HAMADRYAD
Vol. 21, December, 1996
Date of issue: 31 January, 1997

FULL BOOK SCANNED

CONTENTS

PUBLISH *AND* PERISH!

Sometime back, we wrote to the editor of a regional periodical, asking for contributions on herpetology to be peer-reviewed. The rather forceful reply was that the intention was to encourage more people to write what they see.

The purpose of this rather lengthy editorial with the unusual title is to encourage colleagues to exercise caution in reporting new distributional records, in describing new taxa, and in general reporting what is considered publishable new information. Like our well-meaning editor, we too are inundated by manuscripts on the subject by enthusiastic contributors, and many have in the past been published (usually after a painful rewrite). The burgeoning of newsletters, journals, souvenir issues commemorating this and that, and even in-house publications have ensured that a great many of these reports do get published, and therefore enter the realms of public domain. Because of the lack of peer-review in most of the regional journals however, errors of identification are common. The general scarcity of library resources only contributes to the problem. In addition, the inability of most colleagues to refer to the type specimens of amphibians and reptiles (most of which are in museums abroad) and the non-availability of identification resources (for amphibians specially acute: the last word on the subject is over a century old) have been contributory factors for major mistakes that have appeared in the recent herpetological literature from this region. Field guides and revisions of these faunal groups are too few and far in between. Too many of the existing ones have been based on existing literature (including misleading or invalid information), which have copied what has already been said many times over, while adding precious little new findings. One should ask, have types been referred to (two, perhaps three, people in the region have)? Was at least the original literature consulted? Dutta (1985) showed that the name of the ubiquitous *Rana tigerina* has been misspelt for nearly two centuries. After George Boulenger, few workers have bothered to read the older literature, due in part to their non-availability in most local libraries, and partly due to inability to comprehend (or get translated) papers published in languages other than English. Most of the recent field guides available contain serious mistakes: although the text has been more often than not copied (sometimes verbatim) from the last review of the subject, they introduce new mistakes, and when photographs are provided, these are not uncommonly misidentified.

As noted by Daniels (1996), taxonomic uncertainties have greatly contributed to the status of knowledge of our herpetofauna, which in turn has impeded biogeographic analysis of this fauna. The consequences of a lack of knowledge of the taxonomy and relationships between taxa can be even more severe: Daugherty et al. (1990) showed how bad taxonomy can kill, with species known to have become extinct because of non-recognisation by taxonomists. We also have records of species way out of their natural distributional ranges, including *Rana doriae* in the Western Ghats, *R. hexadactyla* from the Andaman Islands, *R. malabarica* in north-eastern India, *R. keralensis* in northern West Bengal, *Bufo bufo* in southern India, *B. viridis* in Kashmir, *B. beddomii* from Himachal Pradesh, *Hyla annectans* from Madhya Pradesh, *Naja oxiana* in Rajasthan, *Chitra indica* from north-eastern India and so on, *ad infinitum*. Several of these records are notes which had been rejected by referees of this journal, and with persistence, the authors found a less critical editor. Amphibians and reptiles are not like birds and mammals; few species can be quickly and reliably recognised in the field.

Equally damaging are species checklists that are based on these records. The recent flood of such lists, that range from local surveys to large scale (country-wise) lists are replete with errors, including synonyms. Of course, no checklist can satisfy everyone, and the best of checklists become rapidly outdated as new information becomes available. Omissions are also a factor, given the large number of periodicals in the region that make available new names, often in obscure journals with minimal peer review. Since checklists in the region have traditionally depended on these data sources (published records), we feel that their usage is rather limited. Type specimens are not consulted and mere listing of names do not take into account the validity of each taxon. In many cases, the types are not available for study, even for the most thorough of investigators. For example, several of the herpetological types of new species described in the last 20 years are not available in the institutions the authors claims to have deposited them in (see Das, 1996a). A recent report on freshwater biodiversity of tropical Asia attributed part of the reason for the poor quality of publications on the subject to a lack of a critical approach and a lack of exposure to the outside world (Kottelat and Whitten, 1996). The same report observed that, unlike in neighbouring countries, the problem in India is not the lack of data: it is the abundance of uncritical compilations and users, resulting in inconsistencies.

For our well-meaning editor, these may appear to be minor hiccups. For professional colleagues, a source of amusement. But for many species, our lack of understanding of distribution and relationships of this fauna may mean the difference of survival or extinction. Why? Read on.

As general reviews of this species-rich fauna show, both the amphibians (see Inger and Dutta, 1986) and reptiles (Das, 1996b), many of the Indian region's 850 or so known species of what we refer to as herps are found in a single biogeographic province. Linking these to a single zone highlights the importance of conservation of these regions (the most threatened being the Western Ghats and the northeast), the more endemics the better the argument. Distribution is also an important component of the biology of the species: if we fail to note its precise distributional range, we may fail to understand its ecological (a frequently misused term) requirements. Exceptions include perhaps a dozen species in each group (the so-called "weed species", most with a very broad Indian distribution). Even these are worthy of study. For instance, the field guide to the amphibians of the West Bengal plains by Deuti and Bharati-Goswami (1995) is all about amphibian "weeds", including: *Rana limnocharis, R. cyanophlyctis, Tomopterna breviceps, Kaloula pulchra, Bufo melanostictus, Polypedates maculatus* and *P. leucomystax*. For each of these species, there are problems of taxonomy, and further systematic work may result in name changes for these species, thereby also potentially affecting their conservation status.

Ideally, all specimens that represent new distributional records should be collected and deposited in a recognised institution where they can be verified separately by other specialists. A list of such institutions are given in Leviton and Gibbs (1988) and Leviton et al. (1985). In India, they are the Bombay Natural History Society (Bombay), the National Museum of Natural History (New Delhi) and the National Zoological Collection, maintained by the Zoological Survey of India (Calcutta); this last organization also has regional collections in many states in India. We do realise the difficulties of obtaining permission for collection from the relevant authorities, particularly in protected areas and for species that in India are protected under Schedule I of the Indian Wildlife (Protection) Act and as a compromise, we suggest that slide transparencies that show diagnostic characters of species that are not taxonomically difficult are deposited at an institution where they may be verified in the future.

Considering the difficulties, what can an enthusiastic herpetologist do. When a specimen is found, the soil and water types, plant and animal associations, weather, altitude, etc., can be noted. How many of each species was observed on a walk today? Yesterday? A month back? A year back? Ten years back? If removed to the laboratory, its behaviour can be observed. Does it walk, jump, hop, creep or sidewind? Does it climb glass? Does it sit in a corner, and wait for prey? Or does it actively move about in the terraria/aquaria? What does it feed on? Are there any dietary preferences? Is food swallowed head-first or tail-first? How often does it shed? How does it burrow- head-first or feet-first? Does it change colour seasonally or when another of its kind is introduced? Does it hibernate/aestivate? What is the effect of sunlight- does it shun it, or bask in it? How does it shed its skin? In one complete piece or in small pieces? How does it court? Does it call? How many eggs are produced? When and how many hatch? How big are the offspring? What do the larval stages look like? What is the time taken to reach maturity? And when it dies, preserve it well.

When a dead specimen, such as a road-kill, is obtained, dissect it to examine the reproductive status (e.g., maturity, sex, condition of gonads), presence or absence of fat bodies, parasites and food (from both the stomach and the intestines). How did it die, if it is not a road-kill? Drying up or acidification of waterbodies, predation, fungal attack, malnourishment, virus or human vandalism? These basic observations are required for many of our common species, and require little or no equipment to observe, measure and analyze.

More data can be obtained if one has access to a laboratory. Recordings of calls of frogs and geckos (even some turtles!) can be analyzed using sonograms. Tissues (such as liver and/or digits) can be removed and stored in alcohol, for possible use in studies on relationships between populations and species, utilizing DNA and cross-immunological techniques. Skeletal preparations can be made from poorly preserved specimens, to examine bones and cartilage. For very small specimens, clearing and staining with Alazarin Red and Alcian Blue makes the flesh colourless, the bones bright blue and the cartilage red. For rare specimens that are too valuable to dissect, x-rays can reveal the nature of the bones as well as the contents of the stomach, and the number of eggs and embryos.

In summary, the findings need to be known by colleagues, who might include protected areas managers and policy makers, and who can influence the survival of these animals. The most common venue is through publication in a scientific journal, which should be reviewed by referees who are knowledgeable on the subject and can offer valuable insights to the author on his or her observations and generally help improve the manuscript with comments. Thus, peer-review usually improves the quality of the final product, although not all paper contributions pass this test, depending on the comments by the referee(s) on the quality of research or methods used. This allows the author(s) time to pause and either redesign the research or, resubmit with corrections made.

Pioneering research, often under difficult conditions, was conducted on the natural history of our land by Indians at the turn of the century. It is up to us, as editors and contributors to the herpetological literature, to maintain a high publishing standard. Otherwise, we do the pioneers of Indian herpetology, the organisms we strive to understand and ourselves a grave injustice.

LITERATURE CITED

DANIELS, R. J. R. 1996. Biogeography and taxonomic uncertainties as illustrated by Indian amphibians. *Cobra* 24: 2-6.

DAS, I. 1996a. Handbook: Indian lizards [Book Review]. *Herpetol. Rev.* 27: 44-46.

________ . 1996b. Biogeography of the reptiles of south Asia. Krieger Publishing Company, Malabar, Florida.

DAUGHERTY, C. H. A., A. CREE, J. M. HAY & M. B. THOMPSON. 1990. Neglected taxonomy and continuing extinctions of tuatara (*Sphenodon*). *Nature* 347: 177-179.

DEUTI, K. & BHARATHI-GOSWAMI. 1995. Amphibians of West Bengal plains. World Wide Fund for Nature- India, Calcutta.

DUTTA, S. K. J. 1985. Notes on the correct spelling of the Indian bull frog, *Rana tigerina* Daudin. *Bombay nat. Hist. Soc.* 82: 220-221.

INGER, R. F. & S. K. DUTTA. 1986. An overview of the amphibian fauna of India. *J. Bombay nat. Hist. Soc.* 83 (Suppl.): 135-145.

KOTTELAT, M. & T. WHITTEN. 1996. Freshwater biodiversity in Asia with special reference to fish. World Bank Technical Paper No. 33. World Bank, Washington, D.C.

LEVITON, A. E. & R. H. GIBBS, JR. 1988. Standards in herpetology and ichthyology. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. Supplement No. 1: Additions and corrections. *Copeia* 1988: 280-282.

________ , R. H. GIBBS, JR., E. HEAL & C. E. DAWSON. 1985. Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985(3): 802-832.

INDRANEIL DAS
ROMULUS WHITAKER
HARRY V. ANDREWS
Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, India.

Hamadryad, Vol. 21, pp. 4-12, 1996.

DIURNAL AND SEASONAL ACTIVITY PATTERNS OF WATER MONITOR (*VARANUS SALVATOR*) IN THE BHITARKANIKA MANGROVES, ORISSA, INDIA

Bivash Pandav and Binod C. Choudhury

Wildlife Institute of India, P.O. Box 18, Dehradun, India

(with five text-figures)

ABSTRACT.- The activity pattern of the water monitor (*Varanus salvator*) was studied in the Bhitarkanika mangroves of Orissa, eastern India, during the winter and summer months of 1992 and 1993. Activity of *V. salvator* was unimodal in winter, which became uniform in summer. A shift in activity was observed with change in temperature. The results show a significant variation in activity levels with a day and a seasonal shift in diurnal activity.

KEY WORDS.- *Varanus salvator*, activity pattern, mangroves, Bhitarkanika, India.

INTRODUCTION

Investigations of the interrelationships between climate, habitat and activity pattern are of crucial importance in understanding the ecology and behaviour of ectotherms. This is especially true in diurnal lizards (Porter et al., 1973; Avery, 1976; Porter and Tracy, 1983). Observations on activity pattern are instrumental in understanding the ecology, ecophysiology and spatio-temporal organization of the behaviour of an organism. Studies on activity pattern of many varanid lizards have helped provide a better understanding of their biology, including those of *Varanus gouldii* (Green and King, 1978), *V. niloticus* (Cloudsley-Thompson, 1966), *V. komodoensis* (Auffenberg, 1981), *V. griseus* (Stanner and Mendelssohn, 1987), *V. olivaceus* (Auffenberg, 1988) and *V. giganteus* (King et al., 1989).

The water monitor (*Varanus salvator*) is widely distributed in southern and south-eastern Asia, including Indonesia, Malaysia, Philippines, Thailand, Myanmar, Bangladesh, India and Sri Lanka (Smith, 1935). In India, it is found in the deltas of the rivers Brahmani and Baitarini in Orissa, Sunderbans of West Bengal and in the Andaman and Nicobar Islands (Whitaker and Whitaker, 1980). Presence of the species in the north-eastern states of India, including Assam and Meghalaya, has also been reported (Smith, 1935; Das, 1989). Despite the wide distribution of the species, data available on its ecology are meagre. Available literature have largely provided information on distribution and taxonomy (Smith, 1935; Whitaker and Whitaker, 1980; Das, 1989; Gaulke, 1991a), food habits (Gaulke, 1991b), nesting habits (Biswas and Kar, 1981) and growth rate and social behaviour in captivity (Andrews and Gaulke, 1990; Daltry, 1991). Studies on space and time sharing by sympatric *V. salvator* and *V. bengalensis* show that they avoid competition by partitioning spatial and temporal resources (Wikramanayake and Green, 1989; Dryden and Wikramanayake, 1991). This paper describes the diurnal and seasonal activity patterns of *V. salvator* in the mangrove forests of Bhitarkanika.

STUDY AREA

The present study was conducted at the Bhitarkanika Wildlife Sanctuary (20° 04' - 20° 08'N; 86° 45' - 87° 50'E), Orissa State, located on the east coast of India. The sanctuary lies on the deltas of the rivers Brahmani and Baitarini, and has an area of 175 sq km. The mangrove vegetation of the sanctuary is marked by extensive stretches of *Phoenix paludosa*. Pure formations of tree species such as *Heritiera fomes, Excoecaria agallocha, Avicennia officinalis, Aegeceras corniculatum* and *Hibiscus tiliacius* also occur in the sanctuary. The reserve is one of the few remaining strongholds of the endangered saltwater crocodile (*Crocodylus porosus*) in India. Noteworthy among other endangered reptiles are the king cobra *(Ophiophagus hannah)* and the Indian rock python (*Python molurus*). The climate is tropical, characterised by distinct winters, summers and a monsoon. In the winter, the temperature drops to 10° C, while in the summer, the maximum temperature reaches 36° C.

Intensive studies were conducted in the Bhitarkanika block (17 sq km area), referred subsequently as the intensive study area (ISA) of the sanctuary, between December 1992 and April 1993. Approximately 100 ha of the ISA lie on a relatively higher ground and lack mangrove cover, with moist deciduous forests. The non-mangrove habitat has a number of freshwater pools. The remaining portion of the ISA supports mangroves.

METHODS

The activity of *Varanus salvator* was recorded using scan sampling (Altman, 1974), while walking on two standard paths, one in the mangrove habitat (2,000 m), the other in the non-mangrove habitat (1,800 m). On sighting an animal, the time, activity, microhabitat, relative humidity (RH) of the microhabitat and ambient temperature 1 m above ground were recorded. The substrate temperature was measured at the point where the lizard was first sighted.

Temporal activity patterns were examined by dividing the day into four three hour time classes, starting from 0600 hours to 1800 hours. Both the standard paths were sampled in the above time classes. From 1 December 1992 to 30 April 1993, each month was divided into two halves, each described here as a period (fortnight). Thus the study period was divided into 10 such periods. 1 December to 1 February (five periods) were regarded as winter, 2 February to 2 April (five periods) were considered summer.

Those monitors sighted outside of burrows and other retreats were termed 'active'. Activities were classified into four categories: basking (seeking heat in open area or lying with limbs outstretched on relatively warmer substrates), resting (avoiding heat in shaded area or lying with limbs outstretched in cooler substrates), foraging (actively searching for food or feeding) and non-foraging (includes walking and swimming). A lizard's immediate physical environment was considered the microhabitat and was classified on the basis of soil, ground cover and water conditions.

Activity index (*AI*; see Bhatt, 1991; Bhatt and Choudhury, 1993) was calculated to understand the activity in different time classes and periods. The basic assumption involved in *AI* is that the frequency of monitors encountered on the standard paths is a function of activity level of the population. The activity level for time class '*t*' was measured using the following equation:

$$AI = S/n \text{ (sightings/sampling effort)}$$

where S is the total number of monitors sighted on a standard path in a particular time class and n is the number of runs on a standard path for that particular time class.

Based on the level of *AI*, activity was defined as unimodel or uniform. The term unimodel refers to a higher level of *AI* during a certain time class of the day. Activity is defined uniform when there is not much variation between *AI* (i.e., activities evenly spread throughout the day) of the four time classes in a day.

Preferred temperature zone for activity was calculated by clumping frequency of occurrence of animals with different activity and with ambient and substrate temperature class. All the observations were pooled on two hourly time intervals and frequency of occurrence in different activity categories were taken to describe the activity rhythm. Percentage occurrence of different activities were calculated for each microhabitat to comprehend the relationship of microhabitat and activity.

RESULTS

Activity pattern

In all, 663 *Varanus salvator* were encountered on two standard paths during the study. Activity level was highest in 1200-1500 hours time class, $AI = 4.72 \pm 0.58$; and the most active period during the study was the one starting on 1 April ($AI = 5.54 \pm 1.33$; Table 1). Friedman two-way ANOVA shows signiificant differences in activity levels among the time classes (a^2 r = 21.81; $P < 0.05$), as well as periods (a^2 r = 18.31; $P < 0.05$). The diurnal activity pattern and its seasonality is shown in Fig. 1. Activity was unimodel in all periods during the winter, i.e., a peak in *AI* was observed in either 9-12 or 12-15 time classes (Fig. 1).

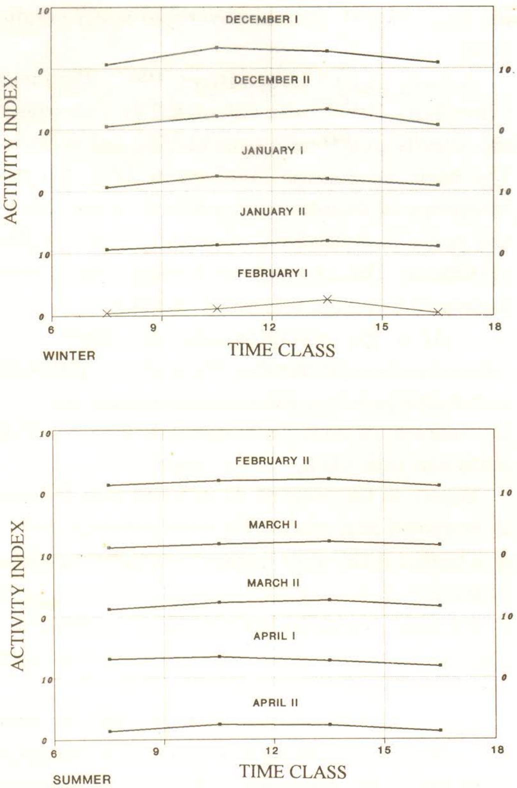

FIGURE 1: Diurnal activity of *Varanus salvator*.

Climatic factors affecting activity

Major activities such as basking, foraging and resting reached a peak at different ambient temperatures. A shift in activity was observed with change in temperature (Fig. 2). Of 204 lizards observed basking, 84 per cent were in ambient temperature zone 23-29° C, with the maximum (63) observed at 25° C. Of the 117 lizards observed foraging, 71 per cent were in 25-31° C ambient temperature zone, with a peak (24) at 31° C (Fig. 2). Peak resting was recorded at 29° C.

Basking lizards were seen in a wide range of substrate temperatures (23-35° C; Fig. 3). Of the 204 lizards observed basking, 42 per cent were in the 29-31° C substrate temperature zone. Of the 117 lizards seen foraging, 71 per cent were in the 23-29° C substrate temperature zone. Substrate temperatures between 25-31° C were utilized for resting by the species (Fig. 3).

Ambient relative humidity showed inverse trend with ambient temperature. Of the basking lizards recorded, 77 per cent and 73 per cent, were recorded in situations of RH 40 and 60 per cent, respectively (Fig. 4). Resting was pronounced in high humidity ranges, and 85 per cent of the 91 lizards observed were in RH 60-75 per cent (Fig. 4).

TABLE 1: Activity Index ($AI = \Sigma S/n$) of *Varanus salvator* in each time class and period between December, 1992 and April, 1993.

Period	Time class				Mean
	06 - 09	09 - 12	12 - 15	15 - 18	95% CI
December-I	1.25	6.75	5.5	1.75	3.18 ± 2.66
December-II	1.0	4.25	6.5	1.25	3.25 ± 2.57
January-I	1.2	4.8	3.8	1.0	2.85 ± 1.7
January-II	1.17	2.5	3.83	2.0	2.38 ± 1.09
February-I	0.8	2.2	5.0	0.8	2.2 ± 1.94
February-II	2.0	3.4	3.8	1.6	2.7 ± 1.04
March-I	2.0	3.0	3.8	2.6	2.85 ± 0.74
March-II	2.3	4.33	5.0	3.0	3.66 ± 1.19
April-I	6.17	6.83	5.5	3.67	5.54 ± 1.33
April-II	2.75	4.75	4.5	2.5	3.03 ± 1.14
Mean 95% CI	2.06 ± 0.98	4.28 ± 0.99	4.72 ± 0.58	2.08 ± 0.53	

TABLE 2: Percentage occurence of *Varanus salvator* in different microhabitats between December 1992 and April 1993.

Microhabitat	Percent activity			
	Basking	Foraging	Resting	Non-foraging
Litter and sand	57.17	26.5	21.9	37.5
Litter and water	1.47	13.7	7.7	24.6
Water	0.0	18.8	0.0	13.3
Sand and mud	0.98	3.4	1.1	3.1
Mud	4.4	33.3	60.5	17.2
Grass	8.82	4.3	1.1	3.5
Tree branch	17.16	0.0	7.7	0.8
No. of lizards	204	117	91	256

Activity rhythm

All activities showed a unimodel pattern throughout the day (Fig. 5). While basking and resting reached peaks between 0800-1000 and 1400-1600 hours, respectively, other activities, including foraging and non-foraging behaviour were pronounced in the 1400-1600 hour time classes (Fig. 5). Basking was a major activity in the winter, while most of the activities were evenly spread throughout the day during the summer.

Microhabitat and activity

Microhabitats utlilized have been classified into seven types: litter and sand, litter and water, water, sand and water, mud, grass and tree branch. Basking lizards were most often seen in litter and sand (67.17 per cent), on exposed ground and on tree branches (17.16 per cent; see Table 2). Most

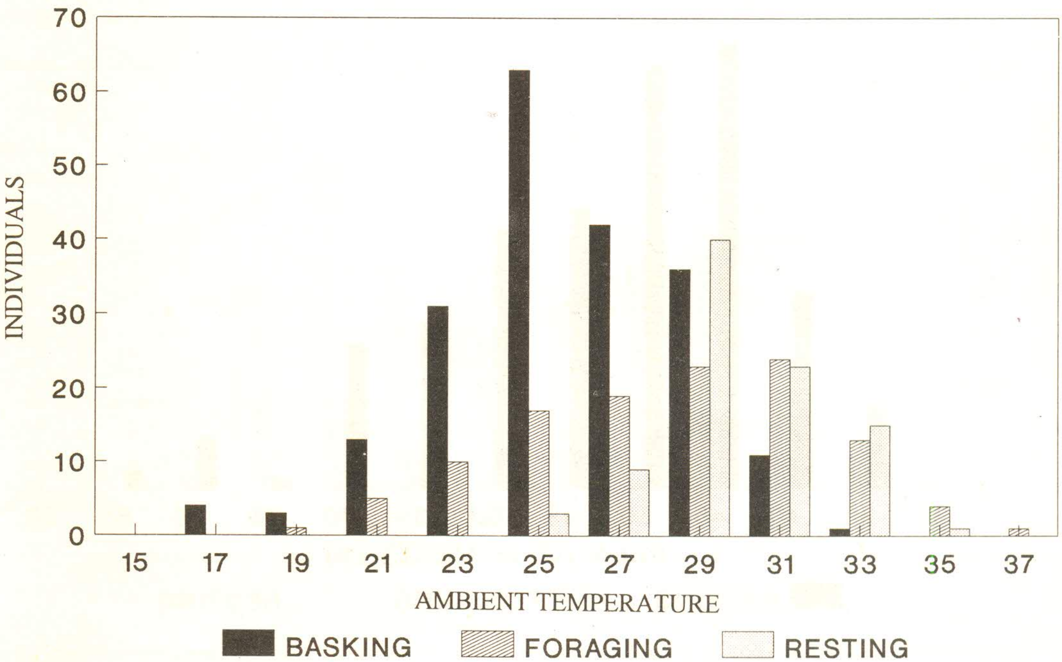

FIGURE 2: Environmental temperature zone influencing activities in *Varanus salvator*.

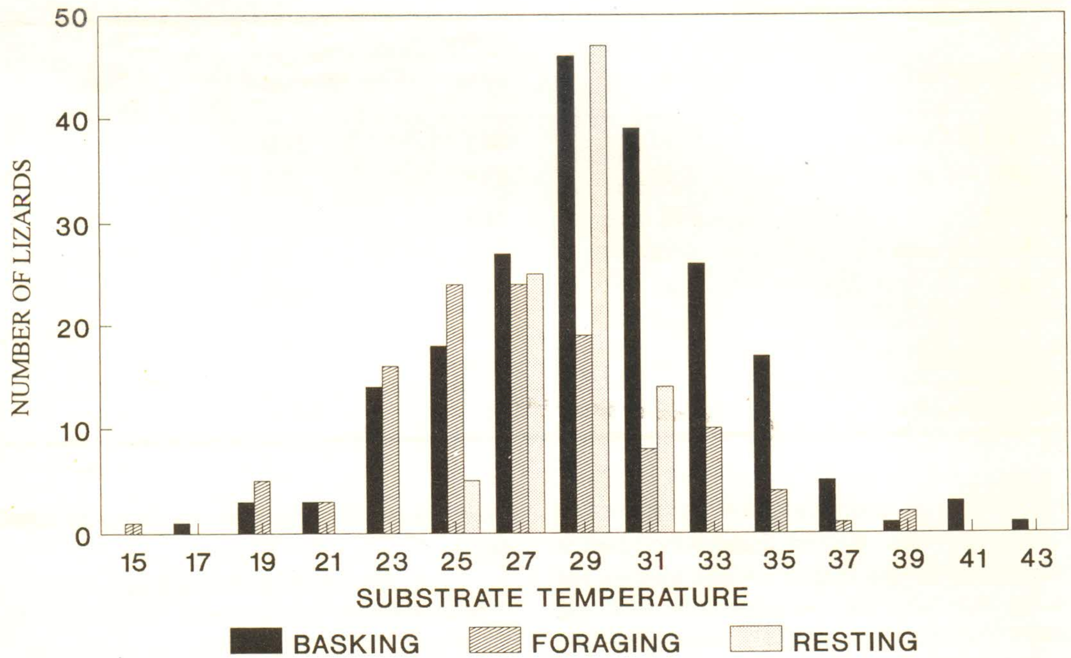

FIGURE 3: Relationship between substrate temperature and activities in *Varanus salvator*.

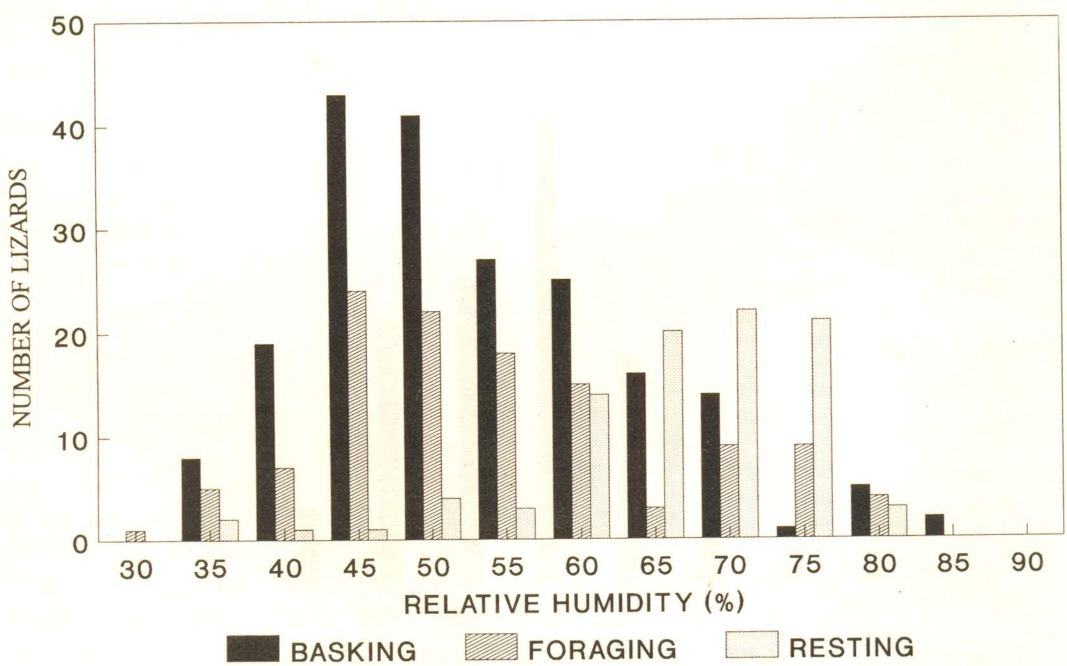

FIGURE 4: Relationship between relative humidity and *Varanus salvator* activity.

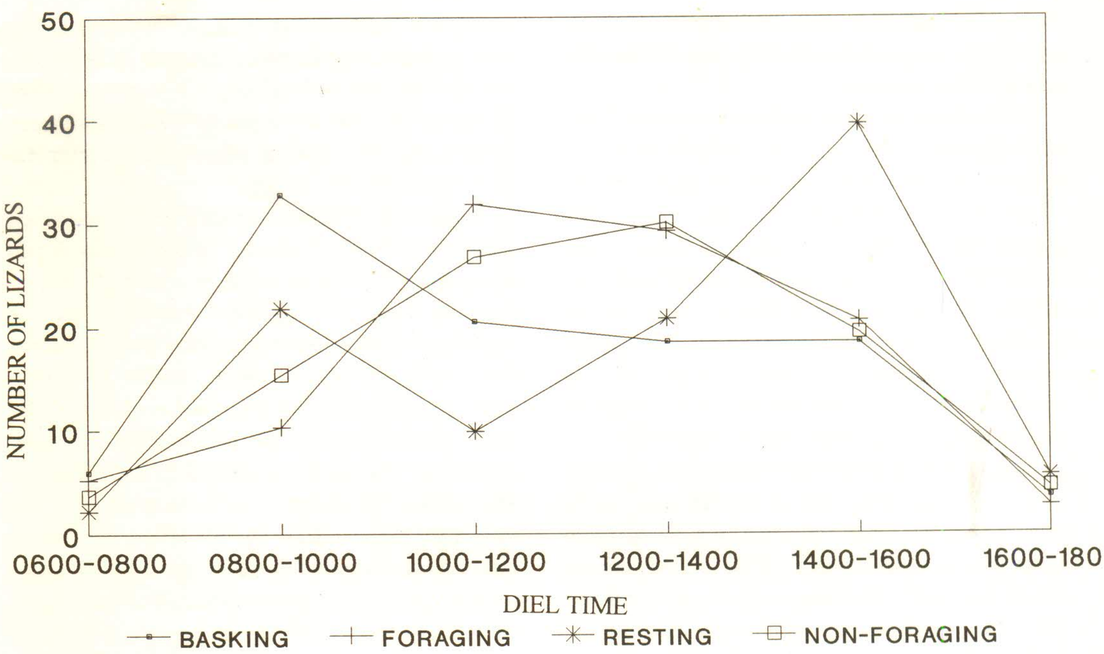

FIGURE 5: Activity rhythm in *Varanus salvator*.

foraging activities took place in microhabitats, such as mud (33.3 per cent), litter and sand (25.6 per cent) and water (18.8 per cent). A higher percentage of resting lizards were observed in the mud (60.5 per cent) under the thickets of *Brownloia tersa* near the creeks in the mangrove habitat.

DISCUSSION

Activity pattern and climatic factors

The results show a significant variation in activity levels within the 12 hour time class, and there is also a seasonal shift in diurnal activity. The observed trend in the activity pattern differs in many respects from the results of earlier workers on other varanids (e.g., *Varanus gouldii*, King, 1980; *V. komodoensis*, Auffenberg, 1981; *V. giganteus*, King et al., 1989). *V. salvator* shows a unimodel pattern of activity in the winter, which becomes uniform in the summer, whereas congeneric species mentioned show a bimodel pattern of activity. In addition, all these species show a considerable seasonal variation in the degree and timing of bimodality.

The seasonal differences in activity patterns recorded here have been interpreted as responses to environmental conditions. Looking at the relationship between activity and ambient temperature, it is evident that the population of *Varanus salvator* studied was most active during certain temperature classes (Fig. 3). The ambient temperature 23-31° C was found most preferred for activities, and can be referred to as the operative environmental temperature zone (sensu Grant and Dunham, 1988). In winter, the temperature was low during 0600-0900 hours and 1500-1800 hours time classes. There was an increase in the activity with increase in temperature during the midday hours in winter. The activity is more dependent on the occurrence of operative environmental temperature in time and space (Grant and Dunham, 1988). In winter, activity peaked during midday. During the hotter periods of the year (the summer), favourable temperatures would occur earlier or later in the day. However, this was not the case in the present study. The coastal habitat of the species did not experience drastic variation in temperature in the summer. The mean environmental temperature of the four time classes did not exceed the operative environmental temperature and hence an uniform activity pattern was observed in the summer.

The summer activity pattern of *Varanus salvator* resembled the spring activity pattern of *Python molurus* in Bharatpur, northern India (Bhatt, 1991). It is interesting to note that in semi-arid regions, such as Bharatpur, spring is the only time in the year when extremes of temperature are absent. Therefore, in a relatively less variable climate, a uniform activity pattern is expected unless it is controlled by other factors, such as availability of food and activity of prey species (Porter et al., 1973; Huey and Saltkin, 1976).

The relationship between temperature and activity in the present study is curvilinear. Such a relationship has been reported by other workers for snakes (Semlitsch et al., 1981; Gibbons and Semlitsch, 1987). *Varanus salvator* selected substrates with higher temperatures for basking and cooler substrates for foraging (Fig. 3). Studies on lizard activity and temperature relations have shown that one of two strategies is used in their thermal biology:

(i) maintaining similar average activity temperature through behavioural means (Parker and Pianka, 1975);

(ii) maintaining similar diel activity patterns but tolerating temperature differences (Heatwole, 1970; Pianka, 1970).

Radiotelemetric study of the thermal biology of the species has shown it to be stenothermic and that it tends to thermoregulate by behavioural means (Wikramanayake and Green, 1989). In the present study, the species was found to select substrates with higher temperatures to increase body temperature during conditions of low ambient temperature.

The body temperature of *Varanus salvator* has been reported to be the lowest among the varanids-29.9° C (Wikramanayake and Green, 1989), which may be due to its semi-aquatic habits. The species feeds mostly on fish and crabs in the tidal mudflats, creeks and pools, and is also known to fed on carrion (Gaulke, 1991b; pers. obs.). In foraging for fish and crabs, fast and agile movements are restricted to the aquatic environments. Water serves as a heat sink and rapidly cools a lizard with high body temperature. This would necessitate shuttling between feeding and basking sites, which could be costly in terms of both time and energy. By maintaining a lower body temperature, the species exploits cooler substrates while foraging or resting, when ambient temperatures are high.

In general, relative humidity and temperature vary inversely. The increase in RH would in part compensate for the decrease in activity by a temperature drop. It is reported that humidity can significantly alter the desiccation rate of snakes (Heatwole, 1976; Lillywhite, 1987). However, Auffenberg (1988) failed to find evidence of the effect of humidity on the behaviour of *Varanus olivaceus*. The variation in RH in the habitat of this species (72-92 per cent) is substantially less than in the present study site (35-95 per cent). Low humidity and high temperature during noon hours might force *V. salvator* to seek cooler microhabitats. This is supported by the observation that a higher number of resting lizards were recorded in microhabitats with high humidity (Fig. 4).

Activity rhythm

Results of the activity rhythm augments the findings of Wikramanayake and Green (1989) on behavioural thermoregulation in *Varanus salvator*. Active lizards were seen in low numbers in the early mornings (0600-0800 hours) and in the evenings (1600-1800 hours). Most lizards emerged from burrows or other retreats after 0700 hours, after which the major activity was basking. Since morning (0600-1000 hours) temperatures were low, heat-seeking behaviour or basking was more pronounced during this time class. Since foraging in the species is associated with walking and swimming, both foraging and non-foraging activities took place simultaneously between 1000-1400 hours. Most of the resting and non-foraging (swimming) lizards were observed during the warmer periods of the day, as also reported in *V. gouldii* by King (1980).

Microhabitat and activity

A higher percentage of basking *Varanus salvator* was seen in microhabitats such as litter and sand on exposed grounds in non-mangrove habitats and on tree branches in mangrove habitats. Soil and litter heat up more rapidly than other substrate types, such as mud. By basking in such microhabitats when the ambient temperature is low, the species absorbs heat from both the substrate and from solar radiation.

The substrate in the mangrove habitat is mud and the canopy is dense. Substrate temperature of the exposed mudflats is less than the ambient temperature. Consequently, a lizard dorsally absorbing heat from solar radiation would rapidly loose it again by ventral conduction while basking on the mudflats. The agamid *Amphibolurus inermis* has been observed basking on tree branches to minimise heat loss by ventral conduction when air and substrate temperatures were low (Heatwole, 1970). In the dense canopied mangrove forest, little sunlight reaches the ground, and the higher branches of trees receive most of the light, which apparently result in higher sightings of basking monitors on tree branches.

Most foraging in *Varanus salvator* takes place in areas sheltering more diverse prey faunas, as reported by Gaulke (1991b). Tidal mudflats of the mangrove swamps hold a diverse spectrum of food in the form of crustaceans and mudskippers. Monitors have been observed feeding on crustaceans such as *Scylla serrata* and fiddler crabs in the tidal mudflats. Higher percentage of resting lizards were observed on mud in close proximity to water. By selecting cooler microclimates, under bushes, near water, the lizards are protected from direct sunlight. Wikramanayake and Green (1989) found that the species in southern Sri Lanka exploited the cooling effects of the breeze to maintain a lower body temperature, which explains the selection of such microhabitats for resting in the population of *V. salvator* studied.

ACKNOWLEDGEMENTS

Field work was conducted by the first author as part of his M. Sc. dissertation in the Wildlife Institute of India. We thank B. N. Nayak, former D. F. O., Bhitarkanika Wildlife Sanctuary, R. K. Swain, former Forest Officer of Kanika Range, and the staff of Raj Nagar Forest Division for cooperation.

LITERATURE CITED

ALTMAN, J. 1974. Observational studies of behavior. Sampling methods. *Behavior* 49: 227-267.

ANDREWS, H. V. & M. GAULKE. 1990. Observations on the reproductive biology and growth of the water monitor (*Varanus salvator*) at the Madras Crocodile Bank. *Hamadryad* 15: 1-5.

AUFFENBERG, W. 1981. The behavioral ecology of the Komodo monitor. University Press of Florida, Gainesville, Florida.

________ . 1986. The Indian monitor lizards. *Sanctuary Asia* 6(4): 326-333.

________ . 1988. Gray's monitor lizard. University Press of Florida, Gainesville, Florida.

AVERY, R. A. 1976. Thermoregulation metabolism and social behaviour in Lacertidae. *In*: Morphology and biology of reptiles. pp: 245-259. A. d'A. Bellairs & C. B. Cox (eds.). Academic Press, London.

BHATT, K. 1991. The diel activity pattern of Indian python (*Python molurus molurus*) at Keoladeo National Park and some factors influencing it. M. Sc. dissertation, Saurashtra University, Rajkot.

________ & B. C. CHOUDHURY. 1993. The diel activity pattern of Indian python (*Python molurus* Linn.) at Keoladeo National Park, Bharatpur, Rajasthan. *J. Bombay nat. Hist. Soc.* 90: 394-403.

BISWAS, S. & S. K. KAR. 1981. Some observations on nesting habits and biology of *Varanus salvator* (Laurenti) of Bhitarkanika Wildlife Sanctuary, Orissa. *J. Bombay nat. Hist. Soc.* 78: 303-308.

CLOUDSLEY-THOMPSON, J. L. 1966. Seasonal changes in the daily rhythm of animals. *Int. J. Biomet.* 10: 119-125.

DALTRY, J. 1991. The social hierarchy of the water monitor, *Varanus salvator. Hamadryad* 16: 10-20.

DAS, I. 1989. New evidence of the occurrence of water monitor (*Varanus salvator*) in Meghalaya. *J. Bombay nat. Hist. Soc.* 82: 253-255.

DRYDEN, G. L. & E. D. WIKRAMANAYAKE. 1991. Space and time sharing by *Varanus salvator* and *Varananus bengalensis* in Sri Lanka. *Mertensiella* (2): 111-119.

GAULKE, M. 1991a. Systematic relationship of the Philippine water monitors as compared with *Varanus s. salvator*, with a discussion of dispersal routes. *Mertensiella* (2): 154-167.

________ . 1991b. On the diet of water monitor, *Varanus salvator* in the Philippines. *Mertensiella* (2): 143-153.

GIBBONS, J. W. & R. D. SEMLITSCH. 1987. Activity patterns. *In*: Snakes: ecology and evolutionary biology. pp: 396-421. R. A. Seigel, J. T. Collins & S. Novak (eds). McGraw-Hill Publishing Company, New York.

GRANT, B. W. & A. E. DUNHAM. 1988. Thermally imposed time constraints on the activity of desert lizard *Sceloporus merriami*. *Ecol.* 69: 167-176.

GREEN, B. & D. KING. 1978. Home range and activity pattern of the sand goanna, *Varanus gouldii*. *Australian Wildl. Res.* 5: 417-424.

HEATWOLE, H. 1970. Thermal ecology of the desert dragon *Amphibolurus inermis*. *Ecol. Monogr.* 40: 425-457.

________ . 1976. Reptile ecology. University of Queensland Press, St. Lucia.

HUEY, R. B. & M. SALTKIN. 1976. Costs and benefits of lizard thermoregulation. *Q. Rev. Biol.* 51: 363-389.

KING, D. 1980. The thermal biology of free living sand goanna *Varanus gouldii* in southern Australia. *Copeia* 1980(4): 755-767.

________ , B. GREEN & H. BUTLER. 1989. The activity pattern, temperature regulation and diet of *Varanus giganteus* on Barrow Island, western Australia. *Australian Wildl. Res.* 16: 41-47.

LILLYWHITE, H. B. 1987. Temperature, energetics and physiological ecology. *In*: Snakes: Ecology and evolutionary biology. pp: 422-477. R. A. Seigel, J. T. Collins & S. Novak (eds.). McGraw-Hill Publishing Company, New York.

PARKER, W. S. & E. R. PIANKA. 1975. Comparative ecology of populations of the lizard *Uta stansburiana*. *Copeia* 1975(4): 615-632.

PIANKA, E. R. 1970. Comparative ecology of the desert lizard *Cnemidophorus tigris* in different parts of its range. *Ecol.* 51: 703-720.

PORTER, W. P. & C. R. TRACY. 1983. Biophysical analyses of energetics, time space utilization and distributional limits. *In*: Lizard ecology: Studies on a model organism. pp: 55-83. R. B. Huey, E. R. Pianka & T. W. Schoener (eds.). Harvard University Press, Cambridge, MA.

________ , J. W. MITCHELL, W. A. BECKMAN & C. B. DEWITT. 1973. Behavioral implications of mechanistic ecology. *Oecologia*, Berlin 13: 1-54.

SEMLITSCH, R. D., B. K. L. BROWN & J. P. CALDWELL. 1981. Habitat utilization, seasonal activity, and population size, structure of the southeastern crowned snake, *Tantilla coronata*. *Herpetologica* 37: 40-46.

SMITH, M. A. 1935. The fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Vol. II. Sauria. Taylor and Francis, London.

STANNER, M. & H. MENDELSSOHN. 1987. Sex ratio, population density and home range of the desert monitor *Varanus griseus* in southern coastal plain of Israel. *Amphibia-Reptilia* 8: 153-164.

WHITAKER, R. & Z. WHITAKER. 1980. Distribution and status of *Varanus salvator* in India and Sri Lanka. *Herpetol. Rev.* 11: 81-82.

WIKRAMANAYAKE, E. D. & B. GREEN. 1989. Thermoregulatory influences on the ecology of two sympatric varanids in Sri Lanka. *Biotropica* 21: 74-79.

Accepted: 7 December, 1996.

Hamadryad, Vol.21, pp. 13-18, 1996.

ON THE IDENTITY AND STATUS OF *SIMOTES SEMICINCTUS* PETERS, 1862 (SERPENTES: COLUBRIDAE)

V. Wallach[1] and Aaron M. Bauer[2]

[1] Center for Vertebrate Studies, Department of Biology, Northeastern University, Boston, MA 02115, USA.
[2] Department of Biology, Villanova University, 800 Lancaster Avenue, Villanova, PA 19085-1699, USA.

(with two text-figures)

ABSTRACT.- The holotype and only known specimen of *Simotes semicinctus* Peters (1862), a *nomen oblitum* for a species supposedly originating from Borneo, is reexamined. The specimen is redescribed with an amplification of Peters' (1862) description, and it is concluded that the type represents a valid but overlooked species. It is believed to be a primitive member of the complex currently included in the genus *Oligodon*. Pending confirmation with a documented specimen, *Oligodon semicinctus* is provisionally considered a member of the Bornean herpetofauna.

KEY WORDS.- *Simotes semicinctus*, *Oligodon*, revalidation, Colubridae, Borneo.

INTRODUCTION

Simotes semicinctus (Fig. 1) was described as a new species of snake by Wilhelm Peters, supposedly from Borneo, in 1862. The name appears to have become a *nomen oblitum*; an exhaustive search has shown that since its description, it has not appeared in the literature again, except for the recent notation in Bauer *et al.* (1995) that it represents a valid species of unknown generic affinity. Neither Boulenger (1894) nor Werner (1929) listed it as a valid name or as a synonym in their colubrid snake catalogues, nor was it mentioned as a member of the Bornean herpetofauna by Bartlett (1895-1896), Boettger (1900), Shelford (1901), Rooij (1917), Haas (1950), Haile (1958), or Stuebing (1991, 1994). Even Peters himself did not refer to the species in his major work dealing with the herpetofauna of the Indo-Australian Archipelago (Peters and Doria, 1878).

Simotes semicinctus was believed by Peters to be most closely related to *S. trinotatus* Duméril, Bibron and Duméril, 1854 (= *Oligodon purpurascens* [Schlegel, 1837]), which differed from *S. semicinctus* by its 21 scale rows, 8 supralabials (with 4-5 entering orbit), and three pairs of small genials following the large anterior pair. Peters (1862) noted that the type of *S. semicinctus* was unusual in having 1) a loreal shield that was longer than deep, 2) a small scale cut from the anterior edge of the supraocular, and 3) oblong costals with rounded apices, possessing single pits dorsolaterally and paired pits laterally, but lacking pits ventrolaterally. Although there are distinct dark dots (single and paired) in the appropriate positions for apical pits (Fig. 2), careful examination with a microscope reveals no circular depressions or other indications of actual pits so this character must be discounted.

MATERIALS AND METHODS

Ventrals scutes were counted using the system of Dowling (1951). Ventrals (VS) and subcaudals (SC) are abbreviated. Relative tail length is defined as tail length/total length. The umbilical scar-anal plate interval is represented as a percentage of total ventral scutes (% VS). It is calculated by counting the number of ventrals from the cranialmost ventral of the scar to the preanal ventral and dividing by the total number of ventrals. Radiographs were taken of the head and body to investigate the osteology. Peters' (1862) description of *Simotes semicinctus* is accurate and relatively detailed but since it was in German and appeared in a now defunct journal, we present below an amplified English version using current scale counting methods and metric units [with Peters' data in brackets when different]. Museum acronyms include CAS (California Academy of Sciences, San Francisco), FMNH (Field Museum of Natural History, Chicago), MCZ (Museum of Comparative Zoology, Cambridge), and ZMB

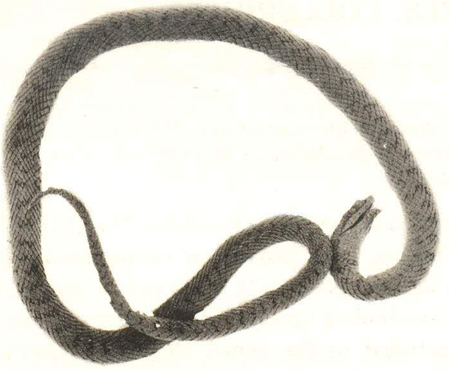

FIGURE 1: Holotype of *Simotes semicinctus* (ZMB 4553), illustrating general body proportions and colouration. Scale bar = 50 mm.

FIGURE 2: Details of left side of head and forebody of *Simotes semicinctus* illustrating lateral head scalation. Scale bar = 10 mm.

(Museum für Naturkunde, Humboldt-Universität, Berlin).

REDESCRIPTION

Simotes semicinctus Peters, 1862: 637-638

Figs. 1-2

Holotype.- An adult male, ZMB 4553, in good condition.

Type locality.- "wahrscheinlich Borneo" [probably Borneo], collector and date unknown. Examination of the ZMB catalogue entry shows that the original data recorded with the specimen were "? Borneo, Mission Barmen."

Description.- The holotype of *S. semicinctus* is an adult male, total length 576 mm (Peters = 580 mm), tail length 124 mm [Peters = 125 mm], tail equal to 21.5% total length; body slightly deeper than broad, midbody vertical diameter 12 mm, midbody horizontal diameter 11 mm; length/width ratio 52.4; 158 angulate ventrals [Peters = 160 ventrals] plus two gulars between first ventral and genials, 52 paired subcaudals, anal shield divided; 19-19-16 oblique rows of smooth pitless scales; rostral visible from above, separating internasals for [half] their length; supralabials 7, 3-4 entering orbit and 1-2 contacting loreal; nostril lateral in a divided nasal (but with superior suture only a weak crease); elongate loreal, 1.5 times as long as deep; one preocular and two postoculars; a small triangular scale cut from anterior edge of supraocular above preocular on right side only; eye moderate in size, contained in snout length two times and head depth three times, pupil round; temporals 1/2 + 3; infralabials 9L/8R, first 5/3 contacting anterior genials, 4th pair the largest; two pairs of subequal genials; umbilical scar-anal plate interval 12.0% VS; elongate terminal spine; maxillary teeth 11-12, weakly recurved and stout but not compressed, subequal, gradually increasing in size posteriorly, lacking diastema; dentary teeth 11-14; palatine teeth 4-6; pterygoid teeth 2-3; vertebrae lacking posterior hypapophyses but with strongly developed prezygapophysial processes, three pairs of lymphapophyses; hemipenis spinose, extending 13 vertebrae caudal of lymphapophyses (ca. 13-16 subcaudals in length), spinose portion occupying distal third of organ.

Colouration (in preservative).- Dorsum olive, middorsal region brownish-olive with 78 narrow (1.0-1.5 scales in thickness) brown crossbars on body that are 8-12 scale rows in transverse width, often irregular and incomplete, each separated by interspaces of 2-3 scales; tail with 25 crossbars of reduced dimensions but similar proportions; lateral body greenish-olive with a row of small brown marks, some of which are confluent with the dorsal crossbars while others alternate with them; head olive-brown with an indistinct brown arrow-shaped marking originating on the frontal, covering the medial halves of the parietals and extending caudally for several scale rows, its base as broad as the neck and most distinct; a black postocular bar from the eye to the angle of the mouth continues on the lateral surface of the neck for one head length; first dorsal crossbar, which is black, two scales thick and eight scales wide; chin and throat yellow; venter yellow anteriorly [Peters = greenish-yellow], mottled with olive-brown pigment that increases posteriorly so that the caudal 3/4 of body is olive with occasional yellow pigmentation; subcaudals olive.

GENERIC SYNOPSIS

The genus *Oligodon* inhabits western, southern and south-eastern Asia, ranging from Iran and Turkmenistan in the west to Taiwan and the Philippines in the east, including Sri Lanka and Malaysia and throughout much of Indonesia (Nias, We, Sipura, Sumatera, Bintan, Bangka, Belitung, Galang, Jawa, Kalimantan, Sumbawa, Timur, Serutu, Sulawesi, Sula, Maluku, Ambon and Yamdena). It ranges from sea level to 2590 m in elevation (Smith and Battersby, 1953; Karsen et al., 1986). Although Leviton (1963) reported more than 165 nominal species in *Oligodon*, there are 135 nominal forms with approximately 70 recognized species by current reckoning (Wallach and Williams, in prep.). Due to its large number of constituent taxa and its extensive geographical range, *Oligodon* is a taxonomically complex and difficult genus to define (Wall, 1923; Pope, 1935; Smith, 1943). Although the consensus today is that of one genus (pending revision of the entire group), some authors have recognized *Holarchus* (*Simotes* is preoccupied) as a genus distinct from *Oligodon* (Taylor, 1922; Pope, 1935; Bourret, 1936; Deuve, 1970).

Wall (1923) considered the following as definitive generic characters: 1) the separation of the internasals by the enlarged rostral for 2/3 of the internasal's length, 2) internasals, when paired, with suture that is half or less than half the internasal-prefrontal length, 3) frontal as long as parietal, 4) two temporals bordering parietals, the posteriormost subequal to or longer than the anterior, and 5) 4th or 5th infralabial as long as, and broader than, the posterior genials.

Snakes of the genus *Oligodon* are small (90-950 mm total body length), short-bodied and stout with cylindrical or slightly compressed bodies and short to moderate tails (relative tail length 9.6-25.0%). Head slightly depressed with short snout, ovate in dorsal view, broadest across temporal region and tapering rapidly to a subtruncate tip, eye moderate with round pupil, rostral enlarged and partially separating the internasals (Wall, 1921; Deraniyagala, 1955). Variation in the genus includes 13-23 midbody scale rows; scales smooth and arranged in longitudinal or oblique rows, with or without scale row reduction; apical pits present or absent; 127-218 rounded or obtusely angulate ventrals; 20-83 paired subcaudals; anal plate single or divided; 0-4 internasals; 2-4 prefrontals; nostril lateral in a divided, semidivided or undivided nasal; loreal present, reduced or absent; 1-3 preoculars; 0-2 presuboculars; 4-8 supralabials, with 3, 4, 5, 2-3, 3-4, 4-5, or 3-4-5 entering orbit; 1-2 postoculars; temporals in two or three series, often asymmetrically arranged with all conceivable combination from 1+1 to 2+2+3 (including 3+4, 0+1+2, and 1+1/1+1); cuneate temporolabial shield present or absent; 6-10 infralabials, with 3-5 contacting pregenials; 1 pair of large pregenials, 1-4 pairs of small postgenials; umbilical scar-anal plate interval 10.8-20.5% VS (mean = 13.6%; n = 29); *in situ* hemipenis extending for 7-35 subcaudals; maxilla and dentary with or without anterior edentulous portion, 6-17 maxillary teeth, 0-10 palatine teeth, 0-23 pterygoid teeth, and 5-20 dentary teeth; hypapophyses absent on posterior vertebrae, lymphapophyses present on the first three caudal vertebrae (Rooij, 1917; Wall, 1921, 1923; Smith, 1943; Deuve, 1970; F. W. Wagner, unpubl.; pers. obs.).

Characteristic cephalic markings of the genus include 1) a dark chevron or arrowhead marking on the parietal and nuchal region, 2) an oblique temporal bar, and 3) a transverse crescentic prefrontal bar continuing laterally as a subocular bar or spot. Sometimes one or more of these markings are fused with each other, with a large nuchal blotch, or with longitudinal body stripes; other times they may be broken into smaller units or absent. A great variety of body patterns occurs but all are essentially variations of transverse bands (narrow crossbars, broad crossbands or oblong blotches) or longitudinal stripes. The venter may be immaculate but is usually checkered with 1-2 dark squarish or quadrangular spots covering up to half a ventral or with 2-3 narrow longitudinal stripes.

Many authors have claimed that the scales of *Oligodon* lack apical pits (Wall, 1921; Leviton, 1963; De Silva, 1980; Mahendra, 1984). However, Boulenger (1894) diagnosed *Simotes* with or without pits and Taylor (1965) reported paired pits in *O. cinereus* and *O. inornatus*. We have observed single pits in the nuchal region of *O. taeniolatus*, paired pits in the nuchal region of *O. subcarinatus*, and paired pits throughout in *O. cinereus*, so at least a few species do possess apical scale pits.

Correlation of geography with three main hemipenis types within the genus occurs as follows: 1) a deeply divided spineless organ, with or without elongate papillae, from southern China and the Indo-Chinese region, 2) a simple organ, usually with large spongy papillae, spines present or absent, within south-eastern Asia, western Indonesia, and the Philippines, and 3) a simple spinose organ, lacking papillae, within India and Sri Lanka (Leviton, 1963).

Seven species of *Oligodon* are currently recognized as inhabiting Borneo (Stuebing, 1991, 1994). These include *O. annulifer* (Boulenger, 1893), *O. cinereus* (Günther, 1864), *O. everetti* Boulenger, 1893, *O. octolineatus* (Schneider, 1801), *O. purpurascens* (Schlegel, 1837), *O. subcariantus* (Günther, 1872), and *O. vertebralis* (Günther, 1865). *Oligodon subcarinatus* was omitted from an earlier checklist by Welch (1988). *Simotes semicinctus* keys out to *Simotes vaillanti* (= *Elaphe porphyracea* [Cantor, 1839]) in Boulenger (1894), *O. purpurascens* in Rooij (1917) and Haile (1958), and comes nearest to *O. arnensis* among the Asian species in Smith (1943). Among the Bornean species of *Oligodon*, *S. semicinctus* most closely resembles *O. purpurascens* (as Peters so believed) but differs in having a divided anal plate (vs. single), 7 supralabials with 3-4 in orbit (vs. 8 with 4-5 in orbit), and only two pairs of genials (vs. 4-5). From *O. arnensis* of India, *S. semicinctus* differs in having 19 midbody scale rows (vs. 17), two anterior temporals (vs. one), a long hemipenis (13-16 SC vs. 8 SC), and 78 narrowly separated thin crossbars on the body (vs. 7-30 widely separated crossbands).

DISCUSSION

An examination of the type specimen reveals that it cannot be assigned to any known taxon and thus appears to be a valid species. *Simotes semicinctus* differs from the generic concept of *Oligodon* in a number of ways. However, it appears to be closer to *Oligodon* than to any other genus. Whereas most of the characteristics of *S. semicinctus* fall within the range of variation for *Oligodon* species, certain characters differ from typical *Oligodon*. The head in *Oligodon* is usually short, expanded in the temporal region, and tapering to a subtruncate snout in dorsal profile. In some species (such as *hamptoni*) the head is not discernible from the neck as in *S. semicinctus*. Usually the pregenials are at least twice the size of the small, often multiple, postgenials. However, *O. hamptoni*, like *S. semicinctus*, has only two pairs of genials that are more typically colubrid in shape and size. *Oligodon* is characterized by enlarged and compressed, blade-like posterior maxillary teeth (the common name of *kukri* snake is based on the resemblance of the enlarged, compressed posterior maxillary teeth to the kukri knives used by the Gurkha troops (Wall, 1921). *Simotes semicinctus* resembles certain species having teeth not so highly modified (such as *O. catenata*, *fide* Smith, 1943: Fig. 61b).

The differences between *S. semicinctus* and most *Oligodon* species can be interpreted as plesiomorphic characters in the evolution of the genus towards a semi-fossorial life style (Deuve, 1970). There is a positive correlation between degree of fossoriality and shortness of relative tail length (which has reached its extreme in the scolecophidians). A long tail is a primitive feature for semifossorial and fossorial snakes. Most *Oligodon* species have tails that are 10-15% of the total length, and only a few species have relative tail lengths greater than 20%. With a tail length greater than 21%, *S. semicinctus* is primitive for that character. Apical pits are unknown in fossorial species; the fact that only several species retain pits suggests that they are more primitive members of the genus. Although actual pits are not present in *S. semicinctus*, the retention of pigmented spots in the identical positions of those species that do have pits indicates that *S. semicinctus* may represent a transitional state between presence and absence of scale pits. The long head and elongate loreal of *S. semicinctus* are generalized colubrid conditions that would be considered primitive to the shortened head of *Oligodon* with its squarish loreal. Although the head exhibits a postocular stripe and a weak dorsal arrowhead, it lacks the prefrontal crossbar and subocular spot characteristic of the genus, another indication of a more generalized state. Retention of nearly equal-sized genials in *S. semicinctus* is also a plesiomorphic condition found in more generalized colubrids. The unmodified maxillary teeth in *S. semicinctus* are obviously primitive relative to the typical teeth in *Oligodon*. Therefore, all of the questionable characters lend weight to the hypothesis that *S. semicinctus* is a primitive member of the *Oligodon* group, or at least is a part of the basal stock, has remained generalized, and has retained many plesiomorphic features. We therefore have no reservations in referring Peters' species to *Oligodon* (as *Oligodon semicinctus*), while provisionally considering it a member of the Bornean herpetofauna. Actual confirmation must await collection of another individual with specific locality data or the discovery of one or more documented specimens in a museum collection. Should the genus *Holarchus* be recognized as distinct from *Oligodon* in the future, *S. semicinctus* would be referrable to that taxon.

ACKNOWLEDGEMENTS

Appreciation is due to Rainer Günther (ZMB) of Berlin for allowing us to examine the type of *Simotes semicinctus*. We also acknowledge the curators of the following collections who permitted us to examine *Oligodon* under their care: A. E. Leviton and R. C. Drewes (CAS), H. Marx and H. K. Voris (FMNH), and E. E. Williams and J. P. Rosado (MCZ). The photographs were prepared by James Di Loreto, Office of Printing and Photographic Services, Smithsonian Institution.

LITERATURE CITED

BARTLETT, E. 1895-1896. Notes on the snakes of Borneo and the adjacent islands. Parts I-III. *Sarawak Note Book* 1: 68-85, 2: 100-116.

BAUER, A. M., R. GÜNTHER & M. KLIPFEL. 1995. The herpetological contributions of Wilhelm C. H. Peters (1815-1883). Society for the Study of Amphibians and Reptiles, Ithaca.

BOETTGER, O. 1900. Die Reptilien und Batrachier. *In*: Ergebnisse einer zoologischen Forschungsreise in den Molukken und Borneo. Zweiter Teil. Wissenschaftliche Reiseergebnisse. Band III.W. Kükenthal. (ed.). *Abh. Senckenberg. Naturf. Ges.* 25: 321-402.

BOULENGER, G. A. 1894. Catalogue of the snakes in the British Museum (Natural History). Vol. II. British Museum (Natural History), London.

BOURRET, R. 1936. Les serpents de l'Indochine. Tome II. Catalogue systématique descriptif. Henri Basuyau, Toulouse.

DERANIYAGALA, P. E. P. 1955. A colored atlas of some vertebrates from Ceylon. Vol. 3. Serpentoid Reptilia. Colombo National Museum, Colombo.

DE HAAS, C. P. J. 1950. Checklist of the snakes of the Indo-Australian Archipelago. *Treubia* 20: 511-625.

DE ROOIJ, N. 1917. The reptiles of the Indo-Australian Archipelago. II. Ophidia. E. J. Brill, Leiden.

DE SILVA, P. H. D. H. 1980. Snake fauna of Sri Lanka with special reference to skull, dentition and venom in snakes. National Museums of Sri Lanka, Colombo.

DEUVE, J. 1970. Serpents du Laos. *Mém. Off. Rech. Sci. Tech. Outre-Mer* 39: 1-251.

DOWLING, H. 1951. A proposed standard system of counting ventrals in snakes. *British J. Herpetol.* 11: 97-99.

HAILE, N. S. 1958. The snakes of Borneo, with a key to the species. *Sarawak Mus. J.* 8: 743-771.

KARSEN, S. J., M. W.-N. LAU & A. BOGADEK. 1986. Hong Kong amphibians and reptiles. Urban Council, Hong Kong.

LEVITON, A. E. 1963. Contribution to a review of Philippine snakes, I. The snakes of the genus *Oligodon*. *Philippine J. Sci.* (1962) 91: 459-484.

MAHENDRA, B. C. 1984. Handbook of the snakes of India, Ceylon, Burma, Bangladesh, and Pakistan. *Ann. Zool.* 22B: 1-412.

PETERS, W. C. H. 1862. Präparate von zur craniologischen Unterscheidung der Schlangengattung *Elaps* und über eine neue Art der Gattung *Simotes*, *S. semicinctus*. *Mber. Königl. Akad. Wiss. Berlin* 1862: 635-638.

________ & G. DORIA. 1878. Catalogo dei rettili e dei batraci raccolti da O. Beccari, L. M. D'Albertis e A. A. Bruijn nella sotto-regione Austro-Malese. *Ann. Mus. Civ. Stor. Nat. Genova* ser. 1, 13: 323-450.

POPE, C. H. 1935. The reptiles of China; turtles, crocodilians, snakes, lizards. American Museum of Natural History, New York.

SHELFORD, R. 1901. A list of the reptiles of Borneo. *J. Straits Br. Roy. Asiatic Soc.* 35: 43-68.

SMITH, M. A. 1943. The fauna of British India, Ceylon, and Burma, including the whole of the Indo-Chinese sub-region. Reptilia and Amphibia. III. Serpentes. Taylor and Francis, London.

________ & J. C. BATTERSBY. 1953. On a collection of amphibians and reptiles from Nepal. *Ann. Mag. nat. Hist.* ser. 12, 6: 702-704.

STUEBING, R. B. 1991. A checklist of the snakes of Borneo. *Raffles Bull. Zool.* 39: 323-362.

________ . 1994. A checklist of the snakes of Borneo: addenda and corrigenda. *Raffles Bull. Zool.* 42: 931-936.

TAYLOR, E. H. 1922. The snakes of the Philippine Islands. Bureau of Science, Manila.

________ . 1965. The serpents of Thailand and adjacent waters. *Univ. Kansas Sci. Bull.* 45: 609-1096.

WALL, F. 1921. Ophidia Taprobanica or the snakes of Ceylon. Colombo National Museum, Colombo.

________ . 1923. A review of the Indian species of the genus *Oligodon* suppressing the genus *Simotes* (Ophidia). *Rec. Indian Mus.* 25: 305-334.

WELCH, K. R. G. 1988. Snakes of the Orient: a checklist. Robert E. Krieger, Malabar.

WERNER, F. 1929. Übersicht der Gattungen und Arten der Schlangen aus der Familie Colubridae. III. Teil (Colubrinae). Mit einem Nachtrag zu den übrigen Familien. *Zool. Jahrb. Abt. Syst.* 57: 1-196.

Accepted: 4 December, 1996.

Hamadryad, Vol. 21, pp. 19-22, 1996.

RENESTING INTERVALS OF THE HAWKSBILL SEA TURTLE (*ERETMOCHELYS IMBRICATA*) ON SOUTH REEF ISLAND, ANDAMAN ISLANDS, INDIA

Satish Bhaskar

Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, India.

(with two text-figures)

ABSTRACT.- Data on 106 renesting intervals involving a total of 56 hawksbill sea turtles (*Eretmochelys imbricata*) on South Reef Island, Andamans, India were analyzed. Renesting intervals ranged from 12-17 days, averaging 14.06 days, and show a standard deviation of 1.17 days. The most frequent renesting interval was 14 days (35.8 per cent of total). Fifty instances of multiple renesting involving 32 of the 56 hawksbills were encountered. In 90 per cent of these instances, the variation in renesting of individual turtles were either 0 or 1 day. The maximum number of renesting within a season was six.

KEY WORDS.- *Eretmochelys imbricata*, **renesting interval, multiple renesting, South Reef, Andaman Islands, India.**

INTRODUCTION

Uninhabited South Reef Island, one of 94 islands designated as a Wildlife Sanctuary in India's Andaman and Nicobar Islands, is 450 m long and 90 m wide at its broadest part. It is fringed by an unbroken coral reef on all sides except off its north-eastern corner where the reef is patchy. The island is forested, and extreme spring tides frequently invade the forest edges. A dynamic cycle of erosion and deposition of the coast by the sea occurs, and is linked to the two monsoons, the Southwest (June to September) and the Northeast (October to November).

The island is among three of the most favoured sites by nesting hawksbills sea turtles (*Eretmochelys imbricata*) in the Andaman and Nicobars, with up to eight females coming ashore during a single night, although the average number during the peak nesting season is two per night. Green turtles (*Chelonia mydas*) nest is smaller numbers. Despite the existence of nesting beaches used by hawksbills on neighbouring islands, the closest of which is Interview Island (ca. 2 km distant), evidence from renesting encounters suggests that the hawksbills which nest on South Reef exhibit strong nest site fidelity.

Other than a species of *Rattus*, no vertebrate land animal prey on turtle hatchlings on South Reef, and turtles rarely encounter disturbance while nesting. Humans occasionally camp on the island, most often during the fair season (December to May).

MATERIAL AND METHODS

Each year from 1992 to 1995, a small camp manned by one or two investigators was set up on South Reef during the main hawksbill nesting season. During 1992, 1993, 1994 and 1995, the duration of the camps were, respectively, three months- 12 September to 12 December), two and quarter months- 14 September to 22 November, three and quarter months- 27 June to 9 September and 16 November to 7 December, and two months- 14 June to 18 August (Bhaskar, 1993; 1994a; 1994b; 1995; 1996).

Nesting hawksbills were tagged during these isolated periods with a minimum of disturbance: shaded flashlights were used sparingly. A single hurricane lantern, placed within a carton in order to shade and direct the light downwards, was used at the camp, which was itself concealed behind beach vegetation, primarily *Scavola taccada*. Some nesters, however, may have been disturbed by the offshore activities of local shark fishermen and of Burmese divers intent on collecting commercially valuable marine invertebrates.

Sweeps of the 1 km perimeter of the island were undertaken at about 100 minute intervals commencing at 1915 hours and ending at about 0300 hours, after which hawksbills rarely came ashore. Tagging was delayed until oviposition commenced. Nesting turtles encountered at any stage subsequent to oviposition were allowed to complete the nest, then overturned while returning to the sea, tagged and righted again. Only one in five turtles tagged required to be overturned. Renesting intervals were rounded off to the nearest day.

Two types of tags were used. The first is a corrosion-resistant metal wore carried on a red plastic tag serially numbered AN1, AN2, etc. The second is a metallic corrosion-resistant cattle-ear tag, serially numbered CA707, CA708, etc., and the inscriptions: RETURN ANPWS GPO BOX 636 CANBERRA AUST 2601, or numbered 006X, 007X, etc., carrying the inscription: RETURN WILDLIFE BOX 155 NORTH QUAY 4002 QLD AUSTRALIA.

All tags were inserted through the first and/or second and/or third large scale of the trailing edge of the left fore flipper closest to the turtle's body. Double or multiple tagging was employed in cases where tags were thought to have failed to lock securely. Turtles encountered renesting were found to have never lost tags.

RESULTS

Of 106 renesting intervals recorded for 56 hawksbills, 14 days was the most frequent (35.8 per cent or more than one-third of the total). About four of five (79.2 per cent) renesting intervals fell within the range 13-15 days and 98.1 per cent within the interval of 12-16 days. The range was therefore 12-17 days. Renesting intervals averaged 14.06 days and showed a standard deviation of 1.17 days.

Only three of 286 nestings documented occurred during daylight. A hawksbill that stranded at 1545 hours on 1 October, 1992 and nested was never encountered again on South Reef; another female that nested by daylight was missed by the investigator; a third stranded at 1845 hours on 18 July, 1995, nested, and was seen stranding twice again, at intervals of 15 days 7.5 hours and 15 days 17.5 hours, nesting on both occasions. Thirty-two females were each encountered on three or more occasions, giving a total of 50 renesting intervals. For each turtle, the variation in renesting interval

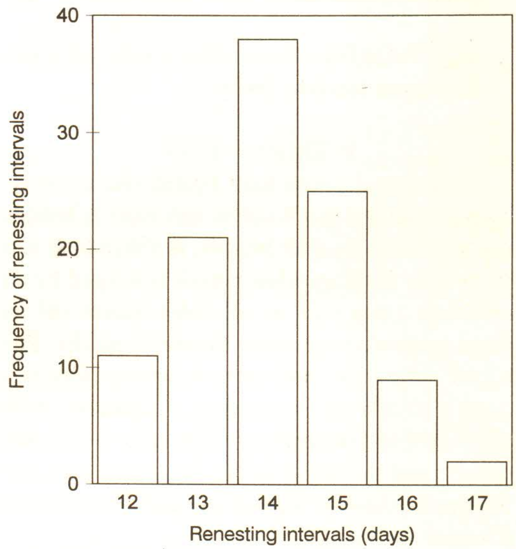

FIGURE 1: Frequency of renesting intervals in hawksbills on South Reef Island.

TABLE 1: Year-wise and cumulative frequencies of renesting intervals for hawksbills on South Reef Island. Abbreviations: RI = renesting interval; f = frequency; n = sample size.

	Frequency of renesting interval									
RI	1992 (n = 15)		1993 (n = 35)		1994 (n = 31)		1995 (n = 25)		Overall (n = 106)	
(days)	f	%	f	%	f	%	f	%	f	%
12	1	6.7	6	17.1	1	3.2	3	12.0	11	10.4
13	5	33.3	11	31.4	3	9.7	2	8.0	21	19.8
14	3	20.0	9	25.6	15	48.4	11	44.0	38	35.8
15	4	26.7	7	20.0	9	29.0	5	20.0	25	23.6
16	1	6.7	2	5.7	3	9.7	3	12.0	9	8.5
17	1	6.7	0	0.0	0	0.0	1	4.0	2	1.9

TABLE 2: Illustration of method used in calculating variation in renesting interval (days) for individual hawksbills on South Reef Island. Abbreviation: RI = renesting interval; Sl = serial number of turtle.

Sl	RI	Variation in RI
A	14, 14	0
B	12, 13, 14	1, 1
C	12, 13, 13	1, 0
D	12, 15	3
E	16, 15, 15	1, 0
F	14, 14, 13	0, 1
G	13, 13, 14, 14, 14	1, 1, 0, 0
H	12, 13, 17	1, 3

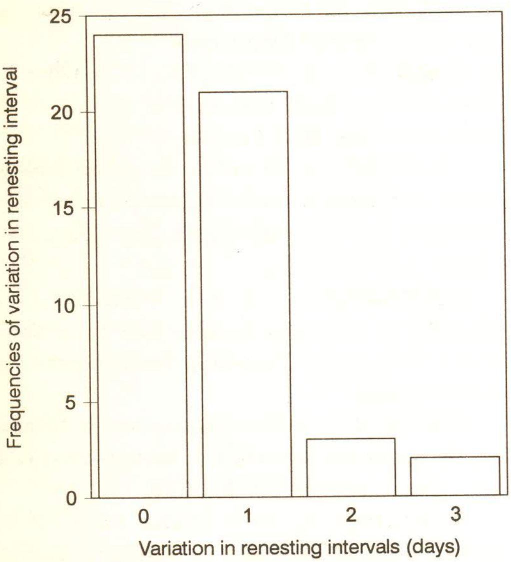

FIGURE 2: Frequencies of variation in renesting interval for mulitple renesting hawksbills on South Reef Island.

TABLE 4: Frequencies of variation in renesting interval (days) for multiple renesting hawksbills on South Reef Island, excluding the 1992 data. Abbreviations: RI = renesting interval (days); n = sample size.

Variation in RI	Frequency of variation in RI	
	Cumulative figures for 1993, 1994 and 1995	%
0	23	52.3
1	18	40.9
2	2	4.5
3	1	2.3

was calculated as in the following examples provided in Table 2.

Using this method, the average variation in the 50 multiple renesting intervals was 0.66 days with a range of zero to three days, standard deviation 0.77 days and a mode of zero days. Ninety per cent of the renesting intervals varied by either zero days (48 per cent) or one day (42 per cent).

The maximum number of times an individual hawksbill was seen nesting was six, at intervals of 13, 13, 14, 14 and 14 days, spanning 68 days. Many hawksbills were encountered only once while nesting. In no year did the study period cover the entire nesting season for the species, and several instances of nesting were missed by the investigators even during the study period.

DISCUSSION

A knowledge of renesting intervals, together with renesting frequencies will reveal the length of time during which a nesting sea turtle is susceptible to predation at or near a nesting beach, or to drowning in fishing nests. It will also facilitate the

TABLE 3: Frequencies of variation in renesting interval for multiple renesting hawksbills on South Reef Island. Abbreviations: RI = renesting interval (days); n = sample size.

Variation in RI	Frequency of variation in RI					
	1992 (n = 6)	1993 (n = 14)	1994 (n = 18)	1995 (n = 12)	Overall (n = 50)	%
0	1	5	11	7	24	48
1	3	8	6	4	21	42
2	1	0	1	1	3	6
3	1	1	0	0	2	4

tagging of nesters by limiting the number of nights of search needed.

While the published information mention that renesting interval of the hawksbill is 15-19 days (Carr and Stancyk, 1975; Diamond, 1976; McKeown, 1977; see also Hirth, 1980; Groombridge and Wright, 1982: 191, for a review), and one worker has even reported a mean of 24.5 days (Vaughan, 1981), the present study gave the range of 12-17 days. The difference obviously relates to geographically distinct populations. It is also possible that the low level of human-engendered disturbance to nesting turtles on and around South Reef Island resulted in the prevalence of near-natural renesting interval, as observed in this study.

However, disturbance may not have been negligible during the first year of the study (1992), when a parallel study on sea kraits (*Laticauda* spp.) necessitated more frequent use of a flashlight on the nesting beach at South Reef. With the data from 1992 deleted, a variation of zero days in renesting interval occurred in over half (52.3 per cent) of the 44 instances of multiple nesting by the hawksbills recorded, and was either zero or one day in 93.2 per cent of these instances.

ACKNOWLEDGEMENTS

This project was initiated and funded by the Centre for Island Ecology/Andaman and Nicobar Islands Environmental Team, a division of Madras Crocodile Bank Trust and the Royal Netherlands Embassy. I thank the Andaman and Nicobar Forest Department for issuing me permits and for providing transport and logisitc support. Romaine Andrews oversaw the preparation of several reports, including this paper. Harry Andrews obtained the necessary turtle tags. For help received during various phases of the project, I also thank Divisional Forest Officers at Mayabunder, Saw Bonny and Mark Bastian and their staff.

LITERATURE CITED

BHASKAR, S. 1993. Andaman and Nicobar Sea Turtle Project. Phase II. Report submitted to the Centre for Herpetology and the Andaman and Nicobar Forest Department.

BHASKAR, S. 1994a. Andaman and Nicobar Sea Turtle Project. Phase IV. Report submitted to the Centre for Herpetology and the Andaman and Nicobar Forest Department.

BHASKAR, S. 1994b. Andaman and Nicobar Sea Turtle Project. Phase VI. Report submitted to the Centre for Herpetology and the Andaman and Nicobar Forest Department.

BHASKAR, S. 1995. Andaman and Nicobar Sea Turtle Project. Phase VI A. Report submitted to the Centre for Herpetology and the Andaman and Nicobar Forest Department.

BHASKAR, S. 1996. Andaman and Nicobar Sea Turtle Project. Phase VIII. Report submitted to the Centre for Herpetology and the Andaman and Nicobar Forest Department.

CARR, A. & S. STANCYK. 1975. Observations on the ecology and survival outlook of the hawksbill turtle. *Biol. Conserv.* 8: 161-172.

DIAMOND, A. W. 1976. Breeding biology and conservation of hawksbill turtles, *Eretmochelys imbricata* L., on Cousin Island, Seychelles. *Biol. Conserv.* 9: 199-215.

GROOMBRIDGE, B. & L. WRIGHT. 1982. The IUCN Amphibia-Reptilia Red Data Book. Part I. Testudines, Crocodilia, Rhynchocephalia. IUCN, Gland.

HIRTH, H. F. 1980. Some aspects of the nesting behavior and reproductive biology of sea turtles. *American Zool.* 20: 507-523.

McKEOWN, A. 1977. Marine turtles of the Solomon Islands. Ministry of Natural Resources, Fisheries Division, Honiara.

VAUGHAN, P. 1981. Marine turtles: a review of their status and management in the Solomon Islands. Ministry of Natural Resources, Fisheries Division, Honiara.

Accepted: 5 July, 1996.

Hamadryad, Vol. 21, pp. 23-26, 1996.

STUDIES ON THE TERRESTRIAL BEHAVIOUR OF *LATICAUDA COLUBRINA* IN THE ANDAMAN ISLANDS, INDIA

Sohan Shetty[1] and K. V. Devi Prasad

Salim Ali School of Ecology, Pondicherry University, Pondicherry 605 014, India.
[1]Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, India.

ABSTRACT.- Aspects of the terrestrial behaviour of *Laticauda colubrina* were studied on South Reef Island, Andamans. The landward and seaward movements of these snakes peaked between 1800 and 0400 hours, with about 40 snakes active during this time. Females were more numerous and spent relatively more time on land than did the males. Buttressed and fallen trees were used extensively on land. Selection of sites by males and juveniles appears to be influenced by the sex of the snake already present at a site.

KEY WORDS.- *Laticauda colubrina*, terrestrial behaviour, habitat selection, Andaman Islands, India.

INTRODUCTION

Sea snakes of the genus *Laticauda* are amphibious and use terrestrial habitats to mate, nest and to meet other biological requirements (Saint Girons, 1964; Guinea, 1981). Sightings of the yellow-lipped sea krait (*L. colubrina*) have been reported on many islands in the Andamans Archipelago, but no major study has previously been conducted here. Although widespread in distribution, information on aspects such as time spent on land, use of resting sites and other behavioural aspects on land is scant. This study attempts to quantify behavioural aspects such as landward and seaward movements, time spent on land and habitat and microhabitats utilized.

STUDY AREA

The Andaman and Nicobar Islands are an archipelago of over 350 islands situated in the Bay of Bengal between coordinates 06° 45'N and 13° 41'N and 92° 12'E and 93° 57'E. Heavy precipitation (mean annual rainfall: 3,180.5 mm), mild temperatures (minimum 16.7° C; maximum 36.1° C) and high average humidity characterise the island's tropical climate.

This study was carried out on South Reef Island (area: 117 ha; 12° 46'N; 92° 39'E), located in North Andamans, between December 1995 and January 1996. Offshore, the eastern face of this elliptical island is fringed with coral reefs while the western face has a vast extent of rocks and dead coral. There is a broad belt of sandy shore, 4-24 m wide. Inland, there is a thick vegetation cover dominated by five species, including *Mimusops littoralis, Gyrocarpus americanus, Scavola koenigii, Hibiscus tiliaceus* and *Ipomoea pes-caprae*.

METHODS

The landward and seaward activity of the snakes was estimated on a 170 m sandy stretch on the eastern face of the island. Preliminary observations showed that all movements took place between 1800-0400 hours. It took about one hour to search and record details, hence the stretch sampled was examined hourly. The time, direction of movement and sex of the snake were noted for each observation. This method (the actual count method) was followed for a period of three weeks. To minimize any bias induced by the observer, all activities that could cause stress to the snake (including measuring, tagging or methods involving handling) were avoided.

The above method, however, failed to detect all moving snakes. An alternative method was utilized, using a path cleared and the tracks counted at the end of each hour. The tracks were erased as soon as they were counted to avoid recounting. This enabled a total count of the movements per day and this method (the track count method) was employed for six days.

To estimate time spent on land, the island was divided into three sections. One section was searched every day (to keep efforts constant) and sites which had snakes in them numbered. Sites in all sections were monitored every day. This also provided details of snakes that joined existing snakes at a site.

Preliminary observations showed that snakes mostly chose either live or dead trees during their stay on land. The sites used were further classified based on qualitative descriptions and quantified. Data on feeding and sloughing were also collected. Only those snakes with distended stomachs were considered to have consumed prey. Others may have consumed smaller prey, but were not considered under this category.

Analysis of variance (ANOVA) was used to compare utilization of live and dead sites and time spent on land by males and females (live sites were those located in a living tree and dead sites were those in the remains of dead trees). A χ^2 test was conducted to see if habitat use is influenced by the sex of the snake already present in a site. Statistical analyses were conducted using Microsoft Excel 5.0.

RESULTS

Activity

The activity (landward and seaward movements) of snakes were restricted to between 1800-0400 hours. As it was not possible to sample each hour slot equally, the number of snakes coming inland were interpolated for all the time slots sampled. The actual count method gave 1.9 snakes active per hour (n = 102 in 21 days), while the track count method yielded 3.6 snakes active per hour (n = 221 in six days). Most activity took place between 1800-2300 hours, after which activities diminished. No activity was observed during the day. According to the track counts (n = 221), an average of 39.8 snakes were active per day, the majority of which were females (n = 31).

There appeared to be sexual dimorphism in the time spent on land. Females spent an average of 6.25 days (± 3.95 SD), while males spent an average of 4.04 days (± 4.59 SD). The variance for this data is high as the time spent ranged between one to 22 days by females and between two to 16 days by males. The *F*-test results show significant differences in the time spent on land by the two sexes, the females spending more time on land than males ($P < 0.01$; $F = 10.31$; $P = 0.001$; $F_{crit.} = 6.80$).

Habitat types and habitat use

In concurrence with preliminary observations, all snakes chose either live or dead trees during their stay inland. These were subdivided into microhabitats and the number of snakes residing in each is given in Table 1.

TABLE 1: Number of *Laticauda colubrina* residing in each microhabitat type.

Microhabitat type	No. of snakes
Between buttress	22
Between root	2
Under root	8
In log	19
Under log	21
In buttress	2
Under litter	6
In tree	1
Total	81

TABLE 2: Microhabitat type and number of individuals of *Laticauda colubrina*.

	Dead tree	Live tree
No. of sites	61	26
No. of snakes	113	55
Snakes per site	1.85	2.12

On average, there were two snakes per site (Table 2). There was no significant difference between use of live and dead trees ($P < 0.01$; $F = 1.1391$; $P = 0.3109$; $F_{crit} = 4.965$).

While monitoring sites every day, there were cases where some individuals (henceforth called 'guests') joined snakes already in a site (called 'hosts'). The sites selected by female hosts were favoured by both male and juvenile 'guests'. While females are noticeably longer, males could not be distinguished from juveniles while in a resting site, as there are no external sexually dimorphic character to separate the two. Table 3 shows the sex of 'hosts' and the number of cases when the 'guest' was a female, $\chi^2 = 46.8984$ ($F_{crit} = 9.488$); $P < 0.05$; df = 4.

TABLE 3: *Laticauda colubrina* host and guest statistics.

	Male or juvenile guest	Female guest
Male host	1	4
Female host	23	3
Male and Female host	4	3

Sloughing and feeding

In all, 27 snakes were observed to go into a moult and 12 sloughs were seen. Of the 81 snakes observed coming ashore, 31 had distended stomachs. The rest are assumed not to have consumed food recently. None of the sea-bound snakes showed signs of having eaten. Twelve (13.63 per cent) of the sites had fresh faecal matter.

No attempts were made to tag these snakes, as previous studies have revealed the temporary nature and ineffectiveness of the tags (Saint Girons, 1964; Bhaskar, 1996; Engkamat et al., 1991).

DISCUSSION

The result of this study seem to differ considerably from those of Saint Girons (1964) in New Caledonia and are discussed below.

The movement of *Laticauda colubrina* from land to sea and vice versa begins in the evening around 1800 hours. This activity is high for about five hours, after which it declines, but not on a linear scale. All movements cease by 0400 hours. On the contrary, Saint Girons (1964) reported activity in New Caledonia even during the day. On South Reef, an average of 39.8 snakes moved between land and sea every day. Of these, the number of females exceeded the number of males. Both these results differ from the study in New Caledonia, where in about six days, only 69 movements (as against 221 movements in the same time span) were recorded, and males outnumbered females. Saint Girons (1964) proposed that females spent more time in water, and hence subject to higher predation by 'solely marine' predators. In the present study, females were found to spend more time on land.

Snakes come to the land to rest, slough and digest food (Guinea, 1981; Saint Girons, 1964). Mating and nesting was not encountered. The milky eyes and pale skin colour indicated that the snakes had gone into a moult. Snakes at 27 sites were seen to moult, but only 12 sloughs were seen, suggesting that sloughing was completed elsewhere, the sloughs were destroyed by fire ants and maggots, or blown away by wind.

The main habitats availble for snakes on South Reef are buttresses of live trees and rotting trees. On an average, there were two snakes per site in both habitat types, suggesting no apparent preference in site selection. When habitats are subclassified, it is seen that 50 per cent of the snakes rested in or under fallen logs and 28 per cent used buttresses.

During the study period (30 days), only six sites were revisited. The mean time between visits was 6.71 days (± 5.4 SD). This, and the fact that there were 40 cases of snakes going to sites already occupied, suggest the possibility of the same site being reused. The time span and data are however insufficient to make any conclusions about the permanency of these resting sites. The number of male guests visiting female hosts (Table 3) suggests that males and juveniles go to sites which are already occupied. A mention about the number of males and juveniles choosing sites already occupied by females should be made ($\chi^2 = 46.8984$ [$F_{crit.} = 9.488$]; $P < 0.05$; df = 4). The sex of the guest thus appears to be influenced by the sex of the host.

CONCLUSION

From these preliminary studies, it appears that the behaviour of the Andamans population of *Laticauda colubrina* differs considerably from other populations studied and requires careful reassessment. The marked difference between the results obtained from this study and that reported by Saint Girons (1964) indicate that long term studies on *Laticauda colubrina* should be undertaken in the Andaman and Nicobar Islands to answer these and other questions.

ACKNOWLEDGEMENTS

We are grateful to the Centre for Island Ecology/Andaman and Nicobar Environmental Team, a division of the Madras Crocodile Bank Trust, the Royal Netherlands Embassy, University Grants Commission and Pondicherry University for funding this study. We also thank the Andaman and Nicobar Forest Department for permission and support.

LITERATURE CITED

S. BHASKAR. 1996. Sea kraits on South Reef Island, Andamans, India. *Hamadryad* 21: 6-10.

ENGKAMAT, L. A., R. B. STUEBING & H. K. VORIS. 1991. A population size estimate of the yellow-lipped sea krait, *Laticauda colubrina*, on Kalampunian Damit Island, Sabah, Malaysia. *Copeia* 1991(4): 1139-1142.

GUINEA, M. L. 1981. The sea snakes of Fiji. *4th Int. Coral Reef Symp., Manila* 2: 581-585.

HERRE, A. W. C. T. & D. S. RABOR. 1949. Notes on Philippine sea snakes of the genus *Laticauda*. *Copeia* 1949(4): 282-284.

KLEMMER, K. 1967. Observations on the sea krait *Laticauda laticaudata* in captivity. *Int. Zoo Yrbk.* 7: 229-231.

PERNETTA, J. C. 1977. Observations on the habits and morphology of the sea snake, *Laticauda colubrina* (Schneider) in Fiji. *Canadian J. Zool.* 55: 1612-1619.

SAINT GIRONS, H. 1964. Notes sur l'écologie et la structure des populations des Laticaudinae (Serpents, Hydrophiidae) en Nouvelle Caledonie. *La Terre et la Vie* (2): 185-214. See also: Notes on the ecology and population structure of the Laticaudinae (Serpentes, Hydrophiidae) in New Calidonia. *Bull. Chicago Herpetol. Soc.* 25: 197-209. (English translation by I. M. Fauie, P. A. Gritis & H. K. Voris.)

STUEBING, R. B. 1988. Island romance: the biology of the yellow-lipped sea krait. *Malayan Natural.* 41: 9-11.

Accepted: 8 December, 1996.

Golden frog (*Rana aurantiaca*), Western Ghats near Nagercoil, Tamil Nadu, southern India
© Indraneil Das (Fujichrome Velvia 50 ASA)

Leopard gecko (*Eublepharis macularius*), Pakistan © Indraneil Das (Fujichrome Velvia 50 ASA)

Ornate flying snake (*Chrysopelea ornata*), Thekkady, Kerala, southern India © Rom Whitaker (Fujichrome Provia 100 ASA)

Chinese eyed turtle (*Sacalia bealei*), China © Indraneil Das (Fujichrome Velvia 50 ASA)

Hamadryad, Vol. 21, pp. 27-35, 1996.

SEA KRAITS ON SOUTH REEF ISLAND, ANDAMAN ISLANDS, INDIA

Satish Bhaskar

Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

(with six text-figures)

ABSTRACT.- Of 391 adult yellow-lipped sea kraits, *Laticauda colubrina*, encountered on land on South Reef Island in the Andamans, 48.3 per cent were males. The sexes show no significant difference in the number of black annuli (mean 42.1, range 36-50 ± 2.33 SD). The ratio of tail length to total length measured in 58 adult males and 41 adult females show that the tail is consistently larger in males, although males were generally shorter on average. Five examples of *L. laticaudata* were seen on shore, which had on average 70.4 black annuli (range 65-75 ± 4.6 SD). One female laid three eggs on 13 November, 1993.

KEY WORDS.- *Laticauda colubrina, L. laticaudata*, **sexual dimorphism, South Reef, Andamans, India.**

INTRODUCTION

South Reef, an uninhabited islet measuring 450 x 90 m in India's Andaman and Nicobar Islands hosts two species of sea snakes that come ashore- *Laticauda colubrina* (Schneider) and *L. laticaudata* (Linnaeus). Two species of marine turtles (*Chelonia mydas* and *Eretmochelys imbricata*) nest on the island. Despite being well forested, the terrestrial herpetofauna and mammalian appear impoverished, and no freshwater ponds exist. The Andamans receive two monsoons, the Southwest (June to September) and the Northeast (October-November).

Individuals of *Laticauda colubrina* come ashore onto South Reef during every month of the year, and *L. laticaudata* at least over the period June-November. Based on the frequencies of sightings, the relative abundance of *L. colubrina* and *L. laticaudata* on South Reef is about 200: 1.

MATERIAL AND METHODS

Data on sea snakes were collected on South Reef during four spells spread over four years (1992-1995) and totalling about a year, spent primarily in a study of sea turtles. Sea kraits were collected, tagged, measured, had their black annuli counted and the presence of ticks and injuries documented and released. Collections were done from 12 September to 7 December, and again from 17 June to 6 July, 1995. mainly by night (between 1900 and 0100 hours) as snakes were encountered on the beach either coming up from or returning to the sea. About 10 per cent of the 391 snakes tagged were collected within the forest by day as they rested. Total length (L) and tail length (T) were measured in 23 examples of *Laticauda colubrina* in 1992 and 73 in 1995. Sex was determined primarily from size (length and girth) but also from the courtship behaviour, measurements of th T/L ratio, and the size composition of snakes found in aggregations within the forest. Snakes were released at night usually within 12 hours of capture. Individuals of *L. laticaudata* that were captured were held in snake bags for durations of up to three days before being released.

Tags used were of two types: a flat, holed plastic tag measuring 1.2 x 0.6 mm, inscribed with the letters 'AN' and a serial number, and attached to (either by a corrosion-resistant metal wire or a fishing line) to the dorsal half of the tail through a 1 mm diameter hole punched by a nail; and a 'Jiffy' type monel metal wing tag (no. 1005, size 3, intended for chicks, from the National Band and Tag. Co., Newport, KY, USA) inscribed with the letters 'LDWF' and a serial number. The site of tagging was the same as that for the plastic tags. The graph of T vs snout-vent length (SV) was drawn following Cogger et al. (1987).

RESULTS

Laticauda colubrina

Black annuli: The number of black annuli in a random sample of 391 snakes which included males and females averaged 42.1 (range 36-50 ± 2.22 SD, mode 43, i.e., 18.2 per cent of total). Incomplete annuli when present were ignored or counted as whole according to whether they enveloped less than half or more than half of the snake's circumference. The incomplete black annulus on the head was included in the count. No significant difference exists between the sexes in the number of black annuli present (males: mean 42.3; range 36-47 ± 2.20 SD, mode 41, i.e., 19.6 per cent of the sample of 189 males; females: mean 42.0; range 37-50 ± 2.24 SD, mode 43; i.e., 24.8 per cent of the sample of 202 females). In an extreme example, 23 of 45 black annuli were incomplete ventrally.

Relative length of tail: Tail length expressed as a percentage of total length was consistently larger in males (mean 13.1, range 11.2-16.7 ± 1.13 SD, n = 58) than in females (mean 9.2, range 7.3-10.4; ± 0.73 SD; n = 41). None of the 99 examples had T/L percentage between 10.5 and 11.1, making this ratio characteristic for each sex.

TABLE 1: The number of black annuli in *Laticauda colubrina*, South Reef Island.

	Males				Females				Both sexes			
Year	n	range	$\bar{x}$	± SD	n	range	$\bar{x}$	± SD	n	range	$\bar{x}$	± SD
1992	149	39-47	42.6	2.01	169	37-50	42.1	2.17	318	37-50	42.4	2.11
1995	40	36-47	40.9	2.38	33	37-49	41.3	2.52	73	36-49	41.1	2.43
Pooled	189	36-47	42.3	2.20	202	37-50	42.0	2.24	391	36-50	42.5	2.22

TABLE 2: Percentage frequencies of black annuli in *Laticauda colubrina*, South Reef Island.

No. of black annuli	Frequency					
	1992		1995		Pooled	
	n = 318	% n	n = 73	% n	n = 391	% n
35	0	0.0	0	0.0	0	0.0
36	0	0.0	1	1.4	1	0.3
37	1	0.3	3	4.1	4	1.0
38	10	3.1	5	6.8	15	3.8
39	15	4.7	8	11.0	23	5.9
40	38	11.9	11	15.1	49	12.5
41	43	13.5	20	27.4	63	16.1
42	54	17.0	11	15.1	65	16.6
43	67	21.1	4	5.5	71	18.2
44	40	12.6	4	5.5	44	11.3
45	29	9.1	1	1.4	30	7.7
46	13	4.1	2	2.7	15	3.8
47	7	2.2	2	2.7	9	2.3
48	0	0.0	0	0.0	0	0.0
49	0	0.0	1	1.4	1	0.3
50	1	0.3	0	0.0	1	0.3
51	0	0.0	0	0.0	0	0.0

TABLE 3: Percentage of black annuli in *Laticauda colubrina* males, South Reef Island.

No. of black annuli	Frequency					
	1992		1995		Pooled	
	n = 149	% n	n = 40	% n	n = 189	% n
35	0	0.0	0	0.0	0	0.0
36	0	0.0	1	2.5	1	0.5
37	0	0.0	2	5.0	2	1.1
38	0	0.0	2	5.0	2	1.1
39	7	4.7	4	10.0	11	5.8
40	17	11.4	6	15.0	23	12.2
41	23	15.4	14	35.0	37	19.6
42	28	18.8	5	12.5	33	17.5
43	20	13.4	1	2.5	21	11.1
44	24	16.1	2	5.0	26	13.8
45	17	11.4	0	0.0	17	9.0
46	10	6.7	1	2.5	11	5.8
47	3	2.0	2	5.0	5	2.6
48	0	0.0	0	0.0	0	0.0

TABLE 4: Percentage frequencies of black annuli in *Laticauda colubrina* females, South Reef Island.

No. of black annuli	Frequency					
	1992		1995		Pooled	
	n = 169	% n	n = 33	% n	n = 202	% n
35	0	0.0	0	0.0	0	0.0
36	0	0.0	0	0.0	0	0.0
37	1	0.6	1	3.0	2	1.0
38	10	5.9	3	9.1	13	6.4
39	8	4.7	4	12.1	12	5.9
40	21	12.4	5	15.2	26	12.9
41	20	11.8	6	18.2	26	12.9
42	26	15.4	6	18.2	32	15.8
43	47	27.8	3	9.1	50	24.8
44	16	9.5	2	6.1	18	8.9
45	12	7.1	1	3.0	13	6.4
46	3	1.8	1	3.0	4	2.0
47	4	2.4	0	0.0	4	2.0
48	0	0.0	0	0.0	0	0.0
49	0	0.0	1	3.0	1	1.0
50	1	0.6	0	0.0	1	1.0
51	0	0.0	0	0.0	0	0.0

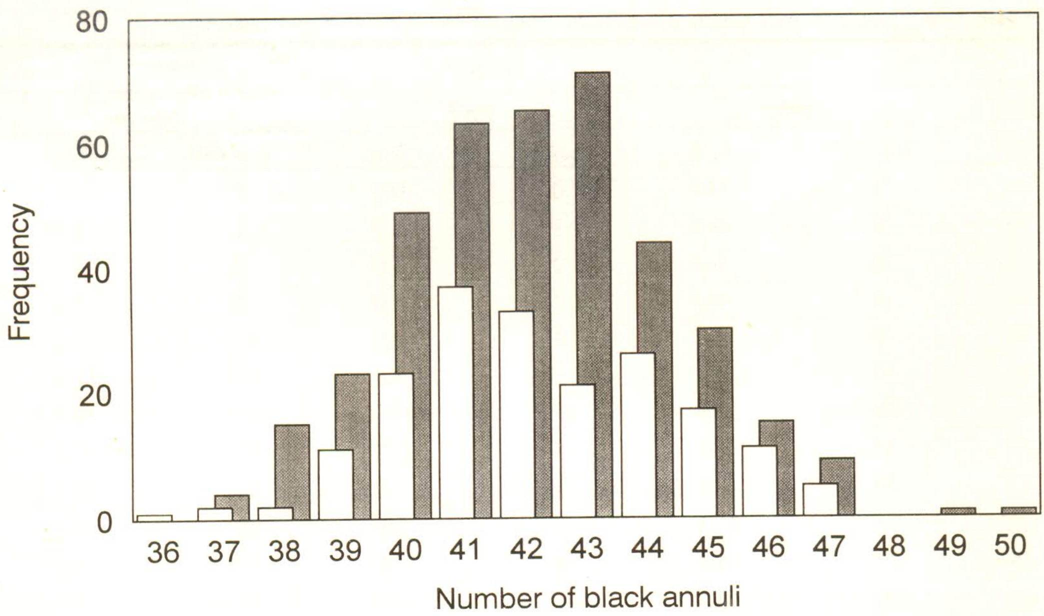

FIGURE 1: Frequency of black annuli in males (in white; n = 189) and females (in grey; n = 202) of *Laticauda colubrina*, South Reef Island.

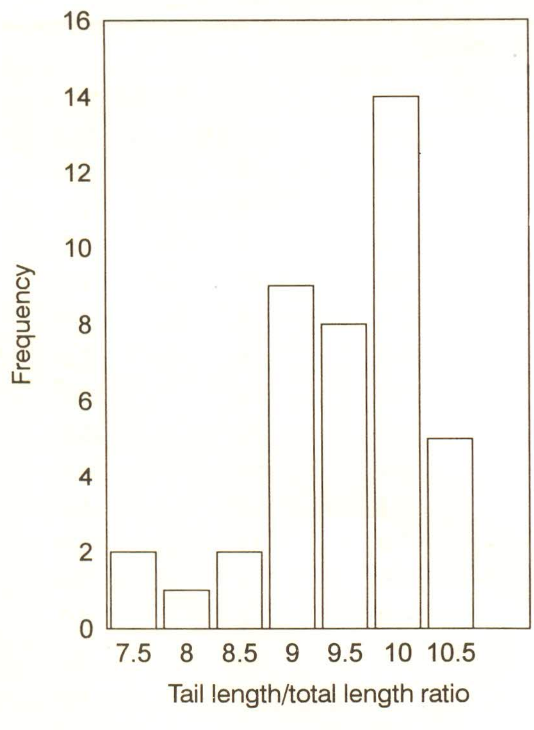

FIGURE 2: Frequency of tail length to total length ratio in female *Laticauda colubrina*, South Reef Island.

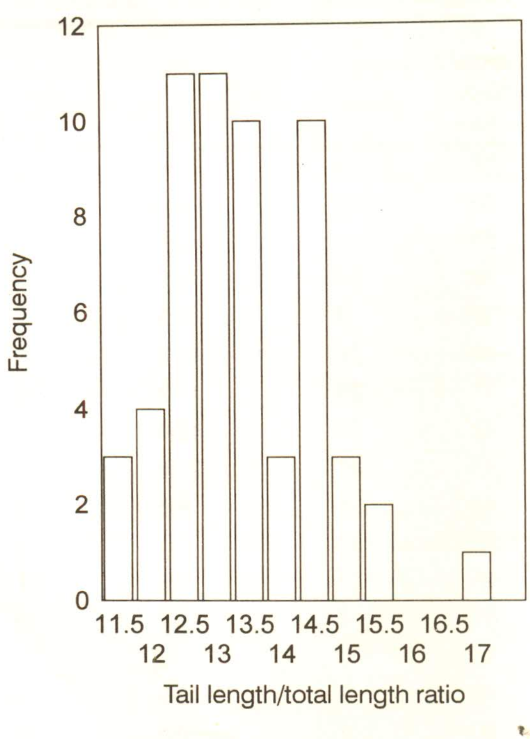

FIGURE 3: Frequency of tail length to total length ratio in male *Laticauda colubrina*, South Reef Island.

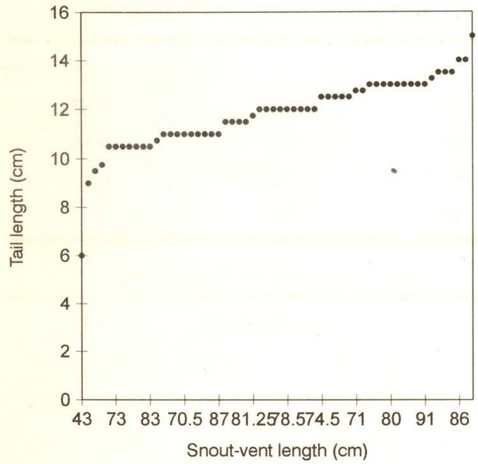

FIGURE 4: Relationship between snout-vent length and tail length in male *Laticauda colubrina*.

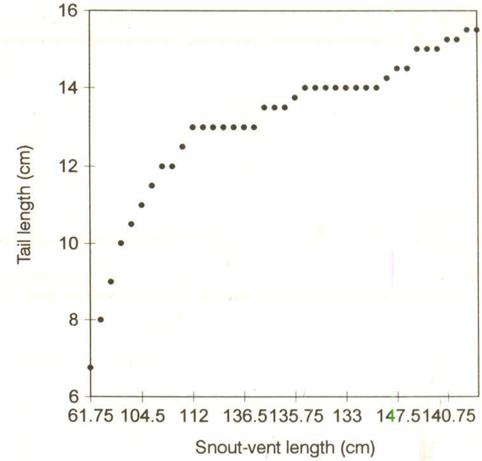

FIGURE 5: Relationship between snout-vent length and tail length in female *Laticauda colubrina*.

Sex ratio: From the observed frequency of occurrence of courtship activity and the absence on land of normal males shorter than 74.5 cm and of normal female shorter than 100.5 cm, it was concluded that all snakes encountered were sexually mature. Saint Girons (1964) found males longer than 50 cm to be mature on Petit Taenia in New Caledonia. Of 391 examples on South Reef, 48.3 per cent were males, 51.7 per cent females.

TABLE 5: Tail length (T) / Total length (L) % in *Laticauda colubrina*, South Reef Island.

	Males				Females			
Year	n	$\bar{x}$	± SD	range	n	$\bar{x}$	± SD	range
1992	18	13.3	1.38	11.2-16.7	8	8.8	0.77	7.4-9.8
1995	40	13.1	0.99	11.2-15.2	33	9.3	0.69	7.3-10.4
Pooled	58	13.1	1.13	11.2-16.7	41	9.2	0.73	7.3-10.4

Lengths and weights: Males were usually shorter than females, although lengths overlapped. Random samples of 58 adult and 38 adult females found on land had the following lengths- males: mean 90.7 cm, range 74.5-114.0 ± 8.4 SD; females: mean 143.4 cm, range 100.5-169.5 ± 17.7 SD cm. All figures exclude lengths in the cases of two snakes considered aberrants, a male of length 49.0 cm (the smallest, by 25.5 cm, of 189 males, for which data are available) and a female of length 68.5 cm (the smallest, by 32.0 cm, of 202 females). Only one (5.6 per cent) of the 18 males measured in 1992 was longer (by 0.25 cm) than the shortest (100.75 cm) female of that year. In 1995, however, eight (20 per cent) of 40 males were as long as, or longer than the shortest (100.5 cm long) female measured that year, the mean difference being 2.9 cm (and only 1.6 cm, if an unusually long 114 cm male is excluded). Three (7.9 per cent) of 38 females were shorter than the two longest males which measured 114 and 104 cm, the mean difference being 12.4 and 2.4, respectively.

The longest of 202 females measured 171.0 cm. This individual was not included in the random sample of 38. Among 202 females, the greatest girth measured 22.0 cm, but the snake involved regurgitated an eel head-first within 36 hours of measurement. A 154.0 cm female weighed 3.25 kg apparently after feeding. A female of girth 17.75 kg weighed only two kilos; another of girth 15.5 cm weighed 3.0 kg, apparently also after feeding, and mucilage oozed from its nostrils.

TABLE 6: Sex ratio in *Laticauda colubrina* specimens found on land, South Reef Island.

		Males		Females	
Year	(n)	n	% n	n	% n
1992	318	149	46.9	169	53.1
1995	73	40	54.8	33	45.2
Pooled	391	189	48.3	202	51.7

TABLE 7: Lengths (in cm) of *Laticauda colubrina* males and females found on land on South Reef Island.

	Males				Females			
Year	n	$\bar{x}$	± SD	range (cm)	n	$\bar{x}$	± SD	range (cm)
1992	18	88.6	6.6	78-101	6	141.5	21.7	100.8-160.5
1995	40	91.7	9.1	74.5-114	32	143.8	17.3	100.5-169.5
Pooled	58	90.7	8.4	74.5-114	38	143.4	17.7	100.5-169.5

TABLE 8: Geographical variation in relative length of tail (percentage tail length to total body length) in *Laticauda colubrina*.

		Males			Females		
Source	Location	range	$\bar{x}$	n	range	$\bar{x}$	n
Mao & Chen (1980)	Taiwan	12-15	14.0	7	9.0-11.0	10.0	16
Girons (1990)	New Caledonia	12.4-12.8	12.6	3	9.1-9.9	9.5	4
This study	South Reef Island	11.2-16.7	13.1	58	7.3-10.4	9.2	41

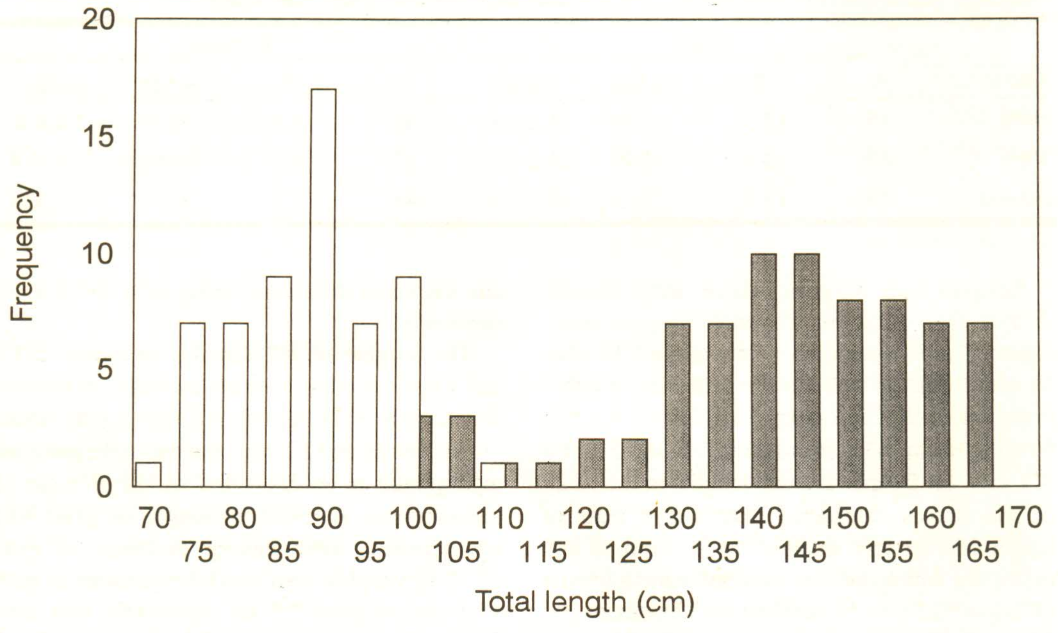

FIGURE 6: Frequency of body length of male and female *Laticauda colubrina* on South Reef Island.

Natural history notes: In all, 285 individuals were checked for the presence of ticks and injuries. Ticks (of unknown species) were present on the bodies of 22.8 per cent of samples, and injuries, invariably in the form of a healed or more or less fresh bite-shaped lesion, possibly inflicted by the marine eels which constitute the mainstay of their diet, in 10.2 per cent. Ticks were found under the scales on the dorsal, lateral and ventral parts of the body, and more frequently, on the dorsal ridge of the tail. Ticks often left U- or V-shaped notches on this ridge, and less frequently, scars and small holes (up to 2 mm in diameter) in the relatively narrow parts of the tail. Blemishes caused by ticks were not included in the counts of injuries. In one instance, a tick was present on the lower lip of a female that had lost an eye.

Individual snakes came shore from the sea on most nights, doing so from dusk onwards; commencing from an hour or more after dusk, others reentering the sea from the forest. Here, they have been observed to have rested at a single site from 10-19 days, moulting in some instances. A female tagged and released on land was re-encountered on land 58 days later. It was also seen stranding twice 17 days apart. Other individuals were reencountered after shorter durations, e.g., 37 days for a male. No snakes were seen reentering the sea at night later than 0415 hours. It is believed that most, if not all females that come ashore voluntarily do so after having consumed an eel, several species of which occur in the sea around South Reef. Three eels of unidentified species were obtained by inducing regurgitation. In each case, digestion had barely commenced, suggesting that the three snakes involved had swallowed their prey less than 24 hours prior to stranding. The shortest interval between successive strandings was 10 days, recorded for a female.

Though males and females usually came ashore singly, males often followed females from sea to land where they apparently located females using olfaction, sometimes attempting to mount them on the beach before a sheltered nook had been found. Up to two males have been observed coming ashore near and presumably following a female, and up to four males followed a departing female. In the latter instance, all the males returned to the forest without entering the sea despite having followed the female down the beach slope to the edge of the swash zone. On a good night, the fresh tracks of over 30 snakes can be found on the island's perimeter. After stranding, females often lie stretched out across the sloping beach sand above the existing tide line for an hour or two, in many instances with only their heads concealed under leaves of *Ipomoea*. They then entered the forest where a cool microhabitat was chosen.

Resting habitats on land were usually shaded from direct sunlight. One favoured spot was a recess where rainwater had collected in the fork of a tree 1 m above the substrate. Individual snakes stayed here singly, some for over four days at least. Water temperature here, measured at 1130 hours on a warm day on 9 November, 1992, was 26.2° C, 3.6° C cooler than sea temperature near shore.

There is evidence that *Laticauda colubrina* comes ashore in cohorts on occasions. Two females and a male collected on 1 November, 1992, and released on the beach on 2 November were all reencountered 37 days later as they stranded again, albeit at different points along the beach. Small aggregations of *L. colubrina* were frequently found on land, the usual composition being one female with either one, two or three males. In only one out of 36 aggregations checked was more than one female present- this one had two females and two males. Aggregations consisting exclusively of males (up to three males) were also found. Both sexes were also frequently found resting singly in the forest by day. During the 1995 study, only single snakes were found on land between 14 June (when the study began) and 28 June. The first aggregation (consisting of three males) was found on 29 June, after which both aggregations and single individuals were found. Copulation was observed only once, on 12 November (H. Andrews, pers. comm.). Sloughing was recorded in several instances, one female sloughing 17 days after choosing a resting site. The following resting sites were found on land by day: in crevices in fallen trees; under loose bark on or near fallen trees; inside hollow boles of fallen trees; in nooks between tree buttresses; on the substratum under *Pandanus* vegetation; under mats of fallen leaves within the forest; under beached flotsam, e.g., bamboo and driftwood; on beach sand under fallen leaves of *Scaevola* which borders the forest; under *Ipomoea* leaves (in the early morning or on overcast days); inside a hole in a beached coral boulder; under a plastic ground-sheet. No resting sites higher than 1.5 m above the substratum were found. The island being only 90 m broad, it can be stated only that thessnakes found resting sites at least 45 m into the forest. Some individuals are known to have stranded successfully on opposite shores of the 450 m long island.

Laticauda colubrina frequently exhibited positive phototaxis on land at night. This makes them vulnerable to destruction by humans who may attract them, with or without intent, by lighting a fire or even a hurricane lantern or flashlight within the forest.

On none of several islands in the Andamans and Nicobars surveyed was aggressive behaviour towards humans reported or observed, even by divers. Despite the tagging process used being visibly traumatic to the snakes, only one of 391 snakes showed any aggression before, after, or at the time their tails were punctured. This individual had inadvertently been handled roughly, and struck the back of the investigator's hand thrice within a second, apparently with its mouth closed. Sea kraits were trampled on accidentally at night by slipper-shod feet on at least 20 occasions on South Reef, triggering escape reactions in the snake in each case. In three instances, the investigator, while seated, felt around his ankle the tongues of sea kraits that had apparently been attracted to the lantern light.

Each year, up to 10 sea kraits are washed up on South Reef in a battered and weakened condition when rough seas coincide with spring tides and an abundance of flotsam. Most of these die on the shore within a fortnight, in some cases falling prey to the white-bellied sea eagle (*Haliaetus leucogaster*), one recent and three disused nests of which existed on the island.

An estimated 800 individuals of *Laticauda colubrina* stranded on South Reef between 24 August and 12 December, of which 314 were tagged. Fewer individuals strand during the drier months (December-May), but quantitative data are unavailable. The impact of South Reef's substantial rat population on the survivorship of eggs or hatchlings of sea kraits remains unknown. Though sometimes arboreal, rats compete with adult sea kraits over the latter's resting habitats on South Reef.

Laticauda laticaudata

Five individuals of *Laticauda laticaudata* were encountered on the shores of South Reef. Two were females (seen on 7 November, 1992 and 9 October, 1993) and three males (31 October, 1992, 11 October, 1993 and 24 June, 1995). The number of black annuli present averaged 70.4 (range 66-75 ± 4.56 SD). Two snakes whose black caudal annuli were counted had 11 each.

A female laid three eggs in a snake bag on 13 November, 1993. Since it had been then held for 35 days, it cannot be assumed that the clutch would have been laid on South Reef had the snake been free. The eggs measured 61.1 x 63.8 (mean 62.0) x 17.2 x 18.7 (mean 18.2) mm. In all instances, the body and tail colouration was ultramarine on the dorsum, shading to progressively lighter blue towards the ventrum.

DISCUSSION

No eggs, hatchlings or specimens of *Laticauda colubrina* shorter than 49 cm have been found in any month of the year on South Reef. Oviposition in this species takes place on rocky islands (Stuebing, 1988; Pernetta, 1977). Neither igneous nor clastic sedimentary rocks occur above high tide level on South Reef; sedimentary limestones exist but lie buried under coral sand a few centimetres to 2 m deep, except where erosion of the coast by the sea occurs, offering this species little or no nesting habitats. Currently, erosion takes place largely on the island's south-western corner, where rectangular blocks of sedimentary limestone up to 1.5 x 1 m in size and 30 cm thick are sometimes broken off and exposed. This stretch which includes only 50 m of the island's 1 km coastline attracts a disproportionate share of the sea kraits that strand, though substantial numbers also come ashore on the island's sandy shores, which extend for about 700 m. All five specimens of *L. laticaudata* encountered stranded on the eroded stretch.

A hatchling *Laticauda colubrina* is reported to have been seen crawling down a beach slowly on

Landfall Island, the northern-most of the Andamans, in May. Oviducal eggs have also been found in May in Borneo (Das, 1992), their numbers being nine and five in the two gravid females found. Clutch sizes in *L. semifasciata* (Reinwardt) in the Sea of Japan range from one to eight (Toriba and Nakamoto, 1987), a clutch from Taiwan had five eggs (Mao and Chen, 1980). Seven oviducal eggs were reported for a specimen of *L. laticaudata* (Wall, 1921), as against three eggs in the clutch laid during the present study.

The number of black annuli in the five specimens of *Laticauda laticaudata* found on South Reef (range 65-75) are among the highest recorded for the species. Counts vary widely, ranging from 20 for a specimen from Java to 66 for one from the Sulu Sea, and from 39 to 55 in the Japanese archipelago (Taylor, 1965). *L. laticaudata* from Taiwan show five to six black annuli on the tail (Mao and Chen, 1980), compared to 11 on each of two specimens from South Reef. It is noteworthy that the background colouration on the body and tail in all five examples from South Reef was ultramarine, rather than bluish-grey usually recorded elsewhere. The lengths of *L. colubrina* males recorded by Mao and Chen (1980) from Taiwan (mean 87 cm, range 69-104 cm; n = 7) are comparable to those on South Reef (mean 90.7 cm, range 74.5-114.0 cm; n = 58), but females were shorter (mean 115.6 cm; range 65.9-165.2 cm; n = 16; vs mean 143.4 cm, range 100.5-169.5 cm; n = 41) on South Reef. On New Caledonia, a sample of 174 individuals of *L. colubrina* which included subadults and adults had 36.2 per cent and 63.8 per cent males (Saint Girons, 1964). The South Reef study found more females than males (51.7 per cent vs 48.3 per cent) in a sample of 391 snakes, although this difference is not statistically different.

ACKNOWLEDGEMENTS

The study on South Reef formed part of a project initiated and funded by the Centre for Island Ecology/Andaman and Nicobar Environmental Team, a division of the Madras Crocodile Bank Trust and the Royal Netherlands Embassy. I thank the Andaman and Nicobars Forest Department for having issued permits, the three Divisional Forest Officers at Mayabunder between 1992 and 1995, and Saw Bonny, Camp Officer, and his crew on Interview Island, for providing logistic support. Mark Bastian rendered assistance in 1992 and Arjun Sivasunder in 1995 and Harry Andrews oversaw the project through four years.

LITERATURE CITED

COGGER, H., H. HEATWOLE, Y. ISHIKAWA, M. McCOY, N. TAMIYA & T. TERUUCHI. 1987. The status and natural history of the Rennell Island sea krait, *Laticauda crockeri* (Serpentes: Laticaudidae). *J. Herpetol.* 21: 255-266.

DAS, I. 1992. Notes on egg sizes and ticks of the yellow-lipped sea krait (*Laticauda colubrinus*) on Pulao Punyit, Brunei Darussalam. *Hamadryad* 19: 45-46.

MAO, S.-H. & B. Y. CHEN. 1980. Sea snakes of Taiwan. A natural history of sea snakes. National Science Council Special Publication No. 4, Taipeh.

PERNETTA, J. C. 1977. Observations on the habits and morphology of the sea snake, *Laticauda colubrina* (Schneider) in Fiji. *Canadian J. Zool.* 55: 1612-1619.

SAINT GIRONS, H. 1964. Notes sur l'ecologie et la structure des populations des Laticaudinae (Serpents, Hydrophiidae) en Nouvelle Caledonie. *La Terre et la Vie* (2): 185-214. See also: Notes on the ecology and population structure of the Laticaudinae (Serpentes, Hydrophiidae) in New Calidonia. *Bull. Chicago Herpetol. Soc.* 25: 197-209. (English translation by I. M. Fauie, P. A. Gritis & H. K. Voris.)

STUEBING, R. B. 1988. Island romance: the biology of the yellow-lipped sea krait. *Malayan Natural.* 41: 9-11.

TAYLOR, E. H. 1965. The serpents of Thailand and adjacent waters. *Univ. Kansas Sci. Bull.* 45(9): 609-1096.

TORIBA, M. & E. NAKAMOTO. 1987. Reproductive biology of Erabu sea snake *Laticauda semifasciata* (Reinwardt). *The Snake* 19: 101-106.

WALL, F. 1921. Ophidian Taprobanica, or the snakes of Ceylon. Government Printer, Colombo.

Accepted: 10 December, 1996.

Hamadryad, Vol. 21, pp. 36-42, 1996.

PLACEMENT AND PREDATION OF NEST IN LEATHERBACK SEA TURTLES IN THE ANDAMAN ISLANDS, INDIA

Arjun Sivasundar[1] and K. V. Devi Prasad

Sálim Ali School of Ecology, Pondicherry University, Pondicherry 605 014, India.
[1]Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

(with four text figures)

ABSTRACT.- Selection of nest sites by leatherback sea turtles (*Dermochelys coriacea*) was studied at Little Andaman Island and Rutland Island, Andaman archipelago, India. Turtles were found to nest further inland on wider beaches. The elevation of the nest above the high tide line and the distance of the nest from the vegetation line were more controlled; 83.81 per cent of the nests were located less than 9 m from the vegetation. Predation of nests was high in two of three sites; 68.57 per cent of all nests were destroyed by *Varanus salvator*.

KEY WORDS.- Nest site selection, nest predation, *Dermochelys coriacea*, Andaman Islands, India.

INTRODUCTION

The leatherback sea turtle (*Dermochelys coriacea*) is the largest marine reptile and has the greatest distributional range of any reptile, inhabiting waters from New Zealand to north of the Arctic Circle (Standora et al., 1984). This circumglobal species nests on beaches of tropical areas, generally on high energy mainland coasts, and forages widely and regularly in temperate waters. The species has been described as a temperate zone form with a tropical nesting range (Ross, 1982). It seems likely that this wide ranging, powerful swimmer has the highest level of gene flow around the world, amongst all sea turtle species (Hendrickson, 1982).

The selection of a nest site by sea turtles is based on several physical and chemical factors, such as grain size, dune configuration, compressibility of beach sand and smell; thermal variation in the beach sand may also be an important environmental cue to nest site selection (Stoneburner and Richardson, 1981). The presence of vegetation on the beach may play a role in nest site selection. Nest success is believed to be influenced by a number of interacting ecological factors, such as sand temperature, sand particle size, water content and salinity.

Favourable nest placement is critical to the survival of sea turtle populations and hence there is a considerable interest in nest placement by sea turtles from a conservation standpoint. For sea turtles, the survival of the offspring may be strongly related to the distance that the nest is laid from the sea, and from the supralittoral vegetation behind the beach (Mrosovsky, 1983). For nests laid too near the sea, there is a risk of egg loss due to erosion, and mortality due to salt water inundation; for nests laid too far from the sea, there is a risk of disorientation of hatchlings into supralittoral vegetation.

Hatchling success is influenced by several abiotic factors, such as temperature (Mrosovsky et al., 1984), oxygen levels (Ackerman, 1980), chloride levels (Bustard and Greenham, 1968) and mositure content (McGhee, 1990; Mortimer, 1990). All developmental stages are vulnerable to rain-induced suffocation. Eggs in flat, poorly-drained areas are more susceptible to mortality than those situated in elevated dunes (Kraemer and Bell, 1980). Mositure content of the sand is believed to be one of the cues for hatchlings to finding the sea, and this varies along the sea to vegetation axis.

Nest site location may not only affect nest success, but may also affect hatchling sex ratio, since sex determination in the species is dependent on the incubation temperature (Chan and Liew, 1995; Mrosovsky and Yntema, 1980), which is dependent on the nest site.

STUDY SITES

The Andaman and Nicobar Islands are an archipelago of over 350 islands in the Bay of Bengal, India, between 06° 45' and 13° 41'N (extent 740 km) and 92° 12' and 93° 57'E (extent 190 km). They receive a mean annual rainfall of 3,180.5 mm and the temperature varies between 16.7-36.1° C.

Little Andaman is the southern-most of the Andamans group of islands. South Bay (study site 1) is located in the southern-most tip of the island and faces south-west. It shows rocks and reef formations along the corners and sandy beaches in the centre. The nesting beach at South Bay is around 5 km in length. The width of the nesting beach is in the range 2-80 m. It consists of two distinct sections. The offshore approach to the first section is shallow and rocky, with reef formations which are exposed at low tide. Hence, approach to this section at low tide is not possible. The offshore approach to the second section is shallow and sandy. Ground vegetation, mainly *Ipomoea pes-caprae* is present in almost all parts of the beach.

West Bay (study site 2) is located on the western coast of Little Andaman Island. The beach at West Bay is similar in all respects to the second section of the one at South Bay. The length of the nesting beach is around 6.2 km and the width varies from 15-90 m. Water monitor lizards (*Varanus salvator*) are uniquitous on this island and are the primary predators of sea turtle eggs and hatchlings, and the beaches are covered with their spoor. Almost all nests found on these beaches had been excavated and the eggs eaten by these lizards.

Rutland Island is located south of South Andaman Island. Jahazi beach (study site 3), which is on the west coast, is about 2 km long, the width of the beach varying from 2.5-45 m. The offshore approach to this beach is deep and sandy. *Varanus salvator* is present on this island, but there is no evidence of turtle egg predation.

METHODS

At the time of the study, the nesting season for leatherback sea turtles in the Andaman Islands were almost over, and many of the nests recorded had been laid a few hours to several days before the collection of data. Since these are virtually uninhabited areas, the beaches are undisturbed and crawl marks and body pits of the nesting turtles were clearly visible for several weeks after nesting.

The nesting beaches were patrolled on foot and nest location data collected. The following parameters were recorded for each nest:

1. Distance of the nest from high tide line (HTL) along the slope of the beach, which was measured with a pre-measured nylon rope;
2. Distance from vegetation line (VL), also measured with the same rope;
3. Number of nesting attempts made by the turtle, in vegetation, on sand, and the total;
4. Slope of the beach at the nesting site. This was measured by placing two poles 10 m apart on the sea-to-vegetation line and measuring the vertical difference (v metres) between the two poles using a rope running from the bottom of the pole at a higher elevation horizontal to the other pole; the angle was then calculated as $\tan^{-1}$ (v/10); horizontal placement of the rope was ensured using a spirit level, and vertical placement of the poles was ensured using a plumb line;
5. Predation status of the nest;
6. Type of vegetation in and around the nesting site;
7. Beach width at the point of nesting; and
8. Vertical height of the nest above the high tide line, calculated from the distance from HTL and the slope of the beach (see Horrocks and Scott, 1991).

Variation in nest sites between the three study sites was studied using ANOVA ($P < 0.05$). Multiway correlations were calculated for the various parameters. Statistical analyses were conducted using Microsoft Excel 5.0.

The number of nesting attempts were categorised as vegetation attempts and sand attempts, and analyzed for individual sites as well as for the three sites considered together; nests were also categorised as preyed upon and intact, and analyzed similarly.

RESULTS

Nest site preference

There was no significant variation between sites in the distance from the nest to the vegetation and in the slope of the beach at the nest site, while there was a significant difference between sites in the other nesting site parameters, such as the number of nesting attempts, distance to high tide line, height above high tide line, width of beach at nest site and height of beach at nesting site (i.e., difference in height between the high tide line and the vegetation line).

Nesting attempts

Most nests (85 of 105, or 80.95 per cent) were laid in three or fewer attempts. There was a significant variation between the three sites ($F_{2, 102} = 10.58$, F_{crit} 3.085, $P < 0.05$), with turtles at South Bay making the maximum number of nesting attempts (mean 3.615 ± 2.155 SD) per nest.

Distance from high tide line

Almost all the classes were used, and there are several peaks. Of 105 nests, 84 (80 per cent) were in the range 9-42 m from the high tide line (Fig. 1). The mean (24.243 m) and median (24 m) distance from the high tide line are nearly equal, and are much higher than the average of 11.76 m reported for leatherbacks nesting in Culebra, Puerto Rico in 1986 and 1987 (Tucker, undated). There was a significant variation between the three sites ($F_{2, 102} = 76.24$, $F_{crit} = 3.085$, $P < 0.05$), with turtles at West Bay nesting furthest from the high tide line (mean 33.458 m ± 9.809 SD).

Height above high tide line

Most nests (93 of 105, or 88.57 per cent) were at an elevation of 4 m or less above the high tide line (Fig. 2). Nests were clumped in the regions of lower elevation, possibly due to the topography of the beaches which slope quite gradually from the high tide line to the vegetation. There was a significant variation between the three sites ($F_{2, 102} = 16.29$, $F_{crit} = 3.085$, $P < 0.05$), with nests situated highest above the high tide line in the West Bay (mean 3.328 m ± 2.894 SD).

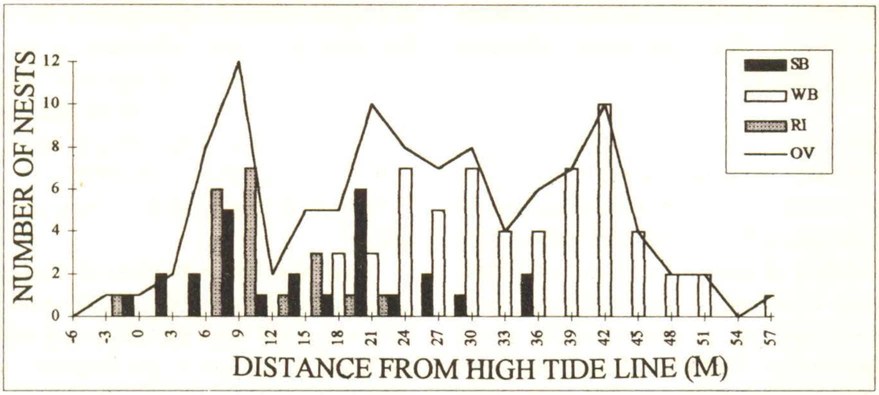

FIGURE 1: Distance of *Dermochelys coriacea* nest from high tide line. Abbreviations: SB = South Bay; WB = West Bay; RI = Rutland Island; OV = Overall.

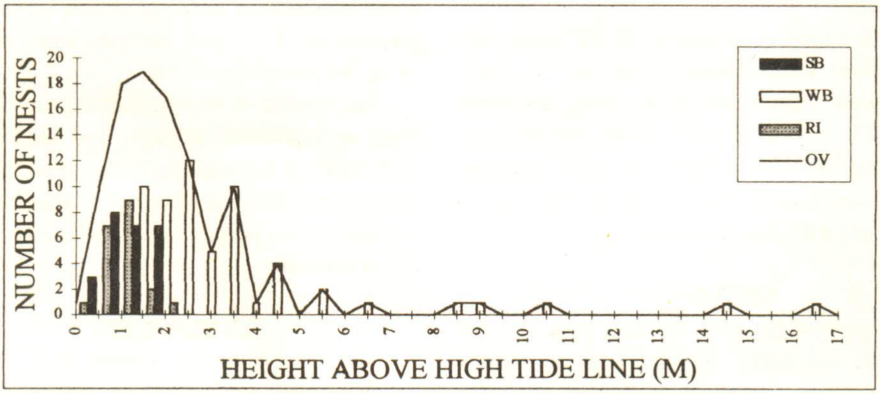

FIGURE 2: Height of *Dermochelys coriacea* from high tide line. Abbreviations as in Fig. 1.

Distance from vegetation line

Distance from the nest to the vegetation line was in the range 0-36 m, with 88 of 105 (83.81 per cent) nests falling within 9 m of the VL, and the remaining 17 between 9-36 m. The overall distance from the vegetation line was 5.1 m (± 7.25 SD), which is lower than the average (6.55 m) reported by Tucker (undated) for leatherbacks nesting in Culebra, Puerto Rico. Among the three sites, the average distance from the vegetation was the highest in West Bay (mean 5.894 m ± 7.988 SD; see Fig. 3). There was no significant variation between the three sites ($F_{2,\,102} = 1.17$, $F_{crit} = 3.085$, $P < 0.05$).

Slope of beach

The average gradient of the beach at the nest sites was 5.5° (± 4.55 SD). In terms of numbers, 84 (80 per cent) nests were on sections with slopes of 6° or less, the remaining 21 in steeper sections varying from 6°-39° in gradient. According to Mortimer (1982), leatherbacks nesting beaches typically slope steeply, thus reducing the distance between the waterline and the nest sites. In the sites in the Andamans, however, the nests were neither too steep nor were placed too close to the waterline, on average. Among the three sites, the gradient of the beach was higher on West Bay (mean 5.69° ± 4.127 SD) and South Bay (mean 5.69° ± 6.51 SD) than at Rutland Island (mean 4.72° ± 2.13 SD), but the variation was not significant ($F_{2,\,102} = 0.364$; $F_{crit} = 3.085$, $P < 0.05$).

Beach width

Nests were located on sections of beach varying from 1.5 - 79.5 m. All classes were used, and the frequency distribution shows several peaks. Of 105 nests, 82 (78.1 per cent) were in the 9-45 m range. Among the three sites, there was significant variation in this parameter ($F_{2,\,102} = 55.69$, $F_{crit} = 3.085$, $P < 0.05$).

Beach height

Of all nests in the three sites, 89 (84.76 per cent) were located on stretches of beach 4 m or

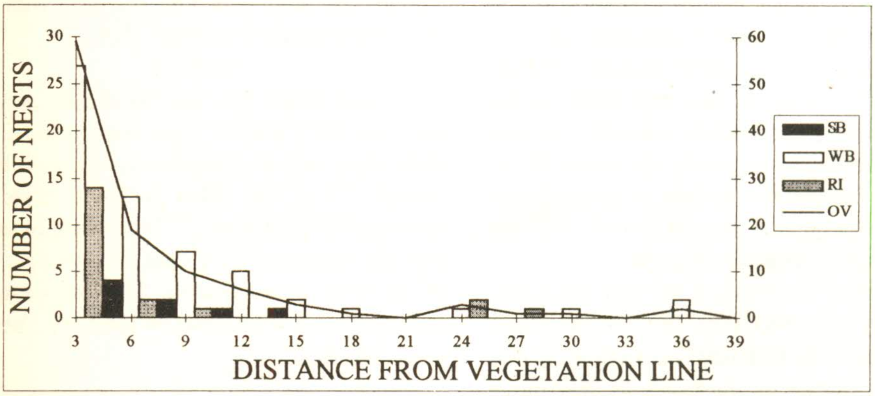

FIGURE 3: Distance of *Dermochelys coriacea* nest from the vegetation line. Abbreviations as in Fig.1.

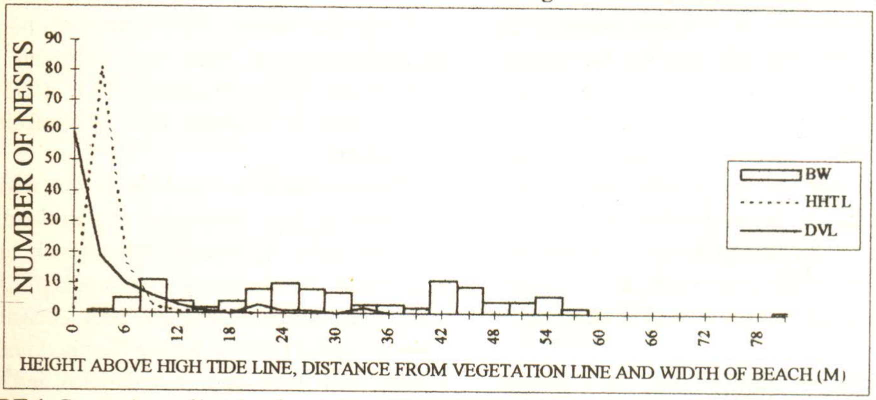

FIGURE 4: Comparison of height of nest above high tide line (HHTL), distance from vegetation (DVL) and beach width (BW) of *Dermochelys coriacea*.

less in elevation, the remainder in the 4-20 m range. This suggests that beaches of lower elevation are preferred. There was a significant variation in the height of the beach at the nest site between the three sites ($F_{2,\ 102} = 17.28$, $F_{crit} = 3.085$, $P < 0.05$).

The distance of the nest from the high tide line had a strong positive correlation ($r = 0.891$, $P < 0.05$) with beach width. Consequently, the elevation above the high tide line also correlates positively with the beach width ($r = 0.535$). This indicates that turtles move further inland on wider beaches, and not an invariant distance from the sea, which is in accordance with the findings of Eckert (1987) for leatherbacks and Hays and Speakman (1993) for loggerhead sea turtles (*Caretta caretta*).

The correlation (r) between beach width and the distance from vegetation line was 0.496, suggesting that turtles do not vary the distance from the vegetation line as much as they vary the distance from the high tide line on sections of beach with varying width. Figure 4 compares the frequency distribution of height above high tide line, distance from vegetation line and width of the beach. It is evident that while beaches of all widths are used by nesting leatherbacks, the height above the high tide line and the distance of the nest from the the vegetation line are controlled, and the preferred range is relatively narrow.

The height of the beach at the nest site correlated strongly ($r = 0.985$; $P < 0.05$) with the height of the nest above the high tide line, suggesting that turtles move further up the beach as they move further inland on wider beaches. There was no significant correlation ($r = 0.069$) between the distance from the high tide line and the slope of the beach. This is contrary to the findings of Horrocks and Scott (1991) for hawksbill sea turtles (*Eretmochelys imbricata*), where the distance from the high tide line was greater on less steep beaches and less on the steeper beaches, suggesting that these turtles attempt to select nesting sites based on the elevation of the beach, by varying the distance they move inland on beaches of different slopes.

Of 105 nests, 34 (32.4 per cent) were in vegetation, the remaining 71 (67.62 per cent) on open sand. In all 105 nests, there was supralittoral vegetation, and thus turtles had the option of nesting either in vegetation or in open sand. From the relative proportions of nests in vegetation and sand, it would appear that they preferred to nest in open sand, but within the first 9 m from the edge of the vegetation.

The average ratio of nests in open sand to vegetation was 2.09, and was highest on South Bay (4.2) and lowest on Rutland Island (1.5). In all sites, fewer attempts were made in vegetation (30.45 per cent) than on open sand (69.55 per cent). In all, 266 attempts were made for 105 nests, i.e., 161 (60.53 per cent) aborted attempts, averaging 2.53 attempts per nest. In individual sites, the highest number of attempts per nest was on South Bay (3.62) and lowest on Rutland Island (1.85). Of attempts on sites with vegetation, 61.62 per cent were aborted, while the corresponding figure for attempts on sand was slightly lower (58.02 per cent). Of all aborted attempts, 70.81 per cent were on sites with vegetation and 29.19 per cent on open sand, indicating that sites with vegetation were rejected far more often.

Predation

On both South Bay and West Bay, predation was high (88.5 and 83.1 per cent, respectively), while there was no predation on Rutland Island. Overall, 72 of 105 (68.6 per cent) nests were destroyed by predators, 27.78 per cent in vegetation, the remaining (72.22 per cent) on open sand. Of all nests in vegetation, 58.8 per cent were destroyed, and of all nests on sand, 73.2 per cent were destroyed.

DISCUSSION

Comparing historical records of sea turtles in the Andamans (e.g., Man, 1883; Portman, 1899) with recent ones (Bhaskar, 1981; 1993; this study), there is evidence of a large decline in populations.

The two islands on which the present study was conducted (Little Andamans and Rutland) harbour the only significant leatherback nesting beaches in the Andamans Archipelago. A few other areas where nesting has been occasionally reported in the past (including Cuthbert and Karmatang, both in the Middle Andamans, and Magar Nala in Little Andaman Island) were also surveyed, but no evidence of nesting was found.

Developmental activities, increased human pressure and removal of large quantities of beach sand for construction are some of the probably reasons for this decline in nesting activities.

As have been reported, predation of eggs is extremely high on Little Andaman Island. Yet, the two beaches at West Bay and South Bay have continued to be the most important nesting sites in these islands for leatherbacks for the last 20 years. This study has shown that vegetation-backing beaches and the first few metres from the vegetation line are preferred nesting sites, as are sites that are low in elevation. These factors should be taken into consideration when prioritizing sections of habitats for conservation or inclusion into the protected areas system. While the available data are insufficient to make any conclusions on population trends, it is likely that, given the present predation rate, few hatchlings from the present generation will survive to sexual maturity.

With such a high predation rate, it is vital that no further pressure is placed on nesting leatherbacks. So far, the nesting beaches at Little Andaman Island have been free from human disturbance, except for a small part on the West Bay, by the Onge tribals. This status has to be maintained if this important nesting ground of leatherbacks is to remain intact. Further work needs to be done on the population status of the species in the region, the impact of predation and the population dynamics of *Varanus salvator* (a major egg-predator) in the area.

ACKNOWLEDGEMENTS

We are grateful to the Centre for Island Ecology/Andaman and Nicobar Environmental Team, a division of the Madras Crocodile Bank Trust, Royal Netherlands Embassy, University Grants Commission and Pondicherry University for funding this study, and to the Andaman and Nicobar Forest Department for permission and support.

LITERATURE CITED

ACKERMAN, R. A. 1980. Physiological and ecological aspects of gas exchange by sea turtle eggs. *American Zool.* 20: 575-583.

BHASKAR, S. 1981. Sea turtle survey of Great Nicobar and Little Andaman Islands. Report to the World Wildlife Fund- India.

________ . 1993. The status and ecology of sea turtles in the Andaman and Nicobar Islands. Centre for Herpetology Publication No. ST 1/93: 1-37.

BUSTARD, H. R. & P. GREENHAM. 1968. Physical and chemical factors affecting hatching in the green sea turtles, *Chelonia mydas*. *Ecology* 49: 269-276.

CHAN, E. H. & H. C. LIEW. 1995. Incubation temperatures and sex-ratios in the Malaysian leatherback turtle *Dermochelys coriacea*. *Biol. Conserv.* 74: 169-174.

ECKERT, K. L.1987. Environmental unpredictability and leatherback sea turtle (*Dermochelys coriacea*) nest less. *Herpetologica* 43: 315-323.

HAYS, G. C. & J. R. SPEAKMAN. 1993. Nest placement by loggerhead turtles, *Caretta caretta*. *Anim. Behav.* 45: 47-53.

HORROCKS, J. A. & N. M. SCOTT. 1991. Nest site location and nest success in the hawksbill turtle *Eretmochelys imbricata* in Barbados, West Indies. *Mar. Ecol. Prog. Ser.* 69: 1-8.

HENDRICKSON, J. R. 1982. Nesting behavior of sea turtles with emphasis on physical and behavioral determinants of nesting success or failure. *In*: Biology and conservation of sea turtles. pp: 53-57. K. A. Bjorndal (ed). Smithsonian Institution Press, Washington, D.C.

KRAEMER, J. E. & R. BELL. 1980. Rain induced mortality of eggs and hatchlings of loggerhead sea turtles (*Caretta caretta*) on the Georgian coast. *Herpetologica* 36: 72-77.

LIMPUS, C. J., V. BAKER & J. D. MILLER. 1979. Movement indiced mortality of loggerhead eggs. *Herpetologica* 35: 335-338.

McGHEE, M. A. 1990. Effects of moisture on eggs and hatchlings of loggerhead sea turtles (*Caretta caretta*). *Herpetologica* 46: 251-258.

MAN, E. H. 1883. The aboriginal inhabitants of the Andaman Islands. Reprinted 1978, Sanskaran Prakashak, New Delhi.

MORTIMER, J. A. 1982. Factors influencing beach selection by nesting sea turtles. *In*: Biology and conservation of sea turtles. pp: 45-51. K. A. Bjorndal (ed). Smithsonian Institution Press, Washington, D.C.

________ . 1990. The influence of beach sand characteristics on the nesting behavior and clutch survival of green turtles (*Chelonia mydas*). *Copeia* 1990: 802-817.

MROSOVSKY, N. 1983. Ecology and nest site selection of leatherback turtles, *Dermochelys coriacea*. *Biol. Conserv.* 26: 47-56.

________ , P. H. DUTTON & C. P. WHITMORE. 1984. Sex ratios of two species of sea turtle nesting in Suriname. *Candian J. Zool.* 67: 2227-2239.

________ & C. L. YNTEMA. 1980. Temperature dependence of sexual differentiation in sea turtles: implications for conservation practices. *Biol. Conserv.* 18: 271-280.

PORTMAN, M. V. 1899. The history of our relations with the Andamanese. Office of the Superintendent of Government Printing, Calcutta.

ROSS, J. P. 1982. Historical decline of loggerhead, ridley and leatherback sea turtles. *In*: Biology and conservation of sea turtles. pp: 189-195. K. A. Bjorndal (ed). Smithsonian Institution Press, Washington, D.C.

STANDORA, E. A., J. R. SPOTILA, J. A. KEINATH & C. R. SHOOP. 1984. Body temperatures, diving cycles and movement of a subadult leatherback turtle, *Dermochelys coriacea*. *Herpetologica* 40: 169-176.

STONEBURNER, D. L. & J. I. RICHARDSON. 1981. Observations on the role of temperature in loggerhead turtle nest site selection. *Copeia* 1981: 238-241.

TUCKER, A. D. Undated. A summary of leatherback turtle *Dermochelys coriacea* nesting at Culebra, Puerto Rico from 1984-1987 with management recommendations. Report submitted to the U.S. Fish and Wildlife Services.

Accepted: 10 December, 1996.

Hamadryad, Vol. 21, pp. 43, 1996

A NOTE ON REPRODUCTION IN THE DESERT MONITOR (*VARANUS GRISEUS*)

Of the four monitor lizard species in India, *Varanus griseus*, the desert monitor, is the least known. Auffenberg et al. (1988) reported that it hatches between July and September in neighbouring Pakistan. This short communication presents data on egg deposition and incubation in the wild.

Three burrows were located during a visit between July-August, 1993 to Fatehgarh, Agra District, northern India. One contained five eggs that were laid on 12 October. They were buried in sand and dry leaves, and were leathery-shelled, oval and pale-yellowish in colour. Eggs were not measured or weighed. A single hatchling (total body length ca. 12 cm) emerged on day 284 (on 24 July, 1994). The rest of the eggs failed to hatch for unknown reasons. Subsequently, on day 325, the dried-up eggs were dissected and were found to contain dead embryos. The sole surviving young lizard was active, drinking water and eating small insects for five days after hatching.

I thank A. K. Sinha and Sant Prakash, Department of Zoology, Dayalbagh Educational Institute, Agra for advice and Munna Lal for assistance during field work.

LITERATURE CITED

AUFFENBERG, W., H. REHMAN, F. IFFAT & Z. PERVEEN. 1988. Notes on the biology of *Varanus griseus koniecznyi* Mertens (Sauria: Varanidae). *J. Bombay nat. Hist. Soc.* 87: 27-36.

BRIJ KISHOR GUPTA, The Coimbatore Zoological Park and Conservation Centre, Pioneer House, Peelamedu, Coimbatore 641 004, Tamil Nadu, India.

Accepted: 1 November, 1995.

Hamadryad, Vol. 21, pp. 43-44, 1996

ON THE TICK *APONOMA GERVAISI* IN *VARANUS BENGALENSIS* AND *V. GRISEUS*

Ticks are obligate blood-sucking ectoparasites of terrestrial vertebrates, occasionally transmitting other parasites and a large variety of infectious diseases, including tick-borne fever, tularemia and louping ill (Marcus, 1981). They are usually found under the scales of reptiles, around the chin, eyes, cloaca, body folds and in the buccal cavity (Bernard, 1991). Heavy infestation and tick-feeding activities produces host reactions such as toxicosis-like sweating, sickness, tick paralysis caused by salivary fluids and toxins, skin wounds susceptible to secondary bacterial infections, and irritations that cause skin trauma, anemia and even death (Fraser et al., 1991).

The present study was undertaken at five localities in Agra, northern India, in order to identify the ecoparasites of the monitor lizards, *Varanus bengalensis* and *V. griseus*. In all, 25 lizards that were caught by local animal dealers in 1992-1993 were examined. All individual animals were externally examined and ticks from 15 lizards removed by applying alcohol and dichlorodivinyl phosphonate, dichlrovos (DDVP) pest strips, as described by Momin et al. (1990). All ticks were identified at the Parasitology Laboratory of the Zoology Department, Dayalbagh Educational Institute, Agra.

The incidence of infestation by ticks (a single species: *Aponoma gervaisi*) was found to be high, occurring in the cloacal region and the buccal cavity. The number of animal of each of the two host species examined and the intensity of

TABLE 1: Number of *Varanus bengalensis* examined and found infested by ticks

Site	Examined	Infested	Ticks collected
Fatehabad	4	4	25
Pinahat	3	2	12
Bazidpur	1	-	-
Agra	2	1	8
Shamshabad	2	1	5

TABLE 2: Number of *Varanus griseus* examined and infested by ticks.

Site	Examined	Infested	Ticks collected
Fatehabad	1	1	6
Bazidpur	2	1	17

intestation are given in Tables 1 and 2. Further epidemiological studies are required to understand the patterns of infestation, which was found to be 66 per cent in the two species. Auffenberg and Auffenberg (1990) have reported *A. gervaisi* as a parasite of *Varanus bengalensis* in Pakistan and India.

I thank A. K. Sinha, Sant Prakash and Som Prakash, Department of Zoology, Dayalbagh Educational Institute, Agra for advice and N. V. K. Ashraf for comments.

LITERATURE CITED

AUFFENBERG, W. & T. AUFFENBERG. 1990. The reptile tick *Aponoma gervaisi* as a parasite of monitor lizards in Pakistan and India. *Bull. Florida Mus. nat. Hist. Biol. Sci.* 35(1): 1-34.

BARNARD, S. 1991. Common ectoparasites of reptiles. *Zoo Zen* 7(2): 46-47.

FRASER, M. C., J. A. BERGERON, A. MAYS & S. E. AIELLO. 1991. The Merck veterinary manual. Merck & Co., Rahway, New Jersey.

MARCUS, L. C. 1981. Veterinary biology and medicine of captive amphibians and reptiles. Lea & Febinger, Philadelphia.

MOMIN, R. R., D. K. PETHKAR & R. H. SABAPURA. 1990. Parasites of reptiles. *Zoos' Print* 5(10): 20-24.

BRIJ KISHOR GUPTA, The Coimbatore Zoological Park and Conservation Centre, Pioneer House, Peelamedu, Coimbatore 641 004, Tamil Nadu, India.

Accepted: 15 December, 1995.

Hamadryad, Vol. 21, pp. 44-45, 1996

GEOGRAPHIC VARIATION IN THE NUMBER OF BANDS IN *LATICAUDA COLUBRINA*

This note deals with the variation in the number of black bands in the yellow-lipped sea krait, *Laticauda colubrina*, observed on South Reef Island (area: 117 ha; 12° 46'N; 92° 39'E), in the Andaman Islands, India. Searches were conducted in selected stretches of beach on the island every night for an average of three hours per night. The total number of black bands of each of the 70 snakes encountered over a period of three weeks was counted. Statistical analyses were conducted using Microsoft Excel 5.0.

The differences in the number of bands in the species between locations was found to be significant, although sample sizes in previous studies were small. A t statistic of -427.4; P (T = t) two tail = 0.001; t critical two tail = 12.71) was obtained in a comparison of data from this study with that presented by Guinea (1981) from Fiji. In terms of the number of dark bands, the Andamans

TABLE 1: Geographic variation in the mean number of dark bands in *Laticauda colubrina*. Figures in parentheses are sample sizes. In the study by Mao and Chen (1980), mean number of bands was not calculated and sex-wise breakdown of their sample not provided.

Locality	Authority	Male	Female
Fiji	Pernetta (1977)	30.8 (12)	31.4 (17)
Fiji	Guinea (1981)	30 ± 1.06 (10)	29.7 ± 0.3 (6)
New Caledonia	Saint Girons (1964)	31 (3)	29.5 ± 0.7 (4)
Taiwan	Mao and Chen (1980)	34-37 body; 3-5 tail (16, 7)	
Andaman Islands	This study	41.32± 0.39 (37)	41.12 ± 0.36 (33)

population of *Laticauda colubrina* appears closer to conspecifics from Taiwan, Republic of China (Mao and Chen, 1980), rather than those from Fiji (Pernetta, 1977; Guinea, 1981) or New Caledonia (Saint Girons, 1964). Data on numbers of bands in the species are reported in the literature are provided in Table 1.

We are grateful to the Royal Netherlands Embassy, Centre for Island Ecology/Andaman and Nicobar Environmental Team, a division of the Madras Crocodile Bank Trust, the University Grants Commission and Pondicherry University, for supporting this study. We are also grateful to the Andaman and Nicobar Forest Department for their permission and support.

LITERATURE CITED

GUINEA, M. L. 1981. The sea snakes of Fiji. *4th Int. Coral Reef Symp., Manila* 2: 581-585.

MAO, S.-H. & B. Y. CHEN. 1980. Sea snakes of Taiwan. A natural history of sea snakes. National Science Council Special Publication No. 4, Taipeh.

PERNETTA, J. C. 1977. Observations on the habits and morphology of the sea snake, *Laticauda colubrina* (Schneider) in Fiji. *Canadian J. Zool.* 55: 1612-1619.

SAINT GIRONS, H. 1964. Notes sur l'ecologie et la structure des populations des Laticaudinae (Serpents, Hydrophiidae) en Nouvelle Caledonie. *La Terre et la Vie* (2): 185-214. See also: Notes on the ecology and population structure of the Laticaudinae (Serpentes, Hydrophiidae) in New Calidonia. *Bull. Chicago Herpetol. Soc.* 25: 197-209. (English translation by I. M. Fauie, P. A. Gritis & H. K. Voris.)

SOHAN SHETTY[1] and K. V. DEVI PRASAD, Sálim Ali School of Ecology, Pondicherry University, Pondicherry 605 014, India.
[1]Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram, Tamil Nadu 603 104, India.

Accepted: 5 December, 1996.

Hamadryad, Vol. 21, pp. 45-46, 1996

BREEDING DATA ON *LISSEMYS PUNCTATA* FROM WESTERN INDIA

The Indian flapshell turtle (*Lissemys punctata*) is one of the most abundant freshwater turtles in the Indian region, with a range from Pakistan eastward through India, Nepal, and Bangladesh to western Myanmar (Iverson, 1992). Nonetheless, few data on reproduction of the species are available for the western part of the range. The present study on a captive population of *L. punctata punctata* (the southern subspecies) was carried out between June 1991 and August 1995, in order to obtain information on the breeding biology of the species in the Indian State of Gujarat.

A number of turtles was kept in a gharial (*Gavialis gangeticus*) pond for observation along with the softshell, *Aspideretes gangeticus* at the Sayaji Baug Zoo, Vadodara, Gujarat State, western India. The enclosure was a 6,400 sq m area with a 100 sq m pond of irregular outline and 90 cm depth at the centre. It received a continuous supply of running water. Two sides of the enclosure were sloping and covered with vegetation, the other two sides being flat with a sandy basking platform. All turtles were fed dead fish and chopped meat, although some of the subadult *Lissemys* were observed also feeding on the macrophyte, *Hydrilla* sp.

Courtship behaviour was observed once on 5 April, 1992, at 1000 hours. A male was seen swimming around a large female in shallow water, periodically moving between the front and back of the female. The female was observed to remain stationary while the male approached and tickled her extended neck with his forelimbs, also stroking both sides of her head. The male then swam clockwise around the female, the entire activity lasting about 30 minutes. Subsequently, both turtles swam toward deeper water, and actual mating could not be observed.

Each year from 1991-1995, two nests were found, except in 1994, when a single nest was observed. A total of seven nests was found between June and October of the years of study. All nests were examined on day II after oviposition and data on clutch size, egg and nest dimensions, and distance and height of nest above water level

TABLE 1: Location of nest in *Lissemys punctata*. Measurements in cm.

Nest no.	Distance from water	Height from water	Nest dimensions		Depth to first egg	Egg clutch size
			Depth	Inner Diameter		
1	300	55	18	15	16	10
2	380	55	20	16	16	15
3	450	60	15	16	10	11
4	450	60	17	9	10	10
5	210	50	15	11	10	9
6	105	40	14	12	8	12
7	290	45	14	8	8	13

TABLE 2: Clutch, egg size and incubation period of *Lissemys punctata*. Dimensions in cm.

Nest no.	Date of deposition	Clutch size	Egg dimensions			Date of hatchling	Incubation Period	No. of hatchlings	Hatchling success
			Length	Width	Weight				
1	7 June, 1991	10	2.86	2.78	13.3	20 July, 1992	409	5	50.0
2	5 August, 1991	15	2.82	2.77	12.6	25 July, 1992	355	1	6.6
3	19 October, 1992	11	2.74	2.71	11.0	17 June, 1993	241	10	90.9
4	19 October, 1992	10	2.71	2.68	10.5	8 August, 1993	293	8	80.0
5	5 September, 1993	9	2.60	2.60	-	6 June, 1994	275	5	71.4
6	28 September, 1993	12	2.69	2.62	-	-	-	-	-
7	18 June, 1994	13	2.76	2.71	12.5	11 July, 1995	389	11	84.6
						3 August, 1995	412		

TABLE 3: Average dimensions of hatchlings *Lissemys punctata* (length in cm; weight in gm). Details of nest VI in text.

Nest no.	Carapace		Plastron	Body	Weight
	Length	Width	length	depth	
1	3.70	2.77	3.51	1.51	10.0
2	3.55	2.80	3.50	1.60	9.5
3	3.51	2.78	3.25	1.51	10.0
4	3.60	2.80	3.40	1.50	9.5
5	3.55	2.80	3.40	1.55	8.0
7	3.48	2.82	3.36	1.54	8.5

were recorded (Tables 1 and 2). Except for nest VI, which was relocated to the laboratory before the rainy season, all eggs were incubated *in situ*.

All hatchlings emerged during the rains (between June and August; see Table 2). The incubation period varied greatly (241 to 412 days), and hatching success was 6.6 to 90 per cent. Hatchlings were olive green with small black spots on the carapace; the plastron was light yellow to orange. Three to four black stripes were present on the foreheads. The sizes of the hatchlings are given in Table 3.

All 12 eggs from nest VI were shifted to a plastic tub filled with moist earth in June, 1994. Three eggs from the same clutch that were kept outside during the heavy showers that occurred on 1 August, 1994, produced three hatchlings within 1-2 minutes of the onset of the showers. Of the eggs kept away from the rain, one pipped on 2 August, and a fully formed live turtle with small yolk sac was observed. After successive intervals of 15 days (i.e., on 16 and 31 August), the rest of the eggs were opened and live turtles recovered. From two eggs kept exposed to the rains, two hatchlings emerged within three to four minutes on 7 September, 1994. The remaining five eggs in this clutch were opened after seven more days. Fully developed turtles (without yolk) were found in each of the eggs, except from one that was opened on 7 October, 1994, that contained a fully developed dead turtle.

A nest laid on 18 June, 1994 is worthy of comment. Between 6 and 7 September of the same year, the nesting ground was flooded by the Vishwamitri River, water level rising to 1.8m on 6 September, receding the following day. The nest was submerged for a total of 22 hours. On 11 July, 1995, after an incubation of 389 days, ten hatchlings, and on 3 August, one hatchling, emerged from the nest.

The reproductive biology of *Lissemys punctata* is relatively well known compared to that of the other Indian turtles. Duda and Gupta (1981) mentioned that in Jammu, northern India, in the extreme north of the range of the species, courtship occurs during April in the wild, the same as in Gujarat. The range of clutch sizes obtained in this study (9-15), however, is larger than reported in the literature: 2-8 in south India (Das, 1991) and 5-12 in north India (Yadava and Prasad, 1982).

I thank V. A. Jadeja, Curator, Sayaji Baug Zoo, Vadodara, for support and facilities that made these observations possible.

LITERATURE CITED

DAS, I. 1991. Colour guide to the turtles and tortoises of the Indian subcontinent. R & A Publishing Limited, Portishead.

DUDA, P. L. & V. K. GUPTA. 1982. Courtship and mating behaviour of the Indian softshell turtle, *Lissemys punctata punctata*. *Proc. Indian Acad. Sci. (Anim. Sci.)* 90: 453-461.

IVERSON, J. B. 1992. A revised checklist with distribution maps of the turtles of the world. Privately published, Richmond, Indiana.

YADAVA, M. R. & B. PRASAD. 1982. Observations on the breeding biology of the Indian tropical pond turtle, *Lissemys punctata punctata* (Schoepff). *Indian J. Zootomy* 23: 51-56.

RAJU VYAS, Sayaji Baug Zoo, Vadodara 390 018, Gujarat, India.

Accepted: 5 December, 1996.

THE AMPHIBIAN FAUNA OF SRI LANKA by Sushil K. Dutta and Kelum-Manamendra-Arachchi. 1996. Wildlife Heritage Trust of Sri Lanka, Colombo. Hardcover. 230 pp. Available from: Wildlife Heritage Trust of Sri Lanka, 95 Cotta Road, Colombo 8, Sri Lanka. Price: Sri Lankan Rupees 1,500.

How often does a review begin "now here's a book we've been waiting for"? Well, in this case, herpetologists and general naturalists alike are really pleased with the appearance of Sushil and Kelum's excellent book. It is the first comprehensive work on Sri Lanka's amphibians for 40 years and it serves both as a field guide and the current standard reference for the group.

The hardbound book has a brilliant printed dust jacket and is well bound with excellent printing quality. Most of the colour plates are of a high quality, the majority illustrating live specimens. The text is scattered with good line drawings, showing key morphological features.

The book begins with a preface, acknowledgements and introduction by the authors. The Introduction includes Materials, Methods and an alphabetical listing of the 235 sites sampled during the survey work for the book. It explains amphibian taxonomic nomenclature as well and includes a few paragraphs on conservation.

Starting with the three Sri Lankan caecilians, the book describes each Sri Lankan amphibians using an easy-to-refer format: Diagnosis, Description, Colour, Comments, Distribution, Etymology and Material examined. Each section starts with a key to the genus and species and almost every species has a good colour illustration. Most useful, a diagnostic drawing of the underside of the foot is often given as a further aid in identification. Each species has a small distribution map which is adequate.

The book has six pages of reference at the end, but what is particularly alluring is the Appendix on the "Atlas of unidentified species". As the authors put it, a representative sample of 16 of the specimens collected during work on this book are illustrated here. This is a preview of what is to come: the amphibian fauna of Sri Lanka is undergoing massive revisions thanks to these authors and their colleagues. We can expect to see many more species added to the list in a subsequent edition of this excellent book.

Romulus Whitaker, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

A GUIDE TO THE SNAKES OF PAPUA NEW GUINEA by Mark O'Shea. 1996. Beaumont Publishing Pte. Ltd., Singapore. xii + 239 pp. Paperback. Available from: Beaumont Publishing Pte. Ltd., 9 Joo Koon Circle, Singapore 629041. Price: £32.

Having spent two years in Papua New Guinea (PNG) and another nine months in Irian Jaya, I remember much frustration when finding snakes there and being unable to identify them. Eventually, we wrote an illustrated guide to the common reptiles of PNG (Whitaker et al., 1982), which listed 90 species of snakes.

Mark O'Shea's welcome addition to the herpetological literature lists over 100 species and subspecies of PNG snakes. Nearly two-thirds of the species described have good to passable colour illustrations, with some excellent and some too dark to be useful. Those species that aren't illustrated are described and in some cases sketched for head scale detail. The keys are illustrated with line drawings, that go from the family species levels and are user-friendly, good for both scientists and amateur alike. The checklist gives type localities and where the specimen is deposited, invaluable to anyone working on the systematics of New Guinea snakes. The section on snake-bite is written by the well-known authority on tropical snake-bite, Professor David Warrell and his colleague Dr. David Lalloo. New Guinea has some seriously dangerous snakes, such as the taipan, Papuan black snake, death adder (all found in nearby Australia) and the small-eyed snake (a New Guinea endemic). Snake-bite is rare, but the frequency of serious bites is proportionately very high. This is a valuable book for hospitals throughout New Guinea, as very little is known there about which snakes cause serious bites.

The sections in Pidgin on snake-bite and how to use the book are a step in the right direction. A smaller, less technical version in Pidgin and Motu would be very handy once this present book is given adequate exposure. Mark correctly states that work on snakes in PNG's neighbour, the Indonesian province of Irian Jaya, is crying to be done.

New Guinea is still largely covered with forest. Mangroves, swamp forest, rainforest, montane forest and even a glacier adorn this huge island. Many areas remain unexplored and several of the snakes Mark lists in his book have yet to be described. The death adder, for instance, is remarkable in variation, and may eventually prove to be three or four distinct species.

The book ends with distribution maps of all the snakes species, comparison of two pairs of look-alikes (taipan vs 'Papuan black' and death adder vs the harmless ground boa), a checklist of dangerous snakes by province, a gazetteer of localities, a glossary and references. This is a book we have been waiting for. Admittedly not many of us will visit New Guinea, but it is a region that we are all fascinated with which makes this book a must in every herpetologist's library.

LITERATURE CITED

WHITAKER, R., Z. WHITAKER & D. MILLS. 1982. Reptiles of Papua New Guinea. Wildlife in Papua New Guinea No. 82/2. Division of Wildlife, Department of Lands & Environments, Konedobu.

Romulus Whitaker, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

AMPHIBIANS AND REPTILES OF NORTH AFRICA. BIOLOGY, SYSTEMATICS, FIELD GUIDE by Hans Hermann Schleich, Werner Kästle and Klaus Kabisch. 1996. Koeltz Scientific Publishers, Koenigstein. iv + 630 pp. Hardcover. Available from: Koeltz Scientific Publishers, P.O. Box 1360, 61453 Koenigstein, Germany. email: koeltz@ibm.net. Price: Deutsch Mark 220.

The herpetofauna of North Africa east of the Saharas has, for many years, remained a grey area within the Dark Continent. While the common perception of this region may be an excess of barren waste, a wide variety of habitat conditions prevail that are increasingly coming under severe pressure as man aggressively transforms the land for agriculture and his livestock threatens the natural vegetation by overgrazing. The Maghreb states (Morocco, Algeria and Tunisia), plus Libya, the region treated in this work, is unique for a number of reasons, including its location at the cross-roads of the Mediterranean, western European, Saharo-Sindian and Ethiopian realms and subrealms, and the unique morphological and physiological adaptations shown by the herpetofauna to cope with conditions of heat stress and extreme aridity (including reduction of water loss through lungs and keratinized skin) and the excretion of nitrogenous wastes in the form of solid uric acid.

The three authors responsible for this magnificent tome include Schleich (a neo- and palaeoherpetologist with the Institut für Paleontology, University of Munich), Kästle (a retired college instructor) and Kabisch (a professor with the University of Leipzig). The format of the book, coverage of the literature, which adds life history information from outside the area under consideration, quality of the colour plates and line drawings are reflections of the thoroughness of these authors.

There is so much information on the land and on general natural history of the fauna that these have been dealt with in separate large chapters. 'Climate and vegetation' includes macroclimate (meteorological data of the region, illustrated with climatographs of 20 localities), microclimate (illustrating temperature gradients below sand surface on a summer's day) and vegetation zones (that analyze relationships between plants, temperature, humidity and precipitation, and show frequency of serious bites is proportionately very high. This is a valuable book for hospitals throughout New Guinea, as very little is known there about which snakes cause serious bites.

The sections in Pidgin on snake-bite and how to use the book are a step in the right direction. A smaller, less technical version in Pidgin and Motu would be very handy once this present book is given adequate exposure. Mark correctly states that work on snakes in PNG's neighbour, the Indonesian province of Irian Jaya, is crying to be done.

New Guinea is still largely covered with forest. Mangroves, swamp forest, rainforest, montane forest and even a glacier adorn this huge island. Many areas remain unexplored and several of the snakes Mark lists in his book have yet to be described. The death adder, for instance, is remarkable in variation, and may eventually prove to be three or four distinct species.

The book ends with distribution maps of all the snakes species, comparison of two pairs of look-alikes (taipan vs 'Papuan black' and death adder vs the harmless ground boa), a checklist of dangerous snakes by province, a gazetteer of localities, a glossary and references. This is a book we have been waiting for. Admittedly not many of us will visit New Guinea, but it is a region that we are all fascinated with which makes this book a must in every herpetologist's library.

LITERATURE CITED

WHITAKER, R., Z. WHITAKER & D. MILLS. 1982. Reptiles of Papua New Guinea. Wildlife in Papua New Guinea No. 82/2. Division of Wildlife, Department of Lands & Environments, Konedobu.

Romulus Whitaker, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

AMPHIBIANS AND REPTILES OF NORTH AFRICA. BIOLOGY, SYSTEMATICS, FIELD GUIDE by Hans Hermann Schleich, Werner Kästle and Klaus Kabisch. 1996. Koeltz Scientific Publishers, Koenigstein. iv + 630 pp. Hardcover. Available from: Koeltz Scientific Publishers, P.O. Box 1360, 61453 Koenigstein, Germany. email: koeltz@ibm.net. Price: Deutsch Mark 220.

The herpetofauna of North Africa east of the Saharas has, for many years, remained a grey area within the Dark Continent. While the common perception of this region may be an excess of barren waste, a wide variety of habitat conditions prevail that are increasingly coming under severe pressure as man aggressively transforms the land for agriculture and his livestock threatens the natural vegetation by overgrazing. The Maghreb states (Morocco, Algeria and Tunisia), plus Libya, the region treated in this work, is unique for a number of reasons, including its location at the cross-roads of the Mediterranean, western European, Saharo-Sindian and Ethiopian realms and subrealms, and the unique morphological and physiological adaptations shown by the herpetofauna to cope with conditions of heat stress and extreme aridity (including reduction of water loss through lungs and keratinized skin) and the excretion of nitrogenous wastes in the form of solid uric acid.

The three authors responsible for this magnificent tome include Schleich (a neo- and palaeoherpetologist with the Institut für Paleontology, University of Munich), Kästle (a retired college instructor) and Kabisch (a professor with the University of Leipzig). The format of the book, coverage of the literature, which adds life history information from outside the area under consideration, quality of the colour plates and line drawings are reflections of the thoroughness of these authors.

There is so much information on the land and on general natural history of the fauna that these have been dealt with in separate large chapters. 'Climate and vegetation' includes macroclimate (meteorological data of the region, illustrated with climatographs of 20 localities), microclimate (illustrating temperature gradients below sand surface on a summer's day) and vegetation zones (that analyze relationships between plants, temperature, humidity and precipitation, and show maps of temperature ranges in selected localities and vegetational zones). A chapter on zoogeographic affinities deal with the influences from abutting zoogeographic realms, hypothesized migration routes and radiations that include phylogenetic trees of speciose groups such as *Uromastyx*, *Chalcides* and *Agama* sensu lato. Treated next in this chapter are endemics, the three centres of endemism in northern Africa being the Atlantic coastal strip, western Maghreb and eastern Maghreb. Disjunctions in the distribution of species and relictual forms are discussed and illustrated with a map that shows the most important relatively moist refugia, which will be of great importance in conservation planning.

Altitudinal information is presented in the form of illustrated charts, showing topographical gradients and the occurrence of taxa at particular elevations through six transects that the authors select, over west, middle and east Morocco, west and east Algeria and one in Egypt. A short section deals with the herpetofauna of the islands off the north African coast, which includes area and distance from the mainland, as well as a species inventory. Dubious records are discussed over one page, giving the source and appropriate comments. The survey of species numbers within each genus is listed by country covered by the book.

Ecological aspects include details of habitats/microhabitats selected by each of the amphibian and reptile species, which is followed by a general discussion on thermal requirements and miscellaneous aspects of ecology, including living on sand, undersand respiration, activity cycles, hibernation (including the timing of activity and locality for many species, which is tabulated), female and male reproductive cycles, reproductive modes, population densities and biomass (also with a table summarising the necessary information for selected taxa), trophic complexes and the role of these species in food webs. The last section of the text on general issues is on the impact of man, and includes information on the use of amphibians and reptiles as food, for medication, for shows, for the manufacture of souvenir and for the pet trade, in addition to habitat change and finally, protective measures adopted. This latter aspect, I feel, is a little too short, as protected areas could have been mentioned here.

This work is much more than a field guide (although its compact size renders it suitable for carrying to the field), containing detailed life history accounts of many species. A substantial amount of this information is in the form of pleasing thumbnail sketches that adorn the sides of the text of each page, including details of scalation and morphology, skeletal features, sexual dimorphism, behaviour (often in the form of flow diagrams), plus graphs of activity patterns, sonograms of calls and embryological development stages.

But most people will delve straight into the species accounts, and these too are meticulously compiled. Following a key to the major groups of amphibians and reptiles is a key to amphibian eggs, a key to amphibian larvae, and finally, keys to adult amphibians and reptiles, all illustrated with line drawings. For each species, a typical account consists of: the scientific name and authority, etymology, synonymy, plus names in English, French, German, Arabic and Berber.

Identifications include size and shape, plus general characteristics, measurements, scalation (in case of reptiles), external morphology, colouration (and its variability), ontogenetic changes in colouration and sexual dichromatism, sexual dimorphism, similar co-occuring species (with which it may be confused), osteological and dentitional features, ecology and general behaviour, habits, activity range (such as, space used for foraging), activity pattern (diel and annual), thermal behaviour (including methods for regulating body temperature), locomotion, population density, structure and dynamics, longevity (mostly from captivity), social behaviour, community ecology, feeding strategy and diet, predators and anti-predatory behaviour, effects of poison on humans (in case of certain snakes), reproduction, geographic range (including zoogeographic affinities, habitat and microhabitats selected), systematics, comments on systematic problems, subspecies, additional notes as found appropriate, and finally references. Species accounts are highly heterogenous in length, and are sometimes very detailed (e.g., *Uromastyx acanthinura*, pp: 298-310).

Following the species accounts is a checklist of the amphibians and reptiles of Egypt (excluding the Sinai Peninsula), plus keys to species. The appendices include scientific terms, geographic and topotypic names of Arabic and Berber origin, list of birds and mammals that prey on North African amphibians and reptiles, an index of scientific names, as well as listings of English, French, German and Spanish names of each species.

The references section is 30 pages long, which will be an invaluable contribution to the herpetology of Africa and the Mediterranean. It is followed by a list of sources of text figures and finally, a four page addenda that includes a key to the Moroccan species of the genus *Chalcides* and one last map.

Typos are few, although on occasion, one comes across terms like 'transsect' (p. 31 et seq.) for 'transect', 'relictory' (for relictual) and 'endemisms' for 'endemic'

Distribution maps of all species are provided, which include line drawings of the northern African region, with broken lines indicating the extent of distribution of many species. Precise localities of the rarer species are indicated, but the size of the maps (constrained by the size of the book) and lack of references to towns and cities or geological features, will limit their usefulness. Species are illustrated with colour photographs gathered together in 63 plates in the centre of the book, with captions identifying the species, besides providing such information as locality and distribution within the region covered in the book. Each plate carries three colour photographs, and the general standards of photography, colour separation and printing are high. Following the photos of individual species are illustrations of footprints of various species of reptiles on a variety of natural substrates, which will be useful for the field naturalist engaged in rapid assessments of herpetological diversity as well as tourists with more limited time. A set of pictures depicting the various habitats in the region show sandy and rocky deserts, drying *sebkahs*, coastal sand dunes, scrublands, as well as more mesic habitats, such as woodlands, flooded grasslands and cultivated areas. The last plate shows human interactions with the herpetofauna, including their usage in the medicinal and pet trade.

In summary, the work represents a very useful addition to the literature of Africa, and will also be of use in southern Europe and western Asia, because of many co-occuring species and genera. For us in India and Pakistan, the colour plates and descriptions of species will be useful for diagnosing taxa that range all the way from Africa into the arid north-west of our region. Many have already broken down under close scutiny to reveal a satellite of sibling species (e.g., the saw-scaled vipers of the genus *Echis*), and many others, doubtless, will follow.

Indraneil Das, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

SARZAMEEN-A-PAKISTAN KAY SAAMP by Mohammed Sharief Khan 1993. Urdu Science Board, Lahore. 208 pp. Hardcover. Available from Urdu Science Board, 299 Upper Mall, Lahore, Pakistan. Price: Pakistan Rupees 150.00.

The snake fauna of the arid land bordering India in the west is rich in species diversity and important from a medical point of view. Dealt with in the form of monographs and technical papers by western biologists, including Robert Mertens and Sherman Minton, these are inaccessible to the common man. This component of the herpetofauna is treated by Pakistan's best known herpetologist, Dr. M. S. Khan (a professor of zoology and founder of Herp Laboratory at Rabwah, Pakistan) in the format of an illustrated field guide that provide simple but useful keys, adequate descriptions, and most important, colour plotographs. The text itself appears to have been carefully planned, making it a delight to refer to.

This hardcover book measures 28 x 21 cm (and is hence probably unwieldy in the field) is organized into a general introduction to snakes (43 pages), with details of morphology, anatomy, scalation, including terminology, and details on how scale counts can be made, locomotion, preservation of specimens for study, all aspects illustrated the Sinai Peninsula), plus keys to species. The appendices include scientific terms, geographic and topotypic names of Arabic and Berber origin, list of birds and mammals that prey on North African amphibians and reptiles, an index of scientific names, as well as listings of English, French, German and Spanish names of each species.

The references section is 30 pages long, which will be an invaluable contribution to the herpetology of Africa and the Mediterranean. It is followed by a list of sources of text figures and finally, a four page addenda that includes a key to the Moroccan species of the genus *Chalcides* and one last map.

Typos are few, although on occasion, one comes across terms like 'transsect' (p. 31 et seq.) for 'transect', 'relictory' (for relictual) and 'endemisms' for 'endemic'

Distribution maps of all species are provided, which include line drawings of the northern African region, with broken lines indicating the extent of distribution of many species. Precise localities of the rarer species are indicated, but the size of the maps (constrained by the size of the book) and lack of references to towns and cities or geological features, will limit their usefulness. Species are illustrated with colour photographs gathered together in 63 plates in the centre of the book, with captions identifying the species, besides providing such information as locality and distribution within the region covered in the book. Each plate carries three colour photographs, and the general standards of photography, colour separation and printing are high. Following the photos of individual species are illustrations of footprints of various species of reptiles on a variety of natural substrates, which will be useful for the field naturalist engaged in rapid assessments of herpetological diversity as well as tourists with more limited time. A set of pictures depicting the various habitats in the region show sandy and rocky deserts, drying *sebkahs*, coastal sand dunes, scrublands, as well as more mesic habitats, such as woodlands, flooded grasslands and cultivated areas. The last plate shows human interactions with the herpetofauna, including their usage in the medicinal and pet trade.

In summary, the work represents a very useful addition to the literature of Africa, and will also be of use in southern Europe and western Asia, because of many co-occuring species and genera. For us in India and Pakistan, the colour plates and descriptions of species will be useful for diagnosing taxa that range all the way from Africa into the arid north-west of our region. Many have already broken down under close scutiny to reveal a satellite of sibling species (e.g., the saw-scaled vipers of the genus *Echis*), and many others, doubtless, will follow.

Indraneil Das, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

SARZAMEEN-A-PAKISTAN KAY SAAMP by Mohammed Sharief Khan 1993. Urdu Science Board, Lahore. 208 pp. Hardcover. Available from Urdu Science Board, 299 Upper Mall, Lahore, Pakistan. Price: Pakistan Rupees 150.00.

The snake fauna of the arid land bordering India in the west is rich in species diversity and important from a medical point of view. Dealt with in the form of monographs and technical papers by western biologists, including Robert Mertens and Sherman Minton, these are inaccessible to the common man. This component of the herpetofauna is treated by Pakistan's best known herpetologist, Dr. M. S. Khan (a professor of zoology and founder of Herp Laboratory at Rabwah, Pakistan) in the format of an illustrated field guide that provide simple but useful keys, adequate descriptions, and most important, colour plotographs. The text itself appears to have been carefully planned, making it a delight to refer to.

This hardcover book measures 28 x 21 cm (and is hence probably unwieldy in the field) is organized into a general introduction to snakes (43 pages), with details of morphology, anatomy, scalation, including terminology, and details on how scale counts can be made, locomotion, preservation of specimens for study, all aspects illustrated with simple but neatly executed line drawings. An identification key to the Pakistani snake species (10 pages) appears next, the diagnostic characters in Urdu terminating in both the local vernacular (Urdu) as well as the scientific name and authority. To aid non-technical users, there are two pages (pg. 63 and 68) illustrating features used in the key. The bulk (72 pages) of the book is composed of the species accounts, which are generally arranged family-wise according to Smith's (1943) scheme of classification, commencing with the scolecophidians, although terminating with the hydrophids, instead of the viperids. The venomous snakes are treated again specially in 20 pages of text, with details of scalation and dentition, as well as suggested treatment for snake bites. A chapter (18 pages) deals with serpent myths in Pakistan and elsewhere, including the beliefs of the Hopi Indians, the Aztecs, the Mayas and the Greeks. The last few pages of the main body of the text deal with conservation issues. A two page systematic index lists 61 species, followed by an Urdu index and finally, a two page bibliography of relevant literature in Urdu as well as English.

The seven colour plates, each carrying six species, depict over three-fourth of the known snakes of Pakistan. An additional five plates show various serpent-associated motifs, artefacts and phenomenon, including the ubiquitous (in this region) snake charmer. Although the colour plates are not of the highest standard, the book is unique in depicting most of Pakistan's snakes alive within the covers of a single book, and several species are illustrated for the very first time. Perhaps the author would now consider an English language edition of this important work, which would aid not only non-Urdu speaking visitors to Pakistan, but also colleagues in neighbouring countries sharing this fauna.

LITERATURE CITED

SMITH, M. A. 1943. Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese region. Vol. III. Serpentes. Taylor and Francis, London.

Indraneil Das, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

ACHARJYO, L. N., S. K. KAR & S. K. PATNAIK. 1996. Studies on captive breeding of the gharial, *Gavialis gangeticus* (Gmelin) in Orissa. *J. Bombay nat. Hist. Soc.* 93(2): 210-213.

ADLER, G. H., C. C. AUSTIN & R. DUDLEY. 1995. Dispersal and speciation of skinks among archipelagos in the tropical Pacific Ocean. *Evol. Ecol.* 9: 529-541.

AENGELS, R. 1995. Notes on an abnormal feeding behaviour of head started Indian python (*Python molurus molurus*). *Cobra* 22: 24.

________ 1996. Captive breeding of reptiles at the Madras Snake Park. *Cobra* 24: 13-15.

________ & R. RAJARATHINAM. 1996. Breeding notes on checkered keelback watersnake in Madras Snake Park. *Cobra* 23: 38.

AI, X., Y. CHEN & J. FAN. 1996. Determination of *Bufo gargarizans* Cantor some biological parameters (sic). *Sichuan J. Zool.* 14(4): 165-176. [In Chinese with English abstract.]

AKRAM, S. M. & J. I. QURESHI. 1995. Snakes of Faisalabad, Punjab, Pakistan. *The Snake* 27(1): 25-29.

ALLEN, R. 1996. The reptile trade in Cambodia. *The Rephiberary* (229): 21-22.

ANANJEVA, N. B. & T. N. MATVEYEVA-DUJSEBAYEVA. 1996. Some evidence of *Gonocephalus* species complex divergence basing on skin sense organ morphology. *Russian J. Herpetol.* 3(1): 82-88.

AUTUMN, K. & D. F. DE NARDO. 1995. Behavioral thermoregulation increases growth rate in a nocturnal lizard. *J. Herpetol.* 29(2): 157-162.

BAIG, K. J. & W. BÖHME. 1996. Description of two new subspecies of *Laudakia pakistanica* (Sauria: Agamidae). *Russian J. Herpetol.* 3(1): 1-10.

BAKER, J. 1996. The Declining Amphibian Populations Task Force. *Zoos' Print* 11(5): 34-36.

BARTHOLOMEW, B. 1996. Biogeography of the reptiles of south Asia [Book Review]. *Intermontanus* 5(5): 38-39.

BECKER, H. 1996. Bamerkungen zur Haltung und Nachzucht von *Cuora flavomarginata flavomarginata* (Gray, 1863). *Salamandra* 32(2): 65-72.

BELT, P., A. MALHOTRA, R. S. THORPE, D. A. WARRELL & W. WÜSTER. "1997" 1996. Russell's viper in Indonesia: snakebite and systematics. *In*: Venomous snakes: ecology, evolution and snakebite. pp: 219-234. R. S. Thorpe, W. Wüster & A. Malhotra (eds). Symp. Zool. Soc. London (70). Clarendon Press, Oxford.

BENNETT, D. 1995. A note on the foraging behaviour of *Varanus salvator* at Kuala Selangor Nature Park, peninsular Malaysia. *SWHS J.* 2(4): 16-18.

________ . 1995. A little book of monitor lizards. Viper Press, Aberdeen. 208 pp + 17 colour plates.

________ & B. L. LIM. 1995. A note on the distribution of *Varanus dumerilii* and *V. rudicollis* in peninsular Malaysia. *Malayan nat. J.* 49(2): 113-116.

BHUPATHY, S. 1995. Status and distribution of the river terrapin *Batagur baska* in the Sunderban of India. SACON Tech. Rep. 3. Sálim Ali Centre for Ornithology & Natural History, Coimbatore. iii + 37 pp.

________ 1995. Distribution of *Python molurus bivittatus* in India. *Cobra* 21: 2-5.

________ 1995. Reptile fauna of Indian Sunderban, West Bengal. *Cobra* 22: 11-13.

BOGIN, Y. & Y. L. WERNER. 1995. Comparative longevity of Israeli chamaeleons (Reptilia: Sauria: *Chamaeleo chamaeleon* sspp.). *Herpetol. J.* 5(2): 239-240.

BOUR, R., A. DUBOIS & R. G. WEBB. 1995. Types of recent trionychid turtles in the Muséum national d'Histoire naturelle, Paris. *Dumerilia* 2: 73-92.

BOZHANSKI, A. T., V. M. MAKEYEV, M. V. MIROUTENKO & V. Y. FROLOV. 1996. Distribution, numbers and morphological characteristics of the Central Asian tortoise (*Agrionemys horsfieldi*) in Turkmenistan. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 207-209. SOPTOM (ed.). Editions Soptom, Gonfaron.

BRANDTSTAETTER, F. "1995" 1996. Etymology of the scientific names of the crocodiles from Sri Lanka. *Lyriocephalus* 2(1 & 2): 56-57.

________ & M. REDL. "1995" 1996. An annotated list of the scientific names of turtles from Sri Lanka. *Lyriocephalus* 2(1 & 2): 52-55.

BRECKENRIDGE, W. "1995" 1996. Declining amphibian populations task force. *Lyriocephalus* 2(1 & 2): 92.

BRONGERSMA, L. D. 1996. On the availability of the name *Dermochelys coriacea schlegelii* (Garman, 1884) as a species or subpecies of leatherback turtle. *Chelonian Conserv. & Biol.* 2(2): 261-265.

CARD, W. & A. G. KLUGE. 1995. Hemipeneal skeleton and varanid lizard systematics. *J. Herpetol.* 29(2): 275-280.

CHAN, E.-H. & H.-C. LIEW. 1996. Decline of the leatherback population in Terengganu, Malaysia, 1956-1995. *Chelonian Conserv. & Biol.* 2(2): 196-203.

________ & _______ . 1996. *In-situ* incubation of green turtle eggs in Pulau Redang, Malaysia: hope after decades of egg-exploitation. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 68-72. SOPTOM (ed.). Editions Soptom, Gonfaron.

CHAN-ARD, P., K. THIRAKHUPT & P. P. VAN DIJK. 1996. Observations on *Manouria impressa* at Phu Luang Wildlife Sanctuary, Northeastern Thailand. *Chelonian Conserv. & Biol.* 2(1): 109-113.

CHANDI, M. 1995. Wildlife conservation and sustainable development- crocodile farming as a welfare measure. M. A. dissertation, Madras Christian College, Madras.

CHEN, Y. 1996. Genitality of *Ermia maogshanensis* (sic). *Sichuan J. Zool.* 15(2): 62-64. [In Chinese.]

CHENG-I.-J. 1996. Sea turtles status and research in Taiwan. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 87-88. SOPTOM (ed.). Editions Soptom, Gonfaron.

CHERIAN, P. T. 1995. Some ecological observations on *Heosemys sylvanica* (Henderson)(Reptilia: Testudinidae). *Cobra* 22: 8-10.

CHISZAR, D. & H. M. SMITH. 1996. A checklist of modern coins (1801 to present) featuring herpetozoa, Part 1. *Bull. Chicago Herpetol. Soc.* 31(5): 77-95.

________ & _______ . 1996. A checklist of modern coins (1801 to present) featuring herpetozia, Part 2. *Bull. Chicago Herpetol. Soc.* 31(6): 109-118.

CHOUDHURY, A. 1995. The Assam roofed turtle *Kachuga sylhetensis* in Sadiya- a new locality record. *J. Bombay nat. Hist. Soc.* 92(3): 426.

________ . 1996. The keeled box turtle, *Pyxidea mouhotii* Gray on the north bank of the Brahmaputra- a new record. *J. Bombay nat. Hist. Soc.* 93(1): 97.

________ . 1996. Distribution of *Kachuga smithii* (Gray) in Assam. *J. Bombay nat. Hist. Soc.* 93(2): 301.

CHRISTIAN, A. & T. GARLAND, JR. 1996. Scaling of limb proportions in monitor lizards (Squamata: Varanidae). *J. Herpetol.* 30(2): 219-230.

CORVINUS, G. & H. H. SCHLEICH. 1994. An upper Siwalik reptile fauna from Nepal. *Cour. Forsch.-Inst. Senck.* 173: 239-259.

DALTRY, J. C. 1995. The evolutionary biology of the Malayan pit viper, *Calloselasma rhodostoma*: a study of the causes of intraspecific variation. Ph. D. Dissertation, University of Aberdeen, Aberdeen. x + 282 pg.

________ , J. C., G. PONNUDURAI, C. K. SHIN, N.-H. TAN, R. S. THROPE & W. WUSTER. 1996. Electrophoretic profiles and biological activities: intraspecific variation in the venom of the Malayan pit viper (*Calloselasma rhodostoma*). *Toxicon* 34(1): 67-79.

________ , W. WÜSTER & R. S. THORPE. 1996. Diet and snake venom evolution. *Nature, London* 379: 537-540.

________ , ________ & _______ . "1997" 1996. The role of ecology in determining venom variation in the Malayan pitviper, *Calloselasma rhodostoma*. *In*: Venomous snakes: ecology, evolution and snakebite. pp: 155-171. R. S. Thorpe, W. Wüster & A. Malhotra (eds). Symp. Zool. Soc. London (70). Clarendon Press, Oxford.

DANIELS, R. J. R. 1995. Habitat selection in Western Ghats' amphibians- Anura: Implications for species conservation. *Cobra* 20: 7-16.

________ . 1995. Amphibians of West Bengal plains [Book Review]. *Cobra* 20: 20-21.

________ . 1995. Notes on the status of monitor lizards & crocodiles in India. *Cobra* 21: 6-11.

________ . 1996. Biogeography and taxonomic uncertainties as illustrated by Indian amphibians. *Cobra* 24: 2-6.

________ & G. ANURADHA. 1996. Ambient temperature influences the population count of frogs. *Cobra* 23: 4-9.

DAS, I. 1994. A check-list of the amphibians and reptiles of Andaman and Nicobar Islands. *J. Andaman Sci. Assn.* 10 (1 & 2): 44-49.

________ . 1995. Turtles and tortoises of India. Oxford University Press, Bombay. x + 176 pp + 16 colour plates.

________ . 1996. Resource use and foraging tactics in a south Indian anuran community. *J. South Asian nat. Hist.* 2(1): 1-30.

________ . 1996. *Limnonectes shompenorum*, a new frog of the *Rana macrodon* (Anura: Ranidae) complex from Great Nicobar, India. *J. South Asian nat. Hist.* 2(1): 60-67.

________ . 1996. First record of *Heosemys spinosa* from the Philippines, with biogeographic notes. *Chelonian Conserv. & Biol.* 2(1): 80-82.

________ . 1996. Geographic distribution: *Rana chalconota* (copper-cheeked frog). *Herpet. Rev.* 27(1): 30.

________ . 1996. Handbook: Indian lizards [Book Review]. *Herpetol. Rev.* 27(1): 44-46.

________ . 1996. Biogeography of the reptiles of south Asia. Krieger Publishing Company, Malabar, Florida. 16 colour plates + ix + 87 pp.

________ . "1995" 1996. Aspects of the biodiversity and biogeography of Sri Lanka. *Lyriocephalus* 2(1 & 2): 17-20.

________ . "1995" 1996. Systematics and the herpetofauna of Sri Lanka. *Lyriocephalus* 2(1 & 2): 69-70.

________ . 1996. Folivory and seasonal change in diet in *Rana hexadactyla* (Anura: Ranidae). *J. Zool., London* 238(4): 785-794. (extracted in 1996 *BBC Wildlife* 14(9): 22.)

________ . 1996. Reproductive patterns and lipid mobilization in *Rana hexadactyla* at a seasonal locality. *Ethol., Ecol. & Evol.* 8(2): 125-133.

________ . 1996. Herpetology of China [Book Review]. *Raffles Bull. Zool.* 44(1): 317-319

________ . 1996. Spatio-temporal resource utilization by a Bornean rainforest herpetofauna: Preliminary results. *In:* Tropical Rainforest Research: Current Issues. pp: 315-323. D. S. Edwards, W. E. Booth & S. C. Choy (eds). Kluwer Academic Publishers, Dordrecht.

________ . 1996. Freshwater turtles: a colouring book for children. People's Trust for Endangered Species, London. 20 pp.

________ . 1996. Status of knowledge of the biology and conservation of non-marine turtles of the Philippines. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 81-83. SOPTOM (ed.). Editions Soptom, Gonfaron.

________ . 1996. Overview: The Asia-Pacific region. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 98. SOPTOM (ed.). Editions Soptom, Gonfaron.

________ & K. CHANDRA. 1994. Two snakes new to Andaman and Nicobar Islands. *J. Andaman Sci. Assn.* 10 (1 & 2): 114-115.

________ & A. DE SILVA. 1996. A directory of herpetologists in south Asia. Amphibia and Reptile Research Organisation of Sri Lanka, Peradeniya. 48 pp.

________ & R. WHITAKER. 1996. A bibliography of the king cobra (*Ophiophagus hannah*). *Smithsonian Herpetol. Inf. Serv.* (108):1-24.

DAS, S. & S. K. DUTTA. 1996. Population dynamics and growth in captivity and natural population of *Tomopterna rolandae* (Anura: Ranidae). *Zoos' Print* 11(8): 16-20.

DENG, X. & Y. YIYUN. 1996. Faunal analysis and servey (sic) of lizards in Hvnan (sic) Province. *Sichuan J. Zool.* 15(1): 15-18. [In Chinese with English abstract.]

DE SILVA, A. "1995" 1996. An introduction to the herpetofauna of Sri Lanka, part 2: Historical aspects. *Lyriocephalus* 2(1 & 2): 3-16; pl. 1-8.

________ "1995" 1996. The reptiles of Sri Lanka, a checklist and common names Part 1: Testudines, Crocodylia and Lacertilia. *Lyriocephalus* 2 (1 & 2): 25-33.

________ "1995" 1996. Further notes on *Cyrtodactylus frenatus* (Reptilia: Gekkonidae). *Lyriocephalus* 2(1 & 2): 60.

________ "1995" 1996. Snakes of the world A checklist, 1 Venomous snake [Book Review]. *Lyriocephalus* 2(1 & 2): 61.

________ "1995" 1996. Research needs and management of the herpetofauna of Sri Lanka: a national conservation strategy. *Lyriocephalus* 2(1 & 2): 66-68.

________ 1996. The herpetofauna of Sri Lanka: a brief review. Privately published, Gampola, Sri Lanka. 99 pp + 15 plates.

________ . 1996. Sri Lanka: a quantum leap in amphibian research. *Zoos' Print* 11(8): 35.

________ . 1996. The status of *Geochelone elegans* in North western Province of Sri Lanka: preliminary findings. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 47-49. SOPTOM (ed.). Editions Soptom, Gonfaron.

________ . 1996. An annotated bibliography of the Amphibia of Sri Lanka. Privately printed, Gampola. 48 pp.

________ & P. DE SILVA. "1995" 1996. Some observations on *Kaloula taprobanica* (Amphibia: Anura: Microhylidae) in Sri Lanka. *Lyriocephalus* 2(1 & 2): 48-51; Pl. 9.

DEUTI, K. 1996. The Himalayan salamander. *Cobra* 23: 35-37.

________ . 1996. Amphibians of India: some more species. *Cobra* 24: 18-20.

________ . 1996. Ethological studies on the amphibians recorded from Bethuadahari Wildlife Sanctuary, Nadia District, West Bengal. *Zoos' Print* 11(5): 4-5.

DUNAYEV, E. A. 1996. On the possible use of the ethological features in the taxonomy and phylogeny of toad agamas, *Phrynocephalus* (Reptilia, Agamidae). *Russian J. Herpetol.* 3(1): 32-38.

DUTTA, B. 1996. Leatherback's nesting under threat. *Cobra* 23: 10-14.

DUTTA, S. K. 1996. Status of *Limnonectes limnocharis* (Anura: Ranidae) species complex in Asia. *Zoos' Print* 11(8): 15, 21.

________ & K. MANAMENDRA-ARACHCHI. 1996. The amphibian fauna of Sri Lanka. Wildlife Heritage Trust of Sri Lanka, Colombo. 230 pp.

ECKERT, S. A., H.-C. LIEW, K. L. ECKERT & E.-H. CHAN. 1996. Shallow water diving by leatherback turtles in the South China Sea. *Chelonian Conserv. & Biol.* 2(2): 237-243.

EDWARDS, J. & J. DEAS. 1996. The monitors seen during a short trip to Singapore and West Java. *Varanews* 4(4): 3-4.

EISELT, J. 1995. Ein Beitrag zur Kenntnis der Archeolacerten (sensu Méhely, 1909) des Iran. *Herpetozoa* 8(1/2): 59-72.

FERNANDO, P. & M. SIRIWARDHANE. 1996. *Microhyla karunaratnei* (Anura: Microhylidae), a new species of frog endemic to Sri Lanka. *J. South Asian nat. Hist.* 2(1): 135-142.

FISHER, S. 1996. Illegal turtle trade in Sri Lanka and the Maldives and an encouraging note of progress. *Mar. Turtle Newsl.* (71): 10-11.

FLECK, J. 1996. Neues über die Gattung *Tylototriton. Elaphe* 4(2): 79-80.

FRAZIER, J. 1995. Decline of the sea turtles: causes and prevention [Book Review]. *Herpetol. Rev.* 26(4): 216-217.

________ . 1996. Measurement error: taboo in Testudine investigations. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 266-268. SOPTOM (ed.). Editions Soptom, Gonfaron.

GANS, C. "1995" 1996. New records of skinks from Sri Lanka. *Lyriocephalus* 2 (& 2): 21-24.

GAULKE, M. 1996. Die Herpetofauna von Sibutu Island (Philippinen), unter Berüchsichtigung zoogeographischer und ökologischer Aspekte. *Senck. Biol.* 75(1/2): 45-56.

GEORGE, S. 1996. One more amphibian species from Pooyamkutty, Kerala. *Zoos' Print* 11(5): 8.

________ & L. ALEX. 1995. First record of *Uperodon globulosum* (Anura: Microhylidae) from Kerala. *J. Bombay nat. Hist. Soc.* 92(3): 427.

________ , K. H. KRISHNAN, G. VARGHESE, S. S. KUMAR, S. THOMAS & N. K. ARJUNAN. 1996. A note on captive rearing of *Rhacophorus malabaricus. Zoos' Print* 11(8): 36-37.

________ , J. M. SAMUEL & V. S. JOSEKUMAR. 1996. Survey of the amphibian fauna of Thattekad Bird Sanctuary, Kerala. *Zoos' Print* 11(5): 7-8.

GERLACH, J. & K. L. CANNING. 1996. A new species of the western Indian Ocean gecko *Ailuronyx* (Reptilia; Gekkonidae). *Herpetol. J.* 1(2): 37-42.

GEROSA, G., P. CASALE & S. V. YERLI. 1996. Report on a sea turtle nesting beach study (Akyatan, Turkey), 1994. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 173-180. SOPTOM (ed.). Editions Soptom, Gonfaron.

GHASKADBI, S. & H. V. GHATE. 1995. Immunoneutralization of insulin partially modifies dorsoventral patterning in developing frog embryos. *J. Biosci.* 20(4): 473-480.

GHATE, H. V. & A. D. PADHYE. 1996. Impact of urbanization on amphibians of Pune. *Zoos' Print* 11(5): 14-16.

________ , ________ & S. GHASKADBI. 1996. Defective neurulation in frog embryos exposed to dilute sea water. *Curr. Sci.* 71(4): 320-326.

GOLUBEV, M. L., Y. K. GORELOV, E. A. DUNAYEV & T. I. KOTENKO. 1995.[On the finding of *Phrynocephalus guttatus* (Gmel.)(Sauria, Agamidae) in Turkmeniya and its taxonomic status.] *Byulleten Moskovskago Obschchestva Ispytatelej Prirody, Otd. Biol.* 100(3): 31-39. [In Russian with English abstract.]

GUNATILLEKE, I. A. U. N., P. B. KARUNARATNE & C. V. S. GUNATILLEKE. "1995" 1996. Status of natural habitats in relation to the herpetofauna of Sri Lanka. *Lyriocephalus* 2(1 & 2): 71-80.

GUNAWARDHANA, J. "1995" 1996. Legal protection of reptile and amphibians in Sri Lanka. *Lyriocephalus* 2(1 & 2): 88-91.

GUPTA, B. K. 1995. Preliminary survey on the trade in common Indian monitor (*Varanus bengalensis*) in Uttar Pradesh. *Cobra* 21: 17-19.

________ & B. RATHINASABAPATHY. 1994. Housing reptiles. *Zoos' Print* 9(8): 45-46.

________ & _______ . 1995. Freshwater turtles: illegal trade in Coimbatore, south India. *Cobra* 22: 20-21.

GUPTA, R. C. & C. S. BHARDWAJ. 1996. Reproductive behaviour of Indian mugger (*Crocodylus palustris*) at Bhor-Saindan Crocodile Sanctuary, Haryana. *J. Bombay nat. Hist. Soc.* 93(1): 97-101.

HALLERMANN, J. 1996. Morphologie und systematische Stellung der Schlangenschleiche *Dibamus novaeguineae* (Squamata: Dibamidae). Zusammenfassungen Jahrestagung der Deutschen Gesellschaft für Herpetologie und Terrarienkunde e. V. in Stuttgart. pp: 9-10. DGHT, Rheinbach.

HARIT, D. N. 1996. Indigenous method of translocation of the tucktoo *Gecko* (sic) *gecko* Linn. as practised in Mizoram, India. *J. Bombay nat. Hist. Soc.* 93(2): 302.

HERMANN, H.-W. & U. JOGER. "1997" 1996. Evolution of viperine snakes. *In*: Venomous snakes: ecology, evolution and snakebite. pp: 43-61. R. S. Thorpe, W. Wüster & A. Malhotra (eds). Symp. Zool. Soc. London (70). Clarendon Press, Oxford.

HOLFERT, T. 1995. Haltungserfahrungen beim Berberskink (*Eumeces schneideri*). *Elaphe* 3(4): 8-12.

HOLLOWELL, M. 1996. Experiences with a water monitor (*Varanus salvator*). *The Rephiberary* (229): 9-13.

HOSSAIN, M. L. & M. S. SARKAR. 1995. Observations on the narrow-headed softshell turtle (*Chitra indica*) in Bangladesh. *J. Bombay nat. Hist. Soc.* 92(3): 423-426.

HUA, T., B. CHEN, Z. HUA & C. WANG. 1996. Development and degeneration of dorsal glands of *Alligator sinensis*. *Sichuan J. Zool.* 15(2): 59-61. [In Chinese with English abstract.]

HUANG, G.-W., M. NAKAMURA & T. KOSUGI. 1995. Relationship between concentration of crude venom from *Trimeresurus flavoviridis* in the circulating blood and the appearance of DIC in rabbits. *The Snake* 27(1): 31-41.

HUANG, W.-S. 1995. Notes on egg clutch size of the black burrowing snake, *Achalinus niger*. *J. Taiwan Mus.* 48(2): 105-108.

IKEBE, C., M. AMANO, T. KOIZUMI, M. KURO-O & S.-I. KOHNO. 1995. Cytogenetic studies of Hynobiidae (Urodela) XIII. Morphological variation of chromosome No. 4 and the C-banded karyotype in *Onychodactylus japonicus* (Houttuyn). *Japanese J. Herpetol.* 16(2): 35-41.

INGER, R. F. 1996. Commentary on a proposed classification of the family Ranidae. *Herpetologica* 52(2): 241-246.

IORDANSKY, N. N. 1996. Jaw musculature of turtles: structure, functions, and evolutionary conservatism. *Russian J. Herpetol.* 3(1): 49-57.

ISOGAWA, K. 1995. Comparative observations on dorsal scales of shed skins of the genus *Agkistrodon* (Viperidae, Crotalinae) from Far East Asia. *The Snake* 27(1): 7-11.

________ & M. KATO. 1995. Mating season of the Japanese mamushi, *Agkistrodon blomhoffi* (Viperidae: Crotalinae), in southern Kyushu, Japan: relation with female ovarian development. *Japanese J. Herpetol.* 16(2): 42-48.

JACKSON, K. & T. H. FRITTS. 1996. Observations of a grooved fang in *Psammodynastes pulverulentus*: does the mock viper resemble a protoelapid? *J. Herpetol.* 30(1): 128-131.

JASMI, A. & C. M. AZIZ. 1996. Burmese brown and yellow-headed tortoise of Peninsular Malaysia. *In*: 7th Vet. Assoc. Malaysia Sci. Congr. Seremban: 115-118.

JAYAWICKRAMA, A. "1995" 1996. Note on *Calotes calotes* feeding. *Lyriocephalus* 2(1 & 2): 59.

________ "1995" 1996. Preliminary observations on amphibians and reptiles at Ritigala, Sri Lanka. *Lyriocephalus* 2(1 & 2): 58-59.

KADOWAKI, S. 1996. Body size and population density of *Bufo japonicus formosus* from Nobeyama Highland, Nagano. *Japanese J. Herpetol.* 16(3): 108-113.

KALAIARASAN, V., R. AENGELS & R. RAJARATHINAM. 1995. A catalogue of herpetological specimens in the Madras Snake Park- Part III- Snakes, to crocodiles. *Cobra* 21: 12-15.

KAM, Y.-C., Z.-S. CHUANG & C.-F. YEN. 1996. Reproduction, oviposition-site selection and tadpole oophagy of an arboreal nester, *Chirixalus eiffingeri* (Rhacophoridae), from Taiwan. *J. Herpetol.* 30(1): 52-59.

KAMOSAWA, M. & H. OTA. 1996. Reproductive biology of the Brahminy blind snake (*Rhamphotyphlops braminus*) from the Ryukyu Archipelago, Japan. *J. Herpetol.* 30(1): 9-14.

KANAMADY, R. D. 1996. Acoustic communication in some Indian anurans: a review. *Zoos' Print* 11(8): 26-35.

KANDAMBY, D. "1995" 1996. Role of the National Museum in the field of herpetology in Sri Lanka. *Lyriocephalus* 2(1 & 2): 84-85.

KARNS, D. R. 1996. Measuring and monitoring biological diversity: standard methods for amphibians [Book Review]. *Herpetol. Rev.* 27(1): 43-44.

KAVERKIN, Y. I. & N. L. ORLOV. 1996. Experience of captive breeding *Eublepharis turcmenicus* Darevsky, 1978 (Eublepharidae, Sauria). *Russian J. Herpetol.* 3(1): 99.

KHAIRE, A. 1996. Breeding in *Python molurus*. Survey and observations. *Zoos' Print* 11(2): 6-8.

KHAN, A. 1996. Chelonians of Bangladesh, their present state and future conservation scenarios. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 42. SOPTOM (ed.). Editions Soptom, Gonfaron.

KHAN, M. S. & S. A. MUFTI. 1994. Oral disk morphology of amphibian tadpole and its functional correlates. *Pakistan J. Zool.* 26(1): 25-30.

KHOZATSKY, L. I. 1996. New turtle from the Early Cretaceous of central Asia. *Russian J. Herpetol.* 3(1): 89-94.

KIKUKAWA, A., N, KAMEZAKI, K. HIRATE & H. OTA. 1996. Distribution of nesting sites of sea turtles in Okinawajima and adjacent islands of the Central Ryukyus, Japan. *Chelonian Conserv. & Biol.* 2(1): 99-101.

KLEMENS, M. W. & J. B. THORBJARNARSON. 1995. Reptiles as a food resource. *Biodiv. & Conserv.* 4: 281-298.

KOK, R. 1995. Zur Haltung und Nachzucht des Pazifikwarans (*Varanus indicus*). *Salamandra* 31(3): 129-136.

KOTTELAT, M. & T. WHITTEN. 1996. Freshwater biodiversity in Asia with special reference to fish. World Bank Technical Paper No. 33. World Bank, Washington, D.C. ix + 59 pp.

KRISHNAMURTHY, S. V. 1996. Future of some anurans in the Malnad region of Western Ghats. *Zoos' Print* 11(5): 9-11.

________ . 1996. Habitat features of amphibians in Sringeri, Western Ghats. *Zoos' Print* 11(8): 2-5.

KÜPPERS-HECKHAUSEN, C. & T. ACKERMANN. 1995. Über Haltung und Nachzucht des Indischen Dornschwanzes (*Uromastyx hardwickii*) im Terrarium. *Salamandra* 31(2): 65-78.

KURAMOTO, M. 1995. Scanning electron microscopic studies on the spermatozoa of some Japanese salamanders (Hynobiidae, Cryptobranchidae, Salamandridae). *Japanese J. Herpetol.* 16(2): 49-58.

KURUVITA, V. & R. V. P. J. RAJAPAKSHA. "1995" 1996. Veterinary aspects of reptiles of Sri Lanka. *Lyriocephalus* 2(1 & 2): 83.

KUSANO, T., K. FUKUYAMA & N. MIYASHITA. 1995. Body size and age determination by skeletochronology of the brown frog *Rana* *tagoi tagoi* in southwestern Kanto. *Japanese J. Herpetol.* 16(2): 29-34.

_______ , _______ & _______ . 1995. Age determination of the stream frog, *Rana sakuraii*, by skeletochronology. *J. Herpetol.* 29(4): 625-628.

KUSANO, T., K. MARUYAMA & S. KANEKO. 1995. Post-breeding dispersal of the Japanese toad, *Bufo japonicus formosus*. *J. Herpetol.* 29(4): 633-638.

LAU, M. 1996. Amphibians in Hong Kong. *Zoos' Print* 11(5): 17-18.

LAZELL, J. 1995. *Gekko chinensis* (Chinese gecko): Spider predation. *Herpetol. Rev.* 26(4): 205.

LEHR, E. 1996. Untersuchungen zum Schildkrötenhandel in Vietnam. Zusammenfassungen Jahrestagung der Deutschen Gesellschaft für Herpetologie und Terrarienkunde e. V. in Stuttgart. pp: 16-17. DGHT, Rheinbach.

LEPTIEN, R. 1996. Descriptions of natural history, behavior and husbandry of two geckos in the genus *Asaccus* from the United Arab Emirates. *Dactylus* 3(1): 18-23.

LIEW, H. C., E. H. CHAN, F. PAPI & P. LUSCHI. 1996. Long distance migration of green turtles from Redang Island, Malaysia: the need for regional cooperation in sea turtle conservation. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 73-75. SOPTOM (ed.). Editions Soptom, Gonfaron.

LIM, B. L. & L. RATNAM. 1996. The green cat snake *Boiga cyanea*: a new record for Malaysia. *Malayan nat. J.* 50(1): 43-46.

LINDSAY, C. 1995. Turtle Islands: Balinese ritual and the green turtle. Takarajima Books, New York. 124 pp.

LUE, K.-Y., J.-S. LAI & Y.-S. CHEN. 1995. A new *Rhacophorus* (Anura: Rhacophoridae) from Taiwan. *J. Herpetol.* 29(3): 338-345.

MALHOTRA, A. & R. S. THORPE. "1997" 1996. New perspectives on the evolution of southeast Asian pit vipers (genus *Trimeresurus*) from molecular studies. *In*: Venomous snakes: ecology, evolution and snakebite. pp: 115-128. R. S. Thorpe, W. Wüster & A. Malhotra (eds). Symp. Zool. Soc. London (70). Clarendon Press, Oxford.

MALKMUS, R. 1995. Over het voortplantingsbiotoop van *Philautus* sp. Mt. Kinabalu (noordelijke Borneo). *Lacerta* 53(3): 68-74.

MALKMUS, R. 1996. Voortplanting van de Dwergpad *Pelophryne misera*. *Lacerta* 54(4): 129-133.

MALKMUS, R. 1996. Kopfseitenflecken bei beiden Geschlechtern von *Rhacophorus angulirostris* Ahl, 1927 (Amphibia: Rhacophoridae). *Salamandra* 31(4): 245-236.

MALKMUS, R. & K. REIDE. 1996. Die Baumfrösche der Gattung *Philautus* vom Mount Kinabalu - Teil I: Überblick und die *aurifasciatus*-Gruppe mit Beschreibung einer neuen Art (*Philautus saueri* n. sp.). *Sauria* 18(1): 27-37.

MALKMUS, R. & K. REIDE. 1996. Die Baumfrösche der Gattung *Philautus* vom Mount Kinabalu - Teil II: Die *vermiculatus*-Gruppe mit Beschreibung einer neuen Unterart (*Philautus aurantium gunungensis* n. ssp.) und die *hosei*-Gruppe. *Sauria* 18(2): 21-28.

MALKMUS, R. & H. SAUER. 1996. Ruhestellung von *Pareas nuchalis* und Erstnachweis dieser Art im Nationalpark Mount Kinabalu/Malaysia. *Salamandra* 32(1): 55-58.

MANAMENDRA-ARACHCHI, K. "1995" 1996. The geckos of Sri Lanka. *Lyriocephalus* 2(1 & 2): 82; Pl. 10.

_______ & D. GABADAGE. 1996. *Limnonectes kirtisinghei*, a new species of ranid frog from Sri Lanka. *J. South Asian nat. Hist.* 2(1): 31-42.

MASKEY, T. M., H. F. PERCEIVAL & C. L. ABERCROMBIE. 1995. Gharial habitat use in Nepal. *J. Herpetol.* 29(3): 463-464.

MATHEW, R. 1995. Hibernating lizards. *Cobra* 21: 16.

MATSUI, M. 1996. Call characteristics and systematic relationships of a Malayan treefrog *Nyctixalus pictus* (Anura, Rhacophoridae). *Herpetol. J.* 6(2): 62-64.

_______ & H. OTA. 1995. On Chinese herpetology. *Herpetologica* 51(2): 234-250.

_______ , _______ , M. W. LAU & A. BOGADEK. 1995. Cytotaxonomic studies of three ranid species (Amphibia: Anura) from Hong Kong. *Japanese J. Herpetol.* 16(1): 12-18.

MICHAUX, B. 1995. Distributional patterns in West Wallacea and their relationship to regional tectonic structures. *Sarawak Mus. J.* 48: 163-179.

MITCHELL, J. C. & A. G. J. RHODIN. 1996. Observations on the natural history and exploitation of the turtles of Nepal, with life history notes on *Melanochelys trijuga. Chelonian Conserv. & Biol.* 2(1): 166-172.

MITRA, D. 1996. Shedding of fangs in king cobra. *Cobra* 23: 39.

MOHANTY, A. K., S. K. DUTTA & N. SINGH. 1996. Breeding, development and life history of *Limnonectes limnocharis* (Anura: Ranidae). *Zoos' Print* 11(8): 8-14.

MOLL, D. 1996. Conservation and management of river turtles: a review of methodology and techniques. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 290-294. SOPTOM (ed.). Editions Soptom, Gonfaron.

MOLLIGODA, H. "1995" 1996. The role of the zoo in herpetology. *Lyriocephalus* 2(1 & 2): 94.

MORI, A., D. LAYNE & G. M. BURGHARDT. 1996. Description and preliminary analysis of antipredator behavior of *Rhabdophis tigrinus tigrinus*, a colubrid snake with nuchal glands. *Japanese J. Herpetol.* 16(3): 94-107.

MOURA-DA-SILVA, A. M., R. D. G. THEAKSTON & J. M. CRAMPTON. "1997" 1996. Molecular evolution of phospholipase A_2s and metalloproteinase/disintegrins from venoms of vipers. *In*: Venomous snakes: ecology, evolution and snakebite. pp: 173-187. R. S. Thorpe, W. Wüster & A. Malhotra (eds). Symp. Zool. Soc. London (70). Clarendon Press, Oxford.

MURTHY, T. S. N. 1995. Reptilia and Amphibia. *In*: Wetland Ecosystems Series 1: Fauna of Chilka Lake. pp: 507-560. Zoological Survey of India.

NAIK, Y. M., K. R. VINOD & B. PILO. 1995. The importance of preservation of biodiversity of amphibians in Shoolpaneshwar Sanctuary. *In*: Proc. Nat. Symp. Recent Trends Indian Wildl. Res. pp: 38-40. A.V.C. College, Mayiladuthurai.

NAKACHI, A. 1995. Seasonal activity pattern of the colubrid snake, *Cyclophiops semicarinatus*, on Okinawajima Island, Ryukyu Archipelago, Japan. *Japanese J. Herpetol.* 16(1): 1-6.

NILSON, G. & C. ANDREN. "1997" 1996. Evolution, systematics and biogeography of Palaearctic vipers. *In*: Venomous snakes: ecology, evolution and snakebite. pp: 31-42. R. S. Thorpe, W. Wüster & A. Malhotra (eds). Symp. Zool. Soc. London (70). Clarendon Press, Oxford.

NISHIMURA, M. 1995. Body mass loss in Habu, *Trimeresurus flavoviridis*, without water supply in biotron. *The Snake* 27(1): 13-20.

NOBUSAKA, R., E. NAKAMOTO, S. MISHIMA & Y. SAWAI. 1995. Note on the reproduction of Hyan, *Calliophis japonicus japonicus* (Guenther). *The Snake* 27(1): 57-59.

NOBUYUKI, T. & H. OTA. 1996. Description of a new species of *Takydromus* from the Ryukyu Archipelago, Japan, and a taxonomic redefinition of *T. smaragdinus* Boulenger 1887. (Reptilia: Lacertidae). *Herpetologica* 52(1): 77-88.

NUITJA, I. N. S. 1996. Status of freshwater turtles in Java Island. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 66. SOPTOM (ed.). Editions Soptom, Gonfaron.

ORLOV, N. 1996. Amphibien und Reptilien der Bergwälder Vietnams. Zusammenfassungen Jahrestagung der Deutschen Gesellschaft für Herpetologie und Terrarienkunde e. V. in Stuttgart. pp: 16. DGHT, Rheinbach.

________ , U. JOGER & P. LENK. 1996. Systematik, Biologie und Terrarienhaltung der Fea-Viper, *Azemiops feae*. Zusammenfassungen Jahrestagung der Deutschen Gesellschaft für Herpetologie und Terrarienkunde e. V. in Stuttgart. pp: 8. DGHT, Rheinbach.

OTA, H. 1995. Endoglyphs and other major venomous snakes of the world: a checklist [Book Review]. *The Snake* 27(1): 65-67.

________ & T. HIKIDA. 1996. The second specimen of *Calotes kinabaluensis* de Grijs (Squamata: Agamidae) from Sabah, Malaysia, with comments on the taxonomic status of the species. *J. Herpetol.* 30(2): 288-291.

PANDAV, B. & B. C. CHOUDHURY. 1996. A note on the occurrence of sub-adult olive ridley turtle along the Gahirmatha coast. *Mar. Turtle Newsl.* (71): 15-17.

PANG, Q. 1996. Anatomy of digestive and respiratory systems of *Varanus salvator. Sichuan J. Zool.* 15(2): 71-72. [In Chinese.]

PARALKAR, V. K. 1995. A common garden lizard (*Calotes versicolor*) killing an adult house sparrow (*Passer domesticus*). *J. Bombay nat. Hist. Soc.* 92(3): 426.

PARKINSON, C. L., S. M. MOODY & J. E. AHLQUIST. "1997" 1996. Phylogenetic relationships of the '*Agkistrodon* complex' based on mitochondrial DNA sequence data. *In*: Venomous snakes: ecology, evolution and snakebite. pp: 63-78. R. S. Thorpe, W. Wüster & A. Malhotra (eds). Symp. Zool. Soc. London (70). Clarendon Press, Oxford.

PAWLEY, R. 1996. Parthenogenetische Arafure Warzenschlangen (*Acrochordus arafurae*) im Brookfield Zoo geboren. Zusammenfassungen Jahrestagung der Deutschen Gesellschaft für Herpetologie und Terrarienkunde e. V. in Stuttgart. pp: 15. DGHT, Rheinbach.

PEREIRA, D. G. A. "1995" 1996. Amphibians and reptiles in Sri Lankan place names. *Lyriocephalus* 2(1 & 2): 34-42.

PETERSON, K. 1996. The global decline in amphibian species: a perceptual deficit in the zoo and conservation community. *Bull. Chicago Herpetol. Soc.* 31(2): 22-26.

PIANKA, E. R. 1995. Evolution of body size: varanid lizards as a model system. *American Natural.* 146(3): 398-414.

PRASCHAG, R. 1996. Schildkröten und Krokodile in Südindien und Sri Lanka. Zusammenfassungen Jahrestagung der Deutschen Gesellschaft für Herpetologie und Terrarienkunde e. V. in Stuttgart. pp: 11. DGHT, Rheinbach.

PREMKISHORE, G. & M. R. CHANDRAN. 1996. Salt loss and gain in two species of fresh water turtles of Tamil Nadu. *Zoos' Print* 11(7): 9-10.

RADHAKRISHNAN, C. 1996. Survey of reptilian fauna of Parambikulam Wildlife Sanctuary, Kerala. *Cobra* 24: 7-12.

________ . 1996. Amphibians from Aralam Wildlife Sancruary (sic) Western Ghats, Kerala. *Zoos' Print* 11(8): 1.

________ . 1996. Comments on the note "First record of *Microhyla rubra* (Jerdon)(Amphibia: Anura) from Maharashtra" by Kamble and Ghate. *J. Bombay nat. Hist. Soc.* 93(1): 101-102.

RAJARATHINAM, R. & V. KALAIARASAN. 1995. Records of cannibalism in captive reptiles. *Cobra* 22: 22-23.

RANGER, S. & P. RICHARDSON. 1996. Marine turtles of Sri Lanka. Turtle Conservation Project, Colombo. 13 pp.

RAO, R. J. 1996. Conservation status of Indian chelonians. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 33-37. SOPTOM (ed.). Editions Soptom, Gonfaron.

________ , S. K. BEHERA & R. K. PANDIT. 1996. Status and conservation of turtles in the Upper Ganga River, India. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 38-41. SOPTOM (ed.). Editions Soptom, Gonfaron.

________ & B. C. CHOUDHURY. 1996. Prospects of captive breeding and restocking of star tortoise in Gujarat. *Zoos' Print* 11(10): 1-4.

RASMUSSEN, A. R. "1997" 1996. Systematics of sea snakes: a critical review. *In*: Venomous snakes: ecology, evolution and snakebite. pp: 15-30. R. S. Thorpe, W. Wüster & A. Malhotra (eds). Symp. Zool. Soc. London (70). Clarendon Press, Oxford.

RASTEGAR-POUYANI, N. 1996. A new species of *Asaccus* (Sauria: Gekkonidae) from the Zagros Mountains, Kermanshan Province, Western Iran. *Russian J. Herpetol.* 3(1): 11-17.

RATH, S., S. MISHRA & S. K. DUTTA. 1996. Morphometric and sex ratio analysis of Indian tree frog, *Polypedates maculatus* (Anura: Rhacophoridae). *Zoos' Print* 11(5): 23-29.

RATHINASABAPATHY, B. 1996. Amphibians: neglected class of vertebrates in zoos. *Zoos' Print* 11(8): 38.

________ & B. K. GUPTA. 1995. Reptiles of Anaikatty in the Nilgiri Biosphere Reserve, south India. *Cobra* 22: 17-19.

RAVICHANDRAN, M. S. 1996. Amphibia of the Kalakad Wildlife Sanctuary, TamilNadu, India. *Cobra* 23: 15-31.

________ & R. S. PILLAI. 1996. Present status of Indian caecilians (Gymnophiona: Amphibia). *Zoos' Print* 11(5): 1, 3.

RAY, P. 1996. Amphibian diversity in and around Tehri Dam Site, UP, India. *Zoos' Print* 11(5): 6.

REIDE, K. 1996. Diversity of sound-producing insects in a Bornean lowland rain forest. *In:* Tropical Rainforest Research: Current Issues. pp: 77-84. D. S. Edwards, W. E. Booth & S. C. Choy (eds). Kluwer Academic Publishers, Dordrecht.

REISS, J. 1996. Palatal metamorphosis in basal caecilians (Amphibia: Gymnophiona) as evidence for lissamphibian monophyly. *J. Herpetol.* 30(1): 27-39.

RHODIN, A. G. J. 1996. Status and conservation of *Chelodina mccordi*, an isolated and restricted freshwater turtle from Roti Island, Indonesia. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 67. SOPTOM (ed.). Editions Soptom, Gonfaron.

RICHARDSON, P. "1995" 1996. The status of marine turtles and their conservation in Sri Lanka. *Lyriocephalus* 2(1 & 2): 81.

ROESLER, H. 1996. Field observations and captive husbandry in *Eublepharis turcmenicus*, Darevsky, 1978. *Dactylus* 3(1): 24-28.

ROSS, W. 1995. Body language in agamids of eastern Saudi Arabia. *Trop. Fish Hobbyist* June, 1995: 124, 127-129, 131-133.

ROY, D. 1996. Importance of bioacoustic analysis in amphibian taxonomy and conservation. *Zoos' Print* 11(8): 22-25.

________ . 1996. Courtship in frogs: role of acoustic communication in amphibian courtship behaviour. *Resonance, J. Sci. Ed.* 1(12): 39-48.

________ , B. BORAH & A. SARMA. 1995. Analysis and significance of female reciprocal calls in frogs. *Curr. Sci.* 29(3): 265-270.

SACHSSE, W. 1996. 25 years captive propagation of chelonians- 40 species- Survey of the efforts in general. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 235-236. SOPTOM (ed.). Editions Soptom, Gonfaron.

SAIDAPUR, S. K. & B. HOQUE. 1996. Long-term effects of ovariectomy on abdominal fat body and body masses in the frog *Rana tigerina* during the recrudescent phase. *J. Herpetol.* 30(1): 70-73.

SANCHEZ-HERRAIZ, M. J., R. MARQUEZ, L. J. BARBADILLO & J. BOSCH. 1995. Mating calls of three species of anurans from Borneo. *Herpetol. J.* 5(4): 293-297.

SARKAR, M. S. & M. L. HUSAIN. 1996. Population ecology, eco-biological status, captive propagation and conservation problems of *Lissemys punctata* in Bangladesh. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 43-46. SOPTOM (ed.). Editions Soptom, Gonfaron.

SATHYANARAYANA, M. C. & K. SAMPATH. 1996. Structural features of helminth parasites of amphibians. *Zoos' Print* 11(5): 30-33.

SATHASIVAM, K. 1995. Sweet toothed gecko. *Blackbuck* 11(3): 79-81.

SCHULTSCHIK, G. & S. STEINFARTZ. 1996. Die Salamandriden des Iran sowie Anmerkungen zur Herpetofauna (Reisebericht Iran 1995). *Elaphe* 4(2): 76-77.

SEKAR, A. G. 1996. Habitat and breeding sites of amphibians of western India. *Zoos' Print* 11(5): 2-3.

________ . 1996. Additions to the updated species list of amphibian fauna of India. *J. Bombay nat. Hist. Soc.* 93(2): 303.

SEKAR, M. & M. J. RAO. 1995. Management of Indian rock python (*Python molurus*) in captivity at Arignar Anna Zoological Park, Vandalur, Madras. *Cobra* 22: 14-16.

SELVANAYAGAM, Z. E., S. G. GNAVAVENDHAN, K. BALAKRISHNAN, R. B. RAO & S. U. ALI. 1995. Survey of medicinal plants with antisnake venom activity in Chengalpattu district, Tamilnadu, India. *Fitoterapia* 66(6): 488-494.

SENANAYAKE, N. "1995" 1996. Human and reptile conflicts: impact on reptiles in Sri Lanka. *Lyriocephalus* 2(1 & 2): 86.

SHANKAR, K. 1996. Nature watch: secret of the shieldtails. *Resonance* 1(8): 65-70.

SHARMA, D. S. K. 1996. Conservation and management project for endangered estuarine turtles in peninsular Malaysia. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 76. SOPTOM (ed.). Editions Soptom, Gonfaron.

SHARMA, D. S. K., A. S. MOHD. NASIR & A. GILES. 1996. Incubation and hatchling emergence of painted terrapin (*Callagur borneoensis*) eggs under hatchery conditions at Paka, Terengganu. *In*: 7th Vet. Assoc. Malaysia Sci. Congr., Seremban: 122-125.

SHARMA, D. S. K., Z. ZAINAL-ZAHARI & R. S. K. SHARMA. 1996. Husbandry of chelonians at Zoo Melaka: current practises and recommendations for improvement. *In*: 7th Vet. Assoc. Malaysia Sci. Congr., Seremban: 101-106.

SHARMA, I. K. 1996. Habitat preferences, niche and conservation of monitor lizards (*Varanus bengalensis* and *Varanus griseus*) in Thar Desert, Rajasthan. *Cobra* 23: 32-34.

SHARMA, R. K. & S. GREWAL. 1996. DNA, RNA, and protein changes in ovarian follicles of the house gecko, *Hemidactylus flaviviridis*. *J. Herpetol.* 30(1): 76-78.

SHETTY, S. 1996. Studies on the terrestrial behaviour of the yellow-lipped sea krait (*Laticauda colubrina*) in the Andaman Islands. M. Sc. Dissertation, Sálim Ali School of Ecology, Pondicherry. 44 pg + 6 pl. + 2 maps.

SHIMOYAMA, R. 1996. Sympatric and synchronous breeding by two pond frogs, *Rana porosa brevipoda* and *Rana nigromaculata*. *Japanese J. Herpetol.* 16(3): 87-93.

SHINE, R., P. HARLOW, J. S. KEOGH & (P.) BOEADI. 1995. Biology and commercial uilization of acrochordid snakes, with special reference to karung (*Acrochrodus javanicus*). *J. Herpetol.* 29(3): 352-360.

________ , ________ , ________ & _____ 1996. Commercial harvesting of giant lizards: the biology of water monitors *Varanus salvator* in southern Sumatra. *Biol. Conserv.* 77: 125-134.

SHRESTHA, T. K. 1996. Conservation strategy for amphibians and reptiles of Nepal. *Zoos' Print* 11(5): 19-21.

________ . 1996. New survival of rare chelonian in the altered habitats of Himalayan rivers of Nepal. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 52-56. SOPTOM (ed.). Editions Soptom, Gonfaron.

________ . 1996. Wetland use, habitat fragmentation and their impacts on turtles in Nepal. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 57-61. SOPTOM (ed.). Editions Soptom, Gonfaron.

SIDEEK, S. M. & R. M. BALDWIN. 1996. Assessment of the Oman green turtle (*Chelonia mydas*) stock using a stage-class matrix model. *Herpetol. J.* 6(1): 1-8.

SINGH, K. S. 1995. On a collection of reptiles and amphibians of Manipur. *Geobios New Reports* 14: 135-145.

SINHA, R. K. 1996. Commercial exploitation of freshwater turtle resource in the middle Ganges River System in India. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 14-20. SOPTOM (ed.). Editions Soptom, Gonfaron.

SIRIWARDENA, A. "1995" 1996. Vidusara: its contribution towards the herpetology of Sri Lanka. *Lyriocephalus* 2(1 & 2): 86.

SIVASUNDAR, A. 1996. Studies on the nesting of leatherback sea turtle (*Dermochelys coriacea*) in the Andaman Islands. M. Sc. dissertation, Sálim Ali School of Ecology, Pondicherry University, Pondicherry. 45 pg.

SOVAKI, M. 1996. Exploitation of sea turtles in Fiji. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 89. SOPTOM (ed.). Editions Soptom, Gonfaron.

SPOTILA, J. R., A. E. DUNHAM, A. J. LESLIE, A. C. STEYERMARK, P. T. PLOTKIN & F. V. PALADINO. 1996. Worldwide population decline of *Dermochelys coriacea*: are leatherback turtles going extinct? *Chelonian Conserv. & Biol.* 2(2): 209-222.

SRIVASTAVA, A. K. & H. R. BUSTARD. 1995. Phylogeny and zoogeography of the gharial, *Gavialis gangeticus* (Gmelin) (Reptilia, Crocodylia). *J. Bombay nat. Hist. Soc.* 92(2): 230-233.

SUAREZ, A. & C. H. STARBIRD. 1996. Subsistence hunting of leatherback turtles, *Dermochelys coriacea*, in the Kai Islands, Indonesia. *Chelonian Conserv. & Biol.* 2(2): 190-195.

SUBBA RAO, M. V. 1996. Nesting behaviour of the Indian crocodiles, *Gavialis gangeticus*, *Crocodylus palustris* and *Crocodylus porosus* (Reptilia: Crocodylidae). *In*: Readings in behaviour. pp: 212-216. R. Ramamurthi & Geetabali (eds). New Age International Limited, Publishers, New Delhi.

________ . 1996. Captive rearing of the olive ridley sea turtle hatchling for conservation purposes. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 29-32. SOPTOM (ed.). Editions Soptom, Gonfaron.

SWAMINATHAN, D., R. THIRUTHALINATHAN, N. PANEERSELVAM, V. VASAVIAH, P. S. LALITHA & L. NARAYANAN. 1995. Morphometry of major visceral organs of female common krait (*Bungarus* *caeruleus*). *In*: Proc. Nat. Symp. Recent Trends in Indian Wildl. Res. pp: 41-42. A. V. C. College, Mayiladuthurai.

________, N. PANEERSELVAM, R. THIRUTHALINATHAN, V. VASAVIAH, P. S. LALITHA & T. SENTHILKUMAR. 1996. Morphometry of major visceral organs of female rat snake (*Ptyas mucosus*). *In*: Proc. Nat. Symp. Recent Trends in Indian Wildl. Res. pp: 43-44. A. V. C. College, Mayiladuthurai.

TAN, N.-H., K. B. MOHAMMED NOR, K.-M. CHIN & G. PONNUDURAI. 1995. Cross-reactivity of Malayan pit viper (*Calloselasma rhodostoma*) and lance-headed pit viper (*Trimeresurus*) antivenoms against Malaysian pit viper venoms. *The Snake* 27(1): 43-48.

TANAKA, T. 1995. Long-term observations on the molting of a Japanese toad, *Bufo japonicus formosus*. *Japanese J. Herpetol.* 16(1): 7-11.

TASKAVAK, E. & M. ATATÜR. 1996. Threats to survival of Euphrates soft-shelled turtle, (*Rafetus euphraticus* Daudin, 1802) in south-eastern Anatolia. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 228-231. SOPTOM (ed.). Editions Soptom, Gonfaron.

THIRAKHUPT, K. & P. P. VAN DIJK. 1996. Turtle conservation and research in Thailand-some thoughts. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 64-65. SOPTOM (ed.). Editions Soptom, Gonfaron.

THIRUTHALINATHAN, R. & A. V. GOPALAKRISHNAN. 1996. Treatment of necrotic stomatitis in Indian python. *Cobra* 24: 16-17.

TSARUK, O. 1996. Catching and trading with Horsfield's tortoise *Agrionemys horsfieldi* Gray in central Asia. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 205-206. SOPTOM (ed.). Editions Soptom, Gonfaron.

THORBJARNARSON, J. B. 1996. Reproductive charactristics of the Order Crocodylia. *Herpetologica* 52(1): 8-24.

TIWARI, M. 1996. Les tortues de la mer des iles d'Andamans et Nicobars. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 50-51. SOPTOM (ed.). Editions Soptom, Gonfaron.

TORIBA, M. & K. HIRABAYASHI. 1995. Growth and reproduction of Burmese green pit viper *Trimeresurus erythrurus*, in captivity. *The Snake* 27(1): 1-5.

TRAEHOLT, C. 1995. Notes on the burrows of the water monitor lizard, *Varanus salvator*. *Malayan nat. J.* 49(2): 103-112.

TUCKER, P. 1995. Some observations on keeping the wonder gecko (*Teratoscincus scincus*). *SWHS J.* 2(4): 13-15.

UNDERWOOD, G. "1997" 1996. An overview of venomous snake evolution. *In*: Venomous snakes: ecology, evolution and snakebite. pp: 1-13. R. S. Thorpe, W. Wüster & A. Malhotra (eds). Symp. Zool. Soc. London (70). Clarendon Press, Oxford.

URFI, A. J. "1996" 1997. Successful breeding of the Indian python *Python molurus molurus* (Linnaeus) at Sundervan Nature Discovery Centre, Ahmedabad. *Zoos' Print* 12(1): 4-5.

USUDA, H. 1995. [Waving behavior and its effect on the reproductive behavior of *Hynobius nigescens*.] *Japanese J. Herpetol.* 16(1): 19-24. [In Japanese, with English abstract.]

VAN DIJK, P. P. & K. THIRAKHUPT. 1996. Southeast Asian *Chitra*. From distinction to extinction in 15 years? *In*: International Congress of Chelonian Conservation. Proceedings. pp: 62-63. SOPTOM (ed.). Editions Soptom, Gonfaron.

________ & ________. 1996. Translation of Thai text on colour poster. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 323. SOPTOM (ed.). Editions Soptom, Gonfaron.

VASUDEVAN, K. 1996. Reproductive ecology of *Aspideretes gangeticus* (Cuvier) in north India. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 21-28. SOPTOM (ed.). Editions Soptom, Gonfaron.

VENKATESWARLU, T., J. G. PATTANAYAK, S. C. NAHAR & A. MOHAPATRA. 1995. On the collection of snakes from Mahanadi estuary (Orissa, India). *The Snake* 27(1): 49-52.

VERMA, A. K. & D. N. SAHI. 1996. On the size at maturity in the male freshwater turtles, *Kachuga tecta* and *K. smithii* in Jammu. *Zoos' Print* 11(7): 3, 5.

________, ________ & K. VERMA. 1995. The amphibian fauna of Jammu and Kashmir State, India. *Cobra* 20: 2-6.

VILLAREAL, D. L. & H. G. FERNANDEZ. 1996. Bacterial flora present in skin, mouth and cloaca of the leopard gecko, *Eublepharis macularius* Blyth, 1854. *Dactylus* 3(1): 29-35.

VYAS, R. 1996. Records of water snakes (Homalopsidae: Serpentes) from Gujarat State. *J. Bombay nat. Hist. Soc.* 93(1): 101.

________ . 1996. Amphibian fauna of Gujarat State: Updated list and regional distribution. *Zoos' Print* 11(5): 12-13.

________ . "1997" 1996. Notes on growth and maturity of the Indian star tortoise (*Geochelone elegans*). *Zoos' Print* 12(1): 6-7.

WALKER, B. "1995" 1996. Starting research in herpetology. *Lyriocephalus* 2(1 & 2): 93.

WALLACH, V. 1996. Notes and corrections on two scolecophidians: *Ramphotyphlops albiceps* and *Leptotyphlops brasiliensis*. *Herpetol. Rev.* 27(1): 10.

WARRELL, D. A. "1995" 1996. Attitudes to snake bite and reptile conservation. *Lyriocephalus* 2(1 & 2): 87.

________ . "1997" 1996. Geographical and intraspecies variation in the clinical manifestations of envenoming by snakes. *In*: Venomous snakes: ecology, evolution and snakebite. pp: 189-203. R. S. Thorpe, W. Wüster & A. Malhotra (eds). Symp. Zool. Soc. London (70). Clarendon Press, Oxford.

WATERS, R. M., D. CHISZAR & G. M. BURGHARDT. 1996. Strike-induced chemosensory searching in the habu (*Trimeresurus flavoviridis*), an Asian pit viper. *J. Herpetol.* 30(2): 147-151.

WEBB, R. G. 1995. Redescription and neotype designation of *Pelochelys bibroni* from southern New Guinea (Testudines: Trionychidae). *Chelonian Conserv. & Biol.* 1(4): 301-310.

WEBB, R. G. 1995. The date of publication of Gray's Catalogue of shield reptiles. *Chelonian Conserv. & Biol.* 1(4): 322-323.

WEMMER, C. & K. A. NANJAPPA. 1996. "Battalion movement" in recently metamorphosed bicoloured frogs (*Rana curtipes*). *J. Bombay nat. Hist. Soc.* 93(2): 302-303.

WEERASINGHE, A. & B. WALKER. "1995" 1996. Some notes on the turtle hatchery, Yaddehimulla, Unawatuna, Sri Lanka. *Lyriocephalus* 2(1 &2): 32-47.

WEIJERMAN, M. & A. COOKE. 1996. A global overview of approaches to sea turtle conservation. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 308-313. SOPTOM (ed.). Editions Soptom, Gonfaron.

WELDON, P. & T. L. LETO. 1995. A comparative analysis of proteins in the scent gland secretions of snakes. *J. Herpetol.* 29(3): 474-476.

WHITAKER, R. & H. A. ANDREWS. 1996. Snake capture and venom extraction in Tamil Nadu, India. *In*: Assessing the sustainability of uses of wild species. Case studies and initial assessment procedure. R. Prescott-Allen & C. Prscott-Allen (eds). *Occ. Pap. IUCN/SSC* (12): 40-46.

XIANG, J. 1995. Egg and hatchling components of a viviparous snake, *Elaphe rufodorsata*. *J. Herpetol.* 29(2): 298-300.

YIN, F.-Y., Y.-W. GUO, S.-P. TENG & S.-H. MAO. 1996. Fine structure of the tongue and anterior process of the sublingual plica in two species of colubrid water snakes, *Xenochrophis piscator* and *Enhydris chinensis*. *Herpetologica* 52(2): 205-216.

YOKOYAMA, F., M. MATSUI & Y. YOSHIDA. 1995. A method for distinction of sex of Habu, *Trimeresurus flavoviridis*. *The Snake* 27(1): 61-63.

ZHAO, E.-M. 1996. Chelonian fauna and their conservation in China. *In*: International Congress of Chelonian Conservation. Proceedings. pp: 86. SOPTOM (ed.). Editions Soptom, Gonfaron.

________ . 1996. Chinese Reptile and Amphibian Specialist Group. *Species* (26-27): 59.

ZIEGLER, T. & W. BÖHME. 1996. Über das Beutespektrum von *Varanus dumerilii* (Schlegel, 1839). *Salamandra* 32(3): 203-210.

________ & _______ .1996. Zur Genitalmorphologie der Squamaten, speziell der Varanoidea. Zusammenfassungen Jahrestagung der Deutschen Gesellschaft für Herpetologie und Terrarienkunde e. V. in Stuttgart. pp: 14. DGHT, Rheinbach.

Note: The references listed are available for consultation at the library of the Centre for Herpetology. Copies are available from authors, NOT from the Centre.

INTERNATIONAL CONFERENCE ON THE BIOLOGY AND CONSERVATION OF THE SOUTH ASIAN AMPHIBIANS AND REPTILES

The International Conference on the Biology and Conservation of the South Asian Amphibians and Reptiles was held in Kandy between 1-5 August, 1996, with support from the Amphibia and Reptile Research Organization of Sri Lanka (ARROS), University of Peradeniya, IUCN/SSC South Asian Reptile and Amphibian Specialist Group, Department of Wildlife Conservation and Ministry of Environment and Institute of Fundamental Studies. This was the second meeting of the IUCN/SSC South Asian Reptile and Amphibian Specialist Group, the first being at Utkal University, Bhubaneshwar, India, in 1992.

Organized primarily through the efforts of Anslem De Silva of ARROS, the conference was attended by over 150 participants from Bangladesh, Germany, India, Malaysia, Nepal, Pakistan, Singapore, Sri Lanka, the UK and USA. Country

RESOLUTIONS

- It was generally agreed that amphibians and reptiles form a major part of the biological diversity of south Asian ecosystems.
- Moreover, they form an important functional component in these ecosystems and are key indicator species groups of environmental quality.
- Amphibians and reptiles play significant roles as symbols in the cultures throughout southern Asia and are used by humans for various purposes.
- This use of amphibians and reptiles should be done on a sustainable basis, guided by further research. We consider conservation and exploitation not to be mutually exclusive.
- Overall habitat destruction in the south Asian region has severely affected amphibian and reptile populations.
- For effective species conservation, more research is needed on habitat requirements, general population and other aspects of the biology of populations.
- Recent research has shown that the diversity of the herpetofauna of the region is much higher than previously known. Further research on systematics is required to understand the biodiversity of the region.
- On a regional basis, much more effort has to be put in institutional capacity building and improvement of relevant existing structures. We propose the establishment of an institute for research and conservation of the biodiversity of the south Asian region.
- Major universities in south Asia should offer training in systematics, because systematic knowledge is necessary for the long-term protection of biodiversity. Voucher specimens in existing systematic collections should be accessible to the scientific community.
- In order to effectively preserve species, conservation efforts should cover all levels, including education at the school and university levels, training for governmental agencies, public awareness programmes, etc.
- Both *in-situ* and *ex-situ* conservation programmes are encouraged, the latter with adequate research.
- Periodic monitoring programmes to determine the status of species needs to be initiated, and mechanisms for rapid protection of species and habitats identified.
- A detailed review and subsequent implementation of regulation and legislation concerning the herpetofauna in the south Asian countries is urgently required.
- Finally, the third meeting of this Specialist Group should be held within a period of four years.

reports were read by Anslem De Silva (Sri Lanka), M. Farid Ahsan (Bangladesh), Indraneil Das (Bhutan), Jennifer Daltry for Harry Andrews and Romulus Whitaker (India), M. S. Khan (Pakistan), and Tej K. Shrestha (Nepal). Plenaries included: Why (and how) to study herpetology? (Carl Gans), Biogeographic scenarios of Indian amphibians (Sushil K. Dutta), History of herpetology in southern Asia (Indraneil Das), and Biogeography and conservation of South Asian herpetofauna (Walter Erdelen). The abstract book records 54 other abstracts of papers or titles, plus eight abstracts or titles of talks supposed to take place during a workshop at the Giritale Wildlife Sanctuary that was cancelled. The proceedings of the Conference is now being edited.

The Conference also saw the release of the book, *The amphibian fauna of Sri Lanka*, by Sushil K. Dutta and Kelum-Manamendra-Arachchi, published by the Wildlife Heritage Trust of Sri Lanka (see review by Romulus Whitaker, this volume), as well as a directory of herpetologists of the southern Asian region.

Indraneil Das, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

FIRST INTERNATIONAL SYMPOSIUM ON THE HUSBANDRY OF VARANIDS AND IGUANIDS

The First International Symposium on the Husbandry of Varanids and Iguanids was held at the Town and Country Hotel and Convention Center, San Diego, California, U.S.A., between 11-12 May, 1996. The organizers, International Reptiles Expositions (IRE), is an organization based in San Diego that has been, for many years, conducting reptile shows, conferences and seminars in the USA. Participants of the Conference were from USA, UK, Germany, Australia, India, and representatives from the American Zoo and Aquarium Association (AZA) Lizard Advisory Group, Center for Reproduction of Endangered Species (CRES). The objectives of the symposium was to disseminate information on the husbandry of varanid and iguanids, and to discuss areas of concern on reproduction of rare and endangered lizards. The symposium was also aimed at enhancing the potential for cooperative long-term management and encourage better maintenance of captive lizards by focussing attention on species of special concern.

The symposium began with an introduction to the moderator, Robert George Sprackland (author of 'Giant Lizards'). David Good, organizer of the symposium and Director of IRE, presented a brief report on the symposium, which was sponsored by Zoo Med Laboratories, Inc.

The first paper was by Jeff Lemm, Research Assistant, CRES, who stressed on the research on the Cuban rock iguanas at Guantanamo Bay. In the second, I explained my research on the conservation and husbandry of the Bengal monitors, *Varanus bengalensis*. Lori Jackintell, CRES, explained how reproductive strategies of *V. a. albigularis* could be evaluated. This presentation was supported by Pat Morris, San Diego Zoo, with techniques of ultrasound imaging for gender determination in lizards.

The second session included presentations by Trooper Walsh, National Zoological Park (NZP), Washington, D.C., on the developments in the management of the Komodo monitors (*Varanus komodoensis*) at the NZP and in Indonesian zoos. Lucy Spelman, NZP, supported the presentation with medical procedures pioneered at NZP, with applications to other varanid species. Mark Bayless, Editor, *Varanews*, presented details of the natural history, taxonomy and biogeography of African varanids. Hans-Georg Horn of Germany, gave an account of keeping monitors in captivity and emphasized on the biological and legislative problems.

On the first day, there were three special lectures. Brian Waterloo from Berwyn, Illinois, presented his observations on a captive group of Nile monitors (*Varanus niloticus*). David Blair from Escondido, California, spoke on the husbandry of rock iguanas at Cyclura Research Center. Daniel Bennett of the University of Aberdeen, Scotland reports were read by Anslem De Silva (Sri Lanka), M. Farid Ahsan (Bangladesh), Indraneil Das (Bhutan), Jennifer Daltry for Harry Andrews and Romulus Whitaker (India), M. S. Khan (Pakistan), and Tej K. Shrestha (Nepal). Plenaries included: Why (and how) to study herpetology? (Carl Gans), Biogeographic scenarios of Indian amphibians (Sushil K. Dutta), History of herpetology in southern Asia (Indraneil Das), and Biogeography and conservation of South Asian herpetofauna (Walter Erdelen). The abstract book records 54 other abstracts of papers or titles, plus eight abstracts or titles of talks supposed to take place during a workshop at the Giritale Wildlife Sanctuary that was cancelled. The proceedings of the Conference is now being edited.

The Conference also saw the release of the book, *The amphibian fauna of Sri Lanka*, by Sushil K. Dutta and Kelum-Manamendra-Arachchi, published by the Wildlife Heritage Trust of Sri Lanka (see review by Romulus Whitaker, this volume), as well as a directory of herpetologists of the southern Asian region.

Indraneil Das, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India.

FIRST INTERNATIONAL SYMPOSIUM ON THE HUSBANDRY OF VARANIDS AND IGUANIDS

The First International Symposium on the Husbandry of Varanids and Iguanids was held at the Town and Country Hotel and Convention Center, San Diego, California, U.S.A., between 11-12 May, 1996. The organizers, International Reptiles Expositions (IRE), is an organization based in San Diego that has been, for many years, conducting reptile shows, conferences and seminars in the USA. Participants of the Conference were from USA, UK, Germany, Australia, India, and representatives from the American Zoo and Aquarium Association (AZA) Lizard Advisory Group, Center for Reproduction of Endangered Species (CRES). The objectives of the symposium was to disseminate information on the husbandry of varanid and iguanids, and to discuss areas of concern on reproduction of rare and endangered lizards. The symposium was also aimed at enhancing the potential for cooperative long-term management and encourage better maintenance of captive lizards by focussing attention on species of special concern.

The symposium began with an introduction to the moderator, Robert George Sprackland (author of 'Giant Lizards'). David Good, organizer of the symposium and Director of IRE, presented a brief report on the symposium, which was sponsored by Zoo Med Laboratories, Inc.

The first paper was by Jeff Lemm, Research Assistant, CRES, who stressed on the research on the Cuban rock iguanas at Guantanamo Bay. In the second, I explained my research on the conservation and husbandry of the Bengal monitors, *Varanus bengalensis*. Lori Jackintell, CRES, explained how reproductive strategies of *V. a. albigularis* could be evaluated. This presentation was supported by Pat Morris, San Diego Zoo, with techniques of ultrasound imaging for gender determination in lizards.

The second session included presentations by Trooper Walsh, National Zoological Park (NZP), Washington, D.C., on the developments in the management of the Komodo monitors (*Varanus komodoensis*) at the NZP and in Indonesian zoos. Lucy Spelman, NZP, supported the presentation with medical procedures pioneered at NZP, with applications to other varanid species. Mark Bayless, Editor, *Varanews*, presented details of the natural history, taxonomy and biogeography of African varanids. Hans-Georg Horn of Germany, gave an account of keeping monitors in captivity and emphasized on the biological and legislative problems.

On the first day, there were three special lectures. Brian Waterloo from Berwyn, Illinois, presented his observations on a captive group of Nile monitors (*Varanus niloticus*). David Blair from Escondido, California, spoke on the husbandry of rock iguanas at Cyclura Research Center. Daniel Bennett of the University of Aberdeen, Scotland (author of 'A Little Book of Monitor Lizards') spoke on the biology of *V. a. albigularis* hatchlings.

The second day's technical session included presentations by Frank Retes, Tucson, Arizona, on the husbandry and breeding of *Varanus acanthurus, V. beccarii, V. gilleni* and *V. storri*. Rick Hudson, Chairman of the AZ Lizard Advisory Group and Assistant Curator, Herpetology, Fort Worth Zoo, spoke on the conservation strategy for the endangered Jamaican iguana; Don Boyer, Animal Care Manager, San Diego Zoo, presented a paper on the captive husbandry and conservation of the Fiji banded iguana (*Brachylophus fasciatus*); Matt Vincent of Melbourne Zoo and Taxon Coordinator of Australian Varanids spoke on the management of varanids in Australia.

The final session included a slide presentation by Hans-George Horn, entitled "Visiting Australia as a naturalist", a talk by John Phillips, Deputy Director, CRES, on the behavioural, physiological, morphological and ecological aspects of *Varanus albigularis*, *Iguana iguana* and the Jamaican iguana, my talk on the reproductive biology and conservation of the desert monitor (*Varanus griseus*) and finally, a paper by Kelly Bradley of the University of Texas, Arlington, on the population status of Turks and Caicos rock iguana (*Cyclura carinata*). The symposium ended with closing remarks by David Goode, IRE.

BRIJ KISHOR GUPTA, The Coimbatore Zoological Park and Conservation Centre, Pioneer House, Peelamedu, Coimbatore 641 004, Tamil Nadu, India.

NEW BOOKS

AMPHIBIANS OF INDIA AND SRI LANKA (CHECKLIST AND BIBLIOGRAPHY)

Hard cover, with about 250 pages

By
Sushil K. Dutta

Price: Rs. 500.00/US$ 50.00
Publisher: Odyssey Publishing House
Expected date of publication: January, 1997

The book contains a list of all valid species of amphibians of India and Sri Lanka. Each species account contains the original citation, list of synonyms, type location and locality, distribution pattern and taxonomic notes. Most of species have been examined in museum collections. In addition, museum material examined by other workers has also been incorporated. The bibliography (current 1996) includes all aspects of amphibians of the region.

Order from:

Odyssey Publishing House, Acharya Vihar Commercial Complex, Room No. BS 2-3, Acharya Vihar, Bhunaneshwar 751 013, Orissa, India.

Telephone: (091) 0674 415579/481285, Fax: (091) 0674 415579

BIOLOGY AND CONSERVATION OF SEA TURTLES

Paperback with 615 pages

Edited by
Karen Bjorndal

Price: US $26.00
Publisher: Smithsonian Institution Press
Revised Edition: 1995, ISBN 1 56098 619 0

A reprint of the 1982 edition, including brief reviews of 14 subject areas to update the original text. These include: Nesting biology of sea turtles (J. D. Miller), Hatchling orientation (B. E. Witherington), Biology of the early pelagic stage- the "lost year" (A. B. Bolten and G. H. Balazs), Telemetry and the behavior of sea turtles (S. A. Eckert), Molecular genetic studies of marine turtles (B. W. Bowen), Applied and behavioral endocrinology (D. W. Owens), Metabolism, physiology, and thermoregulation (J. R. Spotila), Diseases of marine turtles (L. H. Herbst and E. R. Jacobson), Temperature and sex ratio (N. Mrosovsky), Growth and Age of sea turtles (K. A. Bjorndal and G. R. Zug), Population models and structure (D. T. Crouse and N. B. Frazer), Global overview of the status of marine turtles: a 1995 viewpoint (C. J. Limpus), Anthropogenic threats to sea turtles (K. L. Eckert), and Headstarting as a management tool (J. A. Mortimer).

Order from: National Museum of Natural History, Smithsonian Institution,
Washington, D.C. 20560, USA.

BIOGEOGRAPHY OF THE REPTILES OF SOUTH ASIA

Hardcover with 87 pages, 16 colour plates

By
Indraneil Das

Price: US$ 27.50
Publisher: Krieger Publishing Company
Original edition: 1996, ISBN 0 89464 935 3

At the crossroads of two biogeographic realms, south Asia supports a highly diverse and distinct reptile fauna, with 634 species represented. This book presents an analysis of this fauna, highlighting its richness and endemicity, the patterns and correlates of species diversity, affinities within the region and with extralimital fauna, and barriers to distribution and speciation. It includes over 150 references to the herpetofauna of south Asia as well as to the physiography of the region.

Order from: Krieger Publishing Company, P.O. Box 9542, Melbourne, Florida 32902-9542, USA.

TURTLES AND TORTOISES OF INDIA

Paperback with 178 pages, 16 colour plates

By
Indraneil Das

Price: Indian Rs. 150.00/Foreign US$ 29.95
Publisher: Oxford University Press
Original edition: 1995, ISBN 0 19 563727 5

Update of the biology and conservation of the turtles and tortoises of the Indian region. Includes, Introduction, The Fossil Record, Key to Living Species, Species Accounts, Glossary, References and Index. Individual species accounts include: English name, scientific name and authority, the original citation, morphology, seam contact formula, plastral formula, colour, size, sexual dimorphism, subspecies, vernacular names, other English names, analysis of scientific name, distribution (including localities), habitat and behaviour, diet, reproduction, status and conservation and references. Colour plates illustrate all 32 species recorded from the Indian region.

Order from:

For India:
Oxford University Press,
Oxford House, Apollo Bunder,
Bombay 400 001,
India.

For rest of the world:
Satronics,
PO Box 52261,
Philadelphia, PA 19115,
USA.

AN ANNOTATED BIBLIOGRAPHY OF THE AMPHIBIA OF SRI LANKA

Paperback with 48 pages

By
Anslem de Silva

Price: US$ 10.00 (inclusive of airmail postage)
Publisher: Anslem de Silva, Amphibia and Reptile Research Organization of Sri Lanka
Original edition: 1996, ISBN 955 96005 2 4

A checklist and bibliography of the amphibians of Sri Lanka, containing: Foreword (by M. W. Dissanayake, Director, Department of Wildlife Conservation, Sri Lanka); Preface; Checklist of the Amphibia of Sri Lanka (53 species, each with including scientific names, authorities, dates, suggested English and Sinhalese names and conservation status; Author Index (248 citations annotated with relevant notes); Joint Author Index; Systematic Index; and Subject Index (in 25 categories). Colour cover pages depict *Polypedates eques* and *Ichthyophis glutinosus* female guarding eggs. Volumes on turtles and crocodiles, lizards, snakes and a supplement are in preparation.

Order from: Anslem de Silva, Faculty of Medicine, University of Peradeniya, Peradeniya, Sri Lanka.

A PLEA FOR SNAKE PHOTOGRAPHS

Rom Whitaker and Jenny Daltry of the Centre for Herpetology are compiling a conservation-oriented field guide to the snakes of India, to raise public interest in these reptiles. The guide should also prove useful for identifying snakes in the neighbouring countries of Bangladesh, Bhutan, Nepal, Pakistan and Sri Lanka.

Colour transparencies (slides) of over 100 species have already been amassed, but photographs of the following are still urgently required: most species of the genera *Leptotyphlops* and *Typhlops* (worm snakes); most species of the family Uropeltidae (shieldtails); most species of *Amphiesma* (keelbacks); *Calamaria pavimentata*; *Cantoria violacea*; genus *Dinodon* (false wolf snakes); genus *Dryocalamus* (bridal snakes); genus *Liopeltis* (stripe-necked snakes); most species of *Oligodon* (wolf snakes); *Opheodrys doriae* (green snake); *Pseudoxenodon macrops* (large-eyed snake); genus *Rhabdops* (forest snakes); *Stoliczkaia khasiensis* (Khasi earth snake); genus *Trachischium* (Oriental worm snakes); *Zaocys nigromarginatus* (green rat snake); most species of *Bungarus* (kraits); genus *Calliophis* (coral snakes); most members of the family Hydrophiidae (sea snakes); *Eristicophis macmahoni* (MacMahon's viper).

If you can supply a transparency of any of the above, please write to Dr. Jennifer Daltry, Centre for Herpetology, Madras Crocodile Bank Trust, Post Bag 4, Mamallapuram 603 104, Tamil Nadu, India (Fax: +91 4114 42511), giving details of where the snake was found. Personal observations concerning the distribution or behaviour of any of these snakes are also very welcome.