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Herpetofaunal assemblage with special emphasis on community structure and spatiality in amphibians of Cauvery delta region, Tamil Nadu

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ABSTRACT

We studied the amphibian community structure, spatial overlap and herpetofaunal assemblage at Mannampandal, Tamil Nadu during October, 2010 to January, 2011. The survey methods involved careful visual estimation of amphibians in all the possible microhabitats present in the study area. Five different microhabitat categories were selected, *viz.*, leaf litters, temporary water pools, tree holes, shrubs & grasses (ground vegetation), pathways, open floor & outer edges of buildings. We identified 26 species of reptiles and 14 species of amphibians. There was a significant difference found among the amphibian species occupying in different microhabitats. Species diversity was calculated, Shanon-Wiener H'= 1.55. The high niche overlap was found between *Duttaphrynus scaber* and *Uperodon systoma* followed by *Fejervarya* sp. and *Sphaerotheca breviceps.* The present study on amphibian community is just a representation to show the microhabitat occupancy and adjustment by the amphibians in human settlements and competition among them as, spatial resource partitioning.

Key words: Herpetofauna, community, microhabitat, niche-overlap, human settlement, Mannampandal.

INTRODUCTION

Reptiles and amphibians occupy a diverse range of habitats and microhabitats, found from deserts to grasslands, *from* forests to oceans and from hills to our own houses. India is very rich in herpetofaunal diversity. There are more than 518 species of reptiles (Aengals *et al.*, 2011) and 314 species of amphibians (Dinesh *et al.,* 2011) found in India. The life history, microhabitat preference, and the factors affecting the distribution of most species are unknown. According to IUCN criteria 57% of the amphibians in India are 'threatened' (Vasudevan *et al.*, 2001). Habitat destruction and the resulting fragmentation of population is the most important factor affecting the amphibian population (Adams, 1999). Population size of amphibians are unknown for almost all species, and, as significance, recent trends in population sizes also remain unknown (Dutta, 1997). Generally, most of the fundamental data on species biology and ecology are lacking (Vasudevan *et al.*, 2001). Investigations of amphibian species are receiving considerable attention because of the proposed role of amphibians as indicators of ecosystem deterioration (Wake, 1991). It is expected that the world population growth in the next thirty years will be mostly concentrated in the urban areas (United Nations, 2004) leading to even more rapid degradation of pockets of remnant natural habitats. Due to urbanization, species with specific habitat preferences often experience either decreased density or extirpation, which can result in an increase in opportunistic species (Magura *et al*., 2004). Landscape perspectives have become widespread only in the last decade. Local occurrence of many species can be predicted from data on landscape composition, including especially the densities of nearby ponds and roads (Semlitsch, 2000; Marsh & Trenham, 2001). When species co-exist and interact with each other they constitute a community assemblage. Different kinds of amphibian communities can be recognized by the number of species, the number of individual represents each species. Communities also may be characterized by the habitat they occupied and the habits of the species involved (Daniels, 2005). However, for most species, the spatial distribution of individuals in upland habitats is poorly understood**.** To predict the effects of habitat alteration on population size and viability, data describing the landscape-scale distribution of individuals are needed (Trenham & Shaffer, 2005). Studying multiple species and spatial scales is a key challenge in applied ecology (Meentemeyer & Box, 1987). In India, besides the forest floor and stream communities of amphibians, there are few widely spread species in human modified and agro ecosystems (Daniels, 2005). The human modified ecosystems of the plains as that in rural, cultivated and semi urbanized areas attract number of species of frog and toads. Hence, the purpose of this study is to provide species composition of amphibian community, microhabiatat preference, and spatial niche overlap of amphibians in Anbanadhapuram Vahaira Charity (A.V.C.) College Campus. In addition we also made a note on reptiles at Mannampandal, although Ganesh & Chandramouli (2007) well documented the herpetofauna of Mannampandal. However, it is equally important that, to monitor and know the present status for assessing the impact of human alteration and other human interference on resident population of herpetofauna (Purkayastha *et al*., 2011).

Study area

The study was carried out at Mannampandal (11°6.354´N & 79°41.584´E) Nagapattinam District,

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Tamil Nadu (Figure 1). It is a part of Cauvery delta region in the South-East coast in the alluvial plains. The area is dominated by wet agricultural lands irrigated by the River Cauvery and its tributaries. Woody vegetation is sparse in the form of groves and roadside trees. The predominant wood plant species found in the study area are *Cocos nucifera, Borassus flabellifer, Madhuca indica, Mangifera indica, Enterolobium saman, Tamarindus indicus, Ficus benghalensis, Ficus religiosa, Thespesia populnea, Acacia arabica, Odina wodier* and *Azadirachta indica*. Important shrub species are *Prosopis juliflora, Jatropha glandulifera, Adhathoda vesica*. Plantations of *Casuarina equisetifolia*, *Tectona grandis* and *Bamboosa arundinacea* are also found in the study area (Ali *et al*., 2011). The place is 18 km away from the Bay of Bengal at an elevation of 19 m asl. The area experiences 100 cm of annual rainfall principally during the North-East monsoon. Extensive study of amphibian community was carried out in A.V.C. College Campus; approximately it covers an area of 28 ha.

METHODOLOGY

The survey methods involve extensive survey and careful visual estimation of amphibians in all the possible microhabitats present in A.V.C. College Campus, excluding 1.32 ha plot of Women's hostel. Path ways were scanned, leaf-litter within the area was turned, bricks were lifted and searched underneath, shrubs and grass were shaken and gleaned, fallen logs turned and searched underneath, tree holes, temporary water pools were searched for the presence of amphibians with the help of six persons team. The species were identified by using Smith (1943), Daniel (2002) and Daniels (2005) . The survey was made at night, between 1000 hrs to 1400 hrs thrice a week during the month of October 2010 to January 2011. There were five different microhabitat categories selected, *viz.*, leaf litters, temporary water pools, tree holes, shrubs and grasses (ground vegetation), pathways, open floor & outer edges of buildings. The number of individuals and microhabitat were noted in the data sheet when the amphibians were encountered. Apart from that, reptiles were surveyed during January to December 2010 including all the opportunistic sightings, road kills and rescue calls. Some of the individuals were collected for identification purposes whenever necessary and soon after the identity was ascertained that the individuals were released at the place of capture. The species were identified by using Smith (1943) and Das (2002).

Species diversity index ($\bar{H}$) was determined by Shannon Wiener's index (Shannon & Weaver 1949). $\bar{H} = -\Sigma$ pi ln pi, where, pi = ni/N, which denotes the importance probability of each species in a population; ni =importance value for each species; N = total of importance value.

Concentration of dominance (Cd), known as Simpson index, was measured according to Simpson (1949): Index of dominance (Cd) = $\Sigma (ni/N)^2$.

Species richness or variety index (d) is the mean number of species per sample and determined using the formula of Margalef (1958). Species richness

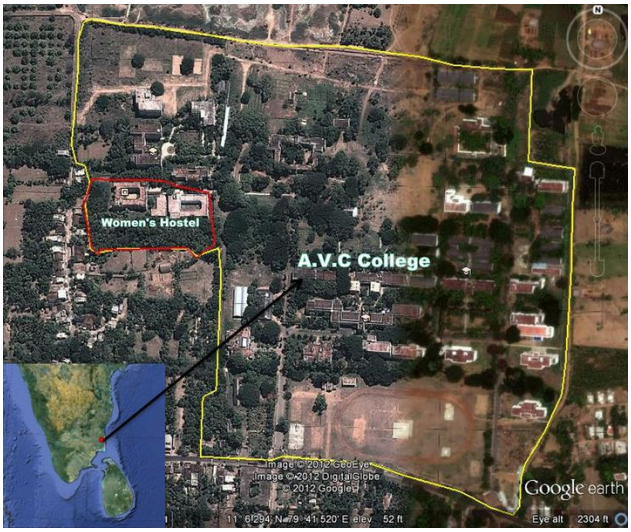

Figure 1. Map of the study area.

index (d) = S-1/lnN; where, S = number of species, N = number of individuals of all species.

Equitability or evenness (e) refers to the degree of relative dominance of each species in that area. It was calculated according to Pielou (1966) as: Equitability (e) = $\bar{H}$/ ln S; where, H = Shannon Wiener's index and S = Number of species.

The niche index was used to examine the patterns in use of the environment (space use), and patterns of distribution in it (*i.e.,* micro habitat choice).

Spatial niche overlap among amphibian species were analyzed by using Pianka's index (Pianka 1973).

$$Ojk = \frac{\sum pij\, pik}{\sqrt{\sum pij^2 \sum pik^2}}$$

where, *Ojk* is the overlapping index between species *j* and *k*, and *pi* is the proportion of a single food item *i* in the diet of species *j* and *k*. Pianka's index varies between 0 (total separation) and 1 (total overlap) (Pianka, 1973). Pianka's index (O) varies between 0 (total separation) and 1 (total overlap).

Euphlyctis cyanophlyctis exclusively only found in one of the microhabitat among the five categorized type, and *Euphlyctis hexadactylus* encountered outside AVC campus, hence excluded from the Niche Overlap calculation.

OBSERVATIONS & RESULTS

A total of 40 species of herpetofauna identified belonging to 14 family and 31 genera, includes 14 species of snakes, 14 species amphibians, 10 species of lizards and 2 turtle species (Table 1). Among amphibians, abundance of *Duttaphrynus melanostictus* was high compare to other species. There was significant difference found among the amphibian species occupying different microhabitats ($\chi 2$ =547.25, p <0.05, df = 4) (Fig. 2). *Duttaphrynus scaber* a rare toad noticeably found to reside in leaf litters. However *Euphlyctis cyanophlyctis* and *Hoplobatrachus tigerinus* mostly encountered in temporary water pools; *Kaloula taprobanica* and *Ramanella variegata* were often found in tree holes during non-rainy days. The Shannon-Wiener diversity and Margalef species richness index calculated

1.55 and 1.882 respectively. The Simpson index and Equability (e) were 0.606 and 0.604. The spatial niche overlap values are given in Table 2. The high niche overlap found between *D. scaber* and *Uperodon systoma*, Niche overlap (O) value = 0.8893 followed by *Fejervarya* sp. and *Sphaerotheca breviceps* (O) = 0.8880. The species which were found to breed at AVC campus were *Duttaphrynus melanostictus, Ramanella variegata, Polypedates maculatus* and *Kaloula taprobanica.* At AVC Campus, street and garden lights attracts lots of flying insects particularly after the rain. These lights, in turn, visited by number of frogs and toads that feast on the insects that fall on the ground. *K. taprobanica* and *D. melanostictus* often found to feed on insects under the light. Among the turtles *Melanochelys trijuga* was encountered once during rainy night hours at AVC campus and often seen nearby ponds and a juvenile road killed specimen was also found. On the other hand *Lissemys punctata* was only encountered twice at Cauvery river channel. Among the lizards, *Calotes versicolor* was more frequent than *Calotes calotes* whereas *Eutropis carinata, Eutropis macularia* were more common than the *Lygosoma punctatum*. *Lygosoma albopunctata* was only ones recorded in leaf litter during evening hours at the college campus. *Varanus bengalensis* is common throughout the Mannampandal, several of them were spotted in termite mounds present at College campus, and also seen in agricultural lands and human habitations. Snakes were encountered in almost all habitats present in the study area. Among the colubrids *Amphiesma stolatum, Xenochrophis piscator, Ahaetulla nasuta, Ptyas mucosa* were more frequently encountered than the others. Three species of venomous snakes identified were *Bungarus caeruleus, Naja naja* and *Daboia russelii. B. caeruleus* and *N. naja* were also not uncommon at Mannampandal. Several of them were rescued from residential houses, shops and open well; whereas *D. russelii* was rare compare to other venomous species found in the study area.

DISCUSSION

The present study reveals that Mannampandal holds handful diversity of herpetofauna. Ganesh & Chandramouli (2007) recorded 45 species of herps from Mannampandal whereas we are able to detect 40 species. Species richness is simply the number of species in a fauna, while equitability represents some measure of the evenness of their distribution. In this study high value of dominance index compare to species diversity of amphibians indicates the lower diversity and may lead to lower stability of the community (MacArthur, 1955). High abundance of *D. melanostictus* compared to other species which may lead to the lower stability in this community. *D. melanostictus* is cosmopolitan in distribution (Dutta, 1997) and is known to occur in a variety of habitats, especially in disturbed areas (Inger *et al.*, 1984). Species with the broadest habitat distribution should show high levels of plasticity. Daniels (1992) stated that the number of individuals that represents each species in community may vary from place to place depending on the amount of rainfall, available habitats and human interference as the structure and diversity of an amphibian community is determined by the availability of food, moisture and micro habitat. Significantly amphibians were encountered in leaf litters, as leaf litters may provide a wider range of microhabitats, allowing more individuals and more species to coexist in the litter microhabitat (Fauth *et al.*, 1989). Furthermore, Fauth *et al*. (1989) found that species richness increased rapidly with an increase in leaf litter depth, as did herpetofaunal density. Deeper leaf litter may provide a wider range of micro- habitats, allowing more individuals and more species to coexist in the litter microhabit.

D. melanostictus and *D. scaber* seemed to be the most similar species pair at the study site. They found to feed on same site. However, *D. scaber* was entirely nocturnal and rather rare and smaller than *D. melanostictus*, hardly exceeds 46 mm when adult (Daniel, 2002). All the frogs and toads are insect eating with few exceptions. *Uperodon systoma* has a strong preference for termites, especially the larger winged forms. On the other hand *D. melanostictus* and *D. scaber* largely feeds on ants. Though these species were found highly overlapped in case of spatiality but there food preference is quite different. On the other hand *Sphaerotheca rolandae* and *Sphaerotheca breviceps* found to overlap their microhabitat. Due to the burrowing nature of these frogs and very little information on the habits of this species it's very difficult to point out the reason behind the high overlap. *Microhyla ornata* found to overlap with *Sphaerotheca rolandae, Sphaerotheca breviceps*, *Fejervarya* sp. *M. ornata* has wide range: throughout Southeast Asia, South China and Taiwan. Furthermore, this species has adapted itself to life in different biotopes and occurs in desert areas like Kutch and areas of heavy rainfall as Kerala and Assam (Daniel, 2002). *Microhyla ornata* feeds mainly on ants and other small sized insects. Apart from that *M. ornata* rarely exceeds 25mm in length. Therefore the amount of food consumption might be diminutive as compared to other species found to share same microhabitat types with *M. ornata*. Schoener's (1974) review, found that habitat, food, and time (in that order) were the most important niche dimensions in most community studies. Here in our study we only analyzed one of the dimension, therefore concrete conclusion can't be made on the niche overlap or coexist of these amphibian species in the same biota. Furthermore, Niche metrics have been used to infer the role of competition, but the interpretations are not straight forward (e.g. Colwell & Futuyma, 1971): a small overlap may indicate that competition is not important, but may also result from intense competition. Theoretically, two niches may overlap 100% on some resource axes, as long as they are separate on others (McNaughton & Wolf, 1979). Niche theory holds that two coexisting species will tend to reduce overlap in use of limited resources to avoid competition (MacArthur & Levins, 1967). Most likely, adjustments in resource use would be made over long periods of association, as species co-evolve. Coexisting species should move toward a tolerable level of overlap determined by the abundance and diversity of resources available (MacArthur & Levins, 1967). The theory of community ecology predicts that spatial and temporal

environmental variations have a crucial role in species coexistence (Desbiez *et al*., 2009). However, the present study on amphibian community is just a model to show the microhabitat occupancy by the amphibians in the human settlements and competition among them as, spatial resource partitioning may be one of the chief indicators of interspecific interactions.

Furthermore, Tamil Nadu with its diversity in ecosystems has a very good potential to support numerous reptiles, especially snakes (Daniels, 2001). In our study we found 14 species of snakes in and around human habitation which initiates human-snake conflict quite often. *Xenochrophis piscator* is one of the most common snakes in India (Daniel 2002; Das 2002, Nath *et al.,* 2011); it was also found to be the most relatively abundant snake at Mannampandal. *X. piscator* and *Naja naja* were more likely to create human-snake conflict in the study area. In most cases, non-venomous snakes were found to be the victims in the human-snake conflict, as most of the people not able to distinguish between venomous and non-venomous snakes. Lack of awareness was the main reason for the killing of snakes (Nath *et al.,* 2011). Awareness programs are needed to be conducted in order to make people acquainted with herpetofauna and their importance for a balanced ecosystem. Snake bite management is another issue which is to be taken up more seriously, although people were seen to reach hospitals immediately after the snake bite. The study of herpetofauna in Mannampandal village is important because Ganesh & Chandramouli (2011) has reported *Polypedates* cf. *leucomystax* from A.V.C Campus, based on evident parietosquamosal. However, Biju (2001) and Daniel (2002) deny its presence in south India. Dutta (1997) remarked that some earlier authors considered *P. maculatus* and *P. leucomystax* to be subspecies and the occurrence of *P. leucomystax* in Sri Lanka is erroneous and in Karnataka, south India is uncertain. The report from the Western Ghats of Karnataka was once considered authentic and then 'changed' to doubtful (Daniels, 1997, 2000 & 2005). Furthermore, Ganesh & Chandramouli (2010) rediscover a rare gekkonid lizard *Hemidactylus scabriceps* originally described from the Ramnad district of Tamil Nadu, India, was recorded from A. V. C. College campus Mannampandal, Nagapattinam district. This is the third known locality for this species in India

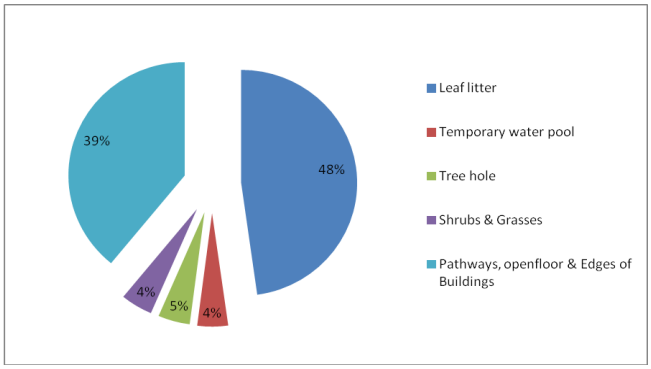

Figure 2. Percentage of amphibians recorded in different microhabitats of A.V.C. College Campus, Mannampandal, Tamil Nadu during October, 2010 to January, 2011.

Table 1. Herpetofaunal species recorded during 2010-11 at Mannampandal, Tamil Nadu.

Sl. No.	Family	Species	IUCN Status	CITES Appendix	IWPA Status
1	Bufonidae	*Duttaphrynus melanostictus* (Schneider, 1799)	Least Concern	Not listed	Schedule IV
		Duttaphrynus scaber (Schneider, 1799)	Least Concern	Not listed	Schedule IV
2	Microhylidae	*Kaloula taprobanica* (Parker, 1934)	Least Concern	Not listed	Schedule IV
		Microhyla ornata (Duméril & Bibron, 1841)	Least Concern	Not listed	Schedule IV
		Microhyla rubra (Jerdon, 1854)	Least Concern	Not listed	Schedule IV
		Ramanella variegata (Stoliczka, 1872)	Least Concern	Not listed	Schedule IV
		Uperodon systoma (Schneider, 1799)	Least Concern	Not listed	Schedule IV
3	Rhacophoridae	*Polypedates maculatus* (Gray, 1830)	Least Concern	Not listed	Schedule IV
4	Ranidae	*Euphlyctis cyanophlyctis* (Schneider, 1799)	Least Concern	II	Schedule IV
		Euphlyctis hexadactylus (Lesson, 1834)	Least Concern	Not listed	Schedule IV
		Hoplobatrachus tigerinus (Daudin, 1803)	Least Concern	II	Schedule IV
		Fejervarya sp.	---	---	---
		Sphaerotheca breviceps (Schneider, 1799)	Least Concern	Not listed	Schedule IV
		Sphaerotheca rolandae (Dubois, 1983)	Least Concern	Not listed	Schedule IV
5	Trionychidae	*Lissemys punctata* (Lacépède, 1788)	Least Concern	II	Schedule I
6	Geoemydidae	*Melanochelys trijuga* (Schweigger, 1812)	Near Threatened	Not listed	Schedule IV
7	Gekkonidae	*Hemidactylus frenatus* (Schlegel, 1836)	Least Concern	Not listed	Schedule IV
		Hemidactylus brookii (Gray, 1845)	Least Concern	Not listed	Schedule IV
		Hemidactylus triedrus (Daudin, 1802)	Least Concern	Not listed	Schedule IV
8	Scincidae	*Eutropis carinata* (Schneider, 1801)	Least Concern	Not listed	Schedule IV
		Eutropis macularia (Blyth, 1853)	Least Concern	Not listed	Schedule IV
		Lygosoma punctatum (Linnaeus, 1758)	Least Concern	Not listed	Schedule IV
		Lygosoma albopunctata (Gray, 1846)	Least Concern	Not listed	Schedule IV

9	Agamidae	*Calotes versicolor* (Daudin, 1802)	Least Concern	Not listed	Schedule IV
		Calotes calotes (Linnaeus, 1758)	Least Concern	Not listed	Schedule IV
10	Varanidae	*Varanus bengalensis* (Daudin, 1802)	Least Concern	I	Schedule I
11	Typhlopidae	*Ramphotyphlops braminus* (Daudin, 1803)	Least Concern	Not listed	Schedule IV
12	Colubridae	*Oligodon arnensis* (Shaw, 1802)	Least Concern	Not listed	Schedule IV
		Oligodon taeniolatus (Jerdon, 1853)	Lower Risk	Not listed	Schedule IV
		Lycodon aulicus (Linnaeus, 1758)	Least Concern	Not listed	Schedule IV
		Coelogathus helena (Daudin, 1803)	Least Concern	Not listed	Schedule IV
		Ptyas mucosa (Linnaeus, 1758)	Least Concern	III	Schedule II
		Dendrelaphis tristis (Daudin, 1803)	Least Concern	Not listed	Schedule IV
		Ahaetulla nasuta (Lacépède, 1789)	Lower Risk	Not listed	Schedule IV
		Amphiesma stolatum (Linnaeus, 1758)	Lower Risk	Not listed	Schedule IV
		Atretium schistosum (Daudin, 1803)	Lower Risk	III	Schedule II
		Xenochrophis piscator (Schneider, 1799)	Least Concern	III	Schedule II
13	Elapidae	*Bungarus caeruleus* (Schneider, 1801)	Lower Risk	Not listed	Schedule IV
		Naja naja (Linnaeus, 1758)	Least Concern	III	Schedule II
14	Viperidae	*Daboia russelii* (Shaw & Nodder, 1797)	Lower Risk	III	Schedule II

Table 2. Spatial Niche overlap among the amphibian species in A.V.C. College Campus, Mannampandal, Tamil Nadu, South India.

Species Name	*Sphaerotheca rolandae*	*Sphaerotheca breviceps*	*Fejervarya* sp.	*Hoplobatrachus tigerinus*	*Polypedates maculatus*	*Uperodon systoma*	*Ramanella variegata*	*Microhyla rubra*	*Microhyla ornata*	*Kaloula taprobanica*	*Duttaphrynus scaber*
Sphaerotheca breviceps	**0.6341**										
***Fejervarya* sp.**	**0.6709**	**0.8880**									
Hoplobatrachus tigerinus	0.0864	0.1144	0.1211								
Polypedates maculatus	0.0520	0.0689	0.0729	0.0094							
Uperodon systoma	0.0868	0.01158	0.0060	0.0006	0.0006						
Ramanella variegata	0.0180	0.0239	0.0253	0.0065	0.0019	0.0001					
Microhyla rubra	0.2418	0.2855	0.3003	0.0386	0.0370	0.2881	0.0080				
Microhyla ornata	**0.5857**	**0.7729**	**0.8183**	0.1054	0.0635	0.0246	0.0220	0.2678			
Kaloula taprobanica	0.1430	0.1888	0.1999	0.0257	0.0155	0.0053	0.3720	0.0652	0.1741		
Duttaphrynus scaber	0.0872	0.0081	0.0022	0.0002	0.0004	**0.8893**	0.00004	0.2978	0.0220	0.0046	
Duttaphrynus melanostictus	0.1373	0.1099	0.1121	0.0143	0.0088	**0.5966**	0.0030	0.2348	0.1110	0.0266	**0.6187**

and the first Indian record in 72 years. Therefore it's necessary to aware the people of Mannampndal village regarding the importance of the area in herpetofaunal research.

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Plate 1. Some Anurans at Mannampandal, Mayiladuthurai, Tamil Nadu.
A. *Duttaphrynus melanostictus* B. *Duttaphrynus scaber* C. *Polypedates maculatus* D. *Uperodon systoma* E. *Ramanella variegata* F. *Kaloula taprobanica* G. *Microhyla rubra* H. *Microhyla ornata* I. *Sphaerotheca breviceps* J. *Sphaerotheca rolandae*

Plate 2. Some Saurians and turtle at Mannampandal, Mayiladuthurai, Tamil Nadu.
A. *Hemidactylus triedrus* B. *Lygosoma albopunctata* C. *Calotes calotes* D. *Varanus bengalensis* E. *Melanochelys trijuga*

Plate 3. Some Serpents at Mannampandal, Mayiladuthurai, Tamil Nadu.
A. Amphiesma stolatum B. *Dendrelaphis tristis* C. *Ahaetulla nasuta* D. *Lycodon aulicus* E. *Oligodon taeniolatus* F. *Ptyas mucosa* G. *Naja naja* H. *Bungarus caeruleus* I. *Daboia russelii*