STATUS SURVEY, DISTRIBUTION AND HABITAT PREFERENCES OF SMALL CARNIVORES IN PARAMBIKULAM TIGER RESERVE, KERALA

By

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THESIS

Submitted in partial fulfillment of the requirement for the degree of

Master of Science in Forestry

Faculty of Agriculture

Kerala Agricultural University

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COLLEGE OF FORESTRY
VELLANIKKARA, THRISSUR – 680 656
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2012

DECLARATION

I hereby declare that the thesis entitled **"Status survey, distribution and habitat preferences of small carnivores in Parambikulam Tiger Reserve, Kerala"** is a bonafide record of research done by me during the course of research and that this thesis has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title, of any other University or Society.

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Certified that the thesis, entitled **"Status survey, distribution and habitat preferences of small carnivores in Parambikulam Tiger Reserve, Kerala"** is a record of research work done independently by **Mr. Sreehari, R. (2010-17-103),** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

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Acknowledgement

I wish to place my sincere gratitude from the bottom of my heart to my major advisor ***Dr. P.O. Nameer****. Associate Professor and Head, Dept. of Wildlife Sciences, College of Forestry, Kerala Agricultural University, Vellanikkra, Thrissur, Kerala, for his marvelous guidance, constant encouragement, invaluable suggestions, stupendous patience, friendly approach and warm concern to me throughout the study period. I consider myself being fortunate in having the privilege of being guided by him, a world renowned wildlife biologist.*

I wish to thank ***Dr. B. Mohan Kumar****, Associate Dean, College of Forestry, for extending the facilities available in the college for conducting the present study. I express my deep sense of gratitude to* ***Kerala Agricultural University*** *for the financial and technical support for pursuance of my research.*

I am extremely grateful to my advisory committee members ***Dr. P.S. Easa****, Scientist, Kerala forest Research Institute, Peechi, Thrissur,* ***Dr. E.V. Anoop****, Associate Professor and Head, Department of Wood Science, College of Forestry,* ***Dr. T. K, Kunhamu,*** *Associate Professor, Department of Silviculture and Agroforestry, College of Forestry for their constant encouragement and constructive suggestions throughout the study period, and also for the critical evaluation of the manuscript.*

I am grateful to ***Dr. Sanjay Molur****, Executive Director, Zoo Outreach Organization (ZOO, WILD), Coimbatore,* ***Dr. Divya Mudappa*** *of Nature Conservation Foundation (NCF), Mysore and* ***Dr. Karthikeyan Vasudevan*** *of Wildlife Institute of India (WII), Dehradun for providing literatures and also for valuable suggestions during the field work.*

I am thankful to Chief Wildlife Warden, Kerala Forest department for granting permission. I am also grateful to ***Mr. Manoharan IFS*** *(former*

PCCF, Kerala Forest Dept.), ***Mr. O.P. Kaler IFS,*** *Chief Conservator of Forests (Wildlife) and Field Director, Parambikulam Tiger Reserve,* ***Mr. Vijayanandan IFS****, Wildlife Warden, Parambikulam Tiger Reserve, for granting permission to access the Tiger Reserve. I also extend my sincere thank* ***Mr. Jayaprakash*** *(RFO, Karimala Range, PKTR)* ***Mr. Sanathkumar IFS*** *(former RFO, Sungam Range, PKTR), late* ***Mr. Thomas*** *(former RFO, Karimala Range, PKTR),* ***Mr. Abubakker*** *(RFO, Orukomban Range, PKTR),* ***Mr. Nadeshan*** *(RFO, Parambikulam, PKTR)* ***Mr. Manoj*** *(Wildlife Assistant, PKTR),* ***Mr. Aneesh*** *(Forester, Karimala range, PKTR) and* ***Mr. Vegi*** *(Forester, Karimala range, PKTR) for extending the facilities for field work and also for providing field staff during the strenuous field works.*

My wholehearted thanks are also due to ***Dr. Pradeep Nair*** *for his guidance in GIS software's and preparing digital maps. I am also expressing my heartfelt thanks to* ***Smt. Sunandha*** *for her valuable guidance and timely help to carry out statistical analysis.*

Special thanks are due to forest watchers ***Mr. Sreenidasan, Mr. Vijayan, Mr. Shanmughan, Mr. Babu, Mr. Rajeesh*** *and the* ***Tiger Monitoring Team*** *of Parambikulam Tiger Reserve who had been with me throughout the field work making the most strenuous task the least one.*

I am extremely thankful to my dear friends, ***Mr. Fredy, C.T., Mr. Jobin, K, Mathew, Mr. Sachin, K, Aravind, Ms. Mareena, M.J., Mrs. Ashmi, R., Mr. Nithin, P.S., Mr. Adarsh, C.K.*** *and* ***Ms. Yasmitha Ulman Nithin*** *for accompanying me during the field work. Their helps will always be remembered.*

Words cannot really express the true friendship that I relished with ***Mr. Ashique Ali. V., Abhilash, G., Adarsh, M., Mr. Malik, F.M., Ms. Sharmila Jayaram, Mr. Sandeep, Das, Mr. Vaazil Shah, Mr. Anas, K.K., Mr. Akhil Das, A., Mr. Deepak, D., Ms. Athira, R.S., Mr. Vishal Vijayan***

and Mr. Muhammed Faizal, A. *for their heartfelt and back-up which gave me enough mental strength to get through all mind-numbering circumstances.*

Special thanks to ***Sajeer, K.V., Sukanya, S., Parvathy Venugopal, Jomals John*** *and* ***Mitra Menon,*** *for their valuable help during various critical stages of my work.*

I would like to extend my deep sense of gratitude to all my colleagues, ***Jiss K.Varkey, Paul C. Roby, Arun lal, P.G., Shiran, K., Geo Basil Paul,., Sindumathy, C.R., Dhanya, P., Aneesh, M.C., Vishnu, R., Anoob, P., Vinu Jacob, Anju, V.S., Soorya Soman, Kiran Thomas, Gemswin Johnson, Maya T. Joy*** *and* ***Lakshmi, A.*** *for their co-operation and support during various stages of my work.*

The support and help rendered by ***Mrs. Mini, J., Mrs. Soumya, Loyd, Ms. Sajitha, M.S., Mrs. Jyothy Haridas, Mrs. Deepa, C.G. Mrs. Kadheeja,*** *and* ***Mrs. Prema*** *will always remembered.*

A word of apology to those have not mentioned in person and a note of thanks to one and all who worked for the successful compilation of this endeavor.

Above all I bow my head before my ***LOVING PARENTS*** *and* ***LORD ALMIGHTY*** *for their blessings.*

Sreehari, R.

Dedicated to

"The New Moon of Lakshadweep"

HandAy Kutty &

BATS

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Introduction

INTRODUCTION

Western Ghats is a 1600km long stretch of mountain range starting from the southern tip of India to river Tapti of Gujarat and covers an area of 160,000km^2. High diversity of plants and animals makes the Western Ghats one of the global biodiversity hotspots of the world (Myers et al., 2000). The forests in Western Ghats are rich in endemic flora and fauna. About 60 genera, mostly monotypic and 2,100 species are endemic to the Western Ghats, mostly to the rainforests. The rest of India has only 84 endemic genera. The southern Western Ghats lying between 8^0 and 11^0 N is the important ecological subunit of the Western Ghats (Myers et al., 2000). The region harbors higher levels of biodiversity and endemism than the rest of the Western Ghats (Vasudevan et al., 2001).

Mammals evolved from reptiles nearly 180-220 million years ago and they have got rampant growth on earth after the extinction of dinosaurs (Wilson and Reeder, 2005). Some mammals like the whales, dolphins and dugongs are adapted to live in water. Similarly, the bats are adapted for an aerial mode of life. They also vary in their dietary habits. There are herbivores, carnivores including flesh-eaters and scavengers, frugivores, insectivores and omnivores among the mammals. All these make the mammals the most successful group of animals on earth. Mammals encompass approximately 5,416 species, distributed in about 1,229 genera, 153 families, and 29 orders (Wilson and Reeder, 2005). Four hundred and twenty species of mammals (7.75% of the world's mammals) are known from India (Nameer, 2008). Around 145 species of mammals have been reported within the political boundaries of Kerala state.

The order carnivora is represented by nine families in India (Wilson and Reeder, 2005; Schipper et al., 2008). Carnivores less than about five kilogram in body weight belonging to the order carnivora are generally called the small carnivores (Yoganand and Kumar, 1999). In terms of number of genus and species, these groups constitute more than 50% of the order Carnivora. There are 195 species of small carnivores, including the

small cats known from the world in ten different families. Out of these, India has 43 species in six families (Appendix I). The families of small carnivores represented in India are Ailuridae, Felidae, Herpestidae, Mustelidae, Prionodontidae and Viverridae (Nayerul and Vijayan, 1993; Wilson and Reeder, 2005; Schipper et al., 2008;). Western Ghats support 17 species of small carnivores in four families. The details of small carnivores of India, Western Ghats and Kerala in relation to the world over are given in Table 1.

Table 1. A comparison of small carnivores of India, Western Ghats and Kerala

Family	**India**	**Western Ghats**	**Kerala**	**World**
Ailuridae (Red Panda)	1	-	-	1
Eupleridae (Fossa)	-	-	-	9
Herpestidae (Mongoose)	7	4	4	34
Mephtidae (Skunk)	-	-	-	12
Mustelidae (Otters, Martens)	16	5	4	59
Nandinidae (African Palm-civet)	-	-	-	1
Prionodontidae (Linsangs)	1	-	-	2
Procyonidae (Olingo)	-	-	-	14
Felidae (small cats only)	10	4	4	30
Vivveridae (Civets)	8	4	4	33
Total	**43**	**17**	**16**	**195**

Source: Nayerul and Vijayan (1993); Mudappa (1999); Nameer (2008); Schipper et al. (2008)

The species of small carnivores known from Western Ghats and Kerala along with their IUCN conservation status are given in Table 2. These include the four felids (Jungle Cat *Felis chaus*, Leopard Cat *Prionailurus bengalensis*, Fishing Cat *Prionailurus viverrinus* and Rusty-spotted Cat *Prionailurus rubiginosus*), four herpestids (Indian Grey Mongoose *Herpestes edwardsii*, Brown Mongoose *Herpestes fuscus*, Ruddy Mongoose *Herpestes smithii* and Stripe-necked Mongoose *Herpestes vitticollis*), four viverrids (Brown Palm Civet *Paradoxurus jerdoni*, Common Palm Civet *Paradoxurus hermaphrodites*, Small Indian Civet *Viverricula indica* and Malabar Civet *Viverra civettina*) and five mustelids (Honey Badger *Mellivora capensis*, Nilgiri Marten *Martes gwatkinsii*, Asian Small-clawed Otter *Aonyx cinerea*, Smooth-coated Otter *Lutrogale perspicillata* and Common Otter *Lutra lutra*). Out of the 17 small carnivores of Western Ghats, eight species (47%) are at different levels of threats such as critically endangered (1), endangered (1), vulnerable (5) and one near threatened. The lesser carnivore community shows a high degree of endemism in the Western Ghats. The Brown Palm Civet, Malabar Civet and the Nilgiri Marten are endemic to species level while Stripe-necked Mongoose and the Brown Mongoose are endemic to sub-species level. Among the various small carnivores of Western Ghats, the taxonomic status of Malabar Civet has been questioned by Nandini and Mudappa (2010).

1.1 MUSTELIDAE

The members of the family Mustelidae are the most diverse group and may be paraphyletic (Wozencraft, 1989a and b). The mustelids are highly adaptive, terrestrial, arboreal or aquatic in nature and primarily flesh eaters. They are mainly solitary, with males and females getting together only for the purpose of reproduction (Kruska, 1990). In south India, otters are represented by three species *viz.* the Eurasian otter, the small-clawed otter and the smooth-coated otter (Nagulu, 1996). All the three species of otters are becoming increasingly rare outside Protected Areas and are threatened in many areas because of the reduction in prey biomass, poaching and reduction of habitat (Foster-

Turly, 1992). They differ from Felidae by the absence of retractile claws and from the family Canidae by having a well developed first digit on the forefoot, well developed anal glands and by not having a deep chested body (Pocock, 1941). The family Mustelidae is subdivided into four subfamilies, Lutrinae, Melinae, Memphitinae and Mustelinae (Wozencraft, 1989a and b). They occur throughout the world except Australia and Antarctica. In India the Mustelidae is represented by three subfamilies, Mustelinae, Melinae and Lutrinae with 16 species.

Table 2. IUCN Red List status of small carnivores of Western Ghats

Species	**Scientific name**	**Family**	**IUCN threat category**
Brown Palm civet	*Paradoxurus jerdoni*	Viverridae	LC
Common Palm Civet	*Paradoxurus hermaphroditus*	Viverridae	LC
Small Indian civet	*Viverricula indica*	Viverridae	LC
Malabar Civet	*Viverra civettina*	Viverridae	CR
Indian Grey Mongoose	*Herpestes edwardsii*	Herpestidae	LC
Brown Mongoose	*Herpestes fuscus*	Herpestidae	VU
Ruddy Mongoose	*Herpestes smithii*	Herpestidae	LC
Stripe-necked Mongoose	*Herpestes vitticollis*	Herpestidae	LC
Jungle Cat	*Felis chaus*	Felidae	LC
Leopard Cat	*Prionailurus bengalensis*	Felidae	LC
Rusty-spotted Cat	*Prionailurus rubiginosus*	Felidae	VU
Fishing Cat	*Prionailurus viverrinus*	Felidae	EN
Eurasian Otter	*Lutra lutra*	Mustelidae	NT
Smooth-coated Otter	*Lutrogale perspicillata*	Mustelidae	VU
Asian Small-clawed Otter	*Aonyx cinerea*	Mustelidae	VU
Nilgiri Marten	*Martes gwatkinsii*	Mustelidae	VU
Honey Badger	*Mellivora capensis*	Mustelidae	LC

Source: Nameer (2008); Schipper et al. (2008)

1.2 VIVERRIDAE

The members of the family Viverridae are characterised by the presence of scent glands external to the anal region (Wozencraft, 1989a and b). They differ from the family Herpestidae in the sense that their anus is not enclosed in the glandular pouch and they have a penieal gland in the genital region (Pocock, 1941). Most of the members have retractile claws. Their ears are comparatively larger with well developed bursa on the external margin. They are distinguished from the members of the family Felidae by the hind foot being five toed, the retention of the inter-ramal tuft of facial vibrissae and typically elongated muzzle. Many of the members have spots or stripes on the body and the tail has ring like marks (Pocock, 1939). They are either terrestrial or arboreal in nature and have wide variety of diet including small mammals, birds, insects and fruits. Viverrids are mostly solitary and nocturnal.

The family viverridae is divided into four subfamilies Cryptoproctinae, Hemigalinae, Paradoxurinae and Viverrinae (Wozencraft, 1989a and b). They are found only in tropical and subtropical Africa and Asia. Of the six subfamilies, the viverrids in India are represented by eight species. Earlier Spotted Linsang was coming under Viverridae but now it is classified under a new family Paradoxurinidae (Schipper et al., 2008).

1.3 HERPESTIDAE

The members of the family Herpestidae are characterised by the uniquely derived nature of their anal sac and the structure of the auditory bulla (Wozencraft, 1989a and b). They are distinguished from Viverrids by the presence of a naked glandular pouch around the anus, with the anal glands opening into the pouch. They have long non-retractile and fossorial claws. The ears have no marginal bursa. The penis, which although short as compared to viverrids, has a well developed baculum and is without penieal glands (Pocock, 1939). The striped-necked mongoose *Herpestes vitticollis* is the largest of the

Asiatic mongoose. The mongoose is terrestrial in nature and has a diverse diet including small mammals, birds, reptiles, crabs, fish and insects. They are mostly gregarious and a few are solitary too. The family Herpestidae is divided into three subfamilies Galiidinae, Herpestinae and Mungotinae (Wozencraft, 1989a and b). They occur in most of Africa and Asia. In India, the family is represented by subfamily Herpestinae with seven species.

1.4 FELIDAE (SMALL CATS ONLY)

The members of the family Felidae varies considerably in size and colour, but all have slender graceful bodies with round head shortened muzzle and erect ears. Based on their body size they are classified into two, like big cats and small cats. The color of felids is also highly variable. It varies from brown to golden. Fur is common in most species and also usually marked with distinctive spots, stripes, or rosettes (Prater, 1971). All felids have retractable claws. The claws are retracted when the animal is relaxed. Unlike canids many of which hunt by running flat out their prey, most cats hunt by stealth, aided by pads on the soles of their feet (Pocock, 1941). The small cats cannot roar like big cats because of completely ossified hyoid apparatus where as in big cats is elastic in nature.

1.5 ROLE OF SMALL CANIVORES IN ECOSYSYTEM SERVICES

The lesser known mammals play important ecological roles in the ecosystem functioning in tropical forests and their removal has a cascading effect on entire communities. Small mammals are an integral component of forest animal communities, contributing to energy flow and nutrient cycling, and playing extremely important roles as predators and pollination agents in tropical forests (Fleming, 1975). Many of them play a major role in seed dispersal and thereby in the vegetation dynamics of their habitat. They also form an important prey base for medium sized carnivores and raptors.

The small carnivores use large variety of habitats ranging from rain forests to arid deserts, high altitude ecosystems, wetlands, and coastal and marine ecosystems for their

sustained reproduction. Conservation of natural habitats at a landscape level should therefore be the highest priority for ensuring survival of the small carnivores and also other wildlife. India has a large network of Protected Areas representing different biogeographic zones and habitat types, which ensure survival of a wide range of wildlife. With increasing human population and associated development activities in the last century, it is not known what is happening to small carnivore populations.

Due to the similarity in body size, they often share more or less the same variety of food items that include small mammals, birds, amphibians, reptiles, fishes, invertebrates and often fruits and seeds. Unlike the large carnivores which depend on a relatively narrow prey base, the survival of a large assemblage of the small carnivores depends on the availability of an equally large assemblage of prey species and food plants. The richness, abundance and distribution of the small carnivores, therefore, are very good indicators of biodiversity both in terms of species and habitat.

There are several constraints in studying the small carnivores. Most of these animals besides being small, are also rare, nocturnal, solitary and often inhabit areas with poor visibility due to thick vegetation. This makes hard to find and observe these animals for studying their behavior and habits. Because of these reasons camera-trapping is preferred to observational studies to document species richness and assess status. However, very few studies have used this method specifically to survey small carnivores (Mudappa, 1998). Apart from the camera trapping method, line transect method for collecting indirect evidences and night transect using vehicles for estimating encounter rates or densities can also be used.

The need to undertake biodiversity studies is accentuated by the rapid destruction of forests, particularly in the tropics. This holds true for the Western Ghats also. The conservation and ecological studies of small carnivores have therefore attracted considerable attention in recent year. The introduction of new technologies such as radio-

telemetry made ecological studies of this community feasible and most of the people are not aware of the existence of many of the species occuring in Western Ghats.

Most of the Protected Areas of the country in general and Kerala in particular do not have a comprehensive inventory of the small carnivores. Even basic information such as the distributional range of these species is not known (Nameer, 2000). There are a few studies on wildlife conducted in Parambikulam Tiger Reserve (PKTR) viz. large mammals (Easa and Balakrishnan, 1986), Asian Elephant (Easa, 1989; Easa and Balakrishnan, 1995), Gaur (Vairavel, 1998), Reptiles (Radhakrishnan, 1996a), Amphibians (Radhakrishnan, 1996b), Ramachandran (1988) studied the ecology and behaviour of Malabar Giant Squirrel, Shijo et al. (2007) studied the food habits and relative abundance of large carnivores through scat analysis technique in PKTR. The foregoing discussions indicate the absence of studies on any aspect of small carnivores in PKTR and hence the present study.

The **objectives** of the present study are,

1. To study the diversity of small carnivores of PKTR
2. To study the status and distribution of small carnivores of PKTR
3. Habitat preference of small carnivores of PKTR
4. To identify the threats on the small carnivores and to suggest measures for the long term conservation

Review of literature

REVIEW OF LITERATURE

As with mammals in general, small carnivores excluding small cats are not equally distributed around the world. Small carnivores are concentrated more in Ethiopian/Afro-tropical region with 57 species. The other zoogeographic regions support the small carnivores in the following manner, the Indomalayan region, 47 species; Neotropics, 33 species, Palaearctic, 16 species and Nearctic, 18 species each. No native small carnivores are known from the Antarctic, Australasian or Oceanic realms (Schipper et al., 2008).

2.1 STUDIES ON THE SMALL CARNIVORES OF THE WORLD

Most of the studies and researches on the order Carnivora are focused on the large carnivores. Little attention is given to the small carnivores like herpestids, viverrids, mustelids and small cats. However Zielinski (1988) He studied the influence of daily variation in foraging cost on the activity of small carnivores. Norrdahl (1995) studied the prey population dynamics of small carnivores in summer. A detailed account on the small carnivore group called 'Genets' was given by Powell and Rompaey (1998) from the Niger Delta. Engel (1998) studied the process of seed dispersal by small carnivores. The ecology of the small carnivores is still unknown to the scientific community. However Salazar (1999) conducted ecological studies on the endemic small carnivores of Mexico. He also studied the natural history, movement patterns, home range size, and temporal and spatial resource utilization of the species. Su (2005) studied about the small carnivores and their threats in Myanmar. Duckworth and Robichaud (2005) studied on the species range in small carnivores of South-East Asia. The small carnivores of Central Sumatra were surveyed by Holden (2006). Long and Hoang (2006) worked on the conservation status of small carnivores in Central Vietnam. Belden et al. (2007) studied about the small carnivores in mixed-use forests of Malaysia. However, Low (2011) did a detailed study on the small carnivores of peninsular Malaysia and reported 13 species of small carnivore. Mcdonald (2000) studied the secondary poisoning risks in small

carnivores. He also studied the hazards caused to small carnivores by the widespread use of rodenticides. Similarly information regarding the feeding habits and foraging behavior of small carnivores are also scanty. A detailed account on the small carnivores of Borneo was given by Dinets (2003).

2.1.1 Studies on the Viverrids

Chris (1998) studied on the diet of viverrids of South Africa. The movements and fruit selection of the viverrids in Thailand was studied by Grassman (1998). Conservation breeding studies of the Owston's Palm Civet *Chrotogale owstoni* in Vietnam was carried out by Rosenthal (1999). Rozhnov and Anh (1999) described a new species of civet from Vietnam called the Tainguen Civet. It was a great finding which paved the way for further studies about the small carnivores. Veron (2001) studied on the palm civets of Malaysia whereas Roberton (2001) conducted studies on Owston's Palm Civet *Chrotogale owstoni*. He also explained the methods used to record growth and health in captive Owston's Palm Civets *Chrotogale owstoni*. Walston and Duckworth (2003) gave the first record of Small-toothed Palm Civet, *Arctogalidia tiairgata* from Cambodia. Moutou (2004) studied the possible role of Oriental civets in the SARS epidemic. He also mentioned on the trade of these civets which led to the spread of this epidemic. Boonratana (2004) studied the viverrids of Vietnam. Lynam et al. (2005) studied on the Large-spotted Civets *Viverra megaspila* of Thailand and Myanmar. Azlan and Azad (2005) studied on the activity patterns of viverrids in secondary forests of peninsular Malaysia.

Jennings et al. (2006) studied on the ranging behavior, spatial organization and activity pattern of the Malay Civet *Viverra tangalunga* on Button Island. Su and Sale (2007) studied the niche differentiation between Common Palm Civet *Paradoxurus hermaphroditus* and Small Indian Civet *Viverricula indica* in regenerating degraded forests of Myanmar. Civet trade in Indonasia was studied by Shepherd (2008). He observed three species of civets includes Common Palm Civet Paradoxurus

hermaphroditus, Masked Palm Civet *Paguma larvata* and Small-toothed Palm Civets *Arctogalidia trivirgata* were under trade. Camera trapping studies on the small carnivores of Indonesia was done by Cheyne (2010) and reported eight species including threatened Banded Linsang *Prionodon linsang*. The study also reported the active period of those small carnivores of Indonesia. Spotlight survey recorded four species of civets in Peninsular Malasyia (Low, 2010). Gray (2010) studied on the ecology and activate period of Large-spotted Civet *Viverra megaspila* and Large Indian Civet *Viverra zibetha* in eastern Cambodia and the illegal hunting and trade in viverrids in Peninsular Malaysia was reported by Shepherd (2010).

2.1.2 Studies on the Herpestids

Chris and Stuart (1998) studied about the White-tailed Mongoose in Southern Arabia. They also gave a detailed account on the herpestids and viverrids of Zanzibar Island and also about the weasels and mongooses of Southern Africa-Dunham (1998) worked on the Ring-tailed Mongoose *Galidia elegans* of Madagascar. Study conducted by Austin and Tewes (1999) threw light on the herpestids, viverrid and mustelid species of Thailand. Azlan (2003) studied the diversity and conservation of herpestids, mustelids and viverrids in disturbed forests of Peninsular Malaysia. Goodman et al. (2005) rediscovered the Narrow-striped Mongoose *Mungotictis decemlineata* from Madagascar. He also worked on the taxonomic status and distribution of this mongoose in Madagascar. Small carnivore monitoring by camera trap and small mammal cage trapping on herpestid and viverrid in the lowland rainforests of Borneo was studied by Wells et al. (2005).

2.1.3 Studies on the Mustelids

Martino and Gimeno (1998) worked on the various diseases prevailing in wild martens. Pulliainen (1999) studied the fidelity and core area in the space and resource use system of the Pine Marten Martes martes. Sidorovich (1999) gave a detailed account on

way to identify the mustelid tracks during surveys and researches. A detailed account on the badgers of Ireland was given by Sleeman et al. (1999). Tumanov and Sorina (1999) studied the age dynamics in body weight and physiological indices in some mustelid species. Sidorovich and Krasko (2000) studied the behavioral interactions between the naturalized American Mink Mustela vison and the native riparian mustelids with implications for population changes. Zagrebelny (2000) carried out detailed studies on the mustelids of Russia.

A regional collection plan for the mustelids in Europe was prepared by Blomqvist and Maran (2000). They also described the need for the conservation and also about the taxonomic uniqueness of mustelids. However, Marinis and Asprea (2001) studied the pattern of variation in the feeding habits of the badgers. Sleeman and Cussen (2001) conducted similar studies on badgers. They studied on the badgers of Fenit Island, Ireland and also their presence or absence in other islands. Kruuk (2000) studied on the status and foraging of the Pantot or Palawan Stink-badger *Mydaus marchei.*

There are some studies which described the ways to measure the small carnivore diversity and density. Sidorovich et al. (2001) explained a new method to estimate the species diversity, density and biomass of water-living prey of semi aquatic mustelids in ponds and small streams. Abramov (2003) studied the head colour patterns of the Eurasian Badger *Meles meles*. Parr and Duckworth (2007) studied on the diet, habituation and sociality of Yellow-throated Marten *Martes flavigula*. Delgado et al. (2011) studied the behavior of *Tayra* using the video-capturing method and the study also pointed out the advantage of video-capturing method over camera trapping.

2.1.4 Studies on Other Small Carnivores

The status and distribution of Fishing Cat *Prionailurus viverrinus* was studied by Roland (1996). Abel and Griffiths (1999) studied the current status of Marbled Polecat *Pardofelis marmorata* throughout its historical range. Zabala and Garin (2001) studied on

the trapping of small carnivores and also the impacts of seasonal changes in small carnivore trappability. The little known small carnivores of Thailand and southern China were surveyed by Tizard (2002) and he reported Spotted linsang Prionodon pardicolor, Back-striped weasel *Mustela strigidorsa* and Yellow-bellied weasel M*ustela kathiah* from the remote areas of Thailand. Similarly the monitoring of small carnivores via indirect evidences was also studied world around. In this line a study was conducted by Francis (2002) on the Hose's Civet, *Diplogale hosei* of Brunei. Marassi and Biancardi (2002) studied on the use of Eurasian Badger, *Meles meles* in an area of the Italian Preamps. A detailed study about the distribution of Red Pandas *Ailurus fulgens* in Nepal was given by Sharma and Belant (2009) and reported that the species is confirmed to eight protected areas of Nepal. The study also reported that the species is distributed in temperate and sub alpine forest at an elevation ranging 2,500 to 4,000 m. Jutzeler (2010) studied the ecology and the behaviour of Fishing Cat in China.

Of the total 165 species of small carnivores, except small cats, assessed for IUCN red-listing two species such as Sea Mink *Neovison macrodon* and Giant Fossa *Cryptoprocta spelea* have become extinct, while one species, Malabar Civet *Viverra civettina* is Critically Endangered. On the remaining species of small carnivores 10 species (6%) are Endangered, 22 (13%) Vulnerable, 10 (6%) Near Threatened, 15 (9%) Data Deficient and 105 (64%) are Least Concern. In general, populations of small carnivores were decreasing (40%) or unknown (35%), with fewer being stable (22%) and only 2% (three species) increasing (Schipper et al., 2008). Emerging threats that could affect small carnivores include contagious disease and climate change. Among the most susceptible to numerous threats are the aquatic and semi-aquatic species, partially due to their restricted, often linear, distribution along rivers and water bodies and because freshwater systems themselves are threatened by contamination, eutrophication, overexploitation, water shortage and flooding. Among small carnivores, otters are most threatened group with seven (54%) of the 13 species for which a category was threatened (Schipper et al., 2008).

2.2 SMALL CARNIVORE STUDY IN INDIA

Most of the studies pertaining to small carnivores in India are from north eastern India and from the Western Ghats.

Yoganand and Kumar (1995) conducted the pioneering study on the distribution of small carnivores in the Nilgiri Biosphere Reserve. Mudappa (1998), who studied the small carnivores using the camera traps found that it is an efficient tool for surveying these animals.

Mudappa (2002a) gave a detailed account of the eight species of small carnivores of Kalakad-Mundanthurai Tiger Reserve (KMTR), Tamil Nadu. Kumara and Singh (2006a, 2006b) conducted an extensive survey and reported 11 species from Karnataka. More recently, Mudappa et al. (2007) studied the responses of small carnivores to rainforest fragmentation in southern Western Ghats. Aparajita et al. (2008) studied the occurrence and conservation status of small carnivores in two Protected Areas in Arunachal Pradesh and reported 15 species of forest-dwelling small carnivores, apart from three other otter species from the region. A very recent study was conducted by Pillay (2009) in southern Western Ghats.

Bahuguna (1998) studied the small carnivores of Darjeeling with special reference to Red Panda. Sunita et al. (2001) did the first ever detailed study on the ecology of the Red Panda in India. Choudhury (1999 and 2000) recorded 22 species of small carnivores of Bengal. He also gave an account on the small carnivores of Nagaland (Choudhury, 2000) and reported nine species of mustelids, seven viverrids and three herpestids. Choudhury (1997a, 1997b, 2002) also studied the small carnivores of Arunachal Pradesh and Assam and reported 23 species including Red Panda *Ailurus fulgens* and Spotted Linsang *Prionodon pardicolor*. The study also reported various threats being faced by the small carnivores in the northeastern region. Choudhury (2004) gave detailed account on the small carnivores of different sanctuaries in Assam. Nandini and Karthik (2007)

reported on the Yellow-throated Martens *Martes flavigula* of northeast India. More recently, the status of Red Panda *Ailurus fulgens* of West Bengal was studied by Mallick (2010). The study also identified various threats faced by the species and suggested some recommendations for the conservation of Red Panda. Lyngdoh et al. (2011) observed that the Spotted Linsang is widely hunted in Arunachal Pradesh for its fur and meat and thus the species is uncommon.

2.2.1 Studies on Viverrids

2.2.1.1 *Studies on Malabar civet*

Malabar civet *Viverra civettina* is endemic to Western Ghats and is as large as the large Indian Civet *Viverra zibetha* (Pocock, 1933). The original description about the Malabar civet *Viverra civettina* was given by Blyth (1862). The next published information about Malabar Civet was by Jerdon (1874), who reported the species as common throughout the Malabar cost from Travancore.

Concern about this species began early this century as several expeditions failed to obtain specimens (Pocock, 1939). The last (and perhaps only) live specimen of the Malabar Civet in a zoo was at the Thiruvananthapuram Zoo in 1929. In 1987, after a gap of 58 years, two skins of recently killed animals were obtained by the Zoological Survey of India, Calicut of a species long suspected extinct (Kurup, I989). In recent times only two possible sightings have been reported: Karanth (1986) in Bhagavathy Valley, Karnataka and Kurup (1989) in Tiruvalla, Kerala.

Most of the past records of the species are from the coastal tracks of the Western Ghats (Jerdon, 1874; Pocock, 1939; Prater, 1971) and from Kanyakumari in the extreme south to Honnavar in the Karnataka in the north. There are also two reports of its occurrence in the higher elevations of the Western Ghats in the high wavy mountains (Hutton, 1949), and in Kudremukh (Karanth, 1986). But for these reports, the Malabar Civet has remained unknown to the scientific community (Rai and Kumar, 1993).

Ashraf et al. (1993) obtained two skins of the animals near Nilambur, an area dominated by cashew and rubber plantations. But, Rai and Kumar (1993) who surveyed the Nilambur and adjoining forests of Kerala could not get any evidence of the species. They however, suggested the presence of Malabar Civets in few locations in Kerala and Karnataka based on indirect evidences. The most recent survey on Malabar Civet by Rao et al, (2007) and Ashraf et al, (2009), could not get any direct evidence to prove the presence of Malabar Civet in south India. Nandini and Mundappa (2010), after reviewing the history of its collection, published and unpublished literature on this species has proposed a novel possibility that the genus *Viverra* does not occur in the wild in South India and Malabar Civet is not a valid taxon.

2.2.1.2 *Studies on Brown Palm Civet*

The Brown Palm Civet or Jerdon's Palm Civet *Paradoxurus jerdoni* is an endemic carnivore restricted to the rainforest tracts of the Western Ghats, a 1,600km long hill chain along the west coast of India. The species has been reported from an altitudinal range of 500-1,300m, being more common in higher altitudes (Mudappa, 1998). They are known to occur in tropical rainforests of the Western Ghats and in areas such as Coorg they are known to use coffee estates as well (Report of G.C. Shortridge in Riely, 1913; Ashraf et al., 1993).

Recent reports include photographs or sight records from Anamalais, Nilgiris, Coorg (Schreiber et al., 1989), Silent Valley (Ramachandran, 1990), and Kalakad-Mundanthurai Tiger Reserve (Ganesh, 1997; Mudappa, 1998). Ashraf et al. (1993) stated that the Brown Palm Civet probably occurs in low densities throughout its range. However, the species appears to be fairly common in Kakachi-Upper Kodayar (Ganesh, 1997) and other areas above 1,000m within the KMTR in the Agasthyamalai hills and also in the Anamalai hills (Mudappa, 2001). Recent studies also suggest that the Brown Palm Civets are not as rare as they were thought to be (Mudappa, 2001). A detailed study about the status and distribution of Brown Palm Civet was carried out by Nandini et al.

(2002b), reported illegal hunting and the conversion of rainforest into tea and coffee plantations were the major threats to the species. Mudappa and Chellam (2002) made some capture and immobilization studies of wild Brown Palm Civets in Western Ghats. Mudappa (2002b; 2006) also made extensive studies on the Brown Palm Civets of Western Ghats.

2.2.1.3 *Studies on Small Indian civet*

The major threats faced by the Small Indian Civets *Vivericula indica* are the illegal hunting for meat and civetone, habitat destruction, along with other antropogenic causes (Gupta, 2000). The skin of the civets is also used for the preparation of ayurvedic medicines against epilepsy (Gupta, 2004). Balakrishnan and Sreedevi (2007a; 2007b) studied on the Small Indian Civets under captivity. They also reported that the practice of capturing civets for keeping under captivity is the major reason for the depletion of civet's population in south India (Balakrishnan and Sreedevi, 2007a).

2.2.1.4 *Studies on Common Palm Civet*

Krishnakumar and Balakrishnan (2003) studied the feeding ecology of Common Palm Civet *Paradoxurus hermaphroditus* in the semi urban areas of Kerala. Borah and Deka (2011) reported the mating behavior of the species. Diet of Common Palm Civet and its role in seed germination in rural habitat in Kerala was studied by Jothis (2011). The study reported that the Common Palm Civet feed on at least 18 fruit species. The study also reported the high germination rate of the seeds collected from the scat of Common Palm Civet.

2.2.2 Studies on Mustelids

2.2.2.1 *Studies on otters*

A detailed study on the ecology of Smooth-coated Otter (*Lutrogale perspicillata*) in National Chambal Sanctuary was conducted by Hussain (1993). Food and feeding

habitats of Smooth-coated Otter under captivity was reported by Haque and Vijayan (1995). Hussain and Choudhury (1995, 1997 and 1998) reported that the fish is the major prey of otters and exceeds more than 80 per cent of the diet. Hussain (1996, 1998) studied the group size, group structure and breeding behavior of Smooth-coated Otter in the lower Himalayas. The first comprehensive study on the otters of Western Ghats was done by Anoop and Hussain (2004; 2005), who studied the ecology and feeding behavior of Smooth-coated Otter in Periyar Tiger Reserve. Meena (2002) reported on the poaching of otters in the Palni Hills. Shenoy (2006) studied on the factors determining the habitat choice of the Smooth-coated Otter.

2.2.2.2 *Studies on Nilgiri Marten*

Most of the published reports on martens were the opportunistic sighting reports from the various Protected Areas of Western Ghats. Yoganand and Kumar (1995) reported Niligiri Marten *Martes gwatkinsii* from Nilgiri Biosphere Reserve and Madhusudan (1995) from Eravikulam National Park. Christopher and Jayson (1996) also reported it from Peppara Wildlife Sanctuary. Kurup and Joseph (2001) made certain observations on the behavior of Nilgiri Marten from the Periyar Tiger Reserve. Balakrishnan (2005) reported the sighting of the Nilgiri Marten from Silent Valley National Park, Attappadi Reserve Forest, Muthikkulam South Reserve Forest, and Nilambur South Reserve Forestnb. A recent study by Krishna and Karnad (2010) reported the sightings of Nilgiri Marten from Anamalai Tiger Reserve, Nelliampathy Reserve forest and Pambadum shola.

2.2.2.3 *Studies on Other Mustelids*

Ramakantha (1992a, 1992b) reported the Yellow-throated Marten *Martes flavigula* and Bornean/Chinese Ferret badger *Melogale moschata* from Manipur. Later, he studied about the natural distribution and ecology of mustelids and viverrids in Manipur and it was the first comprehensive study in that area and later he also reported

the presence of Spotted Linsang in Manipur (Ramakantha, 1995). Jha (1999) studied the status of weasels in Sikkim. Pillai (2000) studied the mating behavior of Ratel *Mellivora capensis* under captivity. Later Joshi and Andavan (2008) reported the Ratel from Gujarat.

2.2.3 Studies on Herpestids

Choudhary (1981) reported that Indian Grey Mongoose *Herpestes edwardsii* predate on Gharial eggs. Mudappa (2002a) reported the occurrence of Brown Mongoose *Herpestes fuscus* in KMTR, Tamil Nadu. Roy (2002) studied the Small Indian Mongoose *Herpestes javanicus* of India. Bose et al. (2003) made some studies on the diseases of mongoose. The status of mongooses in Central India was studied by Shekhar (2003). Rompaey and Jayakumar (2003) did a comprehensive study on the Stripe-necked Mongoose *Herpestes vitticollis*. They studied the distribution, status, food and feeding habits, reproduction and various threats. Mallick (2009) studied the status of endemic Marsh Mongoose *Herpestes palustris* in the wetlands of Kolkata, later Mallick (2011) recorded the species from southern West Bengal.

2.2.4 Studies on Lesser Cats

2.2.4.1 *Studies on Jungle Cat*

Chavan (1987) studied the status of lesser cats in Gujarat. Gogate (1997) surveyed the lesser cats of Maharashtra and listed five species of lesser cats. Jha (2000) reported the species from Sikkim. Some studies on the melanism in Jungle Cat *Felis chaus* were carried out by Chakraborty et al. (1988). Mukherjee et al. (2003) studied the importance of rodents in the diet of Jungle Cat *Felis chaus* and Caracal *Caracal caracal*. Gupta (2000) reported the illegal trade of Jungle Cat for meat in the Nilgiri Biosphere Reserve. Duckworth et al. (2005) studied the population status of Jungle Cat in Indo-China border. They reported that it is a threatened population over there. They also found out that the Jungle Cat is a widespread and adaptable species. Mukherjee and Groves (2007) studied

on the geographic variations in Jungle Cat. Patel (2011) recorded three species of small cats, includes Jungle Cat *Felis chaus,* Rusty-spotted Cat *Prionailurus rubiginosus* and Asiatic wild Cat *Felis silvestris* from eastern Gujarat. He also recorded the major diet of the three small cats.

2.2.4.2 *Studies on Rusty-spotted Cat*

Almost all the published literature on Rusty-spotted Cat *Prionailurus rubiginosus* were occurrence reports. Very little is known of the ecology and habitat of the species (Jackson 1998; Mukherjee 1998). The Rusty-spotted Cat has been reported from Jammu and Kashmir (Chakraborty, 1978), Gujarat (Chavan et al., 1991), Rajasthan (Tehsin, 1994), Madhya Pradesh (Digveerendrasinh, 1995), Tamil Nadu (Christopher and Jayson, 1996), Orissa (Acharjyo et al., 1997), Maharashtra (Dubey, 1999), Tadoba (Karnat, 1999) and Andhra Pradesh (Rao et al., 1999; Manakadan and Sivakumar (2005). In Kerala, the species was reported from Thiruvalla, Kollam and an unconfirmed sighting from Alleppy (Easa et al., 2001).

2.2.4.3 *Studies on Leopard Cat*

Khan (2004) studied the food habits of Leopard Cat *Prionailurus bengalensis* in the Sunderbans. Jayson and Christopher (1996) reported the Leopard Cat from Peppara Wildlife Sanctuary in Trivandrum. They also reported that the sighting of nocturnal mammals has become rare in the Western Ghats. Jha (2000) reported the Leopard Cat from Sikkim.

2.2.4.4 *Studies on Fishing Cat*

Fishing cats *Prionailurus viverrinus* are common in the Sunderbans, but rare in other parts of the state, due to destruction of their habitat. Bhattacharya (1989) reported the status and distribution of Fishing Cat in West Bengal. The species is primarily reported from the Terai region of the Himalayan foothills and from the northeastern India

(Choudhury, 2003). Bhattacharyya (1992) made some studies on the breeding biology of Fishing Cat while Nayerul and Vijayan (1993) studied the food habits of the Fishing Cat in Keoladeo National Park. Jha (2000) reported the species from Sikkim. Scavenging habits of Fishing Cats in Rajasthan was studied by Haque (1998).

2.3 STUDIES ON SMALL CARNIVORES OF KERALA

Studies on the mammals of Kerala date back to the British period but comprehensive account on the mammals of Kerala is yet to be published. This is true especially in the case of small mammals as mammalian studies from Kerala were concentrated on large mammals like Asian Elephant *Elephas maximus*, Tiger P*anthera tigris*, Gaur *Bos gaurus*, Nilgiri Tahr *Nilgiritragus hylocrius* etc. Most of the works pertaining to small mammals were based on captive breeding trials (Xavier and Balakrishnan, 1993). Studies on the lesser known mammals of Kerala are very scanty though the state has a fine distribution of these animals. Yoganand and Kumar (1999) reported the small carnivores likely to be seen in Silent Valley National Park. Anoop and Hussain (2004; 2005), who studied the ecology and feeding behavior of Smooth-coated Otter in Periyar Tiger Reserve. Easa et al. (2001) conducted a study on the small mammals of Kerala including small carnivores. Mailk (2010) reported five species of small carnivores from Chimmony Wildlife Sanctuary in Kerala such as Jungle Cat *Felis chaus*, Indian Grey Mongoose *Herpestes edwardsi*, Smooth-coated Otter *Lutrogale perspicillata*, Common Palm Civet *Paradoxurus hermaphrodites* and Small Indian Civet *Viverricula indica*.

Materials and Methods

MATERIALS AND METHODS

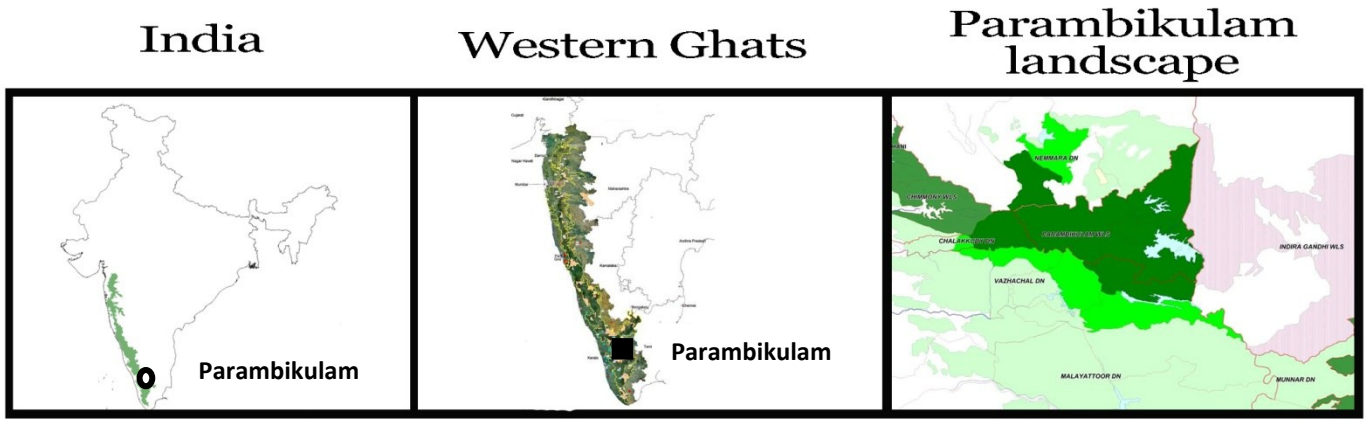
3.1 STUDY AREA

3.1.1Name, Location and Extent

Parambikulam Tiger Reserve (PKTR), the second Tiger Reserve of the state and also the 38th Tiger Reserve of India, came into existence in 2010. PKTR is situated in Palghat district, Kerala state, India (between 76^0 35' and 76^0 50' E and between 10^0 20' and 10^0 26' N) (Fig. 1) with an extent of 643.66km^2 with a core area of 390.89Km^2 and buffer area of 252.77km^2 (Kaler, 2011). The present study was carried out in Parambikulam Wildlife Sanctuary with a extent of 285km^2.

The Tiger Reserve is bordered by the west flowing Karapara River in the west and the same river flowing easterly in part of the south. The PKTR is contiguous with the natural forests of Sholayar and Vazhachal. The boundary on the east is purely an administrative one with the forest clearance running throughout the area bordered by Indira Gandhi Tiger Reserve (Anamalai Tiger Reserve) of Tamil Nadu. The northern side is bordered by the southwest flowing Thekkady River up to the central part of the area and the remaining portion by the forest clearance along the water divide between the northerly and southerly flowing streamlets. The Tiger Reserve is part of the contiguous larger area of forest comprising Anamalais, Nelliampathis, Sholayar, high ranges and Palani hills. The major interception in the Western Ghats ridges is the Palghat gap which lies just north of this area.

A unique forest tramway was in existence at Kuriarkutty at PKTR from 1907 exclusively meant for timber transport from Parambikulam to Chalakudy (Plate 1). Extensive extraction of timber took place during this period, but the tramway was abandoned in 1951. The first plantation in this area was raised in 1912. All the plantations after 1932 were raised under taungya system (Vijayan, 1979).



Parambikulam Tiger Reserve

(Administrative division)

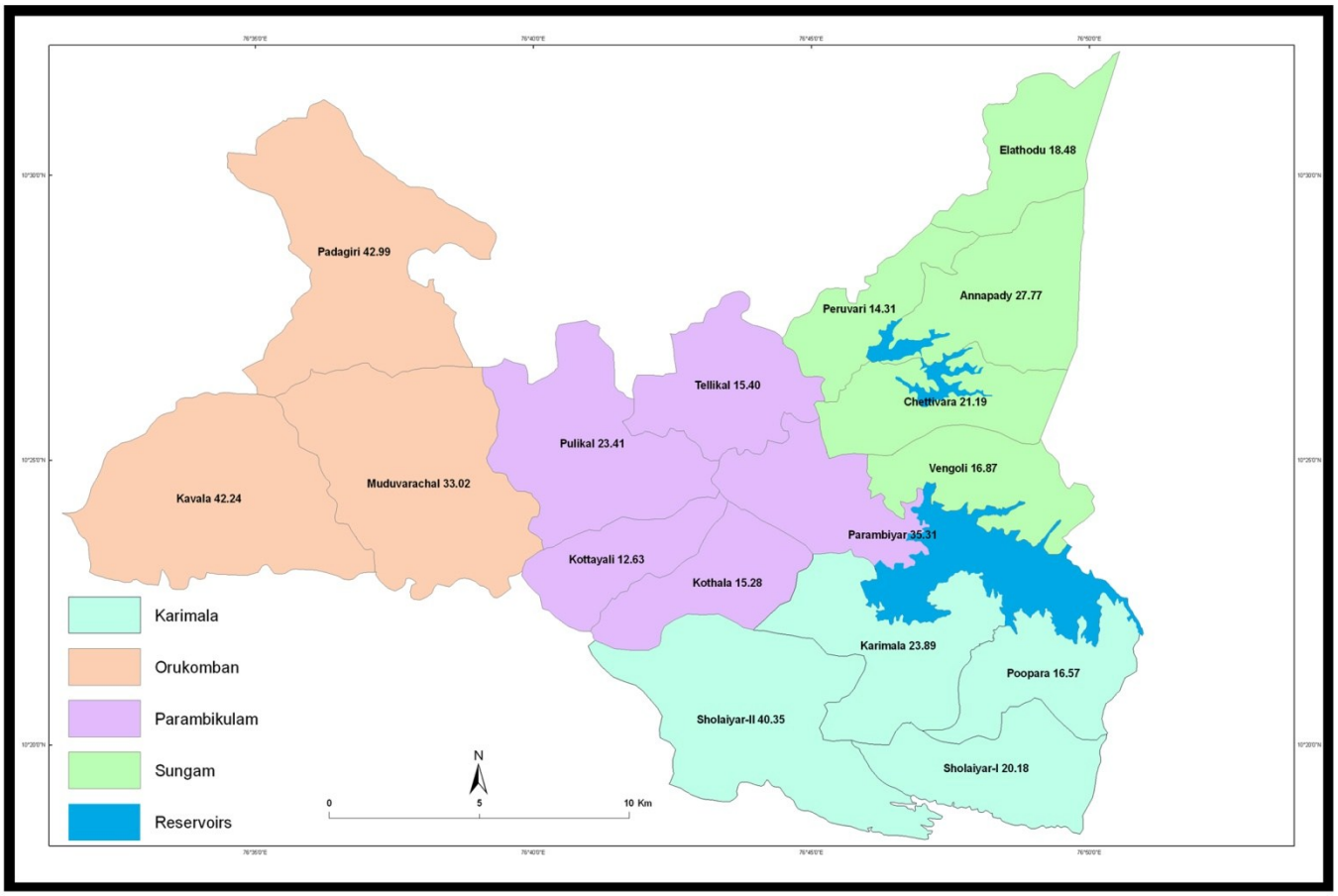


Fig. 1. Location map of Parambikulam Tiger Reserve

28. V.I.P. Coach, Cochin Forest Tramway, 1933.

Source (Ali, 1985)

Remaining of Cochin Forest Tramway

Plate 1. The Cochin Forest Tramway

3.1.2 Geology, Rock and Soil

3.1.2.1 *Geology*

Lying south of the Palghat gap in the Anamalai hills of Western Ghats, the reserve manifests interesting geological formations. The Western Ghats in general is formed of charnockites that had its origin in the Pre Cambrian era, formed about 4600 to 570 million years ago. Major geologic formations are metamorphic where as the intruded ones are igneous in origin (Kaler, 2011).

3.1.2.2 *Rock*

A superfluous observation of the major rock exposures reveals that most of them are banded gneisses, which can be inferred so from its gneissose structure and characteristic foliating nature. Charnockites are seen along the high precipitous slopes. Presence of hypersthane as the major component confirms it as charnockites. Rock specimen, identified as pegmatite, was found from Thunacadavu. Large extent of rocky blanks with outcrops of sheet rock is found in Nelliampathy Hills. Granite fragments were also seen along the foothills, which adhere to the fact that dykes have intruded into the originally metamorphic rocks of the area. Major minerals found in the rocks of the reserve are quartz and feldspars. Biotite Hornblende and Hypersthenes are the other minerals. Mineral deposits of economic importance are not found within the reserve (Kaler, 2011).

3.1.2.3. *Soil*

Different types of soil are met with in the core area of PKTR. It varies from very shallow gravelly soil on the upper slopes to deep filler textured soil on the lower slopes and in the valleys. Alluvial deposits are also met with along the stream and riverbanks. The types of soil found in PKTR include alluvial soil, laterite soil, red soil and the forest and hill soil (Kaler, 2011).

3.1.3 Terrain

The area in general has a slope towards west. The altitude ranges from 430 to 1438m, with the highest peak being Karimalagopuram (1438m) and the lowest, the bank of Chalakkudy river (439m). The Tiger Reserve includes the hilly terrain with undulating plateau. The Nelliampathy hills in the north and west constitute the westerly extension of Anamalais. The hills drop steeply down to Thekkady-Keerapadi in the south-west and raises precipitously up to Pandaravara malai. The hills slope down gently towards the south to Thunacadavu valley of Sungam Range and the valley is fairly large ascending southwards to Vengolimalai (1224m). The Nelliampathy hills in the north-west gradually descend and open up in Thuthampara, Thellickal and Parambikulam valley forming widest valley areas in the Tiger Reserve. The valley ends up in Poopara and Karimala peaks forming the southern boundary of the Tiger Reserve. The mountain slopes in the area are non-symmetric and non-uniform spreading throughout in different directions (Kaler, 2011).

3.1.4 Climate

3.1.4.1 *Rainfall Pattern and Distribution*

The annual rainfall ranges from 1400-2000mm. The PKTR receives rainfall from both South-West and North-East monsoons. The bulk of the annual rainfall is from the southwest monsoon (Kaler, 2011).

3.1.4.2 *Temperature*

The dry season is from December to May. Absolute extreme range of temperature in the PKTR is 32.8^0C. However March is the hottest month with mean monthly temperature of 25.74^0C and January is the coolest month with 21.2^0C (Kaler, 2011).

3.1.4.3 *Wind*

There are two prevailing winds in the tract blowing in the direction of two monsoon currents. But the northeast winds blowing through the Palghat gap of Western Ghats have desiccating effect and cause heavy leaf fall resulting in accumulation of combustible materials on the ground inducing wild fires.

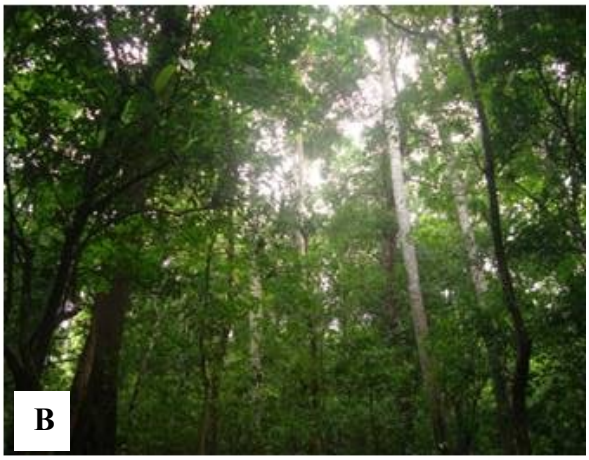
3.1.5 Water Source

The reserve is blessed with both natural and artificial water sources. There are a number of seasonal watercourses, which carry bulk of water in the rainy season, but invariably dry up during summer. There are a few springs noticed most of which are perennial, but some linger for a few months and dry up during the hot months. Even if most of the streamlets and some streams dry up during the summer season there are many streams and rivers, which are perennial in nature spreading as a network over the entire area.

These rivers along with their tributaries form a very good water supply and drainage system. The seven water spread areas, viz., reservoirs of Parambikulam, Peruvarippallam, Poringal, Pothundy, Sholayar, Thunakkadavu and Mangalam augment the water supply in this reserve. The PKTR is drained by Thekkady river, Parambikulam river, Kuriarkutti river, Thunacadavu river, Thellickal river, Karappara river, Bagapallam river, Vetti river and Pulikkal river. In addition to this there are other artificial water sources comprising of man-made water holes and check dams are also present.

3.1.6 Habitat and Vegetation

Natural vegetation (Plate 2) of this reserve is a combination of Malabar and Deccan elements. Micro climatic fluctuations coupled with edaphic, topographic and biotic factors have endowed this reserve with rich floral diversity. The PKTR has a variety of habitats, both natural and man-made. Natural habitats include moist deciduous



A. Evergreen Forest of Karmala, B. Semi-evergreen Forest of Kotayali, C. Dry deciduous Forest of Thekkady, D. Moist deciduous forest of Kothala, E. Seechali *Vayal,* F. Teak Plantation of Sungam

Plate 2. Natural Vegetation in Parambikulam Tiger Reserve

forests to tropical wet evergreen rain forests. Grasslands are seen on the upper reaches of Karimalagopuram and Vengoli hills above 1000m. The man-made habitats are primarily teak plantations, which have an extent of about 90km^2, and were first introduced in the year 1912. In addition to this, a small area of the Tiger Reserve bordering Tamil Nadu is planted with eucalyptus. According to Champion and Seth (1968), the natural vegetation of this reserve can be classified into following forest types (Table 3). The vegetation map is shown in (Fig. 2) and an overview of the Tiger Reserve is shown in Plate 3.

Table 3. Forest types of Parambikulam Tiger Reserve

Sl. No.	**Code**	**Forest type**
1.	IA/C4	West-coast Tropical Evergreen Forests
2.	2A/C2	West coast Tropical Semi-evergreen Forests
3.	3B/C2	Southern Moist Mixed Deciduous Forest
4.	5A/C3	Southern Dry Mixed Deciduous Forests
5.	IIA/C1	Southern Montane Wet Temperate Forests (Sholas)
6.	11A/C1/DS2	Southern Montane Wet Grasslands
7.	2/E3	Moist Bamboo Brakes
8.	8A/C1/E1	Reed Brakes

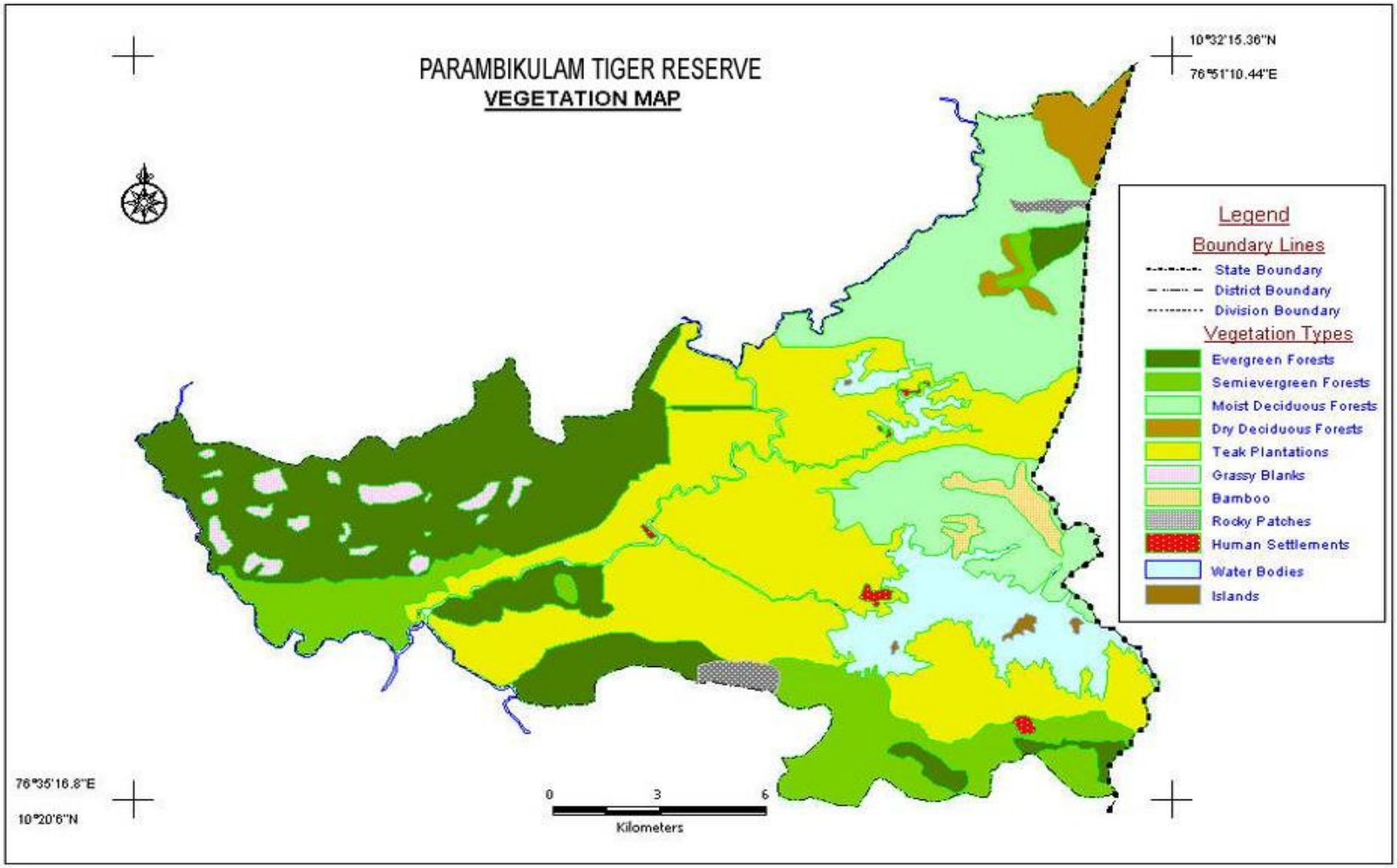


Fig. 2. Vegetation map of Parambikulam Tiger Reserve

Parambikulam Reservoir

Parambikulam Dam View

Plate 3. An overview of Parambikulam Tiger Reserve

3.1.6.1. *West Coast Tropical Evergreen Forests (1A/C4)*

This kind of forests are represented in pockets of Karimala, Pooppara, Medamchal areas of Karimala Range, Muthuvarachal, Orukomban and Padukutty areas of Orukomban Range, Komalappara, Kavala, Myladappan areas of Kavala section in Vellikkulangara Range, Pothumala, Karapara, Pullalamala, Pakuthippalam and Vellattimala areas of Nelliyampathy reserve forests, Malakkippara, Sholayar, Karimalagopuram, Karanthodu, Sheikalmudi of Vazhachal forests. The forest is characterized by the presence of lofty evergreen trees of height up to 45m. The canopy is extremely dense, presence of woody climbers and epiphytes as well as terrestrial orchids, ferns, mosses and other herbaceous flowering plants are also present. Ground vegetation may be generally absent. This type of forest is found in areas wherever humidity and soil moisture conditions are favorable, rainfall is 1500-5000mm or more and altitude is 250 to 1200m.

Tree species like *Palaquium ellipticum, Calophyllum polyanthum, Mesua ferrea, Cullenia exarillata, Dipterocarpus indicus, Artocarpus hirsutus, Hopea parviflora, Vateria indica , Dysoxylum malabaricum, Myristica malabarica, Polyalthia fragrans, Canarium strictum*, etc. form the top storey of these type of forests. While the Middle canopy trees normally attain a height of about 20m or more. The common species are *Aglaia lawii, Diospyros spp. Elaeocarpus glandulous*, *Garcinia gummi-gutta, Garcinia spicta, Hydnocarpus pentandra*, etc. The lower storey is mainly of *Aporusa lindleyana, Vitex altissima, Elaeocarpus serratus, Cinnamomum verum, Evodia lunu-ankenda, Holigarna arnottiana,* etc. *Calamus spp., Dendrocnide sinuata, Nilgirianthus spp., Elettaria cardamomum* etc. form the ground vegetation.

3.1.6.2. *West Coast Tropical Semi-evergreen Forests (2A/C2)*

These forests appear to be ecological zones in areas where the moist deciduous forests merge with evergreen. The ground floor of semi evergreen forests receives more

light than the ground floor of evergreen forests, due to comparatively lighter canopy. Due to variation in the mixture of species of evergreen forests and deciduous Forests, it becomes difficult to determine the exact status of these forests. Tree species like *Adina cordifolia, Artocarpus hirsutus, Bombax ceiba, Syzygium cumini, Holoptelea integrifolia, Hopea parviflora, Lagerstroemia reginae, Mangifera indica, Miliusa tomentosa, Polyalthia fragrans, Sterculia alata, Tetrameles nudiflora, Vitex altissima,* etc. occupies the top canopy. The Middle Canopy is mainly of *Aporosa lindleyana, Cinnamomum malabaricum, Euodia roxburghiana, Mallotus philipenensis, Xanthophyllum arnottianum* etc. Lower Canopy is very similar to the lower canopy of the evergreen forests. These type of forests are present in Minnampara, Pannimudi Thekkady (Kollengode Range), Kaikatty, Suryanelli and Padagiri of Nelliampathy range, Muthuvarachal, Watchmaram, Mukkumpuzha, Poringal, Manimaruthuthodu etc,.

3.1.6.3. *Southern Moist Mixed Deciduous Forests (3B/C2)*

These forests are found over the ridges and lower slopes having elevation of 100m to 400m where the soil is generally rich. The top canopy remains leafless between March and May. They are found along the ridges and lower slopes covering an area of about 60km^2. Tree species observed in the area include *Haldina cordifolia, Albizia procera, Dalbergia sissoides, D. latifolia, Pterocarpus marsupium, Bauhinia racemosa, Tectona grandis, Dillenia pentagyna, Cassia fistula, Xylia xylocarpa, Pongamia pinnata, Careya arborea, Bombax ceiba, Terminalia paniculata, T. bellirica, T. alata, Phyllanthus emblica, Grewia tiliifolia, Lagerstroemia microcarpa* etc. In the lower reaches of the Vengoli and Karimala these forest types are seen. some areas in Kothala, Pulikkal, Thellikkal, Kottayali also having this forest type.

Naturally growing moist teak was one of the dominant species present in these forests. Kannimara teak tree of girth 6.48m and height 48.75m is one of the largest natural teak trees in Asia. In order to represent the old natural growth of Teak trees a plot has been preserved in Sungam range. It has been observed in Anappady, Elathode and

interstate boundary area that the floral elements of dry deciduous forests consisting of Anogeissus, Bombax, Tamarindus etc., exist within the moist deciduous forests.

Bamboo: *Bambusa arundinacea* is growing profusely in these areas as well as in semi evergreen forests. Gregarious growth is found along streams, reservoir banks and around *vayals* providing sufficient fodder and cover to wildlife. During 1983-84, this bamboo had flowered gregariously. The natural regeneration of bamboo is found satisfactory.

3.1.6.4. *Southern Dry Mixed Deciduous Forests (5A/C3)*

The north east portion of PKTR adjacent to the plains of Tamil Nadu has a small patch of this type of forests covering about an area of 15km^2 around Thekkady and Keerappady. This type of forest is attributed to relatively low rainfall and lower altitude any species growing in this forest type are common to the moist deciduous forests. However their percentage of occurrence is low. These forests are highly prone to fire. Due to repeated forest fires in the past, the forests have degraded and thus a few fire-hardy species are growing in these areas.The dry deciduous forests are dominated by *Anogeissus latifolia* along with other species of the moist deciduous forests. Extensive natural regeneration of *Bambusa arundinacea* are also found in the dry deciduous forests.

3.1.6.5. *Moist Bamboo Brakes (2/E3)*

Bamboo brakes are usually found along streams or on badly drained hollows more or less displacing the trees. More or less continuous cover of one or two species of tall clumped bamboos with occasional stands of Terminalias and other trees are found. The moist bamboo brakes are sufficiently aggressive to be able to hold against tree growth. The latter probably gains ground after good seed years, so that gradually the bamboo ceases to dominate.

Bambusa arundinacea, the only bamboo has come up in highly fertile and well drained soil in Muduvarachal, Pulikkal, Kothala, Pooppara, Vengoli and Thellikkal areas of this Tiger Reserve. The Natural bamboo brakes also occur along the stream banks, reservoir banks and in sheltered depressions. Vengoli has the largest area of such bamboo brakes in the Tiger Reserve. In Elathode, Thellikkal east and Thekkady areas where habitats are comparatively dry *Dendrocalamus strictus* is growing. *D. strictus* is not growing gregariously like *Bambusa arundinacea*, but it is heavily browsed, so it has acquired the shape of thicket. However, its regeneration is satisfactory.

3.1.6.6. *Ochlandra Reed Brakes (8A/C1/E1)*

The reed grows into impenetrable thickets of 3m to 5m height with scattered over wood of evergreen trees. They are restricted to moist areas. Unlike bamboos, the reed brakes occur in high altitude within evergreen forests. The stream banks and the areas under the shelter of evergreen and semi evergreen forests of Pooppara, Karimala, Pulikkal, Orukomban and Muduvarachal support reed brakes. The reed does not grow gregariously and its height varies between 2-4m. They occur densely along the stream banks. The following species are found in the Tiger Reserve viz., *Ochlandra rheedii*, *Ochlandra travancorica* and *Ochlandra brandisii.*

3.1.6.7. *Southern Montane Wet Grasslands (11A/C1/DS2)*

The grasslands are viewed as a stable degradation stage of vegetation because of recurrent fire, high wind velocity and shallow soil on the top of high altitude undulating terrain. This type of montane wet grasslands are confined to hill-top of Karimalagopuram, Vengoli and Pandaravarai areas of this Tiger Reserve. The vegetation is dominated by grasses along with several herbaceous and sub-shrubby species. The main grass species that are found includes, *Arundinella leptochloa, Chrysopogon asper, Cymbopogon flexuosus, Sacciolepis indica, Themeda triandra, Zenkeria elegans* etc.

3.1.6.8. *Low Altitude Marshy Grasslands -Vayals*

Low altitude marshy grasslands are termed as *Vayals* in Malayalam which is one of the major characteristics of PKTR. They have profuse growth of grasses and sedges providing high-density feeding ground for the wild herbivores during the lean season also. Some of the grass species growing in *vayals* are *Axonopus compressus, Paspalum spp*. *Eragrostis spp*. and sedges like *Lipocarpa argentea, Fuirena umbellata, Fimbristylis tetragona, Cyprus cuspidatus* and *Rynchospora corymbosa* (coarse and unpalatable species) are also grown in *vayals*.

Moist deciduous tree species of *Butea, Careya, Mitragyna, Adina* and *Terminalia* and Bamboos are seen invading along the fringes of the *vayals*. Similarly the central marshy portions of *vayals* are being invaded by coarse and unpalatable sedges like *Rhyncospora corymbosa*. This reduces the availability of palatable grasses in the *vayals* and hence need special attention.

3.1.6.9. *Teak Plantations*

The valley and the lower hills of the PKTR were planted with teak after clear felling the moist deciduous, evergreen and semi evergreen forests in patches during the period 1921 to 1983. The total area under teak is 8,559.215Ha and its distribution in Karimala, Orukombam, Parambikulam and Sungam ranges. The growth of teak is good in the valley when compared to the elevated locations. Many of these plantations especially, those in the remote corners have not been tended properly. However, many such areas bear a good regeneration of the indigenous species and are preferred by wildlife.

3.1.6.10. *Eucalypts Plantations*

Over a period of time, 81.5Ha of dry deciduous forests in the Elathode section of the PKTR had been converted into eucalypts plantations. Most of these eucalypts

plantations have been clear-felled. Only some stock of 1971 and 1973 plantations were not extracted so far. These plantations however are not of any practical utility for the wildlife since they lack food source even in their under storey.

3.1.7 Fauna

The diverse habitats and strategic locations of Parambikulam make it one of the faunistically rich areas in Kerala. The major herbivores seen in PKTR are Asian Elephants *Elephas maximus*, Gaur *Bos gaurus*, Wild Boar *Sus scrofa*, Sambar Deer *Rusa unicolor*, Spotted Deer *Axis axis*, Barking Deer *Muntiacus muntjac* and Mouse Deer *Moschiola indica* (Easa and Balakrishnan, 1986). The primates seen at PKTR are Lion-tailed Macaque *Macaca silenus*, Bonnet Macaque *Macaca radiata*, Nilgiri Langur *Semnopithecus johnii*, Common Langur *Semnopithecus priam* and Slender Loris *Loris lydekkarianus* are seen in the area. Other arboreals include the Malabar Giant Squirrel *Ratufa indica* and Flying squirrel. Carnivores such as Tiger *Panthera tigris*, Leopard *Panthera pardus*, Sloth Bear *Melursus ursinus* and Wild Dog *Cuon alpinus* could be sighted here. The less charismatic mammals include Porcupine *Hystrix indica*, Pangolin *Manis crassicaudata*, Black-naped Hare *Lepsu nigricollis*. Nilgiri Tahr *Nilgiritragus hylocrius* is found in isolated places at Vengoli and Karimalagopuram. The otters seen in the reservoirs of PKTR are Smooth-coated Otter *Lutrogale perspicillata* (Easa and Ramachandran, 1986).

Nameer and Praveen (2006) recorded 230 species of birds from PKTR. The interesting species of birds recorded from PKTR include Lesser Adjutant-Stork, Lesser Fish-Eagle, Mountain Hawk-Eagle, Nilgiri Wood-Pigeon, Orange-breasted Green-Pigeon, Blue-winged Parakeet, Oriental Bay-Owl, Forest Eagle-Owl, Ceylon Frogmouth, Black-capped Kingfisher, Blue-bearded Bee-eater, Oriental Broad-billed Roller, Malabar Grey Hornbill, Great Pied Hornbill, Great Black Woodpecker, Grey-headed Bulbul, Wynaad Laughingthrush, Nilgiri Flycatcher, White-bellied Blue-Flycatcher and White-bellied Treepie (Nameer and Praveen, 2006).

Sivaperuman et al. (2005) recorded 51 species of spiders belonging to 19 families and 34 genera from various habitats of PKTR. Shijo et al. (2007) studied the food habits and relative abundance of large carnivores through scat analysis technique in PKTR. Later Jahas and Easa (2008) recorded 19 species of Amphibians and 51 species of reptiles from PKTR.

3.1.8 Tribal Community

There are four tribal communities in PKTR. They are Muduva, Kadar, Malayar and Malai-malasar. They are settled in six colonies (Table 4) such as Kadas colony, Kuriarkutty colony, Earthendam colony, Pooppara colony (Plate 4), Sungam colony and Fifth colony with a total population of 1,110.

Table 4. Details of tribal settlement in Parambikulam Tiger Reserve

Sl. No.	Name of Settlement	Range	Name of the Tribe	Area (in Ha)	No. of Families
1.	Kadas Colony	Parambikulam	Kadar	0.4	44
2.	Fifth Colony	Parambikulam	Malamalasar	1.38	14
3.	Kuriarkutty Colony	Orukomban	Kadar	5.09	66
4.	Earthendam Colony	Karimala	Kadar	9.33	38
5.	Pooppara Colony	Karimala	Muduvas	24	40
6.	Sungam Colony	Sungam	Malasar & Kadar	3.07	82
	Total			**43.27**	**289**

Source: Kaler (2011)

Poopara tribal homstead

Cultivation of *Curcuma spp.* in Poopara colony

Plate 4. Poopara tribal colony

3.2. METHODS

3.2.1. Period of Observation

Reconnaissance of the study area was done during February-March 2011. And the intensive filed study was done from June 2011 to May 2012. Monthly observations were made during these periods. The study period was divided into two seasons such as wet season (June to November) and dry season (December to May).

3.2.2. Site Selection

Stratified random sampling with equal allocation of sampling units was followed to select the study sites. Three strata, the evergreen, moist deciduous forests and the plantations were selected for studying the ecology of the small carnivores in the PKTR. This method is used to get the same level of precision for each stratum. This also gives habitat-specific estimates, which may be of greater interest than a single estimate. Though the area shows some semi-evergreen patches, their clear-cut distinction from the evergreen forests was very difficult. Thus the semi-evergreen forests were treated along with the evergreen forests. Three methods were used to study the small carnivores in PKTR such as camera trapping, night transect survey and indirect evidence survey. Apart from this questionnaire survey was also done among the various stake-holders at PKTR to understand the small carnivores and the threats, if any, faced by the small carnivores.

3.2.3. Camera Trap Survey

Camera trapping is one of the best methods to study the small carnivores. Digital scout cameras having passive infra-red sensors for heat and motion detection (Bushnell Trophy Cam model no. 119436 and Wildview Xtreme 4 model no. STC-TGL4M) were used for this survey (Plate 5). Overall 76 trapping stations (Fig. 3) were identified based on footprints and scats of the small carnivore presence (Mudappa et al., 2007). Each of these 76 stations was at least 250m apart. The camera traps were set at a height of 30-

WILDVIEW XTREME 4

BUSHNELL TROPHY CAM

Plate 5. Camera traps used for the study

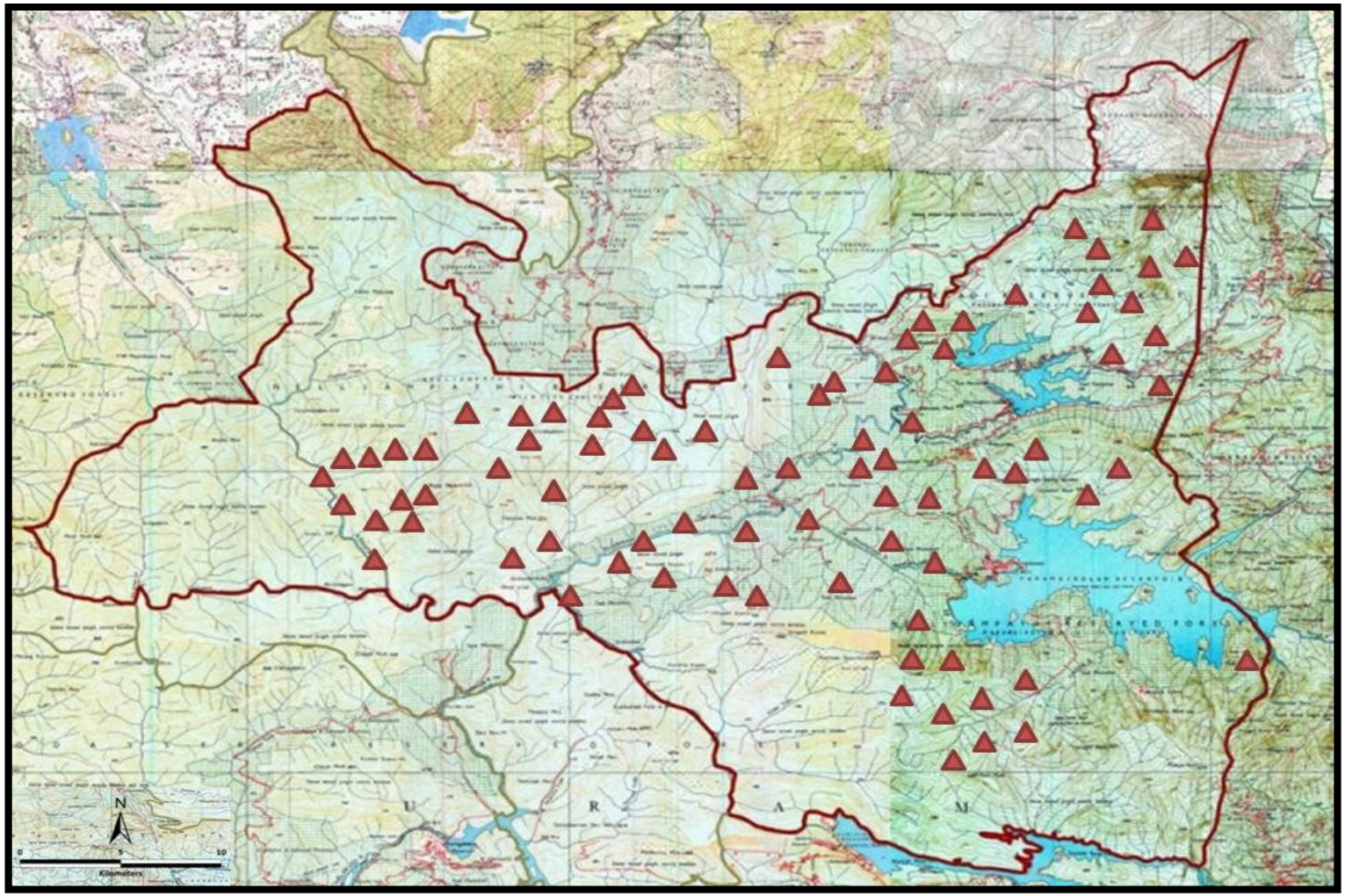


Fig. 3. Camera trap stations in Parambikulam Tiger Reserve

40cm above the ground (Plate 6). The cameras were set up in default mode with the delay of 10 seconds between pictures. The camera trap locations were recorded with a Garmin GPSMAP 76CSx. The cameras were opened from 1800 to 0600hr. At each trapping stations, cameras were opened for 15-16 days each. Thus a total of 1,349 camera-trap nights with 16,188 trapping hours were carried out in the PKTR. The camera trap data is given in Appendix II.

3.2.4. Line Transect Survey for both Direct and Indirect Evidences

Transect of varying length were laid in different habitat (length of transect vary between 2 to 4km). The length of each transect were measured using GPS. Appendix III provides the summary of the length of transects in different forest ranges and vegetation types. A total of 71 transects were laid covering a length of 242km. A single transect can run through more than one vegetation type. All transects were walked at least once and most of them repeated. During the transect walk, the indirect evidences primarily the scats of the small carnivores were recorded (Appendix IV). Direct sightings if any were also noted (Appendix V). The data collected through this method were used for estimating encounter rate of the different species of small carnivores. The scats were identified to the small carnivore group such as civet, mongoose, cat etc or to the species level using Su (2005).

3.2.5. Night Spotlight Survey

For some of the nocturnal mammals which are strictly arboreal, the day transects and camera trapping are ineffectual. Night spotlight survey is an effective method for these animals (Mudappa et al., 2007). It was carried out from 1800hrs to 2300hrs using High Beam LED torches in forest department vehicle. A total of 19 transects were laid covering 344km in 29hrs 30min during night transect survey. Animals directly sighted, along with the habitat of sighting were recorded (Appendix VI).

Fixing camera trap in stream bed

Camera trap in field

Plate 6. Setting up of camera traps

3.2.6 Survey for Otters

Purposive samplings along the reservoir banks and stream shores were made for otter survey. One kilometer transects were laid around the reservoir within a distance of 10m from the water edge, as suggested by Anoop and Hussain (2004). Direct sightings as well as indirect evidences were recorded for presence/absence survey.

3.2.7 Questionnaire Survey

Using a semi-structured questionnaire (Appendix VII, Appendix VIII), a direct survey was done for the forest department officials as well as the local people of PKTR. The objective of the questionnaire survey was to study the understanding of the locals and the forest officials on the small carnivores. It was also intended to understand the conservation issues on small carnivores of PKTR as conceived by the forest officials and the locals in the area. A total of 38 questionnaire survey was done among the local peoples residing in various settlements and the forest department staff.

3.3 DATA ANALYSIS

The diversity of a species can be expressed by various indices. In the present study, the species richness, diversity, relative abundance and seasonal variation in use of different habitats were studied. The following indices which are commonly used for measuring species richness, diversity, abundance, similarity and habitat use were used to analyse the data on the lesser known mammals in the PKTR.

3.3.1 Margalef Species Richness Index

Margalef index is calculated by the formula given below,

$$DMg = \frac{S-1}{\ln N}$$

Where, S is the total number of species recorded and 'N' is the total number of individuals summed over all 'S' species (Magurran, 1988).

3.3.2. Diversity Indices

3.3.2.1. *Simpson's Index, λ*

Simpson (1949) proposed the first diversity index used in ecology as

$\lambda = \Sigma p_i^2$

where, pi is the proportional abundance of the 'i'th species given by

$$p_i = \frac{n_i}{N}$$

Where, i = 1, 2, 3, 4, …..S, n_i is the number of individuals of the i^{th} species and N is the total known individuals for all S species in the population. Simpson's index, which varies from 0-1, gives the probability that two individuals drawn at random from a population belong to the same species. Simply stated, if the probability is high that both

individual belong to the species, then the diversity of the community sample is low (Ludwig and Reynolds, 1988).

3.3.2.2. *Shannon-Wiener Index, H*

The Shannon-Wiener index (Shannon and Wiener, 1963) is a measure of the average degree of "uncertainty" in predicting to what species an individual chosen at random from a collection of 'S' species and 'N' individuals will belong. This average uncertainty increases and as the distribution of individuals among the species becomes even. Thus H' has two properties that have made it a popular measure of species diversity: (1) H'=0 if and only if there is only one species in the sample, (2) H' is maximum only when all S species are represented by the same number of individuals, that is, a perfectly even distribution of abundance (Ludwig and Reynolds, 1988).

The equation of the Shannon function, which uses natural logarithm (ln), is

$$H' = \Sigma (p_i . \ln p_i)$$

Where H' is the average uncertainty per species in the infinite community made up of S species with known proportional abundance p_1, p_2, p_3,…….p_s.

3.3.3 Similarity Indices

The similarity of the group of animals concerned between the study sites were worked out using Jaccard's index (Magurran, 1988).

3.3.3.1. *Jaccard's Similarity Index,* S_j

Jaccard's similarity index (S_j) is given by the formula,

$$S_j = \frac{A}{(a+b+c)}$$

Where, a = number of species common in both sites 1 and 2

b = number of species in site 1 but not in site 2

c = number of species in site 2 but not in site 1

3.3.4 Estimation of Abundance

Different measures were followed to assess the abundance of lesser known mammals in the Tiger Reserve

3.3.4.1 *Abundance of Small Carnivores*

The abundance of scats was used as an indicator of the abundance of the small carnivores since other measures such as camera traps and transect walk for direct sightings give inadequate data. Scat abundance was estimated as the number of scat encounter per kilometer surveyed with respect to a habitat or an area. Even this presented with many difficulties. Based on scat morphology, it was possible to identify the scats only to the family level - mongoose, civets, and otters - and not to species level. All scats seen were recorded and some scat samples were collected for detailed analysis.

$$\text{Abundance} = \frac{\text{Total number of scats obtained}}{\text{Total transect walk in kilometre}}$$

3.3.5 Habitat Use Assessment

3.3.5.1 *Habitat Use Index (HUI)*

This index was used to understand the habitat preference of a species in an area. This index was developed from the indirect evidences recorded from different habitats of the PKTR. In this study, this index is used to analyse the habitat preference of small carnivores and porcupines since they gave only indirect evidences. The HUI is calculated by the formula given below.

$$\text{Habitat Use Index (HUI)} = \frac{N_{HI}}{N_H} \text{ X } 100$$

Where, N_{HI} = Total number of indirect evidences from one habitat (in a season or during the study period)

N_H = Total number of indirect evidences from all the habitats (in a season or during the study period)

3.3.6 Statistical Analysis

Various statistical packages including the Microsoft Office Excel (Version 2007), SPSS (Version 17) and PAST (Hammer et al., 2001) were used for statistical analysis of the data collected.

Results

RESULTS

4.1 SPECIES COMPOSITION OF SMALL CARNIVORES IN PARAMBIKULAM TIGER RESERVE

The present study at PKTR recorded 11 species of small carnivores represented in families such as viverridae, herpestidae, mustelidae and felidae (small cats) (Table 5). The small carnivores identified include four species of herpestids, three species of viverrids, two species of felids and two species of mustelids.

Table 5. Small carnivores recorded from Parambikulam Tiger Reserve

Common Name	**Scientific name**	**Family**
1. Small Indian Civet	*Viverricula indica*	Viverridae
2. Common Palm Civet	*Paradoxurus hermaphroditus*	
3. Brown Palm Civet	*Paradoxurus jerdoni*	
4. Indian Grey Mongoose	*Herpestes edwardsi*	Herpestidae
5. Stripe-necked Mongoose	*Herpestes vitticollis*	
6. Brown Mongoose	*Herpestes fuscus*	
7. Ruddy Mongoose	*Herpestes smithii*	
8. Smooth-coated Otter	*Lutrogale perspicillata*	Mustelidae
9. Nilgiri Marten	*Martes gwatkinsii*	
10. Jungle Cat	*Felis chaus*	Felidae
11. Leopard Cat	*Prionailurus bengalensis*	

The evidences that support the presence of 11 small carnivores of the Tiger Reserve is given in Table 6.

Table 6: Evidences showing the presence of small carnivores in Parambikulam Tiger Reserve.

Evidences	**CPC**	**BPC**	**SIC**	**GM**	**BM**	**RM**	**SM**	**JC**	**LC**	**SO**	**NM**
Camera trap	18	17	19	0	0	1	2	0	1	1	1
Day transect	1	0	0	2	1	0	6	0	0	5	0
Spot light	13	2	14	0	0	0	0	1	1	0	0

CPC: Common Palm Civet; **BPC**: Brown Palm Civet; **SIC**: Small Indian Civet; **GM**: Grey Mongoose; **BM**: Brown Mongoose; **RM**: Ruddy Mongoose; **SM**: Stripe-necked Mongoose; **JC**: Jungle Cat; **LC**: Leopard Cat; **SO**: Smooth-coated otter; **NM**: Nilgiri Marten.

4.2 CAMERA-TRAPPING ON SMALL CARNIVORES AT PARAMBIKULAM TIGER RESERVE

Seventy six camera trap stations were identified by the presence of scats/ tracks. The camera trap sampling was done for a total of 1,349 nights of which 570 nights (42%) were in moist deciduous forest, 524 nights (39%) in evergreen forest and 255 nights (19%) in teak plantations. The trap night efforts in various habitats were in proportion to the habitat types present in PKTR. The details of the trapping effort in various habitat of PKTR are shown in Table 7.

Table 7. Camera trapping effort in various habitats of Parambikulam Tiger Reserve

Sl. No.	Forest sections at PKTR	Trap nights		
		Moist Deciduous Forest	Evergreen Forest	Teak Plantation
1	Karimala	94	112	0
2	Aanapadi	94	0	15
3	Seechali	64	0	0
4	Kariyanchola	52	39	0
5	Kothala	70	14	0
6	Thelikkal	76	0	98
7	Vengoli	120	45	0
8	Kuriyarkutty	0	0	66
9	Orukomban	0	314	0
10	Poopara	0	0	76
	Total trap nights	**570**	**524**	**255**
		1349		

A total of 645 photographs of 24 mammal species, three bird species and a monitor lizard were obtained. Out of these, the carnivores accounted for 189 (29.3%) photographs, among that 31.75% were small carnivores in eight species. The most common species recorded was Small Indian Civet *Viverricula indica* (31.7%) (Plate 7) followed by Common Palm Civet *Paradoxurus hermaphrodites* (30%) (Plate 8), Brown Palm Civet *Paradoxurus jerdoni* (28.3%) (Plate 9) and Stripe-necked Mongoose *Herpestes vitticollis* (3.3%) (Plate 10) (Table 8, Fig. 4,). The Nilgiri Marten *Martes gwatkinsii* (Plate 11), Ruddy Mongoose *Herpestes smithii* (Plate 12), Smooth-coated Otter *Lutrogale perspicillata* (Plate 13) and Leopard Cat *Prionailurus bengalensis* were captured only once (1.7%) in the camera traps during the study period.

Plate 7. Small Indian Civet *Viverricula indica*

Plate 8. Common Palm Civet *Paradoxurus hermaphrodites*

Plate 9. Brown Palm Civet *Paradoxurus jerdoni*

Plate 10. Stripe-necked Mongoose *Herpestes vitticollis*

Camera trapped picture of Nilgiri Marten *Martes gwatkinsii*

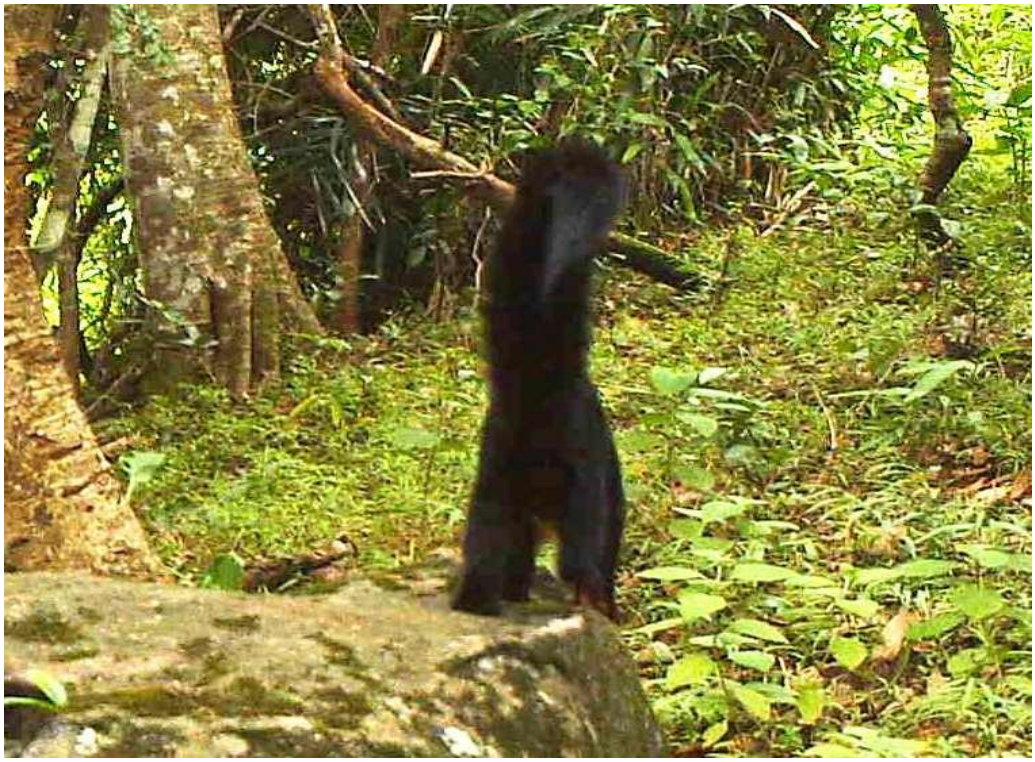


Plate 11. Nilgiri Marten *Martes gwatkinsii*

Plate 12. Ruddy Mongoose *Herpestes smithii*

Plate 13. Smooth-coated Otter *Lutrogale perspicillata*

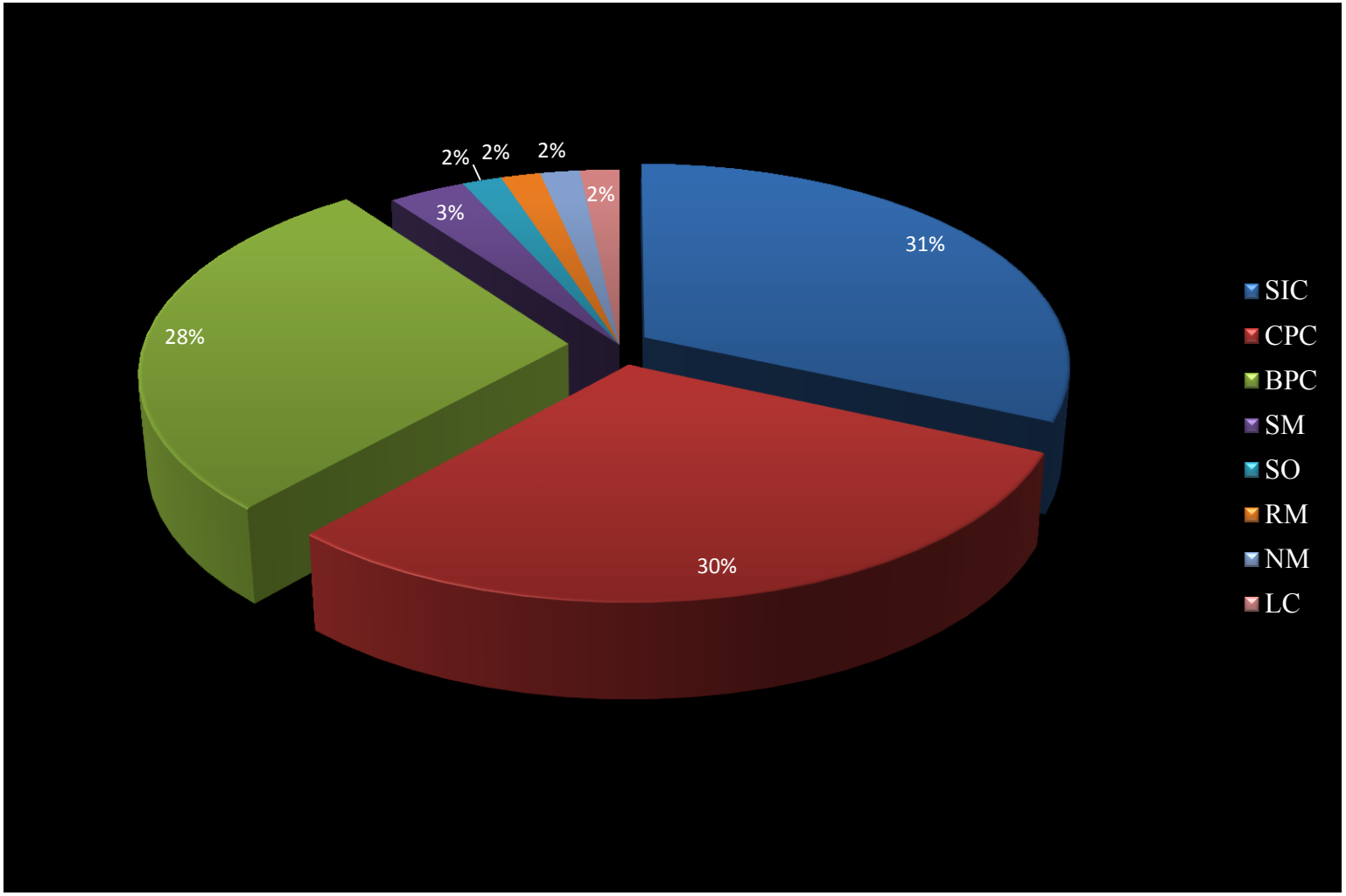


Fig. 4. Relative abundance of small carnivores in Parambikulam Tiger Reserve

Table 8. Success rate of small carnivore detections on cam traps in Parambikulam Tiger Reserve

Site	Camera trap %								Trap success rate (%)
	SIC	**CPC**	**BPC**	**RM**	**SM**	**LC**	**SO**	**NM**	
Karimala	8.3	1.7	15.0	0.0	1.7	0.0	0.0	1.7	**28.3**
Orukomban	6.7	5.0	13.3	0.0	0.0	0.0	0.0	0.0	**25.0**
Vengoli	3.3	11.7	0.0	1.7	1.7	0.0	0.0	0.0	**18.3**
Thelikkal	5.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	**8.3**
Kothala	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**6.7**
Kariyanchola	0.0	3.3	0.0	0.0	0.0	1.7	0.0	0.0	**5.0**
Seechali	0.0	1.7	0.0	0.0	0.0	0.0	1.7	0.0	**3.3**
Poopara	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	**1.7**
Kuriyarkutty	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	**1.7**
Aanapadi	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.7**
	31.7	**30.0**	**28.3**	**1.7**	**3.3**	**1.7**	**1.7**	**1.7**	

CPC: Common Palm Civet; BPC: Brown Palm Civet; SIC: Small Indian Civet; RM: Ruddy Mongoose; SM: Stripe-necked Mongoose; LC: Leopard Cat; SO: Smooth-coated Otter; NM: Nilgiri Marten

The camera traps also documented the presence of 16 other mammals such as Tiger *Panthera tigris*, Leopard *Panthera pardus*, Sloth Bear *Melursus ursinus*, Wild Dog *Cuon alpinus* Asian Elephant *Elephas maximus,* Sambar Deer *Rusa unicolor*, Spotted Deer *Axis axis*, Barking Deer *Muntiacus muntjak*, Mouse Deer *Moschiola indica*, Gaur *Bos gaurus*, Wild Boar *Sus scrofa*, Indian Hare *Lepus nigricollis*, Indian Pangolin *Manis crassicaudata*, Indian Crested Porcupine *Hystrix indica*, Bonnet Macaque *Macaca radiata* and Nilgiri Langur *Semnopithecus johnii* from the PKTR. These species have accounted for the 94% of the camera trap pictures at PKTR. The images captured are shown in Plate 14.

A&B: Tiger, C: Sloth Bear, D: Leopard, E: Barking Deer, F: Gaur

Plate 14. Camera trap images of large mammals from Parambikulam Tiger Reserve

4.2.1 Success Rate of Camera Traps in Various Locations in Parambikulam Tiger Reserve

The camera trap success rates of small carnivores of PKTR in various locations and habitats of PKTR are presented in Table 8. The overall small carnivore success rate is 4.5% (60 of 1349 trap-nights), capturing eight species of small carnivores. The camera capture success rate was maximum at Karimala (28.3%) followed by Orukomban (25.0%) and Vengoli (18.3%). The details on the camera trap success in the various study locations are presented in Fig. 5.

4.2.2 Diversity Indices on the Small Carnivores at Parambikulam Tiger Reserve

The various diversity indices such as number of taxa (S), number of individuals (n), Shannon-Weiner index (H), Simpson's index (1-D) and Margalef index (M) were calculated for the two seasons such as wet season (June to November) and dry season (December to May) (Table 9). Not much of differences could be observed between the wet and the dry season on the small carnivore diversity at PKTR.

Table 9. Diversity indices of the small carnivores of Parambikulam Tiger Reserve

Indices	**Wet Season (Jun-Nov)**	**Dry Season (Dec- May)**
Taxa (S)	7	5
Individuals (n)	29	31
Shannon (H)	1.29	1.19
Simpson's (1-D)	0.63	0.63
Margalef (M)	1.78	1.17

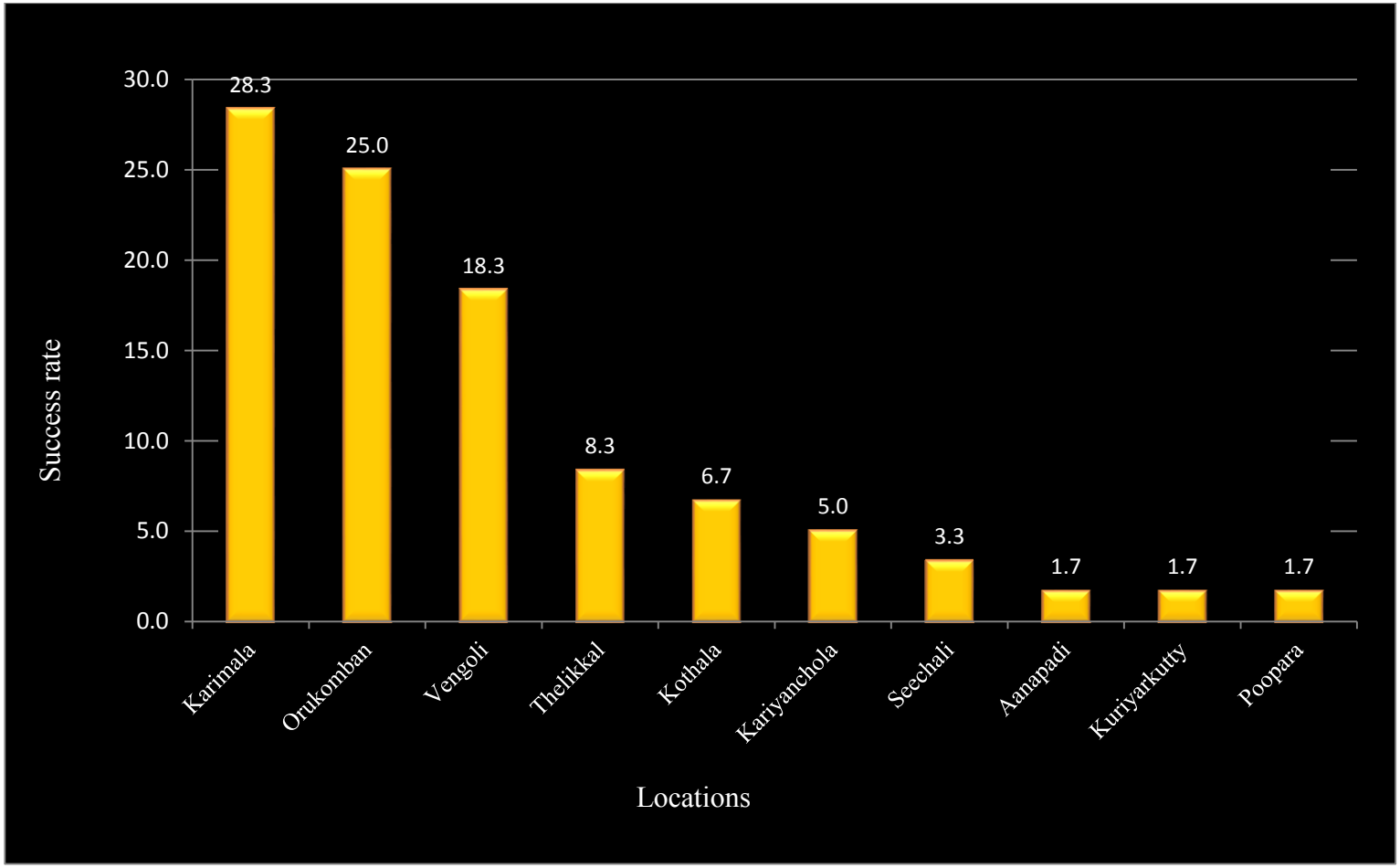


Fig. 5. Camera trap success rate in various locations in Parambikulam Tiger Reserve

Diversity indices for the wet season and for the dry season in the various habitats of PKTR are given in Table 10. In both the dry and the wet seasons the number of taxa of small carnivores was found to be lower in the teak plantations that the natural forests.

Table 10. Diversity indices of the small carnivores in the different habitats in the wet and dry seasons in Parambikulam Tiger Reserve

	Wet			**Dry**		
Indices	**MDF**	**EVG**	**TP**	**MDF**	**EVG**	**TP**
Taxa (S)	7	2	2	5	3	1
Individuals (n)	16	9	4	22	8	1
Shannon (H)	1.56	0.64	0.69	1.21	0.90	0
Simpson (1-D)	0.73	0.44	0.5	0.64	0.53	0
Margalef's (M)	2.16	0.46	0.72	1.29	0.96	0

MDF: Moist Deciduous Forest, EVG: Evergreen Forest, TP: Teak Plantation

Student t-test was carried out to compare the Shannon diversity index among the various habitats of PKTR in wet and dry seasons (Table 11). t-value for comparing the Shannon diversities of wet and dry seasons was found to be non-significant at 0.05 levels indicates that the diversity in both the season are almost similar.

Table11. t-values for the comparison of Shannon diversity index in the different habitats in Parambikulam Tiger Reserve in the wet and dry seasons

	Wet			**Dry**		
Habitats	Moist deciduous	Evergreen	Teak Plantation	Moist deciduous	Evergreen	Teak Plantation
Moist deciduous	NA	2.97**	2.78*	NA	1.15^{ns}	6.36**
Evergreen	2.97**	NA	0.058^{ns}	1.15^{ns}	NA	3.19*
Teak Plantation	2.78*	0.058^{ns}	NA	6.36**	3.19*	NA

**: Significant at 0.01 levels; *: significant at 0.05 levels; ns: non-significant

The Jaccard's Similarity index for small carnivores between various habitats in PKTR in wet and dry seasons are given in Table 12.

Table12. Jaccard's Similarity Indices in the Wet and Dry Seasons

	Wet			**Dry**		
Habitat	Moist deciduous	Evergreen	Teak Plantation	Moist deciduous	Evergreen	Teak Plantation
Moist deciduous	NA	0.29	1	NA	0.29	1
Evergreen	0.29	NA	1	0.29	NA	1
Plantation	1	1	NA	1	1	NA

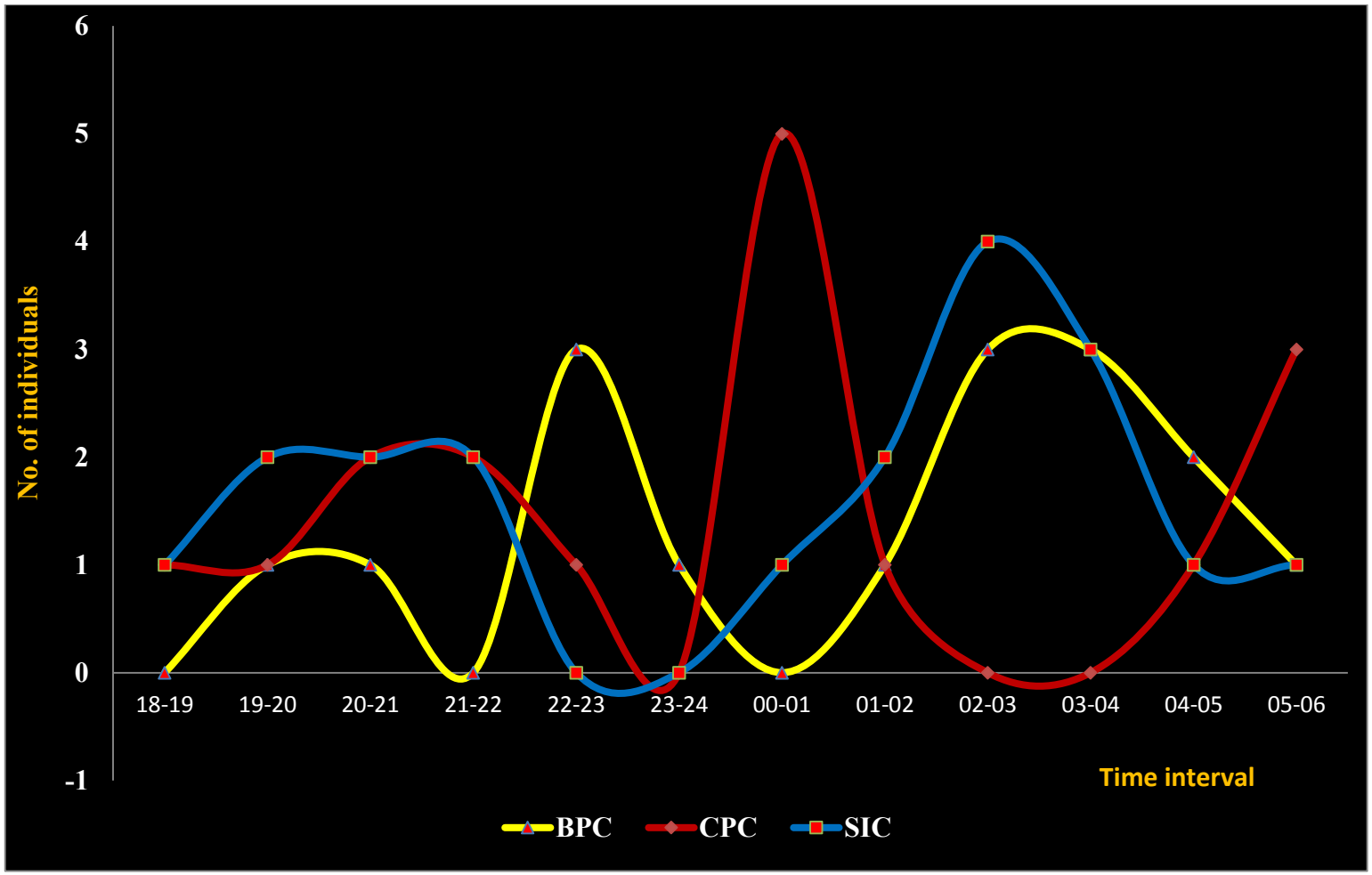
4.2.3 The Time-activity Pattern of Camera Trapped Small Carnivores in Parambikulam Tiger Reserve

A time-activity analysis of the small carnivores that were camera trapped was done at PKTR. For this analysis, only those species of small carnivores that were captured for more than five times alone were used. These included Common Palm Civet, Brown Palm Civet and the Small Indian Civet. Out of the 60 camera trap images obtained during the study period 54 (90%) were of viverrids. Small Indian Civet was the commonest viverrid at PKTR accounting for 35.19% of the camera trap images, followed by Common Palm Civet (33.33%) and Brown Palm Civet (31.48%).

For studying the active period, the camera trapping hours were divided into 1hr interval classes. The Brown Palm Civet had the peak activity time between 22 to 23hrs and 02 to 03hrs (Fig. 6). The activity of Common Palm Civet has been found to be just reverse to that of Brown Palm Civet showing that there is no inter-speies competition. Small Indian Civet is showing a similar pattern of time-activity as that of Brown Palm Civet, but both the species are occupying in different niche.

4.3 INDIRECT EVIDENCES ON SMALL CARNIVORES OF PARAMBIKULAM TIGER RESERVE

The day transects were done on the existing trails, forest roads and streams, searching for indirect evidences of small carnivores at PKTR. A total of 242km was walked through the various habitats in search of the indirect evidences. Eighty eight indirect evidences including 75 scats and 13 tracks pertaining to small carnivores were identified from PKTR (Appendix IV, Plate 15). Apart from the scats, the tracks of civets, mongoose, small cats and otters were also confirmed from the PKTR. In the case of small cats, two tracks were recorded from the moist deciduous forests and one from teak plantation. The otter pugmarks were collected from the stream beds of moist deciduous forests and evergreen forest. It was very difficult to make out the pugmarks from the reservoir banks since the constant water movement washes it away. The single mongoose



BPC: Brown Palm Civet; CPC: Common Palm Civet; SIC: Small Indian Civet

Fig. 6. Active period of three species of civets in Parambikulam Tiger Reserve

A: Civet Scat, B: Pugmark of Small Indian Civet C: Scat of Small Cat D: Pugmark of Small Cat, E. Scat of Mongoose F. Otter Track

Plate 15. Indirect evidences of small carnivores in Parambikulam Tiger Reserve

track was seen from the Orukomban section of the PKTR. Pugmarks of several other carnivores were also collected from the PKTR which include Tiger *Panthera tigris* Leopard *Panthera pardus*, Wild Dog *Cuon alpinus* and Sloth Bear *Melursus ursinus*.

Among the 88 indirect evidences, 57 were of civets (64.8%) (Fig. 7), 13 of otters (14.8%) (Fig. 8), 12 of mongoose (13.6%) (Fig. 9) and six of small cats (6.8%) (Fig. 10).The proportion of the indirect evidences seen in various habitats in PKTR is shown in Fig. 11. The civets dominated among the small carnivores in all the three habitats.

Scat abundance (scats/kilometer) was calculated as a measure to represent the abundance of small carnivores in PKTR. Scat abundance was higher for the civets (0.24) followed by mongoose (0.05), otters (0.04) and small cats (0.02). Scat abundance in various habitats and in the whole PKTR is given in Table 13. The civets were abundant in all the three habitats of the PKTR followed by the otters and mongoose. The least abundant group is the small cats. Abundance of civet is almost two times higher in the moist deciduous forests than the evergreen forest. Similarly, the abundance of mongoose, otters and small cats is higher in the moist deciduous forests when compared to the other habitas. A stacked diagram of the abundance of small carnivores in various habitats and in the whole of the Tiger Reserve is given in Fig. 12.

Table 13. Abundance (scat/kilometer) of small carnivores in Parambikulam T.R.

Habitat	**Civets**	**Mongoose**	**Otters**	**Small Cats**
Moist deciduous	0.14	0.04	0.04	0.02
Evergreen	0.06	0.01	0.01	0.01
Teak Plantation	0.04	0.01	0.01	0.01
Total in the T.R.	**0.24**	**0.06**	**0.06**	**0.04**

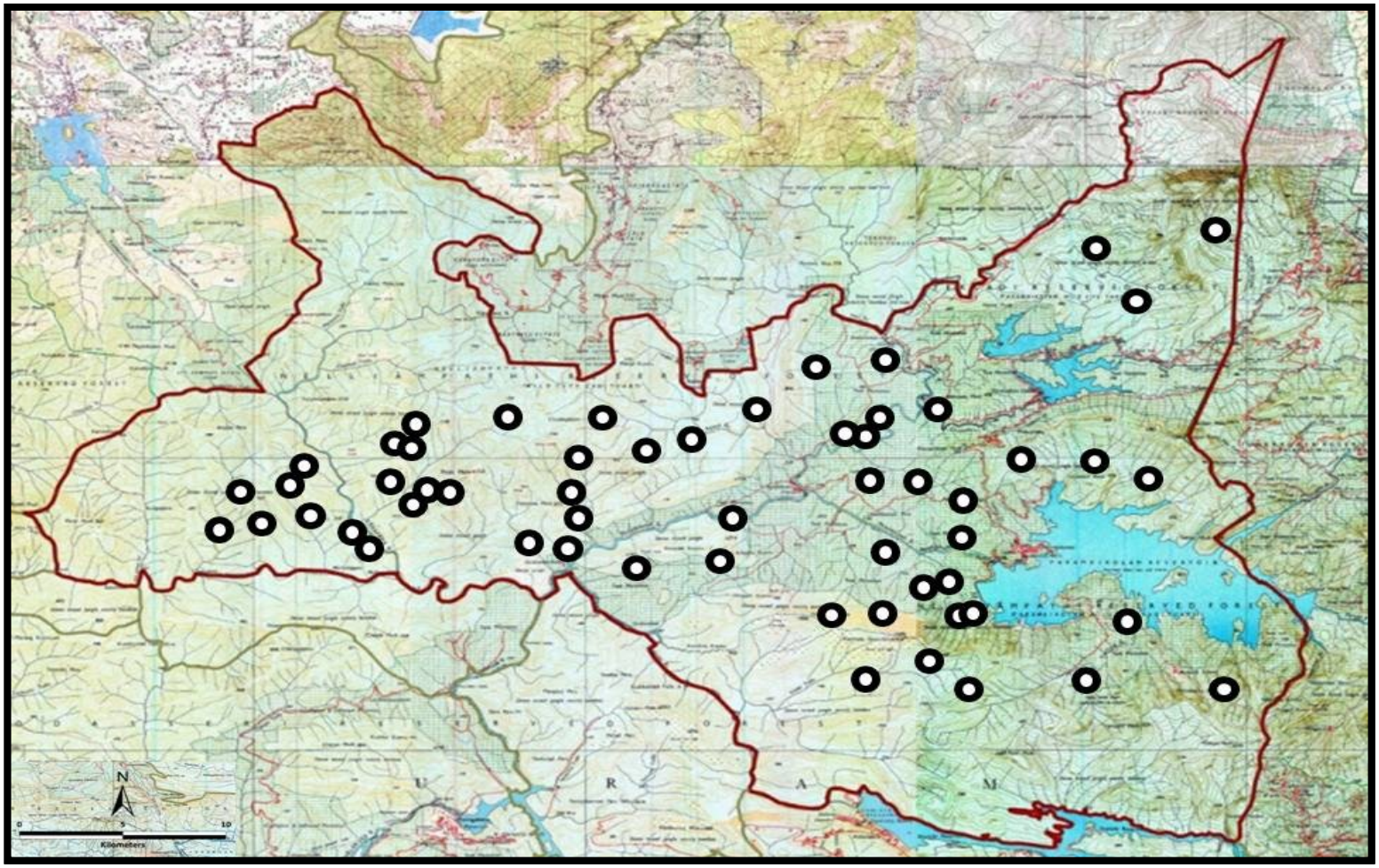


Fig. 7. Indirect evidences of viverrids in Parambikulam Tiger Reserve

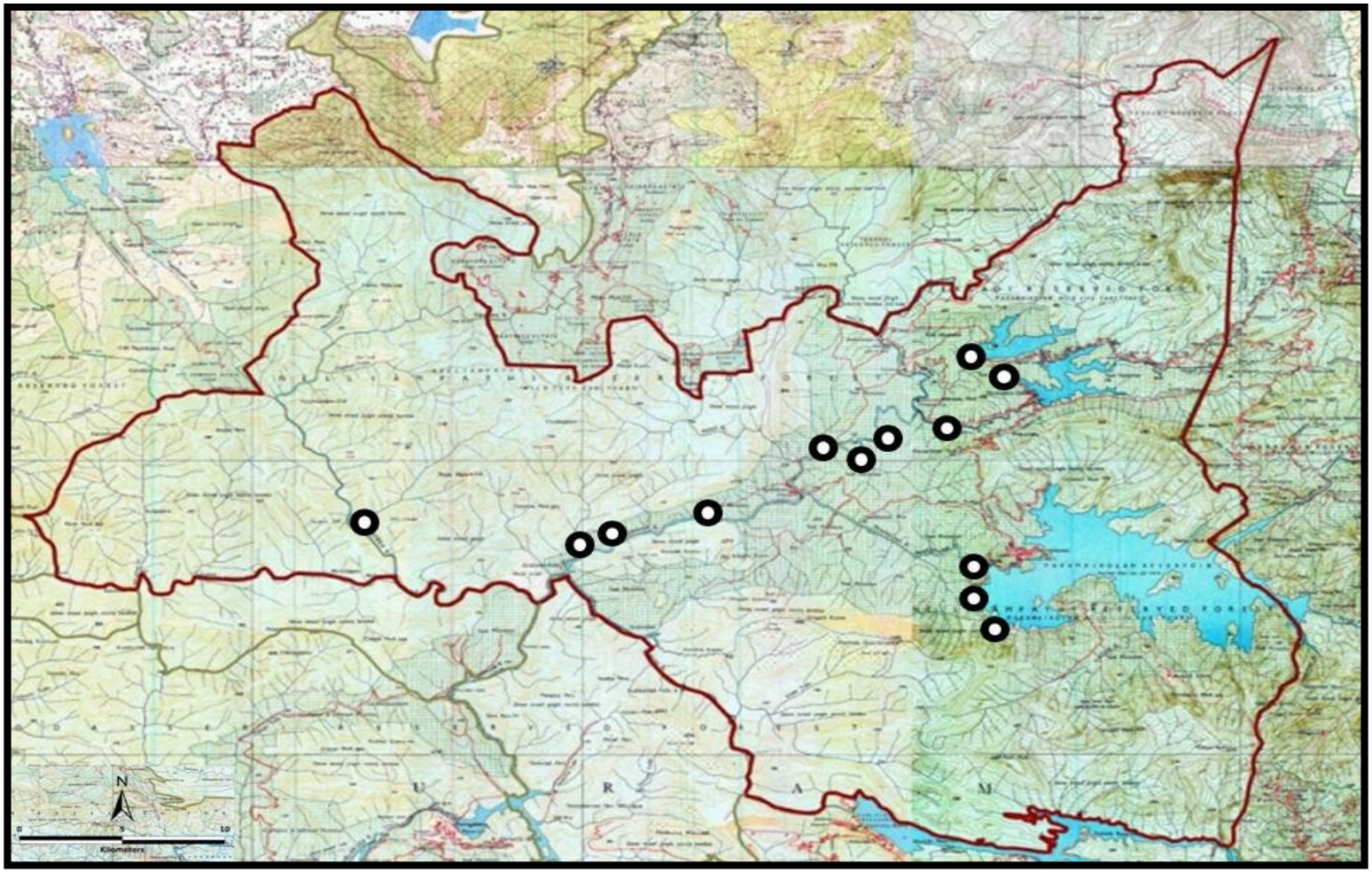


Fig. 8. Indirect evidences of Smooth-coated Otter in Parambikulam Tiger Reserve.

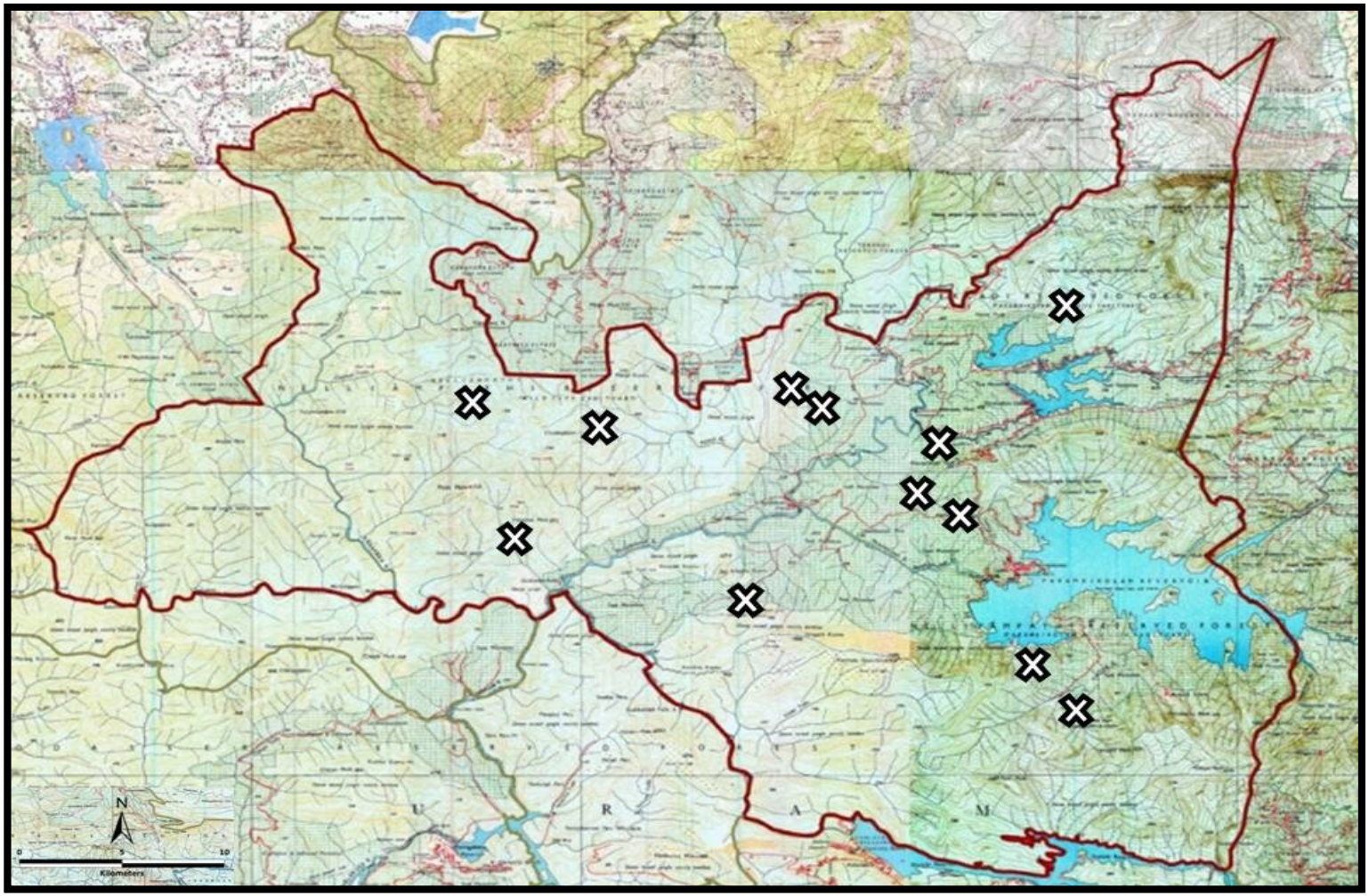


Fig. 9. Indirect evidences of herpestids in Parambikulam Tiger Reserve.

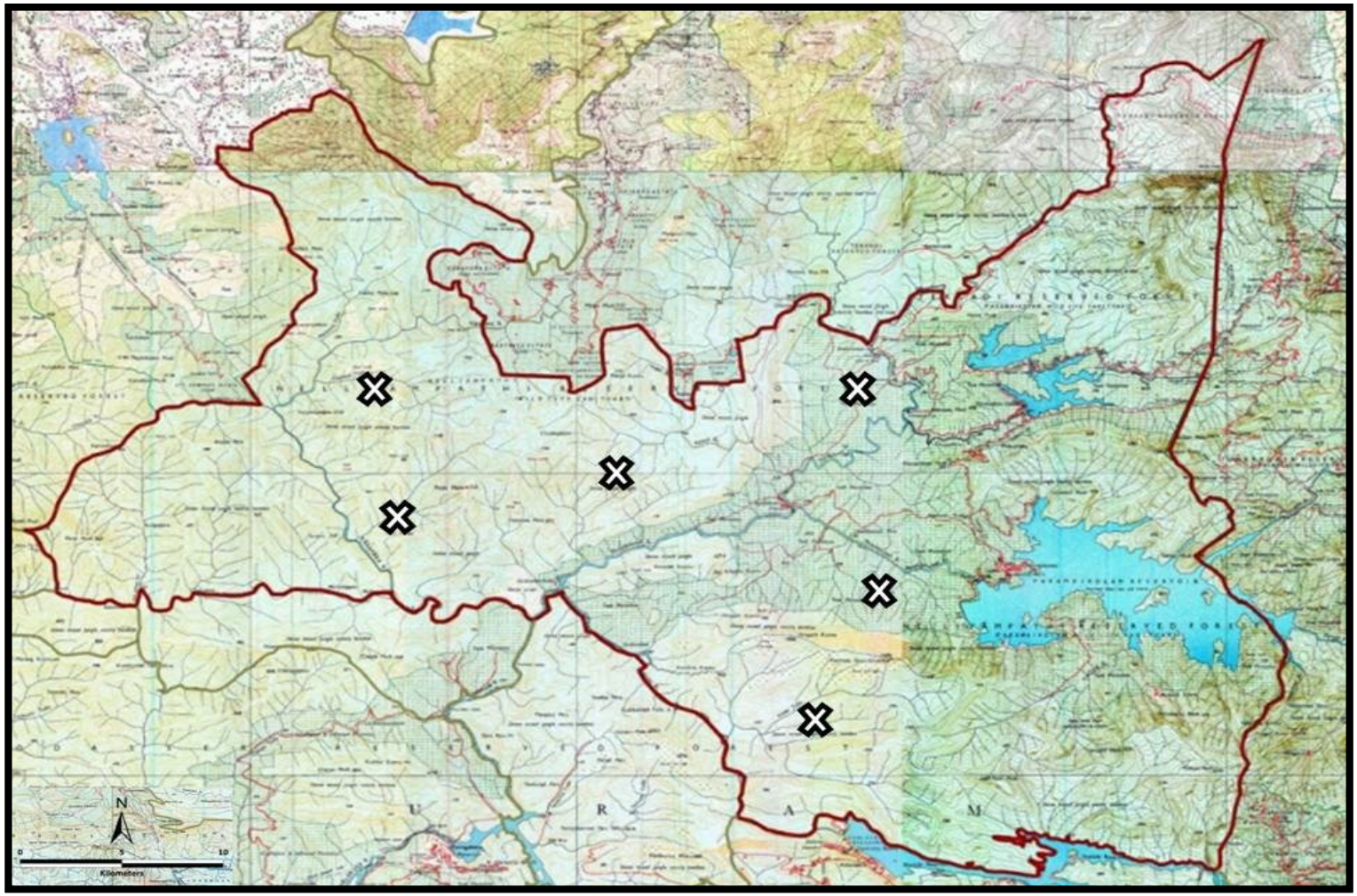


Fig. 10. Indirect evidences of small cats in Parambikulam Tiger Reserve

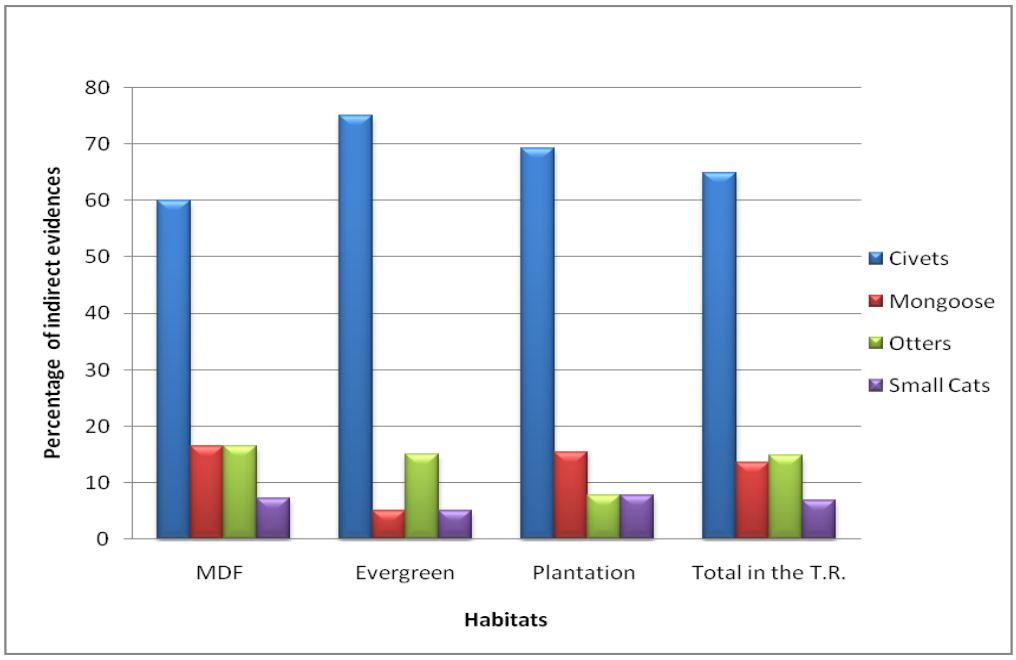


Fig. 11. Proportion of small carnivores in Parambikulam Tiger Reserve using indirect evidence

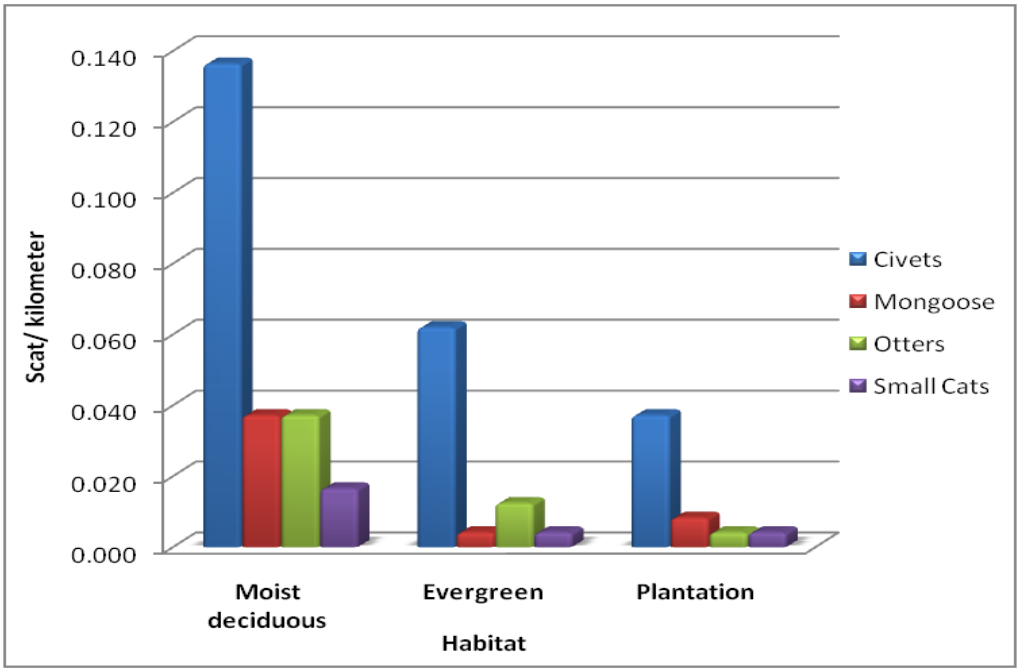


Fig. 12. Abundance (scats/kilometer) of small carnivores of Parambikulam Tiger Reserve

4.4 SMALL CARNIVORES OF PARAMBIKULAM TIGER RESERVE BASED ON DIRECT SIGHTINGS

There were only 15 sightings of five different species of small carnivores in the day transects, though 242km of day transect was walked. These five species include *Herpestes edwardsii*, *Herpestes vitticollis*, *Herpestes fuscus, Lutrogale perspicillata* and *Paradoxurus hermaphrodites*. The day transects data for direct sighting is shown in Appendix V. Because of the diurnal nature of herpestids, the mongoose were sighted most. Stripe-necked Mongoose was the most often sighted small carnivore at PKTR, accounting for 73.33% of direct sightings. It was sighted mostly from the moist deciduous forests followed by teak plantations. The Common Mongoose *Herpestes edwardsii* was sighted twice from the moist deciduous forests at Vengoli and Anapadi section, while the Brown Mongoose *Herpestes fuscus* was sighted once from the evergreen forests of Orukomban. There was also a solitary sighting of Common Palm Civet *Paradoxurus hermaphrodites* among the bamboo clump in moist deciduous forests.

The Smooth-coated Otter *Lutrogale perspicillata* was sighted five times of which two are from Thoonakadavu and Parambikulam reservoir while the rest are from the streams running through Thellikkal, Kuriyarkutty and Kannimara. Altogether 14 individuals of Smooth-coated Otter were sighted during the study period.

4.5 SMALL CARNIVORES OF PARAMBIKULAM TIGER RESERVE USING NIGHT TRANSECT

Nineteen night transect (totaling 29hrs 30min) on forest trails were carried out in PKTR covering a distance of 344km in 29hrs 30min. The night transect data is shown in Appendix VI. Night survey using spotlight resulted in 31 sightings of five different species of small carnivores including Jungle Cat *Felis chaus,* Leopard Cat *Prionailurus bengalensis,* Common Palm Civet *Paradoxurus hermaphroditus*, Brown Palm Civet *Paradoxurus jerdoni* and Small Indian Civet *Viverricula indica.* During the night transect

survey, the small carnivores at PKTR recorded an encounter rate of 1.06 animals/hr of drive and 0.09 animals/km.

The most commonly sighted small carnivore during the nocturnal survey in the reserve was the Small Indian Civet *Viverricula indica*. Fourteen (45.16%) individuals of *Viverricula indica* were sighted during night survey. Out of these seven individuals were spotted from moist deciduous forests, three from evergreen forests and four from teak plantation. The Small Indian Civet *Viverricula indica* had an encounter rate of 0.48 animals/hr of drive and 0.04 animals/km (Table 14). All the individuals were sighted solitary and on the ground. Most of the time, the animals were seen feeding on the fallen fruits and small insects.

The second mostly sighted species of small carnivore during the night transect was the Common Palm Civet *Paradoxurus hermaphroditus*. This accounted for 41.94% of the total small carnivores sighted in the night transects during the study periods. Common Palm Civet had an encounter rate of 0.45 animals/hr of drive and 0.04 animals/km (Table 14). Some were seen running across the road where as some were in the canopy. The species sighted mostly from evergreen forest (six), followed by moist deciduous forest (four) and teak plantation (three).

Only two Brown Palm Civets *Paradoxurus jerdoni* were sighted with an encounter rate of 0.07 animals/hr of drive and 0.01 animals/km (Table 14). It was sighted in the evergreen forest of Orukomban range and other in the teak plantation at Kuriyarkutty. Both the animals were sighted on the branches of the trees.

Leopard Cat *Prionailurus bengalensis* and Jungle Cat *Felis chaus* were spotted only once during the study period from Kuriyarkutty and Parambikulam respectively. Both of them were sighted in moist deciduous forest of respective area.

Table 14. The small carnivore encounter during the night transect survey at Parambikulam Tiger Reserve

Species	animals/hr	animals/km
1. Small Indian Civet, *Viverricula indica*	0.48	0.04
2. Common Palm Civet *Paradoxurus hermaphroditus*	0.45	0.04
3. Brown Palm Civet *Paradoxurus jerdoni*	0.07	0.01
4. Leopard Cat *Prionailurus bengalensis*	0.03	0.01
5. Jungle Cat *Felis chaus*	0.03	0.01

4.5 HABITAT PREFERENCE OF THE SMALL CARNIVORES IN PARAMBIKULAM TIGER RESERVE

The habitat utlisation of the small carnivores at PKTR is presented in Table 15. The data were compiled from the night transects, day transects and the camera traps. Small Indian Civet *Viverricula indica,* Common Palm Civet *Paradoxurus hermaphrodites and* Smooth-coated otter *Lutrogale perspicillata* were recorded from all the three habitats. Brown Palm Civet *Paradoxurus jerdoni* was reported from both moist deciduous and evergreen forest, whereas Indian Grey Mongoose *Herpestes edwardsii,* Ruddy Mongoose *Herpestes smithii*, Nilgiri Marten *Martes gwatkinsii,*Jungle Cat *Felis chaus* and Leopard Cat *Prionailurus bengalensis* were recorded only from the moist deciduous forest. The Brown Mongoose *Herpestes fuscus* was sighted only from the evergreen forests.

Table 15. Presence of small carnivores in different habitats of Parambikulam Tiger Reserve

Species	Moist Deciduous Forests	Evergreen Forests	Teak Plantation
1. *Viverricula indica*	D and I	D and I	D and I
2. *Paradoxurus hermaphroditus*	D and I	D and I	D and I
3. *Paradoxurus jerdoni*	D and I	D and I	NO
4. *Herpestes edwardsii*	D	NO	NO
5. *Herpestes vitticollis*	D and I	NO	D
6. *Herpestes fuscus*	NO	D	NO
7. *Herpestes smithii*	I	NO	NO
8. *Lutrogale perspicillata*	I	D	D
9. *Martes gwatkinsii*	I	NO	NO
10. *Felis chaus*	D	NO	NO
11. *Prionailurus bengalensis*	I	NO	NO

D= Direct sightings, I = Indirect evidences, NO = Not observed

4.6 HABITAT USE INDEX (HUI) OF SMALL CARNIVORES IN PARAMBIKULAM TIGER RESERVE

Habitat Use Index (HUI) of small carnivore species in various habitats of PKTR was developed from the indirect evidences collected during the study period. The HUI of small carnivores is given in Table 16 & Fig. 13. All the small carnivore groups showed a greater preference to the moist deciduous forests, followed by evergreen forests. The teak plantation was used to the minimum extent by the small carnivores during the study period.

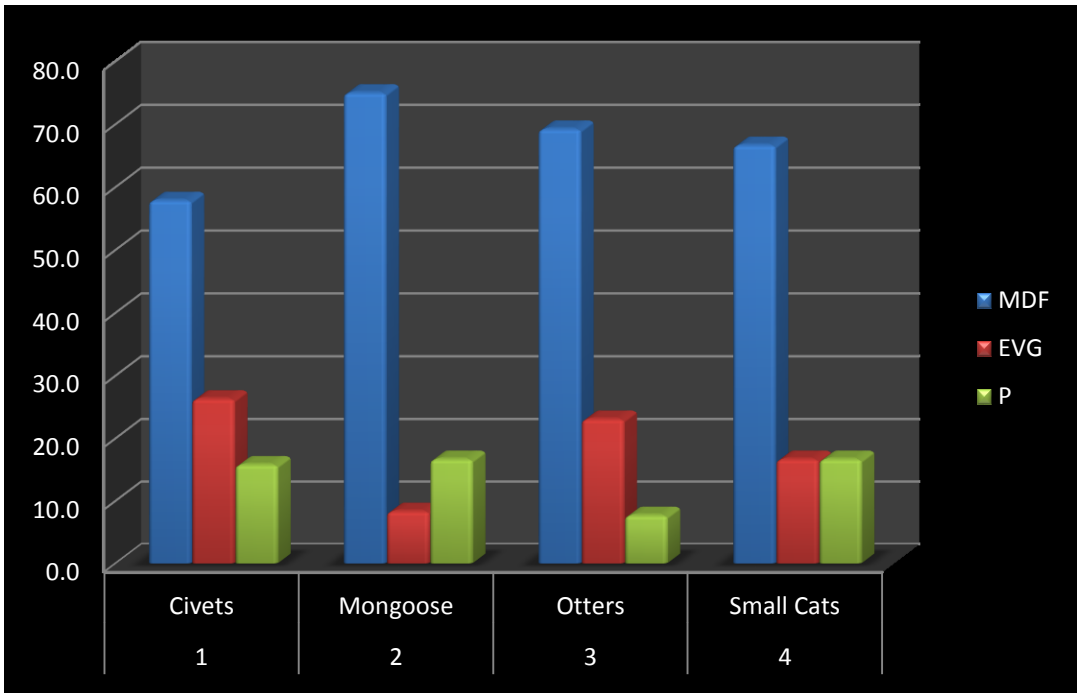


Fig. 13. Habitat Use Index of small carnivores in Parambikulam Tiger Reserve

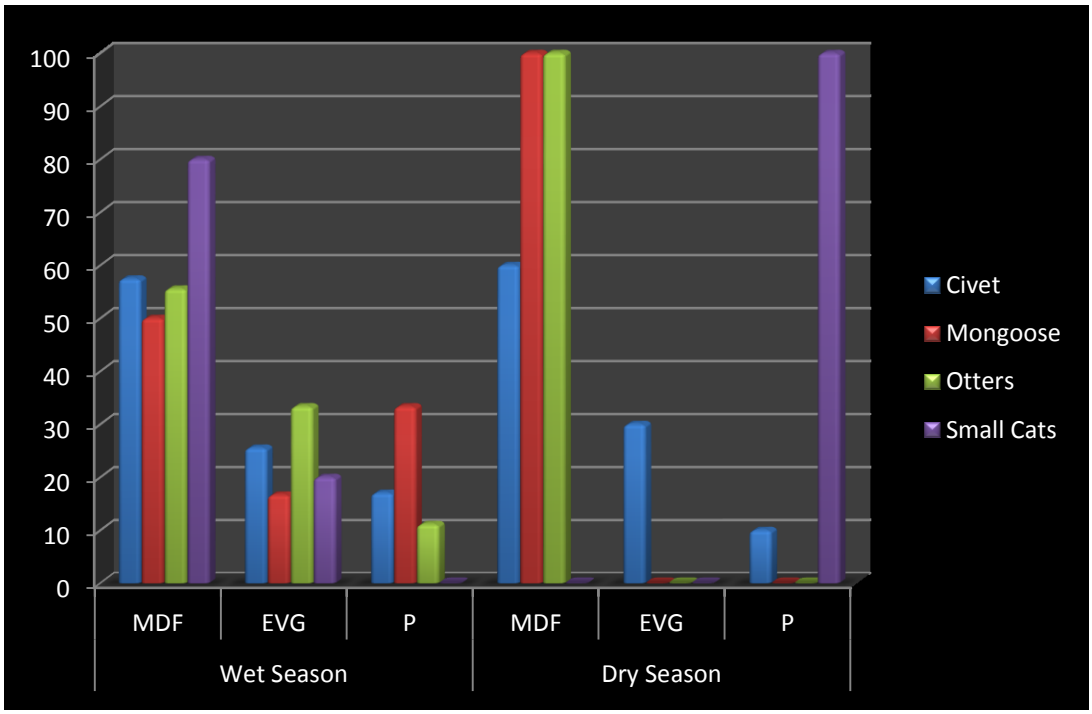


Fig. 14. Seasonal Habitat Use Index of small carnivores in Parambikulam Tiger Reserve

Table 16. Habitat Use Index of small carnivores in Parambikulam Tiger Reserve

Small carnivore group	Moist Deciduous Forest	Evergreen Forest	Teak Plantation
Civets	57.9	26.3	15.8
Mongoose	75.0	8.3	16.7
Otters	69.2	23.1	7.7
Small Cats	66.7	16.7	16.7

Seasonal variation in habitat use of small carnivores is given in Table 17 & Fig. 14. Civets did not show much difference in the HUI between the wet and dry seasons. However, the otters and mongoose tend to use the whole of the wet season in the moist deciduous forests, while the lesser cats used teak plantations during the wet season.

Table 17. Habitat Use Index of small carnivores in different seasons in Parambikulam Tiger Reserve

Small carnivores	Dry Season			Wet Season		
	MDF	EVG	TP	MDF	EVG	TP
Civets	57.4	25.5	17.0	60.0	30.0	10.0
Mongoose	50.0	16.7	33.3	100.0	0.0	0.0
Otters	55.6	33.3	11.1	100.0	0.0	0.0
Small cats	80.0	20.0	0.0	0.0	0.0	100.0

MDF: Moist Deciduous Forest, EVG: Evergreen Forest, TP: Teak Plantation

4.7 QUESTIONNAIRE SURVEY ON THE SMALL CARNIVORES OF PARAMBIKULAM TIGER RESERVE

A questionnaire survey was done among local people living inside the PKTR and among the forest department officials to assess their understanding on the small carnivores and also to study the conservation issues related to small carnivores. A total of 38 respondents were surveyed using the questionnaires (Appendix VII and Appendix VIII). Of these, 76% of the respondents were the locals and the 24% were the forest department officials (Fig. 15). Most of the respondents (84%) have a basic understanding on the small carnivores (Fig. 16). 68% of the respondents were of the opinion that conflict exists between the people living in PKTR and the small carnivores (Fig. 17). The local people opined that two species of small carnivores such as Jungle cat *Felis chaus* and Common Palm Civet *Paradoxurus hermaphroditus* have been occasionally depredating the domestic chicken and thus were considered as problematic.

4.8.1 Poaching

Almost all the respondent said that poaching or hunting of small carnivores was not happening in PKTR (Fig. 18). Table 18 gives the details of offences registered from 2000 to 2010 in PKTR. There was only a couple of poaching incidences (in 2004) between 2000 and 2010.

4.8.2 Perception of Locals Towards Conservation of Parambikulam Tiger Reserve

The survey revealed majorities (84%) of the local people at PKTR have a positive attitude towards the existence of the PKTR (Fig. 19) and they opined that the long-term conservation of PKTR should be ensured. About 79% (Fig. 20) of the local people also opined that the wildlife conservation is very important, as they benefitted out of the PKTR, through the various ecotourism activities that are practiced at PKTR.

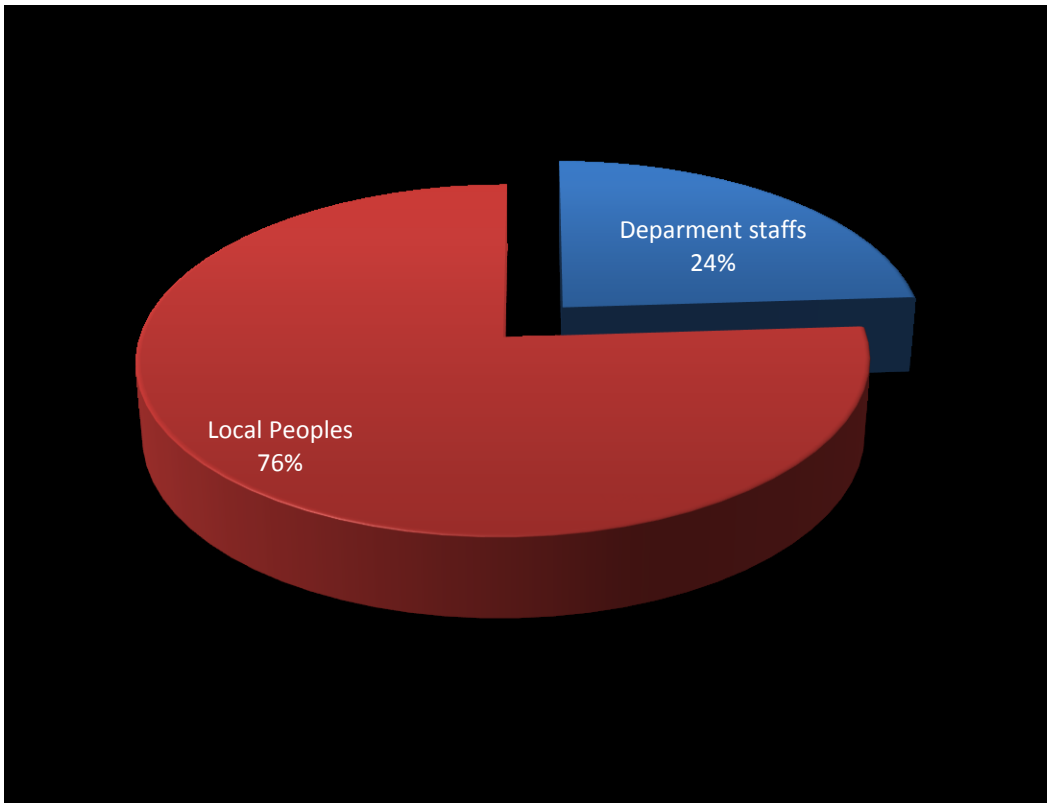


Fig. 15. Details on the type of respondents at PKTR (N=38)

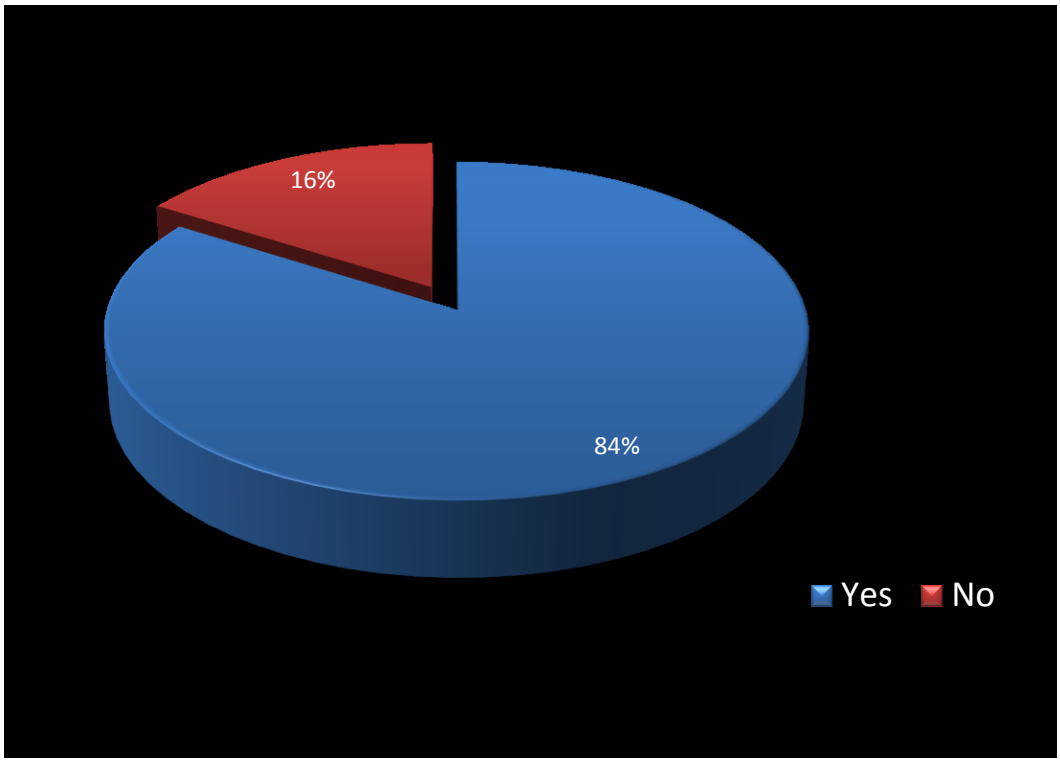


Fig. 16. Ability of the respondent in identifying a small carnivore (N=38)

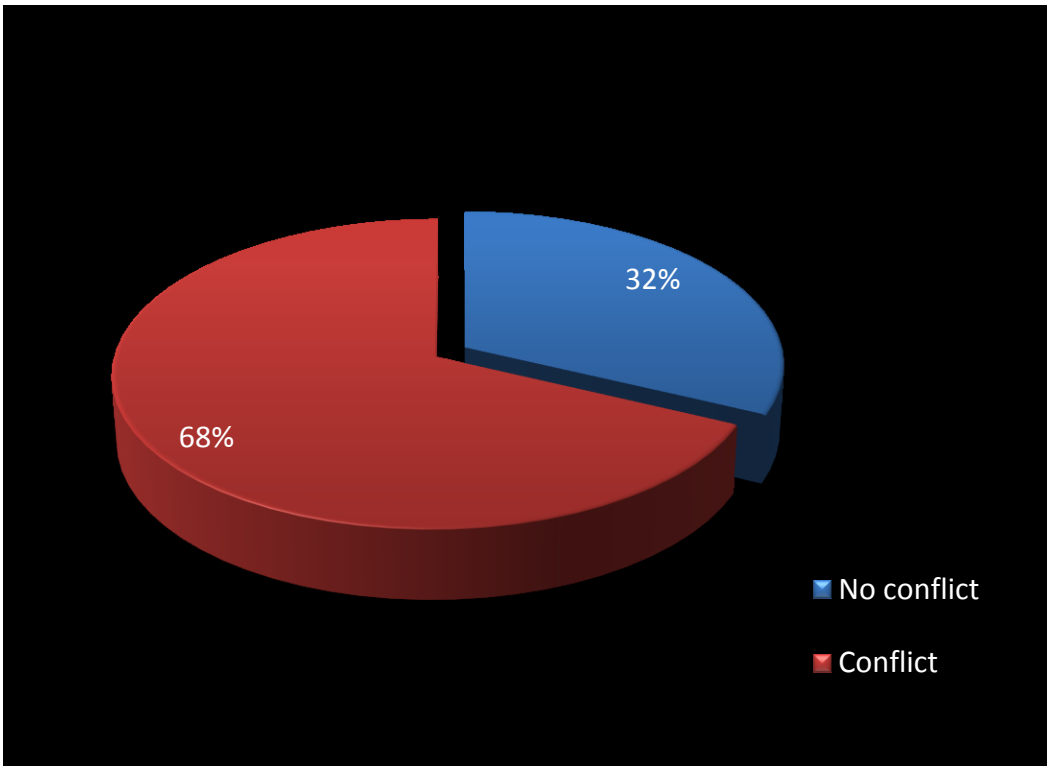


Fig. 17. Conflicts between peoples and small carnivores (N=38)

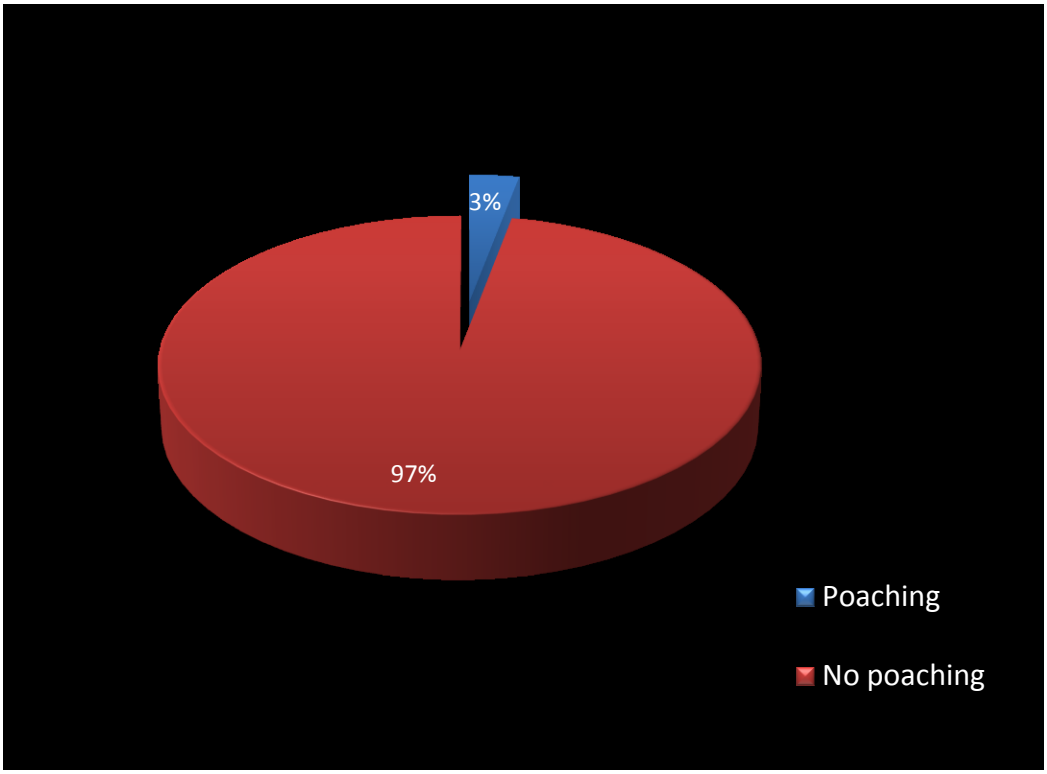


Fig. 18. Poaching of small carnivores (N=38)

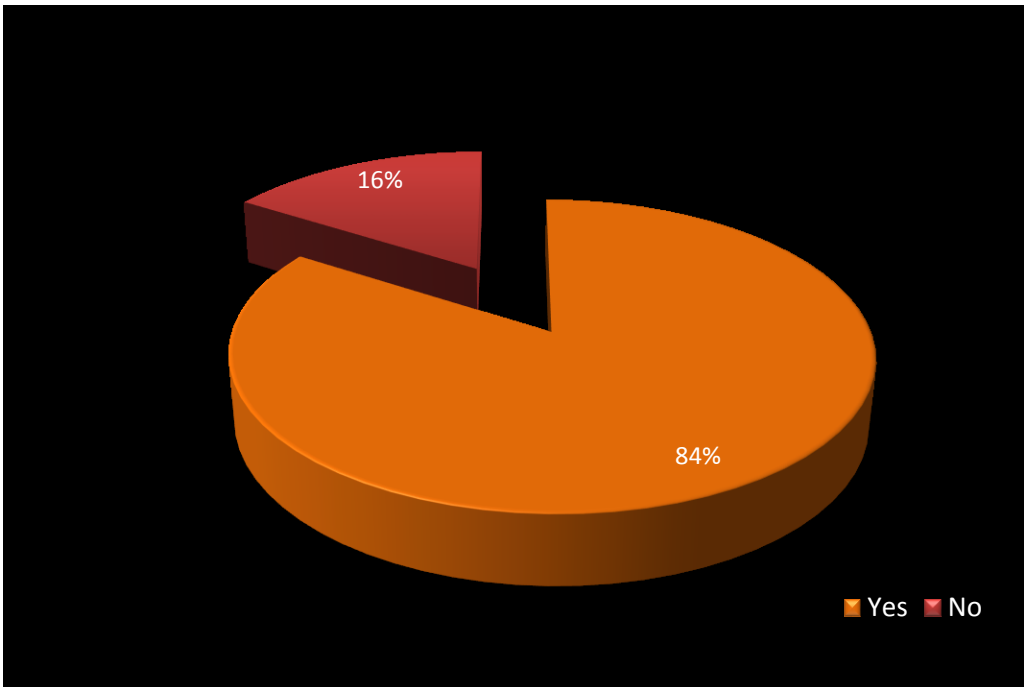


Fig. 19. Attitude of local peoples towards the existence of Parambikulam Tiger Reserve (N=29)

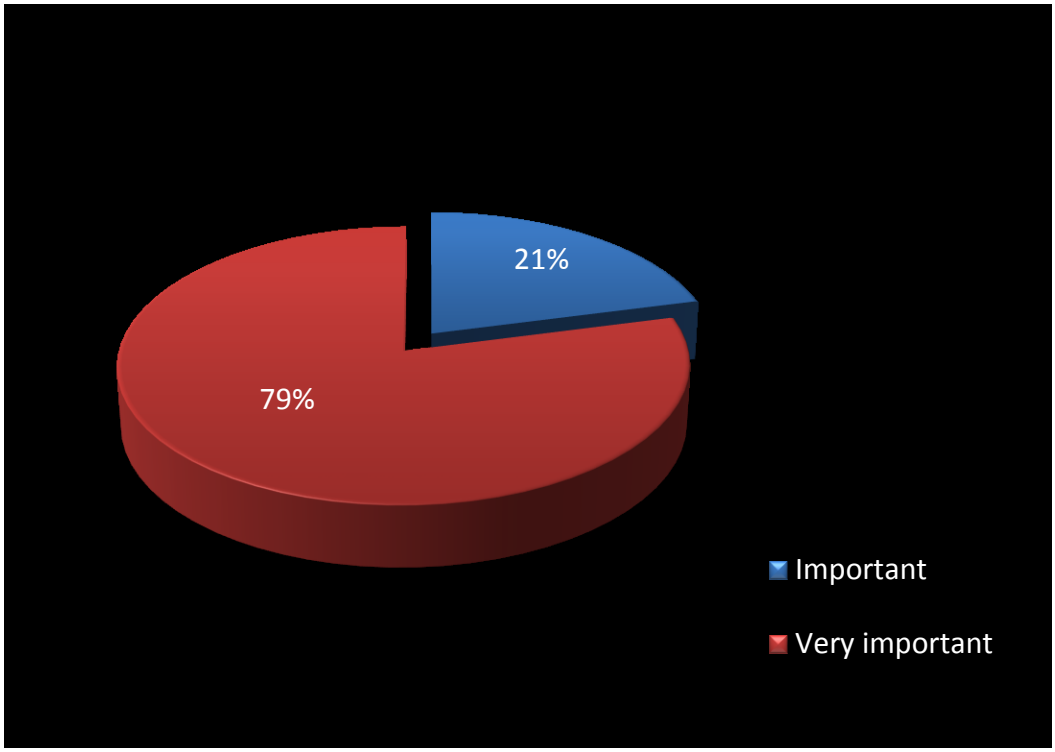


Fig. 20. Perception towards conservation of Small carnivores of Parambikulam Tiger Reserve (N=38)

Table 18. Details of offences registered from 2000 to 2010 in Parambikulam Tiger Reserve

Year	No. of sandalwood smuggling	No. of poaching cases	Ganja cultivation	Total cases
2000	1	-	-	1
2001	3	-	-	3
2002	4	-	1	5
2003	4	-	1	5
2004	12	2	1	15
2005	9	-	-	9
2006	5	-	-	5
2007	4	-	-	4
2008	1	-	-	1
2009	1	-	-	1
2010	2	-	-	2
Total	**48**	**2**	**3**	**53**

Source: Kaler (2011)

Discussion

DISCUSSION

5.1 DIVERSITY OF SMALL CARNIVORES OF PARAMBIKULAM TIGER RESERVE

The present study revealed the presence of 11 species of small carnivores in Parambikulam Tiger Reserve (PKTR). A total of 1349 camera trap nights, 242 km day transect, 29 hrs 30 min of night transect were carried out for the present study. Apart from these, a questionnaire survey was also carried in order to supplement the field data and to understand the threats if any on the small carnivores of the PKTR.

The 11 species of small carnivores identified from PKTR include three species of civets viz. *Viverricula indica*, *Paradoxurus hermaphrodites* and *Paradoxurus jerdoni*, four species of mongoose namely *Herpestes edwardsii, Herpestes fuscus, Herpestes smithii* and *Herpestes vitticollis*, two species of small cat *Felis chaus* and *Prionailurus bengalensis* and two species mustelids such as one otter *Lutrogale perspicillata* and the Nilgiri Marten *Martes gwatkinsii.*

5.1.1 Family Viverridae

5.1.1.1 Common Palm Civet *Paradoxurus hermaphrodites*

This is the most common civet in India. The un-patterned throat and tail help to distinguish Common Palm Civet from other civets. Its body colour varies from a rich cream to brownish black or even jet black. Dark spots coalesce into stripes on the sides. It has three longitudinal stripes on its back, which are visible on close inspection. It is basically an omnivore and is very much fond of the fruits of palms and honey, thus earning its reputation for having a ‘sweet tooth’ (Prater, 1971; Menon, 2003). Weight ranges from 2.4 to 4.0kg, head and body length varies between 480 and 590 mm and tail length between 440 to 535mm.

The palm civets use prominent sites such as rocks and fallen logs along the trails in forest to defecate. Like other civets it is mostly solitary and nocturnal. The Common Palm Civet is mostly a terrestrial frugivore and it is highly tolerant to disturbances. It is mostly found in a wide range of habitats including evergreen, moist and dry deciduous forest and plantations from sea level up to an altitude of 2,400 m and in plantations (Yoganand and Kumar, 1999). It also lives close to human habitation on roofs and in homesteads. 16 subspecies have been reported from Asia (Pocock, 1939).

During the present study, 18 camera trapped images were obtained and 13 individuals were sighted in the night transect. The Common Palm Civet was recorded between the altitude ranges from 450-1200m from PKTR. It was sighted from Karimala, Vengoli, Cheechali, Thelikkal, Orukomban, Kariyanchola, Kuriyakutty and Poopara (Fig. 21).

5.1.1.2 Small Indian Civet *Viverricula indica*

The Small Indian Civet is buff coloured with spots all over its body. The coat can vary from brown to grey. The black and white ringed tail has 8-10 dark bands (Prater, 1971). This civet lacks a spinal crest and has a cream throat with two dark bands across it. Its ears are small, rounded and set close to each other on top of the head, more like a cat's, while its legs are dark and long. It is not very arboreal and prefers thick grass and scrub. It dens in burrows or under rocks. This species occurs in almost all kinds of habitats, including the arid zones of western India. They are omnivorous in diet and are known to feed largely on insects. Secretions from their perineal glands are used to mark territories. Despite being good climbers, they have been observed to forage largely on the ground (Prater, 1971; Menon, 2003). The tail is almost two third the length of head and body and is conspicuously marked with 9-10 concentric black rings. The weight varies from 2.2 - 3.4 kg (Shortridge, 1914; Roberts, 1977). The head and body measure 450 to 630 mm while tail length varies from 369 and 413 mm. Secretions from their perineal glands are used to mark territories. Small Indian civets are commercially exploited for the

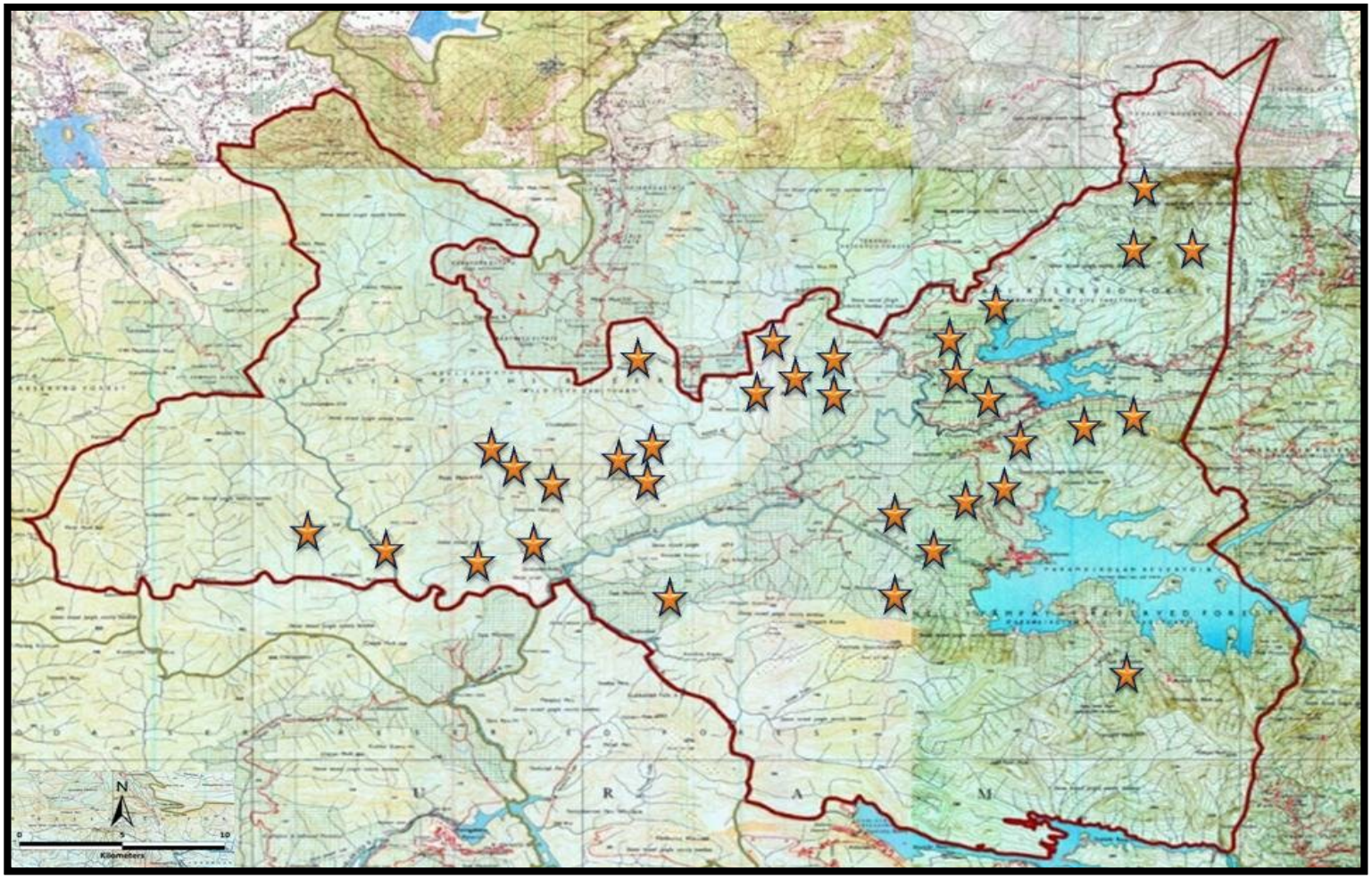


Fig. 21. Distribution map of Common Palm Civet in Parambikulam Tiger Reserve

"civetone" or scent, extracted at regular intervals from the perineal gland that is used in perfume industries and in Indian medicine for its purported aphrodisiac properties. The species is also hunted for it meat which got a great demand in the market. Five subspecies of Small Indian Civet have been identified from India; *V. indica indica* from Western Ghats, *V. indica bengalensis* from the plains of northern India, *V. indica deserti* from Rajasthan, *V. indica wellsi* from Kangra, Kumaun and Uttar Pradesh, and *V. indica baptistae* from upper Bengal and Assam (Pocock, 1939).

During the present study, 19 camera trapped images were obtained and 14 individuals were sighted in the night transect. Most of the occasions, the species was seen foraging on the ground. All the sightings were of solitary animals. The species were mostly reported from the moist deciduous forest type. Small Indian Civets have been reported to be the most common small carnivore in the drier forests of the southern Western Ghats and rare in the tropical wet evergreen forests of the region (Mudappa, 2002a). The Small Indian Civet was recorded between the altitude ranges from 450-1200m from PKTR. It was sighted from Anapadi, Karimala, Kothala, Thelikkal, Orukomban and Vengoli (Fig. 22).

5.1.1.3 Brown Palm Civet *Paradoxurus jerdoni*

It is an endemic carnivore restricted to the rainforest tracts of the Western Ghats (Mudappa, 2002b). The species is a highly arboreal and frugivorous and also plays an active role in seed dispersal of many rainforest tree and liana species. The Brown Palm Civet is more or less similar to the Common Palm Civet in size. The general body colour is brown with deep brown or blackish face and shoulder speckled with buffy-grey, which merge with the greyish flanks. All the limbs are darker, similar to face and shoulder. Unlike common palm civet it lacks distinct marking on the body. The length of the tail is almost the size of head and body with the distal end lighter brown to dirty white. Weight ranges from 2.4 - 4.0kg, head and body length 480 - 590mm and tail length from 400 - 535mm (Pocock 1939, Corbet & Hill 1992, Mudappa 1998). Pocock (1939) has

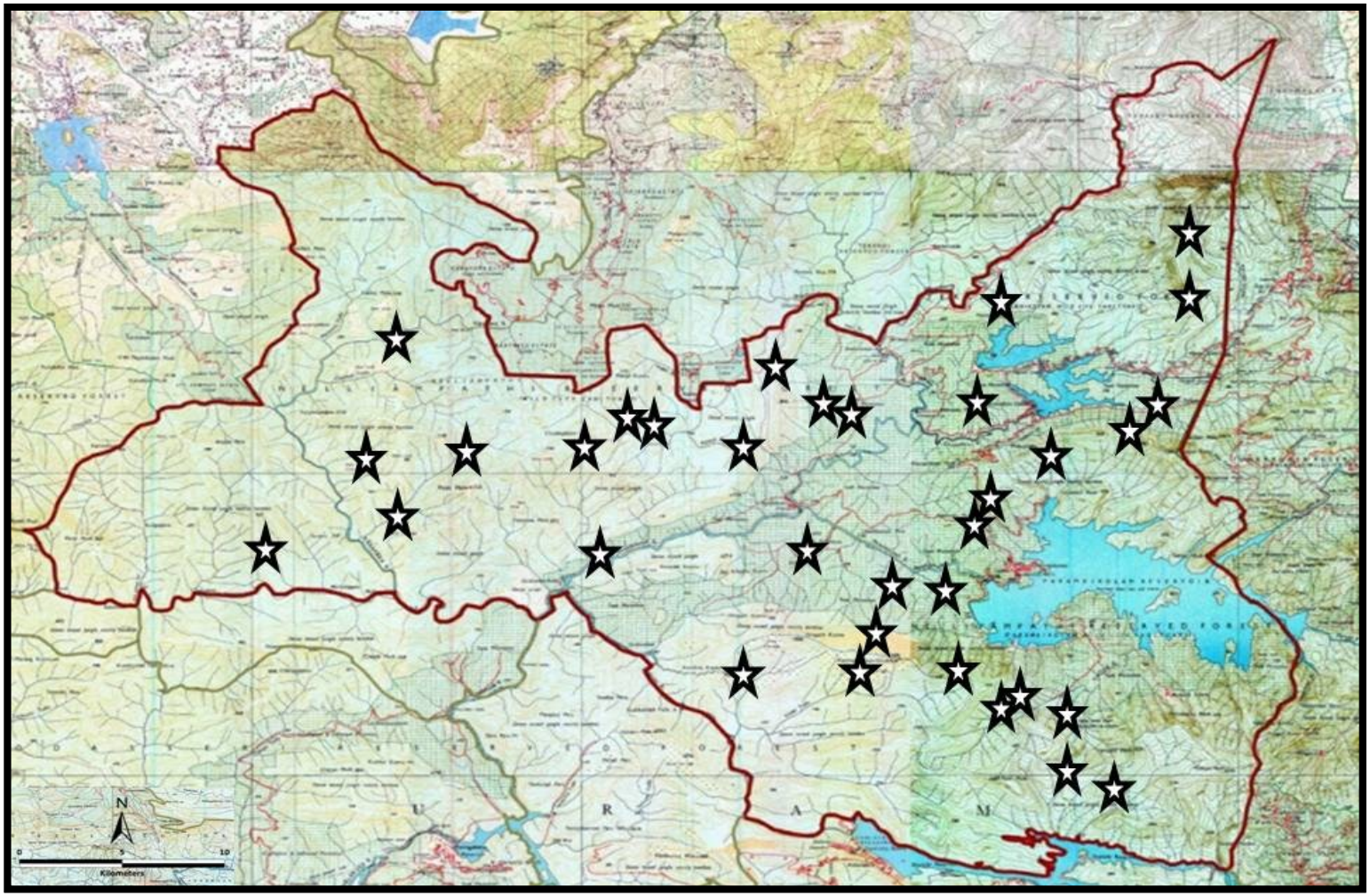


Fig. 22. Distribution map of Small Indian Civet in Parambikulam Tiger Reserve

recognized two subspecies of Brown Palm Civet such as *P. jerdoni jerdoni* which is distributed south of the Palghat gap, (in Palnis, Nilgiris and Travancore), and the second sub species *P. jerdoni caniscus* north of the Palghat gap (from Coorg).

During the present study, 17 camera trapped images were obtained and two individuals were sighted in the night transect. The species was recorded between the altitude ranges from 450-850m from Karimalagopuram and Orukomban (Fig. 23). However, Mudappa (1998) stated that the species is common in higher altitude and reported from an altitude range of 500-1,300m. These records confirm Parambikulam Tiger Reserve holds a good population of this endemic viverrid. Within Kerala, Brown Palm Civet has been reported from Achenkoil Forest Range in Achenkoil Forest Division, Periyar Tiger Reserve, Vazhachal Forest Division (Peringalkutthu & Malakkappara) and Silent Valley National Park (Ramachandran, 1990; Gupta, 1997; Nandini et al., 2002). Although the Brown Palm Civet has been recorded from Anamalai region (Mudappa, 2001), it has not been reported from the PKTR until now and the present sighting is the first confirmed sight record of Brown Palm Civet from PKTR.

5.1.2 Family Herpestidae

5.1.2.1 Indian Grey Mongoose *Herpestes edwardsii*

It has tawny-grey fur is much more grizzled and coarse than that of other mongooses. The legs are darker than body and tail is as along as head to body length. The desert subspecies is more reddish, the southern Indian one is more brownish and the northern Indian one is more greyish. The legs are always darker than the body. Total length is up to 900mm with tail length of around 450mm (Medway, 1978; Corbet & Hill, 1992). Males are always heavier and larger than females with weights ranging from 1.34-1.7kg and 0.89-1.12kg respectively (Medway 1978). It is a very bold and inquisitive animal and often lives near human habitation. It is commonly found in open scrub, cultivated land, rocky patches and forest edges all over India (Prater, 1971; Menon,

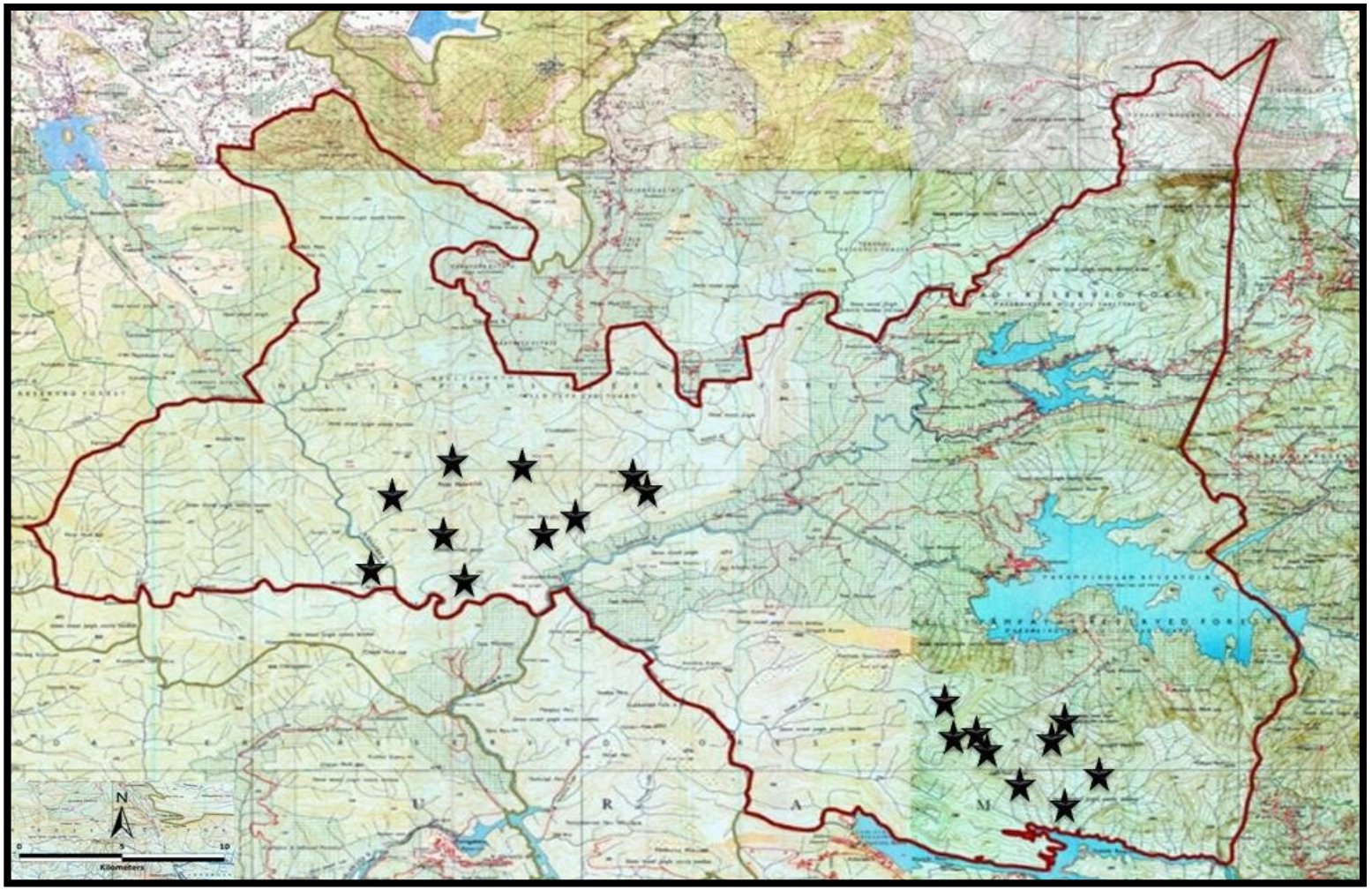


Fig. 23. Distribution map of Brown Palm Civet in Parambikulam Tiger Reserve

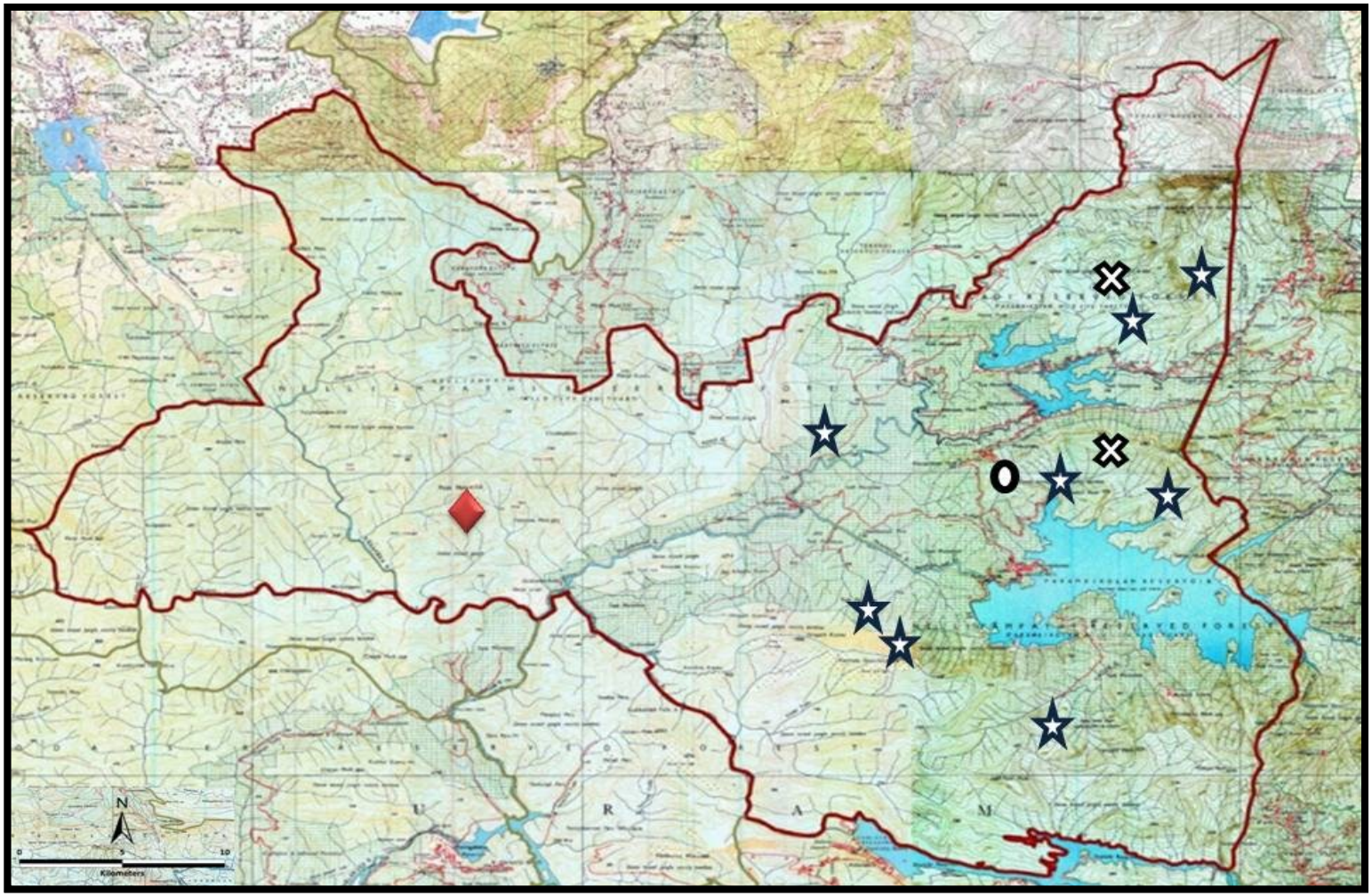
2003). They are found singly or in pairs. They prey on rodents, snakes, bird's eggs and hatchlings, lizards and variety of invertebrates. They breed throughout the year, gestation period is around 60-65 days, litter size 2-5. Maturity is achieved at the age of 6 to 9 months.

Pocock (1939) has identified three Indian subspecies of Indian Grey Mongoose, a north and central Indian race *H. edwardsii nyula* with a fuller somewhat darker coat, a desert race *H. edwardsii ferrugineus*, with reddish fur, and a typical south Indian race *H. edwardsii edwardsii*. In field conditions, however, the subspecies are difficult to identify as there is marked variation in the colour of the coat due to age, season and locality factors.

Though we did not get any photographic evidence of this species in the camera traps, a pair was sighted at base of Vengoli in moist deciduous forests at 10.05 AM on 14 August 2011. In the second occasion a solitary Indian Grey Mongoose was sighted at Anapadi at 6.45 PM on 19 September 2011 (Fig. 24). The species is distributed throughout Kerala and a black morph of the species was recorded from Mannavanshola, Marayur (Easa et al., 2001).

5.1.2.2 Stripe-necked Mongoose *Herpestes vitticollis*

It is the largest of the Asiatic mongoose. It is restricted to the Western Ghats in India and Sri Lanka (Prater, 1971). The species has a distinct black stripe with a white border on the sides of the neck. The Stripe-necked Mongoose occurs in well-wooded habitats, particularly in the dry and moist deciduous forests. It is known to prefer streams and rivers and is believed to feed extensively on crabs. There are reports of it hunting small mammals such as mouse deer in Sri Lanka (Prater, 1971). General colour varies from grizzled dark brown and yellowish-grey to tawny-red. Three to four inches of the tip of the tail is jet black. Head and body length is between 430 to 530mm (Pocock, 1939; Phillips 1984; Corbet & Hill, 1992) tail 304.5 to 325mm and weight ranges from 1.36 to



Brown Mongoose; Stripe-necked Mongoose; Ruddy Mongoose; Indian Grey Mongoose

Fig. 24. Distribution map of Herpestids in Parambikulam Tiger Reserve

2.73kg. The species is typically a forest dwelling species. It is rarely found far away from water sources. This indicates that probably it preys upon frogs and crabs. Though it is diurnal in habit it is more active during crepuscular period. The litter size is probably two to three. Two subspecies of Stripe-necked Mongoose are known from India. The typical form *H. vitticollis vitticollis* from Western Ghats, Coorg and Kerala is characterised by the dominance of chestnut red on its coat and the second *H. vitticollis inornatus* from north Kanara has no red tinge on the upper side of the body (Pocock, 1939).

During the present study, two camera trapped images were obtained and there were six separate sightings in the day transect. The two images were obtained from Karimala and Vengoli with an altitude of 833m and 574m respectively. The details of the direct sightings are given below. On 15 August 2011, three Stripe-necked Mongooses were sighted on the way to Vengoli on another occasion two individuals were sighted on the way to Poopara on 24 January 2012. The other sightings were all solitary individuals from Thelikkal on 18 August 2011, Vengoli on 28 August 2011, and twice from Cheechali on 20 September 2011 and 29 September 2011. The distribution map of Stripe-necked Mongoose in PKTR is given in Fig. 24.

The Stripe-necked Mongoose is distributed from Bombay to Dharwar to Cape Comorin (Jerdon, 1874; Blanford, 1888-1891). In Kerala the known distribution include Periyar Tiger Reserve (Ramachandran, 1985), Eravikulam national Park (Madhusudan, 1995), Anaikatty reserve foreset (Rompaey and Jayakumar, 2003) and Parambikulam Wildlife Sanctuary (Pillay, 2009).

5.1.2.3 Brown Mongoose *Herpestes fuscus*

The Brown Mongoose is found in the forests of the south Indian hill ranges at 900-1850m (Prater, 1971; Corbet & Hill, 1992; Mudappa, 1998). Outside India it occurs in Sri Lanka (Phillips, 1984). On an average the brown mongoose is slightly larger than the grey mongoose and more uniformly dark brown above and below. It is heavily built

with a relatively shorter tail which is only about two-thirds the length of the head and body. The dark brown pelage is often more or less speckled with yellow or tawny colour. The contour hair are less harsh and the upper half or third of the soles of the hind feet are covered with hair throughout the year. The length of the head and body is around 500 mm, tail 300 mm and weight about 2.7kg (Prater, 1971; Phillips, 1984).

Five subspecies of Brown Mongoose have been reported. Out of this only one subspecies *H. fuscus fuscus* is known from Western Ghats, India and the other four subspecies such as *H. fuscus flavidense*, *H. fuscus rubidior*, *H. fuscus maccarthiae* and *H. fuscus siccatus* are known from Sri Lanka (Pocock, 1941, Phillips, 1984).

There was a single sighting of Brown Mongoose from the PKTR in the riverine forests at Orukomban (N 10^0 24' 0.2", E 76^0 41' 38.2") at an elevation of 492m on 21 Sept 2011 at 7:50 AM (Fig. 24). The species was very shy and disappeared as soon as it was sighted. In South India Brown Mongoose is found from 700 to 1,300m from Virajpet in south Coorg and Ooty in the Nilgiri hills, Tiger Shola in the Palni hills, High Wavy Mountains in Madurai, KMTR in Agasthyamalai hills, Valparai plateau in the Anamalai hills, and Peeramedu in Kerala (Pocock, 1939, Prater; 1971; Corbet & Hill, 1992; Mudappa, 1998, 2001). Thus the present sighting is the first confirmed record of this species from Parambikulam TR and the second sighting from Kerala.

5.1.2.4 Ruddy Mongoose *Herpestes smithii*

It is distributed in peninsular India, in Western and Eastern Ghats. The ruddy mongoose is very closely related to Indian grey mongoose *H. edwardsii*, but distinguished by its slightly larger size and black tipped tail extending for 2 to 3 inches at the distal end. Body is generally darker in colour with black and greyish-white speckling and a reddish cast traceable in the hair of the upper side, particularly on the head, neck and between the shoulders. The fore legs are reddish-brown and speckled, while the hind legs are brighter red. The black tipped tail is three-quarters the length of the head and

body, busy at the base, and is usually carried with the tip curved upwards, which is the identification character. Head and body length varies between 390 to 470 mm, tail length 333 to 362 mm and hind feet 78 to 84 mm (Pocock, 1941; Phillips, 1984; Corbet & Hill, 1992). The weight varies from 0.95 to1.85 kg. Males are larger than the females. The Ruddy Mongoose is mainly a forest loving animal in contrast to the grey or small Indian mongoose and prefers more secluded areas. Like other mongoose, it hunts by day as well as by night but it is in fact crepuscular in nature. Its normal food is similar to other mongoose species including carrion. Of the two subspecies, of the Ruddy Mongoose, the Indian race is *H. smithii smithii* and the other *H. smithii zeylanius* found in Sri Lanka (Pocock, 1939).

During the present study a pair of Ruddy Mongoose were camera trapped from the Vengoli hills (N 10^0 24' 22.5", E 76^0 47' 56.1"). The species was recorded from a stream bed in the moist deciduous forest of Vengoli at an elevation of 574m on 12 March 2012 (Fig. 24). In South India the Ruddy Mongoose is known only from Chinnar Wildlife Sanctuary and KMTR (Pillay, 2009). Thus the present record of the Ruddy Mongoose is the first report of the species from PKTR and second confirmed sighting from the State.

5.1.3 Family Mustelidae

5.1.3.1 Nilgiri Marten *Martes gwatkinsii*

The Nilgiri Marten is endemic to Western Ghats. The Nilgiri Marten is almost similar to Yellow-throated Marten *Martes flavigula* of Himalayas in size. Blackish body with yellowish orange neck, typical weasel like leg, stout tail, pointed head and a flat skull with a concave depression on the forehead are the unique identifying characters of Nilgiri Marten (Pocock, 1941; Prater, 1971). The head to body length varies from 550 to 650 mm, tail length 400-450 mm and weight is around 2.1kg (Riely, 1913; Pocock, 1941). Very little information about the distribution, occurrence, abundance and ecology makes the Nilgiri Marten as one of the least known species of martens in the world

(Wirth and Van Rompaey, 1991) and is currently listed in the IUCN Red List as Vulnerable (Choudhury et al., 2012). It is believed to be diurnal and arboreal, like other marten species it possibly descends to the ground for hunting. Nilgiri Martens have been observed to hunt small vertebrates like Mouse Deer and varanus. There is a report of them feeding on the nectar of *Ceiba pentandra* (Hutton, 1944). There is a report of it preying on crows in the high ranges of Kerala (Gouldsbury, 1949) and Malabar Giant Squirrel in the high wavy mountains of Kerala (Hutton, 1944) and on insects (Pocock, 1941). Moist and tropical rainforests are its preferred habitats within an altitdinal range of 300-1200m.

During the present study a single Nilgiri Marten was camera trapped from the Karimala (N 10^0 22' 07.9" E 76^0 45' 50.0") at an elevation of 708 m on 27 July 2011. The species was recorded from the Moist Deciduous forest of Karimalagopuram and this was the first report of the species from the Parambikulam TR (Fig. 25). The Nilgiri Marten has been reported from the following areas in the Western Ghats such as Sholayar (Vijayan, 1979), Brahmagiris (Schreiber et al., 1989), Eravikulam National Park (Madhusudan, 1995), Mukkurthi National Park (Yoganand & Kumar 1995, 1999), Peppara Wildlife Sanctuary and Silent Valley National Park (Christopher & Jayson 1996), Upper Bhavani (Gokula & Ramachandran 1996), KMTR (Mudappa, 2001) and Periyar Tiger Reserve (Kurup and Joseph, 2001). It was also sighted in Silent Valley National Park, Attappadi Reserve Forest, Muthikkulam South Reserve Forest, and Nilambur South Reserve Forest by Balakrishnan (2005). The Nilgiri Marten sightings from the Western Ghats have been compiled by Krishna and Karnad (2010). The additional Nilgiri Marten sighting locations reported by them include, Anamalai Tiger Reserve, Nelliampathy Reserve Forest, Grass Hills National Park, Pambadum shola National Park, Talakaveri Wildlife Sanctuary and Sandynallah in Nilgiris.

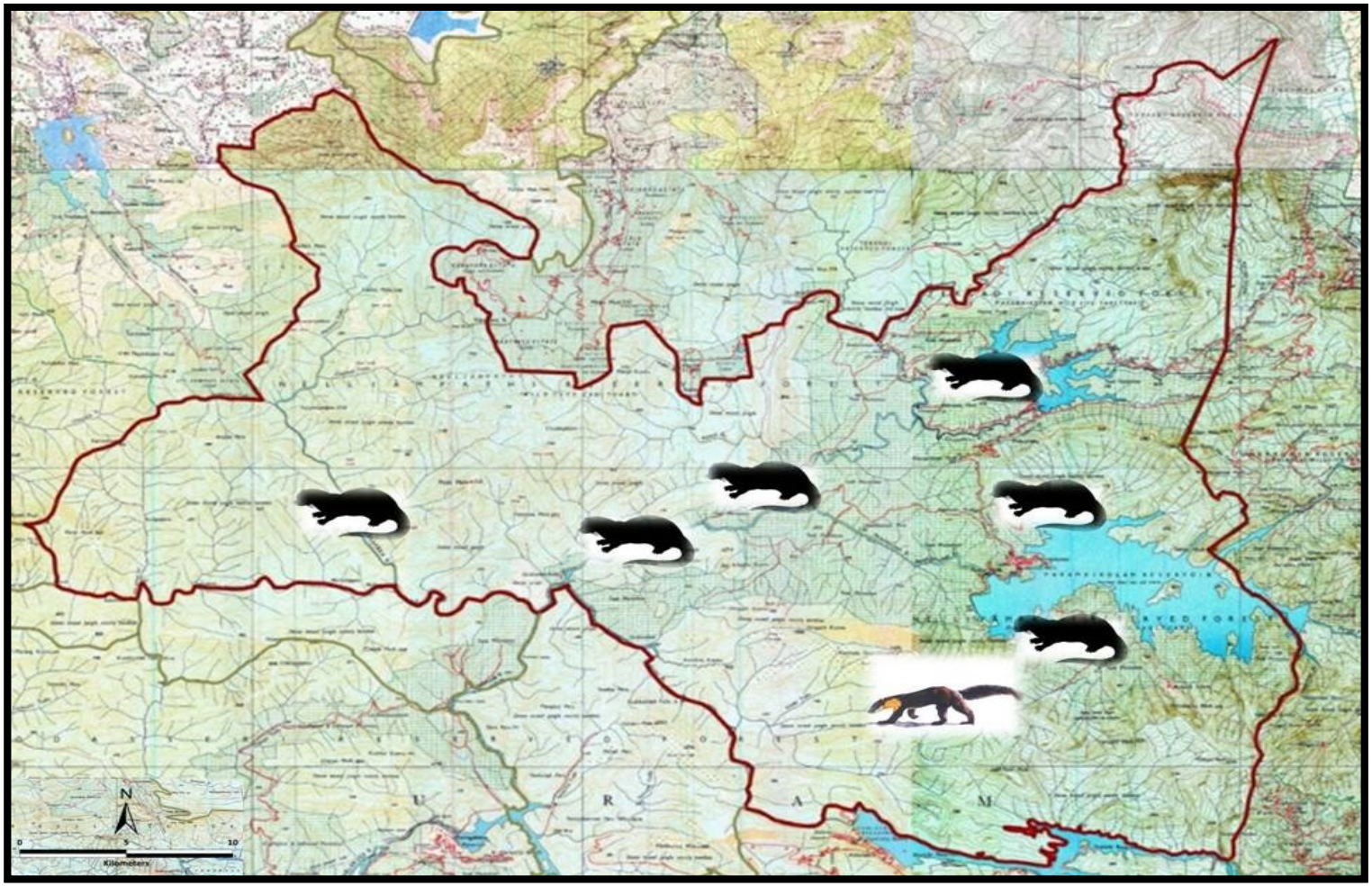


Fig. 25. Distribution map of mustelids in Parambikulam Tiger Reserve

5.1.3.2 Smooth-coated Otter *Lutrogale perspicillata*

The size and proportion of the smooth-coated otter is almost similar to the Eurasian otter. The tail length is more than half the length of the head and body and more than three times the length of hind foot. The total length ranges between 1067 and 1300 mm, head to body 655 and 790 mm and the tail length ranges between 406 and 505 mm (Duplaix & Davis, 1981). In colour, the dorsal part of the body varies from deep, nearly blackish-brown, or lighter brown with a rufous tinge with much paler, tawny or sandy brown. Whereas the underside is always lighter than the dorsal part the paws are paler than the back. The upper lip to the edge of the rhinarium, the cheek to the eye and ear, the sides of the neck, the chin and throat are white or whitish (Pocock, 1941). In its external characters the smooth-coated otter differs from Eurasian otter by its very smooth, sleek coat, i.e. hair texture is velvety. It differs from the other otters in having V-shaped nostrils and its tail is flatter towards the tip. The Smooth-coated Otter is active by day. It is also widespread in the Western Ghats. It is commonly found in plains, including arid areas. These animals are often seen in groups in large rivers, lakes and reservoirs. They are more diurnal or crepuscular in their habit. The species is known to readily adapt to hunting in forests, when water sources dry up (Prater, 1971; Menon, 2003).

Two subspecies were reported by Pocock (1941). One is the *L. perspicillata perspicillata* that is seen in northeast and southern India, Myanmar and Sumatra and the second is the *L. perspicillata sindica* that is seen in north and northwestern India and Pakistan.

There were five direct sightings of Smooth-coated Otter from the PKTR. These sightings were from the Parambikulam reservoir on 05 July 2011, Thunakadavu reservoir 07 July 2011, Kuriyarkutti river at Kuriarkutti 24 September 2011 and Medamchalu 25 December 2011 and a stream near Kannimara teak 05 October 2011 (Fig. 25). Apart from these direct sightings, a group of seven Smooth-coated Otter were also camera trapped from the Seechali on (N 10^0 26' 04.5" E 76^0 48' 18.7") on 09September 2011 at an

elevation of 563m. In addition, otter spraints and tracks were found on the banks of the Parambikulam reservoir and from the Kuriarkuttiu, Kothala, Kottayali river banks. There has only been only two published study on the otters in Western Ghats, viz. Meena (2002) and Anoop & Hussain (2004 & 2005).

5.1.4 Family Felidae

5.1.4.1 Jungle Cat *Felis chaus*

Jungle Cat is the most common wild cat in India. It is buff or grey-brown in colour with reddish ears. The ears have short black tufts. It has two black stripes on its lanky forelegs, and its tail, which is shorter than that of a domestic cat, is black tipped. Its coat is unmarked except for faint red stripes running across the forehead and on the outer surface of the legs. Its eyes are ringed with white, with a dark tear stripe running down each cheek. The Jungle Cat found in Southern India is greyer and lightly speckled on the back. The Jungle Cat is frequently found near the human habitations. It can also hunt animals much larger than itself such as the porcupines. It usually inhabits small dens and also under rocks. It is commonly found in grasslands, scrub jungle, dry deciduous and evergreen forests, semi urban areas and villages (Prater, 1971; Menon, 2003). The main conservation threat for the animal includes poaching and habitat destruction. The jungle cat is frequently by day, more usually in the morning and in the evening. It preys on small mammals principally rodents, are the prey most frequently found in feces and stomach contents. Other prey species are taken more opportunistically, including hares, nutria, lizards, snakes, frogs, insects, and fish. It is probably absent from all closed canopy forests, including rainforest.

A single individual was sighted during the spot-light survey in moist deciduous forests of Parambikulam at 8:20 PM on 18 November 2011 (Fig. 26). Various indirect evidences like the pugmarks and scats were also encountered from moist deciduous,

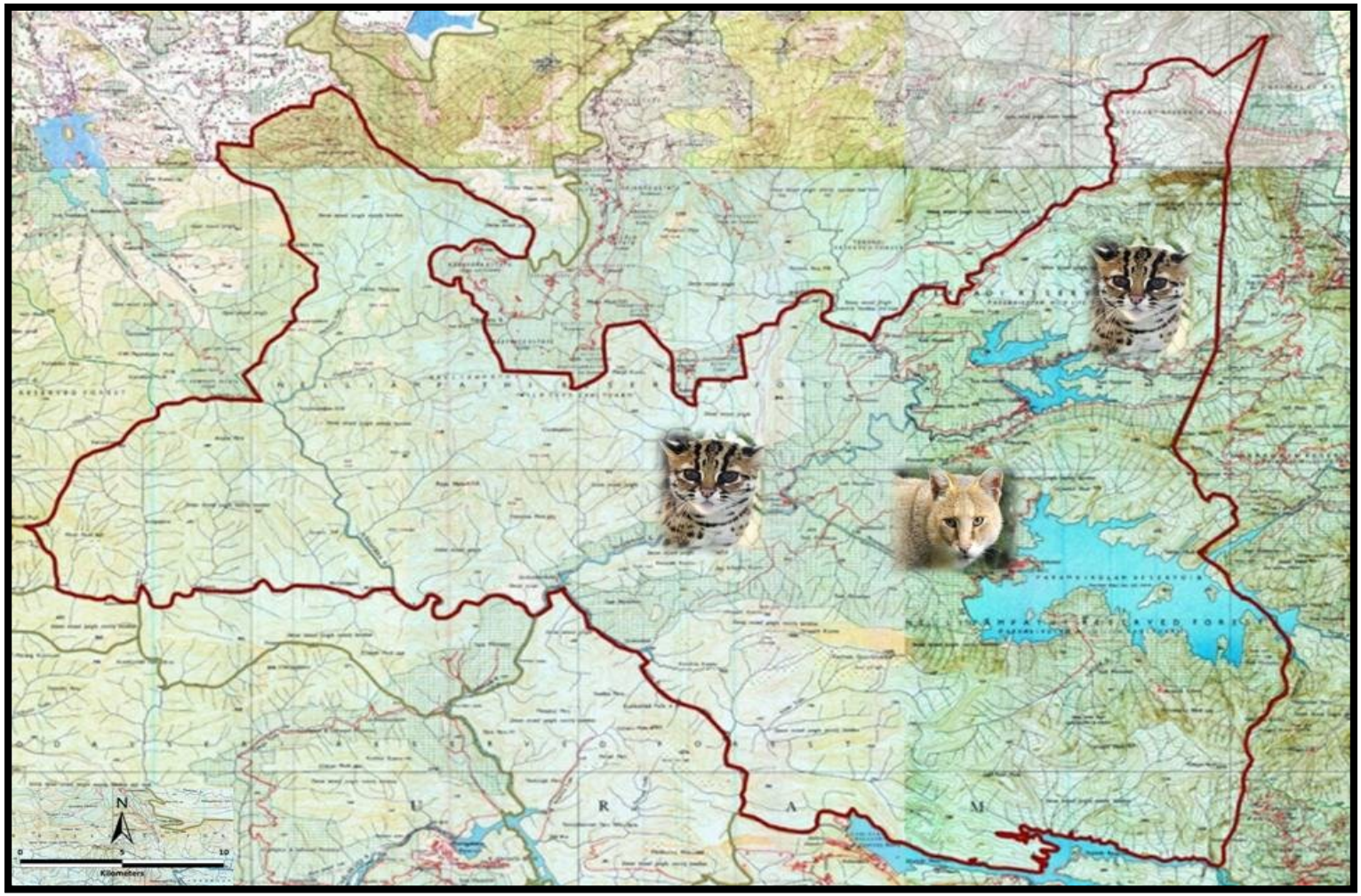


Fig 26. Distribution map of small cats in Parambikulam Tiger Reserve

evergreen and from the plantations of Parambikulam Tiger Reserve during the present study.

5.1.4.2 Leopard Cat *Prionailurus bengalensis*

The species is one of the most adaptable wild cats, similar to leopard. Its colour and marking give it the aspect of a miniature leoprad. The prevailing colour of the body is yellowish above white below ornamented throughout with black or brownish spot. Both colour and pattern are very variable in this species. Among other markings are four more or less distinct bands running from the crown over the neck which breaks up into short bars and elongate spots on the shoulders. There is a pair of horizontal cheek stripes, the lower joining a black bar across the throat and the usual two black bars on the inside of the forearm. The spots on the tail form cross bars towards its end. It is an extremely versatile cat, which is arboreal and preys up on small birds and animals. It is nocturnal in habit and seldom seen. It takes rest in hollows in trees. Total body length comes up to 60 cm and weights from 3 to 7 kg (Prater, 1971; Menon, 2003).

One Leopard Cat was captured in the camera trap 20 September 2011 from the moist deciduous forest near Anapadi. Apart from this on another occasion a Leopard Cat was sighted near to the tramway bridge in Kuriyarkutti tribal settlement at 8:20 PM on 18 November 2011. The species was not shy and when the animal got illuminated by the torches, it starts moving and crossed the river through the bridge. The distribution map of Leopard Cat in PKTR is given in Fig. 26.

5.2 SPECIES RICHNESS AND ABUNDANCE OF SMALL CARNIVORES IN PARAMBIKULAM TIGER RESERVE USING THE CAMERA TRAP STUDIES

At Parambikulam TR, eight species of small carnivores have been captured in the camera trapped from 1349 trap nights. The camera capture rates on the small carnivores from other studies are given below. Mudappa et al. (2007), who studied the small carnivores in KMTR, with a camera trap effort of 295 recorded three species, while her

studies at Anamalai hills with 95 camera trap nights also recorded three species. Rao et al. (2007), during their survey on Malabat Civet using camera traps in Kerala and Karnataka, after 1084 camera trap efforts recorded only four species of small carnivores. Aparajita et al. (2008), who studied the small carnivores of two protected areas in Arunachal Pradesh, reported that after a camera trap effort of 1537 in Namdapha NP they got six species, while at Pakke WLS, after a camera trap effort of 231, they recorded four species.

In Thailand 1,224 trap-nights, five species were captured (Grassman, 1998). In Laos, with 3,588 trap-nights, 11 small carnivore species were camera-trapped (Johnson et al. 2006), and eight were recorded in Vietnam in 6,337 trap-nights (Long & Hoang, 2006). In the Hukaung Valley, Myanmar, even after 8,836 trap-nights, only ten species were captured (Than Zaw et al. 2008). In Malaysia only nine small carnivore species were recorded in 14,054 trap-nights. Variation in species recorded and capture rates may reflect real differences in abundance among sites but it is difficult to make conclusions, given that most of these studies were designed primarily for tigers and other large carnivores. The camera trap capture rates have been generally higher at PKTR when compared to the other locations in the Western Ghats and the Namdapha and Pakke in the north-east. The camera trap capture rate was also higher at PKTR whne compard to the capture success at other locations in South-East Asia.

The higher camera trapping success rates in Karimala (28.3%), Orukomban (25%) and Vengoli (18.3%) of PKTR than in the rest of the locations indicates higher abundances of small carnivores, probably sustained by the lack of human interventions in these places when compared to other locations such as Anapadi, Karian shola, Tellikkal and Kuriarkutti. The higher success rate in Orukomban could be due to the visitations by Brown Palm Civet *Paradoxurus jerdoni*, a species of evergreen biotope. (Mudappa, 2001) has noted that higher food plant species densities in the relatively undisturbed rainforests, particularly species such as *Palaquium ellipticum*, *Holigarna nigra*,

Elaeocarpus spp., Ficus spp. and *Acronychia pedunculata* support good population of Brown Palm Civet.

5.3 DENSITY OF SMALL CARNIVORES IN PARAMBIKULAM TIGER RESERVE USING NIGHT TRANSECT SURVEY

Night transect was an effective method of sampling small carnivores in PKTR. During the night transect survey the small carnivores at PKTR recorded an encounter rate of 1.06 animals/hr of drive and 0.09 animals/km. The Small Indian Civet *Viverricula indica* had an encounter rate of 0.48 animals/hr of drive and 0.04 animals/km, Common Palm Civet *Paradoxurus hermaphroditus* with 0.45 animals/hr of drive and 0.04 animals/km and Brown Palm Civets *Paradoxurus jerdoni* were sighted with an encounter rate of 0.07 animals/hr of drive and 0.01 animals/km. Mudappa (2007) recorded an encounter rate of 1.7 animals/hr of drive and 0.09 animals/km in Kalakad Mundanthurai tiger reserve and 0.26 animals/hr of drive and 0.01 animals/km in Anamalais. Mudappa (2007) also reported the encounter rate of Brown Palm Civet was 0.30 animals /hr during the night transects survey.

5.4 SPECIES RICHNESS AND ABUNDANCE OF SMALL CARNIVORES IN PARAMBIKULAM TIGER RESERVE USING INDIRECT EVIDENCES

The abundance of scats was used as a measure of the abundance of the small carnivores in the reserve. Scat abundance was estimated as the number of scat encounter per kilometer surveyed in different habitats of the reserve. However, based on scat morphology it was possible to identify the scats to the family level only. Indirect evidences like pugmarks or tracks were also recorded for identifying the presence of small carnivores. Using the scat abundance study it was observed that the civets were the most abundant small carnivore at PKTR. This was followed by mongoose and otters. The small cats were the least abundant group among the small carnivores. There was a notable variation in the scat abundance among the three habitats of the reserve. The

overall scat abundance of the small carnivores was seen more for the moist deciduous forests than evergreen forests. The abundance of civets and mongoose were higher in the moist deciduous forests whereas the otters were abundant in the evergreen habitats. The direct sighting also supports the same that all sightings of civets and mongoose were from the moist deciduous forests of whereas out of the three sightings of otters two were from the evergreen habitats of, and one sighting from the moist deciduous forests of.

This estimation, however, has couple of limitations such as; the scat abundance need not be proportional to animal abundance. Yoganand and Kumar (1999), has opined that the fruit eaters such as civets would have a higher defecation rate than meat eaters such as cats and mustelids. Thus one cannot estimate the abundance of small carnivore using the indirect evidence method, it can at the best be used for recording the presence absence of a small carnivore and to supplement the camera trap data.

5.5 STATUS OF SMALL CARNIVORES IN PARAMBIKULAM TIGER RESERVE

Out of the 11 small carnivores recorded from PKTR, Small Indian Civet *Viverricula indica* and Common Palm Civet *Paradoxurus hermaphrodites* are the commonest small carnivores in PKTR and are distributed throughout the Tiger Reserve. Brown Palm Civet *Paradoxurus jerdoni* was found to be common in the evergreen forest and adjoining moist deciduous forest of PKTR.

Of the herpestids, Stripe-necked Mongoose *Herpestes vitticollis* was the commonest one at PKTR and is distributed throughout the PKTR except the evergreen forests. Grey Mongoose *Herpestes edwardsii* was found to be fairly common since the animal was sighted on two occasions during the day time. Brown Mongoose *Herpestes fuscus* and Ruddy Mongoose *Herpestes smithii* were very rare in PKTR and were recorded only once during the entire study period.

Smooth-coated Otter *Lutrogale perspicillata* is the only otter recorded and is commonly found in the reservoirs and beside the streams flowing through PKTR. The

spraints collected from the river banks also confirms the presence of otters in the upstream.

The endemic Nilgiri Marten *Martes gwatkinsii* was found to be a rare animal in PKTR and was recorded only from Karimalagopuram. Moreover, there is no information about the indirect evidences such as scat and pad impression.

Jungle Cat *Felis chaus* was obtained only once during the night transect and found to be very rare in PKTR while the Leopard Cat *Prionailurus bengalensis* was recorded only twice from PKTR and found to be rare

5.6 HABITAT PREFERENCE OF SMALL CARNIVORES IN PARAMBIKULAM TIGER RESERVE

The Habitat Use Index (HUI), which shows the habitat preference, was worked out for each group of small carnivores at PKTR. The HUI showed remarkable variations between the various habitats of the reserve. The Common Palm Civet *Paradoxurus hermaphroditus* has been found in a wide range of habitats including evergreen forests and moist deciduous forests, teak plantations and near human habitations. Studies elsewhere on the Common Palm Civet, have also recorded wide range of habitat use by the Common Palm Civet (Duckworth, 1997; Azlan, 2003; Su, 2005).

Brown Palm Civet *Paradoxurus jerdoni* was camera trapped only from the evergreen forest at PKTR, while during night transects they were sighted from the moist deciduous forests adjoining the evergreen patches too. But never sighted nor camera trapped from among the teak plantations. However, Ashraf et al. (1993), has reported the Brown Palm Civet from tropical rain forests as well as from coffee estates at Coorg. Pillai (2009) has sighted the Brown Palm Civet from the moist deciduous forest of Periyar Tiger Reserve (Pillay, 2009). Mudappa (1998) reported the Brown Palm Civet only from evergreen forests, within an altitude range of 500-1300m. At PKTR we have recorded the

Brown Palm Civet at an altitude of as low as 450m at an evergreen patch in Orukomban in Parambikulam.

Small Indian Civet *Viverricula indica* also has been sighted in the evergreen forests, moist deciduous forests and teak plantations at PKTR. However, Mudappa (2002a) observed that the Small Indian Civet was seldom seen in the undisturbed rainforests of Kalakad-Mundanthurai Tiger Reserve at the same time in Lao PDR Small Indian Civet occurs in the evergreen and semi-evergreen forest (Duckworth, 1997).

In the case of mongoose also the HUI was higher in the moist deciduous forests than the evergreen forests. The direct sightings of both the *Herpestes vitticollis* and *Herpestes edwardsii* were from the moist deciduous forests. *Herpestes edwardsii* has been recorded in dry secondary forests and thorn forests (Shekhar, 2003), he also recorded *Herpestes edwardsii* near human settlements.

HUI of otters in the reserve was also seen higher in the moist deciduous forests than the evergreen habitats. The only otter species identified from the reserve, *Lutrogale percpicillata*, was observed more in the rocky and open areas than the areas having vegetation in the both the habitats sighted. Other studies on otter also show that they prefer to use habitats where food is plentiful and anthropogenic disturbances low (Hussain and Choudhury, 1997; Anoop and Hussain, 2004; Shenoy, 2006).

The small cat from the reserve, Jungle Cat *Felis chaus* and Leopard cat *Prionailurus bengalensis* showed noteworthy variation in habitat use in the reserve. The HUI of the species was seen much higher in the moist deciduous forests when compared to the evergreen forests. Duckworth et al. (2005) observed that in the Laos the Jungle Cat was probably absent from all closed canopy forests, including rainforest. The species may make use of agricultural areas with a low intensity of human use and which retain patches of scrub.

5.7 CONSERVATION STATUS OF SMALL CARNIVORES OF PARAMBIKULAM TIGER RESERVE

Out of these 11 species of small carnivores observed *Martes gwatkinsii* and *Paradoxurus jerdoni* are endemic to Western Ghats. While the *Herpestes vitticollis* and *Herpestes fuscus* are restricted to the Western Ghats and Sri Lanka. Among the 11 species observed in the reserve, *Lutrogale perspicillata, Martes gwatkinsii* and *Herpestes fuscus* have been categorised as Vulnerable as per the IUCN (Choudhury et al. 2008; Hussain et al. 2008; Muddapa et al. 2008).

The present study on the small carnivores of PKTR observed couple of threats to the small carnivores at PKTR. There was an incidence of road kill on the Indian Grey Mongoose *Herpestes edwardsii* between Top Slip and Anappadi check post (Plate 16). Though strictly not within the TR, this is a potential threat to the small carnivores at PKTR too as it is the very same road that pass through the PKTR. During the questionnaire survey, 33% of respondents have reported that the there is a perceivable increase in the population of the Mugger crocodile *Crocodylus palustris* (Plate 17) at PKTR reservoir and this is giving a tough competition to the otters for the food resource. This may be further investigated to ascertain whether the mugger is really causing a competition for the food resource for the Smooth Coated Otter at PKTR.

5.8 CONSTRAINS FOR THE PRESENT SMALL CARNIVORES STUDY IN PARAMBIKULAM TIGER RESERVE

The camera trap model that one use for the small carnivore study is very crucial. Originally we tried the camera trapping trials with WildView Extreme IV. But we realized that WildView Extreme IV has a major disadvantage. WildView Extreme IV camera has the built in problem of delayed triggering. Because of this the camera was triggering but no images of the animal could be captured into the camera as the actual trigger occurs only after the animal has already crossed the camera view point. This is a

Plate 16. Road kill of Indian Grey Mongoose *Herpestes edwarsii*

Plate 17. Mugger crocodile *Crocodylus palustri* in Parambikulam Reservoir

major constraint and we would not recommend WildView Extreme IV for any of the camera trapping studies, particularly on small carnivores. You may still get the images of the animals provided the animal decides to spend more time in front of the camera. Thus for the actual survey using the camera traps we were using Bushnell Trophy Cam.

Another constraint that we faced was that three of our camera traps were destroyed by elephants (Plate 18). So one need to be ready with substitute cameras in case of such contingency.

Plate 18. Camera trap damaged by Asian Elephants (A& B)

Summary

SUMMARY

Small carnivores are small, nocturnal and solitary animals and all these probably make them less studied animals. Accordingly very little information is available on their ecology, behaviour, habits, taxonomy, conservation threats etc. This is particularly true in Kerala. There is only a single specific study on the small carnivore in Kerala, which is on the Smooth Indian Otter at Periyar Tiger Reserve in 2004-2005. The present study is the first-ever study on the small carnivores of Parambikulam Tiger Reserve (PKTR). The objectives of the study were to understand the diversity, abundance, status, distribution and habitat preference of the small carnivores of the Tiger Reserve. The study was carried out for one year from June 2011 to May 2012. The methods employed to study the small carnivores were, camera-trap survey, day transect survey for the direct and indirect evidences, night transect survey using vehicles and questionnaire survey among the various stake holders at PKTR. A total of 1,349 camera-trap nights, 242 kilometres transect walk, 344 kilometres of night transect were carried out during the present study. The salient findings are summarised below.

1. A total of 11 species of small carnivores in four families were recorded from the PKTR during the present study. This includes four species mongooses, three civets, two small cats and two mustelids.

2. The mongooses reported from PKTR are Indian Grey Mongoose *Herpestes edwardsi,* Brown Mongoose *Herpestes fuscus*, Ruddy Mongoose *Herpestes smithi* and Stripe-necked Mongoose *Herpestes vitticollis*. Thus all the four species of mongoose known from the Western Ghats have been recorded from PKTR.

3. The civets reported from PKTR are Common Palm Civet *Paradoxurus hermaphroditus,* Brown Palm civet *Paradoxurus jerdoni* and Small Indian civet

Viverricula indica. Thus out of the four species of viverrids of the Western Ghats three have been recorded from PKTR.

4. The mustelids reported from PKTR are Smooth-coated Otter *Lutra perspicillata* and Nilgiri Marten *Martes gwatkinsii*. Thus out of the four species of mustelids known from the Western Ghats two have been recorded from PKTR.

5. The lesser cats reported from PKTR are Jungle Cat *Felis chaus* and Leopard Cat *Felis bengalensis*. Thus out of the four species of lesser cats of the Western Ghats two have been recorded from PKTR.

6. The camera trap studies show that the 90% of the small carnivores captured in the camera traps belonged to three species of viverrids such as the Small Indian Civet (31.7%), Common Palm Civet (30%) and Brown Palm Civet (28.3%). The other small carnivores accounted for only 10% which includes, Stripe-necked Mongoose (3.3%), Smooth-coated Otter (1.7%), Nilgiri Marten (1.7%), Ruddy Mongoose (1.7%) and Leopard Cat (1.7%).

7. The camera traps also documented the presence of 16 other mammals such as Tiger *Panthera tigris*, Leopard *Panthera pardus*, Sloth Bear *Melursus ursinus*, Wild Dog *Cuon alpinus* Asian Elephant *Elephus maximus,* Sambar Deer *Rusa unicolor*, Spotted Deer *Axis axis*, Barking Deer *Muntiacus muntjak*, Mouse Deer *Moschiola indica*, Gaur *Bos gaurus*, Wild Boar *Sus scrofa*, Indian Hare *Lepus nigricollis*, Indian Pangolin *Manis crassicaudata*, Indian Crested Porcupine *Hystrix indica*, Bonnet Macaque *Macaca radiata* and Nilgiri Langur *Semnopithecus johnii* from the PKTR.

8. The camera trap success rate has been generally higher at PKTR (4.5%) when compared to the other locations in the Western Ghats, north-east Indian and the South-East Asia.

9. Out of the 10 locations used for the camera trapping the camera trapping success rates were higher in Karimala (28.3%), Orukomban (25%) and Vengoli (18.3%) of PKTR, indicating that the small carnivore diversity is more in these sites.

10. A total of 88 incidence of indirect evidences of small carnivores were recorded from 242km transect walk. Abundance of small carnivores (scats/kilometer), with the civets (0.24) having the maximum abundance followed by mongoose (0.05), otters (0.04) and small cats (0.02) at the PKTR.

11. The 242km of day transects also resulted in 15 sightings of five different species of small carnivores. They are Indian Grey Mongoose *Herpestes edwardsii*, Stripe-necked Mongoose *Herpestes vitticollis*, Brown Mongoose *Herpestes fuscus,* Smooth-coated Otter *Lutrogale perspicillata* and Common Palm Civet *Paradoxurus hermaphrodites.*

12. The night spot-light survey transect of 344km on vehicle resulted in 36 sightings of recorded five species of small carnivores including Jungle Cat *Felis chaus,* Leopard Cat *Prionailurus bengalensis,* Common Palm Civet *Paradoxurus hermaphroditus,* Brown Palm Civet *Paradoxurus jerdoni* and Small Indian Civet *Viverricula indica* with an encounter rate of 1.06 animals/hr.

13. The encounter rate small carnivores in the night transect were as follows. The Small Indian Civet *Viverricula indica* was the most encountered animal in the night transect (0.48 animals/hr) followed by Common Palm Civet *Paradoxurus*

hermaphroditus (0.45 animals/hr) and Brown Palm Civet *Paradoxurus jerdoni* (0.07 animals/hr).

14. The Brown Mongoose *Herpestes fuscus* sighted from the PKTR is the first record of this species from PKTR as well as the second from Kerala, the other being from Peerumedu.

15. The Nilgiri Marten *Martes gwatkinsii* sighted is the first record of this species from PKTR. The other locations from Kerala from where Nilgiri Marten is known are Silent Valley National Park, Eravikulam National Park and Pampadum Shola National Park, Periyar Tiger Reserve, Nellimapathy Reserved Forests and Vazhachal Reserved Forests.

16. The Ruddy Mongoose *Herpestes smithii* sighting is the first report of the species from PKTR and second confirmed sighting of Ruddy Mongoose from the State, the other one being from Chinnar WLS.

17. PKTR holds a good population of this endemic Brown Palm Civet *Paradoxurus jerdoni*. This animal has been reported only from the evergreen forests and the adjoining forests of Orukomban and Karimala at PKTR.

18. This is the first report of Brown Palm Civet *Paradoxurus jerdoni* from PKTR. Within Kerala Brown Palm Civet has been reported from Achenkoil Forest Range in Achenkoil Forest Division, Periyar Tiger Reserve, Vazhachal Forest Division (Peringalkutthu & Malakkappara) and Silent Valley National Park.

19. The Common Palm Civet and Small Indian Civets were recorded between the altitude ranges from 450-1200m, Brown Palm Civet (450-900m), Smooth-coated Otter (450-

600m), Nilgiri Marten (708m) Stripe-necked mongoose (500-850m), Indian Grey Mongoose (550-850m), Ruddy Mongoose (574m), Brown Mongoose (492m), Leopard Cat (600-700m) and Jungle Cat (550m) from PKTR.

20. The present study on the small carnivores of PKTR observed couple of threats to the small carnivores at PKTR. There was an incidence of road kill on the Common Mongoose between Top Slip and Anappadi check post.

21. The questionnaire survey suggested that there is a perceivable increase in the population of the mugger crocodile at PKTR reservoir. The population rise in the mugger is said to be a competition for food resource for the Smooth-coated Otter.

22. This may be further investigated to ascertain whether the mugger is really causing a competition for the food resource for the Smooth Coated Otter at PKTR.

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STATUS SURVEY, DISTRIBUTION AND HABITAT PREFERENCES OF SMALL CARNIVORES IN PARAMBIKULAM TIGER RESERVE, KERALA

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ABSTRACT OF THE THESIS

Submitted in partial fulfillment of the requirement for the degree of

Master of Science in Forestry

Faculty of Agriculture

Kerala Agricultural University

DEPARTMENT OF WILDLIFE SCIENCES
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VELLANIKKARA, THRISSUR – 680 656
KERALA, INDIA

2012

ABSTRACT

A study was done at Parambikulam Tiger Reserve (PKTR) to understand the diversity, status, distribution and habitat preferences of the small carnivores at PKTR. The methodology used included the camera trapping, with 1,349camera-trap nights, day transects (242km) and night transects (344km), looking for direct as well as indirect evidences.

The camera trap studies show that the 90% of the small carnivores captured in the camera traps belonged to three species of viverrids such as the Small Indian Civet (31.7%), Common Palm Civet (30%) and Brown Palm Civet (28.3%). The other small carnivores accounted for only 10% which includes, Stripe-necked Mongoose (3.3%), Smooth-coated Otter (1.7%), Nilgiri Marten (1.7%), Ruddy Mongoose (1.7%) and Leopard Cat (1.7%). The 242km of day transects also resulted in 15 sightings of five different species of small carnivores. They are Indian Grey Mongoose, Stripe-necked Mongoose, Brown Mongoose, Smooth-coated Otter and Common Palm Civet. The night spot-light survey transect of 344km on vehicle resulted in 36 sightings of recorded five species of small carnivores including Jungle Cat, Leopard Cat, Common Palm Civet, Brown Palm Civet and Small Indian Civet with an encounter rate of 1.06 animals/hr. A total of 88 incidence of indirect evidences of small carnivores were recorded from 242km transect walk. Abundance of small carnivores (scats/kilometer), with the civets (0.24) having the maximum abundance followed by mongoose (0.05), otters (0.04) and small cats (0.02) at the PKTR. Of the total 11 species of small carnivores recorded from PKTR, the sightings of Brown Mongoose, Ruddy Mongoose, Nilgiri Marten and Brown Palm Civet were the first record of this species from PKTR. Moreover, the Brown Mongoose and Ruddy Mongoose the present sightings were the second sighting records from Kerala, the earlier sightings being from Peerumedu and Chinnar WLS respectively.

APPENDIx

Appendix I: Checklist of small carnivores of India

Sl. No.	Scientific name	Common Name	Family
1.	*Ailurus fulgens*	Red Panda	Aliuridae
2.	*Caracal caracal*	Caracal	Felidae
3.	*Felis chaus**	Jungle Cat	Felidae
4.	*Felis silvestris*	Wild Cat	Felidae
5.	*Lynx lynx*	Eurasian Lynx	Felidae
6.	*Otocolobus manul*	Pallas's Cat	Felidae
7.	*Pardofelis marmorata*	Marbled Cat	Felidae
8.	*Pardofelis temminckii*	Asiatic Golden Cat	Felidae
9.	*Prionailurus bengalensis**	Leopard Cat	Felidae
10.	*Prionailurus rubiginosus**	Rusty-spotted Cat	Felidae
11.	*Prionailurus viverrinus**	Fishing Cat	Felidae
12.	*Herpestes edwardsii**	Grey Mongoose	Herpestidae
13.	*Herpestes fuscus**	Brown Mongoose	Herpestidae
14.	*Herpestes javanicus*	Small Indian Mongoose	Herpestidae
15.	*Herpestes palustris*	Indian Marsh Mongoose	Herpestidae
16.	*Herpestes smithii**	Ruddy Mongoose	Herpestidae
17.	*Herpestes urva*	Crab-eating Mongoose	Herpestidae
18.	*Herpestes vitticollis**	Striped-necked Mongoose	Herpestidae
19.	*Aonyx cinerea**	Small-clawed Otter	Mustelidae
20.	*Arctonyx collaris*	Hog-badger	Mustelidae
21.	*Lutra lutra**	Eurasian Otter	Mustelidae

22.	*Lutra perspicillata**	Smooth-coated Otter	Mustelidae
23.	*Martes flavigula*	Yellow-throated Marten	Mustelidae
24.	*Martes foina*	Beech Marten	Mustelidae
25.	*Martes gwatkinsii**	Nilgiri Marten	Mustelidae
26.	*Mellivora capensis**	Ratel or Honey Badger	Mustelidae
27.	*Melogale personata*	Large-toothed Ferret Badger	Mustelidae
28.	*Melogale moschata*	Small-toothed Ferret Badger	Mustelidae
29.	*Mustela kathiah*	Yellow-bellied Weasel	Mustelidae
30.	*Mustela altaica*	Pale Weasel	Mustelidae
31.	*Mustela ermine*	Ermine or Stoat	Mustelidae
32.	*Mustela putorius*	Tibetan Polecat	Mustelidae
33.	*Mustela sibirica*	Siberian Weasel	Mustelidae
34.	*Mustela strigidorsa*	Back-striped Weasel	Mustelidae
35.	*Prionodon pardicolor*	Spotted Linsang	Prionodontidae
36.	*Arctictis binturong*	Binturong	Viverridae
37.	*Arctogalidia trivirgata*	Small-toothed Palm Civet	Viverridae
38.	*Paguma larvata*	Masked Palm Civet	Viverridae
39.	*Paradoxurus jerdoni**	Brown Palm Civet	Viverridae
40.	*Paradoxurus hermaphrodites**	Common Palm Civet	Viverridae
41.	*Viverra zibetha*	Large Indian Civet	Viverridae
42.	*Viverra civettina**	Malabar Civet	Viverridae
43.	*Viverricula Indica**	Small Indian Civet	Viverridae

*Seen in Western Ghats

Source: (Nayerul and Vijayan.1993; Nameer 2008; Schipper et al., 2008)

Appendix II: Camera trap data on small carnivores at PKTR from June 2011 to May 2012

Sl. No.	Place	Latitude (N)	Longitude (E)	Altitude (m)	Date	Habitat
Common Palm Civet						
1.	Cheechali	10^0 26' 04.5"	76^0 48' 18.7"	563	17/09/2011	MDF
2.	Karimala	10^0 21' 47.4"	76^0 45' 02.7"	1243	26/07/2011	EG
3.	Kariyanchola	10^0 27' 11.5"	76^0 48' 52.1"	638	26/09/2011	MDF
4.	Kariyanchola	10^0 27' 42.8"	76^0 49' 38.9"	724	21/09/2011	EG
5.	Kuriyarkutty	10^0 24' 09.2"	76^0 44' 26.5"	570	23/10/2011	TP
6.	Orukomban	10^0 23' 45.0"	76^0 40' 46.9"	541	22/11/2011	EG
7.	Orukomban	10^0 23' 20.3"	76^0 39' 55.5"	493	16/03/2012	EG
8.	Orukomban	10^0 23' 20.3"	76^0 39' 55.5"	493	30/03/2012	EG
9.	Poopara	10^0 21' 51.4"	76^0 47' 19.5"	711	17/12/2011	TP
10.	Thellikkal	10^0 25' 15.8"	76^0 43' 35.6"	521	08/10/2011	TP
11.	Thellikkal	10^0 25' 16.0"	76^0 43' 36.9"	506	25/04/2012	TP
12.	Vengoli	10^0 24' 48.4"	76^0 47' 08.1"	680	26/08/2011	MDF
13.	Vengoli	10^0 25' 11.7"	76^0 48' 23.2"	831	16/08/2011	MDF
14.	Vengoli	10^0 24' 22.5"	76^0 47' 56.1"	574	06/03/2012	MDF
15.	Vengoli	10^0 24' 22.5"	76^0 47' 56.1"	574	08/03/2012	MDF
16.	Vengoli	10^0 24' 22.5"	76^0 47' 56.1"	574	08/03/2012	MDF
17.	Vengoli	10^0 24' 22.5"	76^0 47' 56.1"	574	11/03/2012	MDF
18.	Vengoli	10^0 24' 22.5"	76^0 47' 56.1"	574	12/03/2012	MDF
Small Indian Civet						
19.	Karimala	10^0 21' 51.6"	76^0 45' 50.0"	708	26/07/2011	MDF
20.	Karimala	10^0 21' 47.4"	76^0 45' 02.7"	1243	25/07/2011	EG
21.	Karimala	10^0 21' 47.4"	76^0 45' 02.7"	1243	10/08/2011	EG

22.	Vengoli	10^0 25' 04.1	76^0 48' 19.2"	774	17/08/2011	MDF
23.	Vengoli	10^0 25' 11.7"	76^0 48' 23.2"	831	21/08/2011	MDF
24.	Aanapadi	10^0 26' 44.6"	76^0 48' 35.7"	561	14/09/2011	MDF
25.	Thellikkal	10^0 25' 15.8"	76^0 43' 35.6"	521	05/10/2011	TP
26.	Thellikkal	10^0 25' 15.8"	76^0 43' 35.6"	521	17/10/2011	TP
27.	Thellikkal	10^0 27' 15.9"	76^0 46' 02.8"	571	14/10/2011	MDF
28.	Kothala	10^0 22' 55.3"	76^0 40' 53.1"	491	25/11/2011	MDF
29.	Kothala	10^0 23' 31.2"	76^0 42' 57.5"	574	28/11/2011	MDF
30.	Kothala	10^0 22' 56.0"	76^0 42' 11.9"	586	01/12/2011	MDF
31.	Kothala	10^0 22' 56.0"	76^0 42' 11.9"	586	02/12/2011	MDF
32.	Orukomban	10^0 24' 0.2"	76^0 41' 38.2"	492	11/11/2011	EG
33.	Orukomban	10^0 24' 0.2"	76^0 41' 38.2"	492	21/11/2011	EG
34.	Orukomban	10^0 24' 18.5"	76^0 42' 48.1"	512	22/11/2011	EG
35.	Orukomban	10^0 24' 02.6"	76^0 42' 31.8"	498	17/11/2011	EG
36.	Karimala	10^0 21' 40.2"	76^0 45' 28.3"	750	16/02/2012	EG
37.	Karimala	10^0 21' 37.7"	76^0 45' 17.1"	1109	19/02/2012	EG
Brown Palm Civet						
38.	Karimala	10^0 21' 57.8"	76^0 45' 42.6"	833	31/07/2011	MDF
39.	Karimala	10^0 22' 08.1"	76^0 45' 50.2"	686	16/02/2012	MDF
40.	Karimala	10^0 22' 08.1"	76^0 45' 50.2"	686	17/02/2012	MDF
41.	Karimala	10^0 22' 08.1"	76^0 45' 50.2"	686	17/02/2012	MDF
42.	Karimala	10^0 21' 40.2"	76^0 45' 28.3"	750	12/02/2012	EG
43.	Karimala	10^0 21' 40.2"	76^0 45' 28.3"	750	13/02/2012	EG
44.	Karimala	10^0 21' 40.2"	76^0 45' 28.3"	750	14/02/2012	EG
45.	Karimala	10^0 21' 40.2"	76^0 45' 28.3"	750	19/02/2012	EG
46.	Karimala	10^0 21' 40.2'	76^0 45' 28.3"	750	19/02/2012	EG
47.	Orukomban	10^0 23' 29.6"	76^0 39' 43.8"	485	25/03/2012	EG

48.	Orukomban	10^0 23' 29.6"	76^0 39' 43.8"	485	28/03/2012	EG
49.	Orukomban	10^0 23' 29.6"	76^0 39' 43.8"	485	31/03/2012	EG
50.	Orukomban	10^0 23' 29.6"	76^0 39' 43.8"	485	11/04/2012	EG
51.	Orukomban	10^0 23' 20.3"	76^0 39' 55.5"	493	16/03/2012	EG
52.	Orukomban	10^0 23' 20.3"	76^0 39' 55.5"	493	29/03/2012	EG
53.	Orukomban	10^0 23' 20.3"	76^0 39' 55.5"	493	30/03/2012	EG
54.	Orukomban	10^0 23' 20.3"	76^0 39' 55.5"	493	21/04/2012	EG
Stripe-necked Mongoose						
55.	Vengoli	10^0 24' 22.5"	76^0 47' 56.1"	574	12/03/2012	MDF
56.	Karimala	10^0 21' 57.8"	76^0 45' 42.6"	833	28/07/2011	MDF
Nilgiri Marten						
57.	Karimala	10^0 22' 07.9"	76^0 45' 50.0"	708	27/07/2011	MDF
Smooth-coated Otter						
58.	Cheechali	10^0 26' 04.5"	76^0 48' 18.7"	563	09/09/2011	MDF
Leopard Cat						
59.	Kariyanchola	10^0 27' 12.7"	76^0 49' 42.5"	653	20/09/2011	MDF
Ruddy Mongoose						
60.	Vengoli	10^0 24' 22.5"	76^0 47' 56.1"	574	13/03/2012	MDF

MDF: Moist Deciduous Forest, EVG: Evergreen Forest, TP: Teak Plantation

Appendix III: Details of the line transects used for the direct and indirect survey during day time, used for the small carnivore survey at PKTR

Transect No.	Date	Starting Point	Ending Point	Transect dist. (KM)	Habitat
1.	25/06/2011	Anapadi	Kariyanchola	3	EVG
2.	25/06/2011	Kariyanchola	Anapadi	3	EVG
3.	05/07/2011	Parambikulam	Earthen dam	3	TP
4.	02/08/2011	Parambikulam	Kothala	4	MDF
5.	02/08/2011	Kothala	Parambikulam	4	MDF
6.	14/08/2011	Tunnel entry	Vengoli	3	MDF
7.	14/08/2011	Vengoli top	Tunnel entry	2	EVG
8.	15/08/2011	Anapadi	Cheechali	3	MDF
9.	15/08/2011	Cheechali	Anapadi	3	MDF
10.	17/08/2011	Anapadi	Kariyanchola	4	EVG
11.	18/08/2011	Kuriyarkutty	Thelikkal	3	TP
12.	18/08/2011	Thelikkal	Kuriyarkutty	3	TP
13.	20/08/2011	Kuriyarkutty	Medamchalu	3	EVG
14.	20/08/2011	Medamchalu	Orukomban	4	EVG
15.	20/08/2011	Orukomban	Muduvarachalu	3	EVG
16.	20/08/2011	Muduvarachalu	Orukomban	4	EVG
17.	21/08/2011	Orukomban	Muduvarachal	3	EVG
18.	21/08/2011	Muduvarachal	Orukomban	4	EVG
19.	25/08/2011	Earthen dam	Poopara	4	TP
20.	25/08/2011	Poopara	Earthen dam	2	TP
21.	26/08/2011	Earthen dam	Karimala	4	MDF
22.	26/08/2011	Earthen dam	Karimala	2	EVG
23.	28/08/2011	Tunnel entry	Vengoli	4	MDF
24.	06/09/2011	Anapadi	Kariyanchola	4	EVG

25.	07/09/2011	Anapadi	Cheechali	3	MDF
26.	09/09/2011	Earthen dam	Karimala	4	MDF
27.	09/09/2011	Earthen dam	Karimala	2	EVG
28.	11/09/2011	Thellikkal	Sungam	4	TP
29.	16/09/2011	Parambikulam	Kothala	4	MDF
30.	17/09/2011	Kothala	Kotayali	4	MDF
31.	19/09/2011	Anapadi	1st No	3	MDF
32.	19/09/2011	1st No	Cheechali	4	MDF
33.	21/09/2011	Kuriyarkutty	Medamchalu	3	EVG
34.	21/09/2011	Medamchalu	Orukomban	4	EVG
35.	21/09/2011	Orukomban	Muduvarachalu	3	EVG
36.	21/09/2011	Muduvarachalu	Orukomban	4	EVG
37.	24/09/2011	Kuriyarkutty	Medamchalu	3	EVG
38.	05/10/2011	Thoonakadavu	Kannimara	3	MDF
39.	05/10/2011	Kannimara	Anakkal vayal	4	TP
40.	15/10/2011	Anapadi	Kariyanchola	4	EVG
41.	17/10/2011	Parambikulam	Kuriyarkutty	3	TP
42.	02/11/2011	Anapadi	Kariyanchola	4	EVG
43.	08/11/2011	Parambikulam	Kuriyarkutty	3	TP
44.	09/11/2011	Kuriyarkutty	Parambikulam	3	TP
45.	20/11/2011	Anapadi	Cheechali	4	MDF
46.	20/12/2011	Parambikulam	Kothala	3	MDF
47.	21/12/2011	Kothala	Kotayali	3	MDF
48.	21/12/2011	Kothala	Kotayali	4	MDF
49.	24/12/2011	Parambikulam	Kuriyarkutty	3	TP
50.	24/12/2011	Parambikulam	Kuriyarkutty	3	TP
51.	25/12/2011	Kuriyarkutty	Thelikkal	4	TP
52.	27/12/2011	Parambikulam	Vengoli	3	MDF

53.	27/12/2011	Parambikulam	Vengoli	3	MDF
54.	27/12/2011	Parambikulam	Vengoli	4	EVG
55.	27/12/2011	Parambikulam	Vengoli	4	EVG
56.	27/12/2011	Parambikulam	Vengoli	3	MDF
57.	27/12/2011	Parambikulam	Vengoli	3	TP
58.	29/12/2011	Cheechali	Anapadi	3	MDF
59.	29/12/2011	Anapadi	Cheechali	3	MDF
60.	30/12/2011	Parambikulam	Kothala	4	MDF
61.	30/12/2011	Parambikulam	Kothala	3	MDF
62.	30/12/2011	Parambikulam	Kothala	4	MDF
63.	30/12/2011	Parambikulam	Kothala	4	MDF
64.	30/12/2011	Kothala	Parambikulam	4	MDF
65.	30/12/2011	Kothala	Parambikulam	3	MDF
66.	30/12/2011	Kothala	Parambikulam	3	MDF
67.	24/01/2012	Earthdam	Poopara	4	TP
68.	24/01/2012	Earthdam	Poopara	4	TP
69.	24/01/2012	Earthdam	Poopara	4	TP
70.	02/02/2012	Kuriyarkutty	Thelikkal	3	TP
71.	02/02/2012	Kuriyarkutty	Thelikkal	4	TP

MDF: Moist Deciduous Forest, EVG: Evergreen Forest, P: Teak Plantation

Appendix IV: Small carnivore indirect evidence data collected from PKTR from June 2011 to May 2012

Sl. No.	Species	Date	Latitude N	Longitude E	Alt (m)	Habitat	Terrain
1.	Civet	25/06/2011	10° 27' 24.3"	76° 49' 47.9"	714	EVG	Plain
2.	Civet	25/06/2011	10° 28' 46.2"	76° 32' 23.3"	689	EVG	MS
3.	Civet	02/08/2011	10° 23' 41.7"	76° 43' 41.1"	520	MDF	Plain
4.	Civet	02/08/2011	10° 23' 03.8"	76° 39' 48.3"	478	MDF	Plain
5.	Civet	02/08/2011	10° 23' 31.2"	76° 42' 57.5"	574	MDF	Slope
6.	Civet	14/08/2011	10° 25' 19.0"	76° 48' 57.4"	1081	EVG	Slope
7.	Civet	14/08/2011	10° 22' 16.4"	76° 46' 42.2"	576	EVG	Slope
8.	Civet	15/08/2011	10° 26' 38.5"	76° 49' 39.2"	589	MDF	Slope
9.	Civet	17/08/2011	10° 27' 30.3"	76° 49' 47.9"	714	EVG	Slope
10.	Civet	21/08/2011	10° 24' 17.2"	76° 41' 36.2"	490	MDF	Plain
11.	Civet	25/08/2011	10° 21' 57.0"	76° 47' 38.0"	745	MDF	Plain
12.	Civet	26/08/2011	10° 22' 03.6"	76° 45' 44.9"	785	MDF	Slope
13.	Civet	26/08/2011	10° 22' 03.8"	76° 45' 45.1"	788	TP	Slope
14.	Civet	26/08/2011	10° 22' 03.1"	76° 45' 44.4"	782	TP	Slope
15.	Civet	26/08/2011	10° 21'51.0"	76° 45' 40.3"	953	TP	Slope
16.	Civet	26/08/2011	10° 21' 57.8"	76° 45' 42.6"	833	MDF	Slope
17.	Civet	26/08/2011	10° 21'51.0"	76° 45' 40.3"	953	MDF	Slope
18.	Civet	26/08/2011	10° 21' 57.8"	76° 45' 42.6"	833	MDF	Slope
19.	Civet	26/08/2011	10° 21'51.0"	76° 45' 40.3"	953	EVG	Slope
20.	Civet	28/08/2011	10° 25' 14.4"	76° 48' 28.2"	890	MDF	Slope
21.	Civet	28/08/2011	10° 24' 27.7"	76° 46' 58.4"	579	MDF	Slope
22.	Civet	28/08/2011	10° 22' 16.4"	76° 46' 42.2"	576	MDF	Plain

23.	Civet	07/09/2011	10º 26' 38.5"	76º 49' 39.2"	589	MDF	Plain
24.	Civet	09/09/2011	10º 22' 03.6"	76º 45' 44.9"	785	MDF	Slope
25.	Civet	09/09/2011	10º 22' 03.3"	76º 45' 45.3"	782	MDF	Slope
26.	Civet	09/09/2011	10º 22' 13.8"	76º 45' 40.1"	792	MDF	Slope
27.	Civet	09/09/2011	10º 22' 02.1"	76º 45' 40.4"	810	TP	Slope
28.	Civet	09/09/2011	10º 21'50.0"	76º 45' 39.3"	943	MDF	Slope
29.	Civet	09/09/2011	10º 21' 57.8"	76º 45' 40.6"	853	MDF	Slope
30.	Civet	09/09/2011	10º 21'55.1"	76º 45' 42.3"	964	TP	Slope
31.	Civet	09/09/2011	10º 21' 56.9"	76º 45' 43.6"	831	TP	Plain
32.	Civet	11/09/2011	10º 23' 33.7"	76º 43' 42.9"	540	MDF	Plain
33.	Civet	17/09/2011	10º 22' 54.5"	76º 41' 07.2"	506	MDF	Plain
34.	Civet	17/09/2011	10º 22' 49.7"	76º 41' 15.4"	501	MDF	Slope
35.	Civet	17/09/2011	10º 22' 47.9"	76º 41' 18.1"	538	MDF	Slope
36.	Civet	17/09/2011	10º 22' 38.5"	76º 41' 40.6"	538	EVG	Slope
37.	Civet	17/09/2011	10º 22' 58.9"	76º 41' 24.9"	624	EVG	Slope
38.	Civet	17/09/2011	10º 22' 20.8"	76º 41' 54.2"	580	EVG	Plain
39.	Civet	21/09/2011	10º 24' 22.5"	76º 42' 54.5"	555	MDF	Plain
40.	Civet	21/09/2011	10º 23' 49.7"	76º 40' 15.8"	541	MDF	Plain
41.	Civet	21/09/2011	10º 21' 54.5"	76º 40' 01.3"	490	MDF	Slope
42.	Civet	15/10/2011	10º 27' 21.5"	76º 48' 52.9"	640	EVG	Slope
43.	Civet	02/11/2011	10º 27' 14.5"	76º 48' 42.2"	639	EVG	Plain
44.	Civet	08/11/2011	10º 23' 22.5"	76º 42' 54.5"	555	MDF	Plain
45.	Civet	08/11/2011	10º 22' 49.7"	76º 41' 15.8"	541	TP	Plain
46.	Civet	08/11/2011	10º 22' 54.5"	76º 41' 01.3"	490	TP	Plain
47.	Civet	20/11/2011	10º 27' 11.5"	76º 48' 52.1"	638	EVG	Slope
48.	Civet	20/12/2011	10º 23' 31.4"	76º 43' 43.1"	553	EVG	Slope

49.	Civet	21/12/2011	10º 23' 31.5"	76º 41' 31.6"	519	MDF	Plain
50.	Civet	21/12/2011	10º 22' 37.2"	76º 41' 39.0"	519	MDF	Plain
51.	Civet	21/12/2011	10º 22' 57.0"	76º 42' 22.5"	571	MDF	Slope
52.	Civet	27/12/2011	10º 24' 56.6"	76º 47' 20.0"	678	MDF	Plain
53.	Civet	27/12/2011	10º 25' 11.7"	76º 48' 23.2"	831	TP	Plain
54.	Civet	30/12/2011	10º 22' 37.2"	76º 41' 39.0"	519	EVG	Slope
55.	Civet	30/12/2011	10º 22' 57.0"	76º 42' 22.5"	571	EVG	Slope
56.	Civet	24/01/2012	10º 21' 57.0"	76º 47' 38.0"	745	MDF	Slope
57.	Civet	02/02/2012	10º 27' 18.7"	76º 45' 32.1"	550	MDF	Plain
58.	Mongoose	20/08/2011	10º 23' 22.5"	76º 42' 54.5"	630	EVG	Slope
59.	Mongoose	25/08/2011	10º 22' 02.2"	76º 47' 00.6"	649	MDF	Slope
60.	Mongoose	25/08/2011	10º 21' 52.0"	76º 47' 31.6"	736	TP	Plain
61.	Mongoose	26/08/2011	10º 22' 03.3"	76º 45' 45.3"	782	TP	Slope
62.	Mongoose	19/09/2011	10º 26' 37.8"	76º 49' 33.3"	596	MDF	Plain
63.	Mongoose	17/10/2011	10º 23' 32.3'	76º 42' 55.5"	546	MDF	Plain
64.	Mongoose	25/12/2011	10º 27' 14.2"	76º 45' 43.1"	557	MDF	Plain
65.	Mongoose	27/12/2011	10º 25' 16.9"	76º 48' 32.6"	936	MDF	Plain
66.	Mongoose	29/12/2011	10º 26' 38.5"	76º 49' 39.2"	589	MDF	Plain
67.	Mongoose	30/12/2011	10º 23' 31.5"	76º 41' 31.6"	519	MDF	Slope
68.	Mongoose	24/01/2012	10º 22' 02.2"	76º 47' 00.6"	649	MDF	Plain
69.	Mongoose	24/01/2012	10º 21' 52.0"	76º 47' 31.6"	736	MDF	Plain
70.	Otter	15/08/2011	10º 26' 43.5"	76º 48' 34.5"	546	MDF	Slope
71.	Otter	18/08/2011	10º 26' 38.0"	76º 45' 48.2"	533	MDF	Plain
72.	Otter	18/08/2011	10º 26' 39.8"	76º 45' 58.4"	533	MDF	Plain
73.	Otter	20/08/2011	10º 22' 49.7"	76º 41' 15.8"	610	EVG	Plain
74.	Otter	21/08/2011	10º 23' 0.9"	76º 41' 58.9"	511	EVG	Plain
75.	Otter	21/08/2011	10º 23' 55.2"	76º 41' 48.9"	520	EVG	Plain

76.	Otter	21/08/2011	10° 23' 45.0"	76° 40' 46.9"	541	MDF	Slope
77.	Otter	21/08/2011	10° 24' 0.2"	76° 41' 38.2"	492	MDF	Slope
78.	Otter	24/09/2011	10° 23' 29.5"	76° 42' 44.5"	645	TP	Plain
79.	Otter	24/12/2011	10° 23' 22.5"	76° 42' 54.5"	555	MDF	Plain
80.	Otter	30/12/2011	10° 23' 41.7"	76° 43' 41.1"	520	MDF	Plain
81.	Otter	02/02/2012	10° 27' 13.2"	76° 45' 40.1"	555	MDF	Plain
82.	Otter	02/02/2012	10° 27' 11.8"	76° 45' 39.1"	563	MDF	Plain
83.	Small cat	18/08/2011	10° 25' 15.8"	76° 43' 35.6"	521	MDF	Plain
84.	Small cat	20/08/2011	10° 22' 54.5"	76° 41' 01.3"	590	MDF	Plain
85.	Small cat	25/08/2011	10° 22' 05.2"	76° 46' 20.5"	590	MDF	Slope
86.	Small cat	06/09/2011	10° 27' 11.5"	76° 48' 52.1"	638	EVG	Slope
87.	Small cat	09/11/2011	10° 23' 21.5"	76° 42' 53.5"	534	MDF	Slope
88.	Small cat	24/01/2012	10° 22' 05.2"	76° 46' 20.5"	590	TP	Plain

MDF: Moist Deciduous Forest, EVG: Evergreen Forest, P: Teak Plantation

Appendix V: Details on the day transects data for direct sighting of small carnivores from PKTR from June 2011 to May 2012

Species	Location	Date	Time	No of Ind.	Distance Band	Alt (m)	Habitat
1. Brown Mongoose	Orukomban	21/09/2011	7.50 am	1	10-15m	492	EVG
2. Common Palm Civet	Thuthanpara	25/07/2011	4.20 pm	1	< 10 m	690	TP
3. Indian Grey Mongoose	Vengoli	14/08/2011	10.05 am	2	20-25m	831	MDF
4. Indian Grey Mongoose	Anapadi	19/09/2011	6.45 pm	1	10-15 m	596	MDF
5. Smooth-coated otter	Parambikulam	05/07/2011	7.45 am	3	15 m	530	TP
6. Smooth-coated otter	Thunakadavu	07/07/2011	9.10 am	2	30 m	520	TP
7. Smooth-coated otter	Kuriyarkutty	24/09/2011	11.50 am	5	> 40m	541	EVG
8. Smooth-coated otter	Kannimara	05/10/2011	11.40 am	2	> 30m	560	TP
9. Smooth-coated otter	Medamchalu	25/12/2011	10.45 am	2	>30 m	492	EVG
10. Stripe-necked Mongoose	Vengoli	28/08/2011	9. 50 am	1	> 30 m	701	MDF
11. Stripe-necked Mongoose	Vengoli	15/08/2011	9.10 am	3	20-25 m	680	MDF
12. Stripe-necked Mongoose	Thellikkal	18/08/2011	11.20 am	2	20-25m	557	TP
13. Stripe-necked Mongoose	Cheechali	20/11/2011	7.20 am	1	20-25m	544	MDF
14. Stripe-necked Mongoose	Cheechali	29/12/2011	5.50 pm	2	20-25 m	546	MDF
15. Stripe-necked Mongoose	Poopara	24/01/2012	12.25 pm	2	>20 m	648	TP

MDF: Moist Deciduous Forest, EVG: Evergreen Forest, P: Teak Plantation

Appendix VI: Details on the night transects data for direct sighting of small carnivores from PKTR from June 2011 to May 2012

Date	Transect distance (km)	Time taken	Species	Location	Time	Distance Band	Habitat
03/07/2011	18	45 min	SIC	Sungam	7.00 pm	5-10 m	MDF
			CPC	Sungam	7.15 pm	10-15 m	TP
06/07/2011	24	1 hr 45 min	LC	Tramway bridge	7.55 pm	10-15 m	MDF
			CPC	Kuriyarkutty	8.10 pm	5-10 m	MDF
			SIC	Aanakkal vayal	8.25 pm	10-15 m	TP
28/07/2011	5	35 min	SIC	Tunnel entry road	8.25 pm	10-15 m	MDF
30/07/2011	5	1 hr	Not sighted				
13/08/2011	18	1 hr 25 min	BPC	Kuriyarkutty	8.50 pm	5-10 m	MDF
29/08/2011	4	1 hr	SIC	Parambikulam dam	7.20 pm	10-15 m	MDF
01/09/2011	36	2 hr 40 min	CPC	Medamchal	7.15 pm	10-15 m	EVG
			SIC	Kuriyarkutty	7.20 pm	5-10 m	EVG
			CPC	Orukomban	8.05 pm	5-10 m	EVG
			CPC	Orukomban	8.50 pm	10-15 m	EVG
19/09/2011	18	45 min	CPC	Valley view point	6.55 pm	10-15 m	MDF
			SIC	Thoonakadavu	7.10 pm	10-15 m	MDF
29/09/2011	5	1 hr	Not sighted				
04/10/2011	24	1 hr 15 min	BPC	Kuriyarkutty	8.40 pm	10-15 m	EVG
			SIC	Kuriyarkutty	8.45 pm	10-15 m	MDF

20/10/2011	20	1 hr 40 min	CPC	Dam view point	8.45 pm	5-10 m	MDF
			CPC	Thoonakadavu	9.10 pm	10-15 m	MDF
			SIC	Dam view point	9.40 pm	5-10 m	TP
			SIC	Tunnel entry board	10.5 pm	10-15 m	TP
02/11/2011	24	3 hrs 20 min	CPC	kottayali	8.10 pm	10-15 m	EVG
			SIC	Kotayali HQ	8.25 pm	10-15 m	MDF
			SIC	Kothala	8.40 pm	20m	EVG
11/11/2011	24	1 hr 45 min	Not sighted				
18/11/2011	5	45 min	JC	Tunnel Entry road	8.20 pm	20-30	MDF
22/11/2011	18	55 min	SIC	Sungam	7.30 pm	10-15 m	EVG
30/12/2011	5	45 min	Not sighted				
06/12/2011	36	3 hrs 25 min	CPC	Kuriyarkutty	9.10 pm	5-10 m	EVG
			CPC	Medamchalu	9.45 pm	10-15 m	EVG
26/12/2011	35	3 hrs 05 min	CPC	Thellikkal	8.30 pm	5-10 m	TP
			CPC	Thellikkal	9.25 pm	10-15 m	TP
			SIC	Thellikkal	9.22 pm	10-15 m	MDF
04/01/2012	20	1 hr 40 min	SIC	Thoonakadavu	8.05 pm	5-10 m	TP

CPC: Common Palm Civet, SIC: Small Indian Civet, BPC: Brown Palm Civet, LC: Leopard Cat, JC: Jungle Cat
EVG: Evergreen, MDF: Moist Deciduous Forest, TP: Teak Plantation

Appendix VII: Questionnaire to assess the status of small carnivores in Parambikulam T.R.
(Response from local people)

1. Name of the respondent :

2. Occupation :

3. Place of living :

4. Have you sighted any small carnivores in this area(Y/N) :

5. If Yes, then where you usually sight them :

	Civet	Lesser cats	otters	Mongoose	Nilgiri marten
Above ground					
Ground level					
Water bodies					

6. Are you able to recognize the small carnivores : Y/N

Sl.No	Carnivore	Able to recognize (Y/ N)	Habitat	Time of sighting
			EVG, MDF, Plantations, *Vayals,* Streams/ Reservoirs	Dawn, Dusk, Day, Night
1	Civet			
2	Lesser cats			
3.	Otters			
4.	Mongoose			
5.	Nilgiri marten			

6.1 If Civet, then

Sl.No	Civet	Able to recognize (Y/ N)	Frequency of sightings		
			Daily	Weekly	Rarely
1	Common Palm Civet				
2	Brown Palm Civet				
3.	Small Indian Civet				
4.	Malabar Civet				

6.2 If Lesser cat, then

Sl.No	Lesser cats	Able to recognize (Y/ N)	Frequency of sightings		
			Daily	Weekly	Rarely
1	Jungle Cat				
2	Rusty-spotted Cat				
3.	Leopard Cat				
4.	Fishing Cat				

6.3 If Otters, then

Sl.No	Otters	Able to recognize (Y/ N)	Frequency of sightings		
			Daily	Weekly	Rarely
1	Common Otter				
2	Smooth-coated Otter				
3.	Claw-less Otter				

6.4 If Mongoose, then

Sl.No	Mongoose	Able to recognize (Y/ N)	Frequency of sightings		
			Daily	Weekly	Rarely
1	Indian Grey Mongoose				
2	Stripe-necked Mongoose				
3.	Ruddy Mongoose				
4.	Brown Mongoose				

7. Is there any conflict between people and small carnivores in and around Parambikulam T. R: Y/N

a) If yes then mention conflict is due to

b) What is the nature of the conflict with small carnivores:

8. Are you aware of any problem faced by small carnivores like:

Sl.No	Problems	Lesser cats	Civets	Otters	Mongoose
1.	Hunting/Poaching				
2.	Road kills				
3.	Disturbance by fire wood collectors				
4.	Disturbance by				
5.	Lack of food throughout year				
6.	Forest degradation / loss of habitat				
	Any other (specify)				

9. If answer to above is yes, then mention the following question

9.1 Frequency of hunting/Poaching:

a. Daily b. Weakly c. Monthly d. Rarely e. Any other (specify)

9.2 Who are the major hunters/poachers:

a. Local people b. Outsiders c. Any others (specify)

10. Purpose of hunting/poaching:

a. Normal consumption b. Local medicine c. Selling outside/trading

11. What is your perception about small carnivore conservation?

a. Very important b. Important c. Not important d. Least concerned

e. Any other (specify):

Date: **Signature of the respondent**

Appendix VIII: Questionnaire to assess the status of small carnivores in Parambikulam T.R.
(Response from forest department officials)

1. **Name of the staff:**
2. **Designation:**
3. **Working place:**
4. **Number of years of service:** a. less than 1 yr. b. less than 5 yr. c. greater than 5 yr.
5. **Are you able to distinguish the small carnivores: Y/N**
6. **If yes then**

Sl.No	Civet	Able to recognize (Y/ N)	Frequency of sightings		
			Daily	Weekly	Rarely
1	Common Palm Civet				
2	Brown Palm Civet				
3.	Small Indian Civet				
4.	Malabar Civet				
5.	Jungle Cat				
6.	Rusty-spotted Cat				
7.	Leopard Cat				
8.	Fishing Cat				
9.	Common Otter				
10.	Smooth-coated Otter				
11.	Claw-less Otter				
12.	Nilgiri Marten				
13.	Grey Mongoose				
14.	Stripe-necked Mongoose				
15.	Ruddy Mongoose				
16.	Brown Mongoose				

7. Any change observed in the sighting of Small carnivores:

Sl. No	Small carnivores	Past (2 years back)		Present (last 2 years)	
		More	Less	More	Less
1	Civet				
2	Lesser cats				
3.	Otters				
4.	Mongoose				
5.	Nilgiri marten				

8. Have you done any census for small carnivores? (Y/N)

9. If yes, what is the method

a. Line/ day transect b. Night transect c. Camera trapping d. Any other method (specify)

10. Is there any monitoring protocol exist for small carnivores?

a. Yes b. No

11. If yes, what is the frequency

a. Monthly b. Yearly c. Once in five years d. Any other

12. Is there any conflict between people and small carnivores in and around Parambikulam T R.?

a. Yes b. No

13. If yes, then mention conflict is due to (group of species):

14. What is the nature of the conflict between people and small carnivores:

a. Crop/Livestock damage b. Damage to other property c. Human injury

d. Disease spread e. Any other (specify):

15. What is the major problem faced by Small carnivores :

Sl.No	Problems	Lesser cats	Civets	Otters	Mongoose
1.	Hunting/Poaching				
2.	Road kills				
3.	Disturbance by fire wood collectors				
4.	Disturbance by honey collectors				
5.	Lack of food throughout year				
6.	Forest degradation/loss of habitat				
7.	Any other (specify)				

16. If there is problem of hunting, then what is their extent in and around Parambikulam TR.?

Sl.No	Small carnivores	Hunting of small carnivores					
		Every week	Every month	Once in six month	Once in a year	rarely	Any other (specify)
1	Civet						
2	Lesser cats						
3.	Otters						
4.	Mongoose						
5.	Nilgiri marten						

17. Number of cases registered for hunting/killing small carnivores:

Sl.No	Small carnivores	Hunting/killing cases registered				
		2010	2009	2008	2007	2006
1.	Civet					
2.	Lesser cats					
3.	Otters					
4.	Mongoose					
5.	Nilgiri marten					

18. Location where most of the hunting/killing cases of Small carnivores occurred

a.

b.

c.

19. Cooperation of people towards conservation of Small carnivores

a. Co-operate all the time

b. Co-operate sometime

c. Won't co-operate

d. Not aware about conservation issues.

Date: **Signature of the respondent**