during the day time. Humidity level in the both the cages ranged between 41% and 60%. The cobras in captivity have spent nearly 85% (17 out of 20 h) of their time resting.

Fig. 2. Time duration (in seconds) of the various activities of captive cobras



Discussion

Since ectotherms such as reptiles have relatively low metabolic rates and variable body temperature, they are not able to carry out vigorous work for long periods of time (Shine, 1991, rp.1995). Behavior is not set entirely by genes, but is the result of gene-environment interaction (McGaugh *et al.*, 1967). Therefore, in the wild, behavioural pattern of a snake will be different from that in captive conditions.

It is not surprising that snakes in captivity rest for a longer time, as in our case (85%) because, for wild snakes, searching for food and avoiding being eaten are probably the two most likely tasks on a daily basis and the system utilized in those roles are often mechanically and functionally identical and interrelated (Diwan & Arora,1995).

In captivity, snakes seldom have the space to prowl or the need to do so, as all the needs of the snakes such as prey, water, territory, etc, are met by the captive snake without any need for it to move around searching. Snakes operate most efficiently at temperature of around 25-30°C (Mattison, 2002) and our temperature readings ranged between 31.8 and 33.5°C, slightly above the mark.

Similar observations during both day and night on wild cobras will enable us to judge the respective behaviours in captive cobras.

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**ELLIOT'S FOREST LIZARD (*CALOTES ELLIOTI*)
IN DRY FORESTS OF ANAIKATTY HILLS,
WESTERN GHATS, TAMILNADU**

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Elliot's forest lizard *Calotes ellioti* is an agamid lizard endemic to the Western Ghats. It has been reported from various locations including Nilgiri Biosphere Reserve, Indira Gandhi Wildlife Sanctuary, Kalakkad-Mundanthurai Tiger Reserve and Malabar Coast (Smith, 1935; Sharma, 2002; Bhupathy & Kannan, 1997; Ishwar *et al.*, 2001; Vijayakumar *et al.*, 2001). Manthey (2008) reported a single record from Mahabaleshwar, Maharashtra state, in the Northern Western Ghats. This species was reported to occur in moist deciduous and evergreen forests (Bhupathy & Kannan, 1997; Ishwar *et al.*, 2003) but has not been reported from dry deciduous forest. The present observation is documented record of this species, reported for the first time from a dry, rain-shadow area (annual rainfall - 650 mm) covered with mixed dry deciduous forest.

On 5th August 2013 we observed a small agamid lizard on *Streblus asper* tree near a seasonal stream in Anaikatty Hills (11° 05' 22" N; 76°47' 24" E, 650 m above mean sea level). The lizard was photo documented using a digital camera (Sony DSC550) and identified as Elliot's forest lizard *Calotes ellioti* based on the three distinct nuchal spines and presence of white spot below the eyes (see Figure). The location was about 20 m away from stream, had about 60% canopy with considerable shrub cover including *Lantana camara*. Being located on the eastern slopes (600 m above msl) of the Western Ghats, the climate of Anaikatty hills is semi arid with temperature ranging from 29 to 38°C and an average annual rainfall of 650 mm and the vegetation is southern mixed dry deciduous forest (Mukherjee, 2007).



Fig. *Calotes ellioti* sighted in dry deciduous forests of Anaikatti hills

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RANDOM HARVEST

Studies on the natural history of king cobra

The latest issue of *HAMADRYAD* (vol. 36, issue 1) is a 'special issue' featuring natural history studies on the king cobra (*Ophiophagus hannah*). One noteworthy aspect is that, unlike many other previous works on the king cobra, this set of articles is largely field-based and not anecdotal accounts or based on captive animals.

The Agumbe Rainforest Research Station (ARRS), is a base station for field researchers in prime king cobra habitat in Agumbe, Karnataka, set up by Romulus Whitaker. ARRS caters to the needs of several field researchers in addition to spearheading king cobra conservation projects.

This special issue is born of the labour of a dozen researchers in ARRS, mainly Gowri Shankar.

Dealing with the king cobra encounters in human-modified rainforests of the Western Ghats, the researchers say that they had captured and relocated 106 king cobras from near about human settlements. With this vast experience they go on to comment that male king cobras are larger (3.5 m long and weigh 4.5 kg weight) and paler (brownish to olive green with black tails), whereas females are smaller (2.5 m long and 3.4 kg weight) and darker (black or dark brown). The team also reports that king cobras were often seen by the local people at around 10.00–12.00 hrs. when the snake goes about hunting for rat snakes and cobras in open paddy-fields where these abound. The team also state that most calls received from the locals for the rescue of king cobras from human habitations were between March and August, the snake's breeding season in southern India.

About the habitat use of the king cobra, another team of scientists from ARRS have radio-tracked five king cobras from December 2010 to April 2011. During this exercise, 30 non-radio-tracked adult king cobras were also sighted in the wild by the team. The researchers say that king cobra movement patterns are strongly influenced by ambient temperature, relative humidity and wind direction and that these snakes prefer to be close to streams with abundant fallen logs as retreat sites. Other occasional shelters recorded were burrows and the like. These snakes were seen to prefer areas having a rich layer of leaf-litter, as thick as 10-17 cm, which habitat is attractive for nest-building.



The scientists also studied the fate of the “rescued” or “translocated” king cobras, by following a radio-tracked translocated snake. The team reports that their home range was significantly larger than that of non-translocated snakes, which leads them to infer about the “deleterious effects of long-distance translocation on king cobras [or any other snake for that matter].” This is of significance in framing a policy on translocation of snakes in general.

The researchers have noted their observations in five instances (three in the wild and two in captivity) of cannibalism, i.e., feeding on its own kind, which is a well-known behaviour of the king cobra. The team says that their observations are the first documentation of cannibalism in wild king cobras and that these observations have clarified some of the doubts in earlier studies on captive king cobras.

There are some interesting observations on the factors influencing human hostility to king cobras. The researchers investigate people’s hostility toward king cobras by factoring in the snake’s size and defensiveness, proximity to human habitations, the time of encounter and season. It was noted that people wanted to kill the snake in over 80% of instances.

As for its unique nesting ecology, the team produce data from their elaborate ‘nest surveys’ done in Karnataka, Mizoram, and Uttarakhand from 2004 to 2010. A total of 15 nests were studied, with thirteen in Shimoga district of Karnataka, and a single nest each in Mizoram and Uttarakhand. Thirteen of the 15 nests had a female king cobra present. The clutch size was found to be 25 (range: 7-43) eggs with an average of 23 (range: 6-38) eggs surviving to term. The team also recorded the lowest king cobra nest temperatures known, the Uttarakhand nest, which came to about 23.0°C. It is mentioned that all the nests were seen in April–June, and the eggs were at various developmental stages.

It is ironical that the king cobra, despite being the world’s largest venomous snake, and a charismatic one that is widely distributed in several tropical Asian countries, it still is one of the least-known in terms of its natural history. This ‘king cobra special issue’ will serve to fill in some of the voids in the available literature on this snake and stimulate further research.

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New caecilian found in Eastern Ghats

Adding to the array of newly discovered Indian amphibians is the recent discovery of a new caecilian named as *Gegeneophis orientalis* in a paper authored by Ishan Agarwal *et al.* published in the journal *ZOOTAXA*, vol. 3696, issue 4. The new amphibian was so named alluding to its 'eastern' / 'oriental' geographic range compared to its all other closely related members. This new species was discovered from wet, forest-clad peaks of northern Eastern Ghats in Andhra Pradesh and Orissa. A unique feature reported in the new species is its bicuspid teeth in the outer as well as inner teeth rows. Also, noteworthy is the fact that *G. orientalis* is the first caecilian reported from Orissa.

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Spotted limbless skink rediscovered

The Indian spotted limbless skink *Sepsophis punctatus* which was first discovered and named by Col. R.H. Beddome way back in 1870 has now been rediscovered from near about the same locality in the Eastern Ghats where Beddome first found it. A team of biologists report in an article authored by Datta-Roy *et al.* in *ZOOTAXA* vol. 3670, issue 1, that their rediscovery is after a gap of 137 years! Beddome first found this snake-like skink in the northernmost stretches of densely forested hill tops of the Eastern Ghats along Andhra Pradesh–Orissa border. It is also noteworthy that this unique species, the only one of its kind in this endemic genus, has also been photographed live for the very first time.

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A new 'spectacled skink' from Meghalaya

A new species of skink that has no moveable eye-lids but only a spectacle-like covering over the eye, has been discovered by researchers in Meghalaya. In the paper published by Roy *et al.*, coauthored by the famed lizard experts Indraneil Das and Aaron Bauer, in *ZOOTAXA* vol. 3701, issue 2, the team elaborate on their finding of this unusual lizard from the sacred groves of Mawphlang, in the northeastern hill state of Meghalaya. This skink has been named as *Sphenomorphus apalpebratus* after the 'spectacle' (brille) covering its eyes. This new species is the first of its kind in its genus.

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Albinism in Indian snakes

Albinism is rare to come by in wild animals, particularly snakes, because albinos do not survive for long in the wild. Being more conspicuous than their normally-coloured kin, they are, firstly, unable to hunt freely and, secondly, for the same reason, they are more vulnerable to attacks by predators. In the recent volume of *Journal of the Bombay Natural History Society* (JBNHS), vol. 109, issue 3, two reports, on the albinism of a burrowing snake have appeared.

The first one, by M. Jadhav & A. Mahabal, on the common sand boa (*Gongylophis conicus*) mention the authors' finding of a totally albino specimen in Laling Ghat, in Dhule district of Maharashtra state.

In the second note, authored by Nivalkar *et al.* the biologists comment on their finding of an albino beaked worm snake (*Grypotyphlops acutus*). Beaked worm snake, is also a burrowing snake, like the sand boa; and is in fact the largest worm snake in India, reaching over 2 ft. in length. This snake was sighted in Dapoli, in Ratnagiri district, Maharashtra.

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The good (?) that power cuts can do

An example of how power cuts can make one switch priorities is given by the evolutionary biologist, Richard Dawkins, in his 2013 memoir *An Appetite for Wonder: The Making of a Scientist*. Dawkins was engaged in a project using computer-generated courtship song of the pacific field cricket *Teleogryllus oceanicus*. In 1973, a strike by mineworkers in England led to a crisis and Prime Minister Edward Heath imposed massive power cuts. Dawkins's cricket research needed electricity and had to be abandoned for the time being. But he managed to use his typewriter and began his first book which became the seminal work *The Selfish Gene*. He could not continue his work on the courtship of the cricket. Was the change-over for the better or for the worse? One really doesn't know! But the fact is that *The Selfish Gene* was the precursor to a series of much-acclaimed books on evolutionary biology that built up a solid reputation for Dawkins. The love song of the cricket would have been an unequal rival.

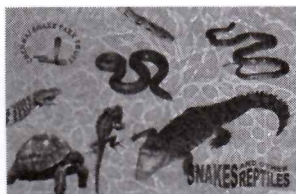
– B. Vijayaraghavan

AIMS AND OBJECTIVES OF THE CHENNAI SNAKE PARK TRUST

- i) To maintain and display a captive collection of snakes and other reptiles as a means of eliciting public interest in them and prompting the public to empathize with them.
- 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.

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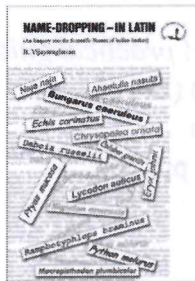
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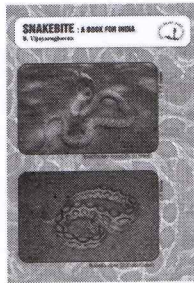
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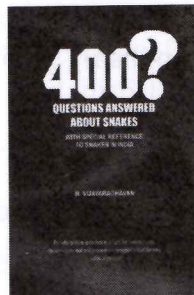
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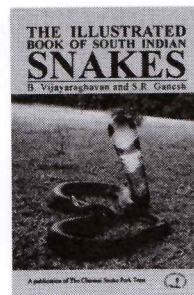
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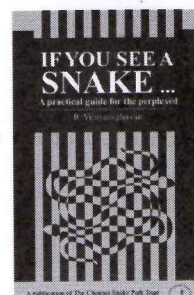
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All manuscripts must be sent in hard copy or on CD-Rom to the Editor, **Cobra**, Chennai Snake Park Trust, Rajbhavan Post, Chennai – 600 022. Or through e-mail to cspt1972@gmail.com

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