STUDIES ON LARGE MAMMALIAN PREDATORS WITH SPECIAL REFERENCE TO WILD DOG, *Cuon alpinas* (Pallas) AND THEIR PREY SPECIES IN PERIYAR, SOUTH INDIA

THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ZOOLOGY

by

ABRAHAM. C.J.

DEPARTMENT OF ZOOLOGY
ST. JOSEPH'S COLLEGE
DEVAGIRI, CALICUT
KERALA

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DEPARTMENT OF ZOOLOGY
(Post Graduate Studies & Research)

ST. JOSEPH'S COLLEGE, Devagiri, Calicut, Kerala, India - 673 008
Phone : (0495) 355901

Date 25-9-2000

CERTIFICATE

This is to certify that the thesis entitled **"Studies on large Mammalian predators with special reference to wild dog, *Cuon alpinus* (Pallas) and their prey species in Periyar, South India"** submitted to the University of Calicut by **Mr. Abraham C. J.** in partial fulfilment for the award of the degree of Doctor of Philosophy in Zoology is a bonafide record of the research work carried out by him under my supervision and guidance and that neither this thesis nor any part of it has formed the basis for the award of any degree or diploma.

Dr. V. J. Zacharias M. Sc; Ph. D.
Head, Department of Zoology
St. Josephs College, Devagiri,
Kozhikode, Kerala, 673008.

DECLARATION

I hereby declare that the thesis entitled "**Studies on large Mammalian predators with special reference to wild dog, *Cuon alpinus* (Pallas) and their prey species in Periyar, South India**" submitted by me for the award of Doctor of Philosophy in Zoology of Calicut University is an original research work done by me in the Department of Zoology, St. Joseph's College, Devagiri, Calicut, and that it has not been submitted earlier in part or in full to any other University for award of any Degree or Diploma.

Abraham. C.J

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INTRODUCTION

Abraham. C.J “Studies on large mammalian predators with special reference to wild dog, cuon alpinas (pallas) and their prey species in Periyar, South India” Thesis. Department of Zoology, St. Joseph's College Devagiri, University of Calicut, 2000

CHAPTER - I

INTRODUCTION

Studies on wildlife interactions especially prey-predator relationship has always been considered as an important research topic which provide helpful support to the concepts of wildlife management. The utilization of prey species by predators has its own importance as it is inevitable for the existence of healthy populations of predators and prey species. Predators have played a significant role in preventing the monopolization of the major environmental requisites by a single prey species (Paine 1966).

Predation limits the population of prey species and at the same time controls the excess growth of the population of some species in certain favourable environmental conditions. In this sense, predation is considered as a limiting factor which usually maintain the ecological balance. It is also pointed out that predator removal could lead to local extinction of prey species (Paine 1966) but predation is not biologically dispensable as was formerly believed, (Hirst, 1967). Slobodkin (1961) calling predators 'prudent', mentions that increased predation is to be compensated by increased fecundity (Klein, 1965; Pimlott et al, 1969). Predator prey relaitonship is very significant among the wildlife interactions because

predators are sensitive indicators of habitat quality and this will help to measure the health and extent of an environment to be preserved (Eisenberg 1972).

In the Indian subcontinent, the big cats except lion and snow leopard and the members of the genus *canis* have a wide distribution as they inhabit a variety of habitats. They are known to have come from central Asia. Though the large carnivores still inhabits many of the forest of India, they have disappeared from some of the earlier habitats. This disappearance is associated mostly with the loss of habitat, depletion of prey species and persecution by man.

Review of Literature

In earlier days man was rather keen on eradicating the cannivores especially wild dogs (dholes) but didn't bother studying and understanding them. However there are numerous first hand accounts about wild dog and other carnivores which could be collected from both earlier and recent books on natural history. These accounts are usually records of fights between dholes and other carnivores, instances of their attacks on prey species, diseases and generalized statements on their behaviour.

The following authors' have documented hunting and feeding strategies, of various predators Jerdon (1874); Smith (1905); Brander, (1908); Pitman, (1924); Burton (1925); Adams (1927, 1949), Pocock, (1936); Anderson (1954); Ali, (1962), Davidar, (1965); Krishnan, (1965, 1975); Williams, (1971); Arjan singh (1973); Sinha, (1975); and Sankhala (1977). These accounts however lack careful and systematic details.

Understanding the need for more scientific studies on carnivores in India attempts were made to collect and analyse data on mammalian predators. Consequently a number of short accounts were published (Cohen et al, 1978; Davidar, 1973, 1974, 1975; Fox and Johnsingh, 1975; Johnsingh 1978; Keller, 1973; and Sharatchandra and Gadgil, 1975).

Table 1

Major Longterm studies on carnivores in the Indian subcontinent

No.	Author	Study area	Aspects of study
1.	Schaller (1967)	Kanha National Park Madhya Pradesh	Tiger and its prey species
2.	Panwar (1979)	"	Population dynamics and Land tenures of tiger
3.	Joslin (1973)	Gir National Park, Gujerath	Ecology of Asiatic lion
4.	Muckenhirn & Eisenberg (1973)	Wilpattu National Park, Srilanka	Home ranges nd predation by Ceylon - Leopard
5.	Seidensticker (1976)	Royal Chitwan National Park, Nepal	Ecological isolation between tiger and Leopard
6.	Laurie & Seiden - Sticker (1977)	"	Behavioural ecology of sloth bear
7.	Mc Dougal (1977)	"	Ecology and behaviour of the tiger
8.	Sunquist 1981	"	Social organisation of the tiger
9.	Johnsingh 1980	Bandipur National Park, Karnataka	Ecology and behaviour of dhole
10.	Rice 1986	Eravikulam National Park, Kerala	Predators and prey
11.	Karanth 1993	Nagerhole National Park	Prey-Predator relations

Most important study on mammalian predator's and their prey species conducted in India was that of Schaller (1964-65) conducted at Kanha National Park, in Madhya Pradesh. His book "the Deer and the tiger" provided an excellent basis of our knowledge about tiger and other predators and their prey species in relation to their habitat in the Indian subcontinent. Other related sutdies in India included those of Rice (1986) on the predators and prey in Eravikulam National Park, Kerala, Johnsingh (1980) on dhole in Bandipur national park, Karnataka, Joslin (1973) on Asiatic Lion in Gir National Park, Gujerat and Panwar (1979) on population dynamics and land tenures of tigers in Kanha. Wright (1960) Bourliere (1963) Rosenweigh (1966) Seidensticker (1976) Mc dougal (1977) Sunquist (1981) Eisenberg (1972) and Karanth (1993) have provided with significant contribution on this topic (Table 1).

Though some of the above studies have provided helpful information on mammalian predators in South India, the rain forest habitats of Kerala lack such details other than the short term study conducted by Rice (1983) at Eravikulam National Park. Hence a long term study on mammalian predators such as the tiger, the leopard, the wild dogs and the jungle cat with special reference to wild dogs in Periyar has been taken up with a view to identifying their prey selection. The food habits of Sloth bear which is not a predator were also studied.

STUDY AREA

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CHAPTER - II

STUDY AREA

Studies were carried out in Periyar tiger reserve and its surrounding areas in the western ghats from December 1991 to December 1995. While I was working in a research project, under the Research Officer, Thekkady.

II.1 Geographic location

Periyar tiger reserve (9° 15' and 9° 40' N lati·and 76° 55' and 77° 25' N. log.) having an area of 777 Sq. Km is a part of the erstwhile cardamom hill reserve, in the southern part of the western ghats and lies in the Idukki district of Kerala. This reserve has a 30 Km long border with the Tamil Nadu in the North and East and has a marginal belt with Tamil Nadu forest about 80 Km^2. In the South, the reserve is bordered by Ranni forest division (Pathanamthitta district), in the West by Erumely forest range of Kottayam division (Kottayam district) and in the north by the Peerumed taluk of the Idukki district.

II.2 Brief History of Periyar

The History of Periyar Tiger Reserve could be traced back to the year 1889 when the Madras presidency made an agreement with the Travancore Maharaja for constructing a dam across the

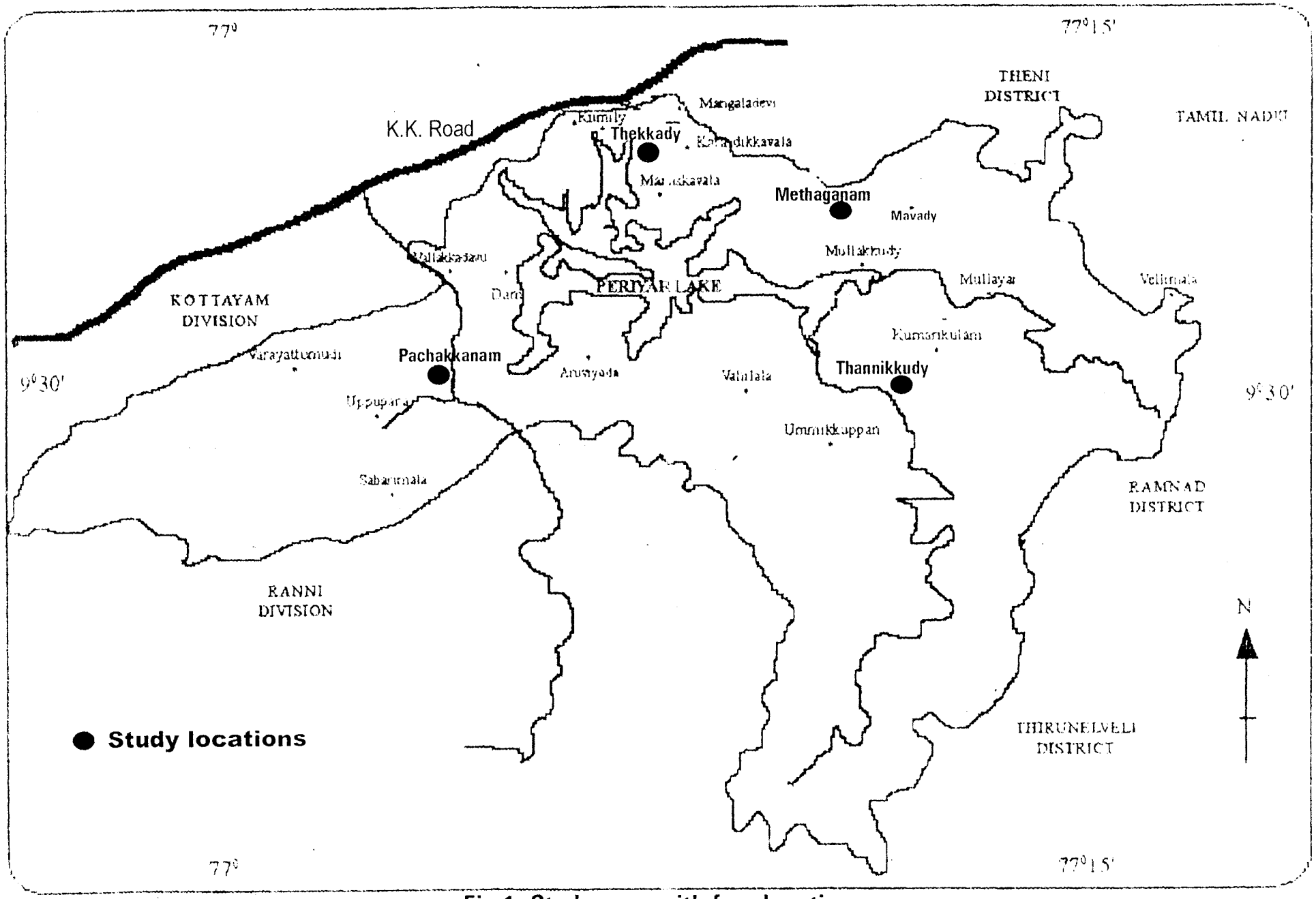


Fig.1 Study area with four locations

Mullapperiyar river. Accordingly the Periyar lake was formed in the heart of the forests in 1896. The forest around the lake Periyar was declared as peiyar lake reserve. This was followed by the appointment of Mr. C.H. Robinson as game warden of the reserve by the Maharaja of Travancore in 1933. The Nellikkampetti Sanctury thus established in 1934 had an area of 600 km^2. Some more areas were added to this sanctury in 1950, making its total area to 777 Km^2 and it was renamed as Periyar wildlife sanctury. It became Periyar Tiger Reserve in 1978 when the sanctury was brought under project tiger. During 1982 the core area (350 km^2) has been proposed as national park (only first notification issued). (Working plan 1986-87; 96-97).

II.3. Physiography of the area

The topography of the study area is characterised by a highly undulating terrain with hills rising upto 2000 M.S.L. with an average elevation of 800 M. Geologically this area is part of the Archaen crystalline rock formation of the southern part of the Indian peninsula. Two principal kinds of soil are found; clay soil of black colour and the sandy red soil (Kurup 1971).

Important feature of the study area is the rivers Periyar, Mullayar and the Pamba. The perennial streams which form

Table - 2
Yearwise rainfall data in Periyar

Year	Station	Rainfall in mm (Monthwise)												Total	Monthly Average
		Jan.	Feb	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.		
1992	Periyar Dam	Nil	36	Nil	46	206	812	716	331	291	304	518	15	3276	272.92
	Thekkady	7	Nil	Nil	132	224	522	585	222	400	372	511	59	3034	252.83
1993	Periyar Dam	Nil	31	47	65	131	340	564	278	73	372	250	38	2189	182.42
	Thekkady	Nil	59	22	39	155	172	328	119	81	228	390	99	1692	141.0
1994	Periyar Dam	30	20	13	65	66	442	565	388	196	425	223	Nil	2433	202.75
	Thekkady	24	16	17	94	79	304	427	213	172	299	285	Nil	1930	160.83

tributaries of these rivers include Ummikkuppanthodu, Churakkottathodu, Kalvarithodu, Aruviodu, Chenthmarathodu, Mlapparathodu, Vazhukkapparathodu and parts of Azhutha. Natural pools are quite absent and some ponds are created all over the sanctury which are dry for more than 6 months. The riverbeds and streambeds are bordered by dense vegetation, mostly of the typical evergreen type here in after mentioned as riverine vegetation which forms an ideal habitat for several animals. The reserve has enough network of roads.

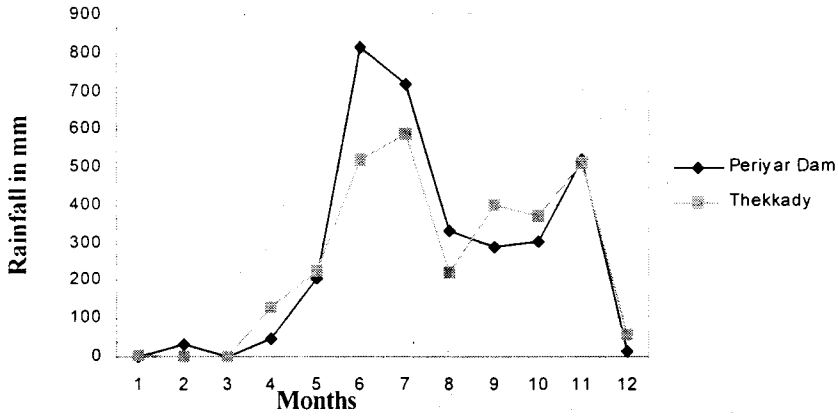
II.4. Climate and Seasonal changes

The climate in Periyar can be described as cool and humid with high rainfall. Three seasons, the hot, the wet and the cool can be indentified in the area (Kurup 1971).

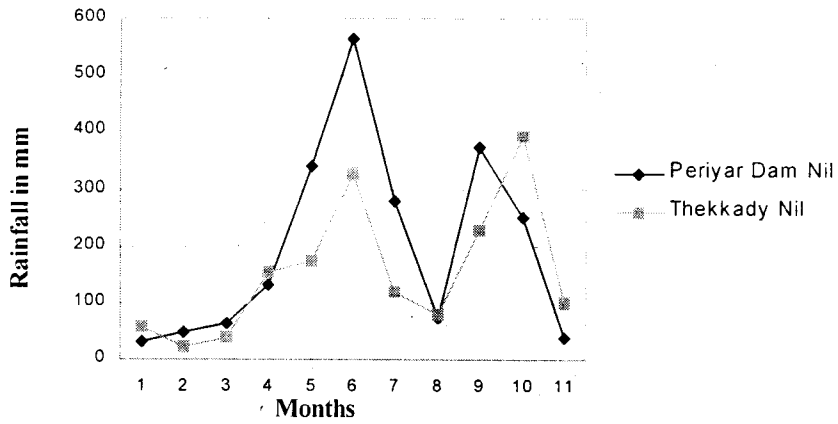
II.4a. Rainfall

Periyar recieved rain from the south west and the north east monsoon. Southwest monsoon starts in June and ends in september and northeast monsoon is in October and November. Monthly average of rainfall is recorded in table 2. Maximum precipitation was in 1992, in the month of June and July in Periyar dam and Thekkady areas respectively (Fig.2) Minimum precipitation was recorded in March at both the above sites. In 1993 maximum rainfall

1992



1993



1994

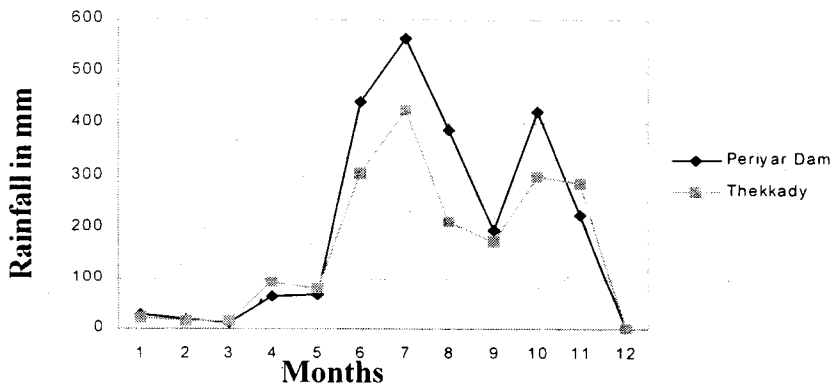


Fig.2 Average monthly rainfall in Periyar dam and Thekkady (1992-94)

recorded was in July in the Periyar dam area and November in Thekkady while minimum was recorded in January at both these sites. Maximum precipitation recorded in 1994 was in July at Periyar Dam and Thekkady while minimum was recorded in December at both the sites.

II.4b. Temperature

Seasonal variations were noted in temperature readings. Temperature data collected is given in Table 3. The cool season starts in November and last up to February. In January 1994 the average minimum temperature was 18.37°c. The hot season starts almost close to the end of the North east monsoon. During November, December and January, the mornings are misty. Maximum temperature was recorded in April and it usually exceeded 30°c (Fig.3).

II.5. Vegetation

The oldest discription on vegetation in Periyar was that of Bordillon (1893). His discription on the Periyar plateau mentions that the grasslands of the area were grazed by the cattle coming from the eastern side. He has also described the regular forest fire occuring in grasslands. The marshy vegetation of the river bed has been observed by Bordillon before it was submerged (1893).

Table - 3

Temperature in Periyar (1994)

Temperature	Months											
	J	F	M	A	M	J	Jy	A	S	O	N	D
Minimum value	18.37	19.47	20.02	22.1	21.69	20.7	20.59	20.39	20.58	20.73	19.1	18.98
Maximum value	25.5	27.88	30.3	30.59	29.36	25.36	25.38	26.03	26.47	26.61	24.35	25.68
Average value	21.93	23.67	25.16	26.34	25.52	23.03	22.98	23.21	23.52	23.67	22.13	22.33

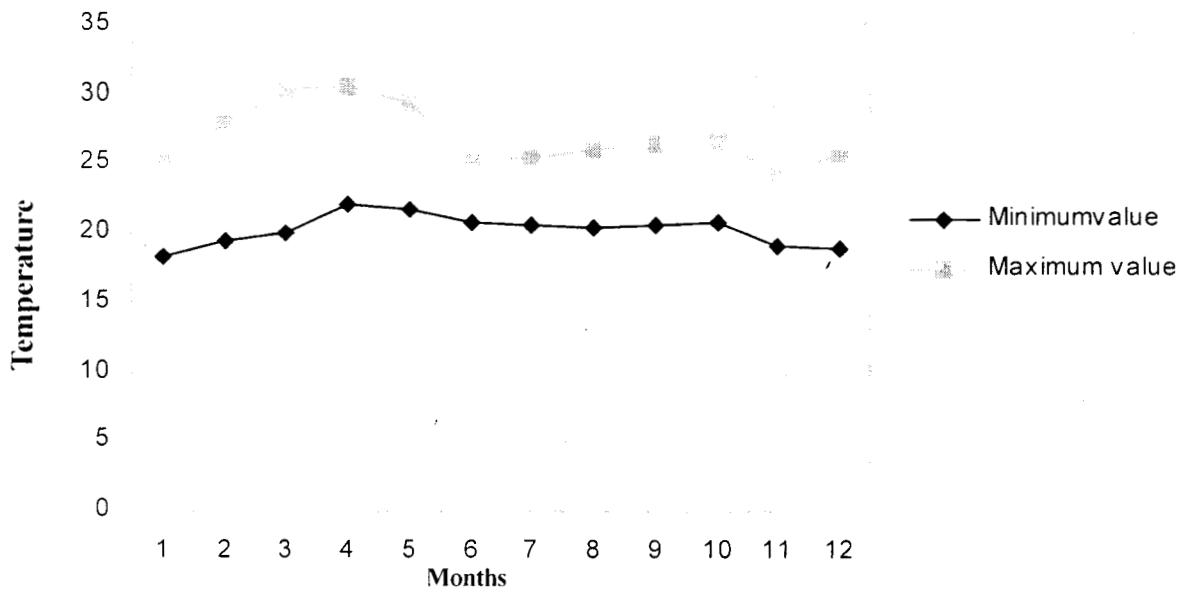


Fig.3 Temperature in Periyar (1994)

The vegetation types with their details were described by Chandrasekharan (1973). Vivekanandan (1980) has given a brief description about the vegetation of Periyar.

The following types of vegetation were identified in Periyar (Fig.4).

II.5a. Tropical wet evergreen forests (305 Sq.Km)

This climax type of vegetation occur around and beyond Mlappara, Ummikkuppan and Sabarimala. This vegetation consists of lofty trees with thick middle storey and undergrowth of herbs, cane brakes and ferns. The canopy is almost closed. Species such as *Cullenia exarillata, Mesua ferrea, Myristica beddomei, Vateria indica* etc. dominated here. *Podocarpus latifolius* an endemic species, the only tropical conifer in India is fairly common here.

II.5b. Semievergreen forests (275 Sq. Km)

The semievergreen vegetation is seen in areas like Anchuruly Cheriyakanam, Valiyakanam, Menakkvala, Vaikkappadappu, Ummikkuppan etc. Tree species such as *Artocarpus hirsuta, Salmalia malabarica, Hopea parviflora* etc. dominated here. There are plenty of openings in the canopy where *Trema orientalis, Dillenia pentagyna* etc. come up. The undergrowth is almost dense.

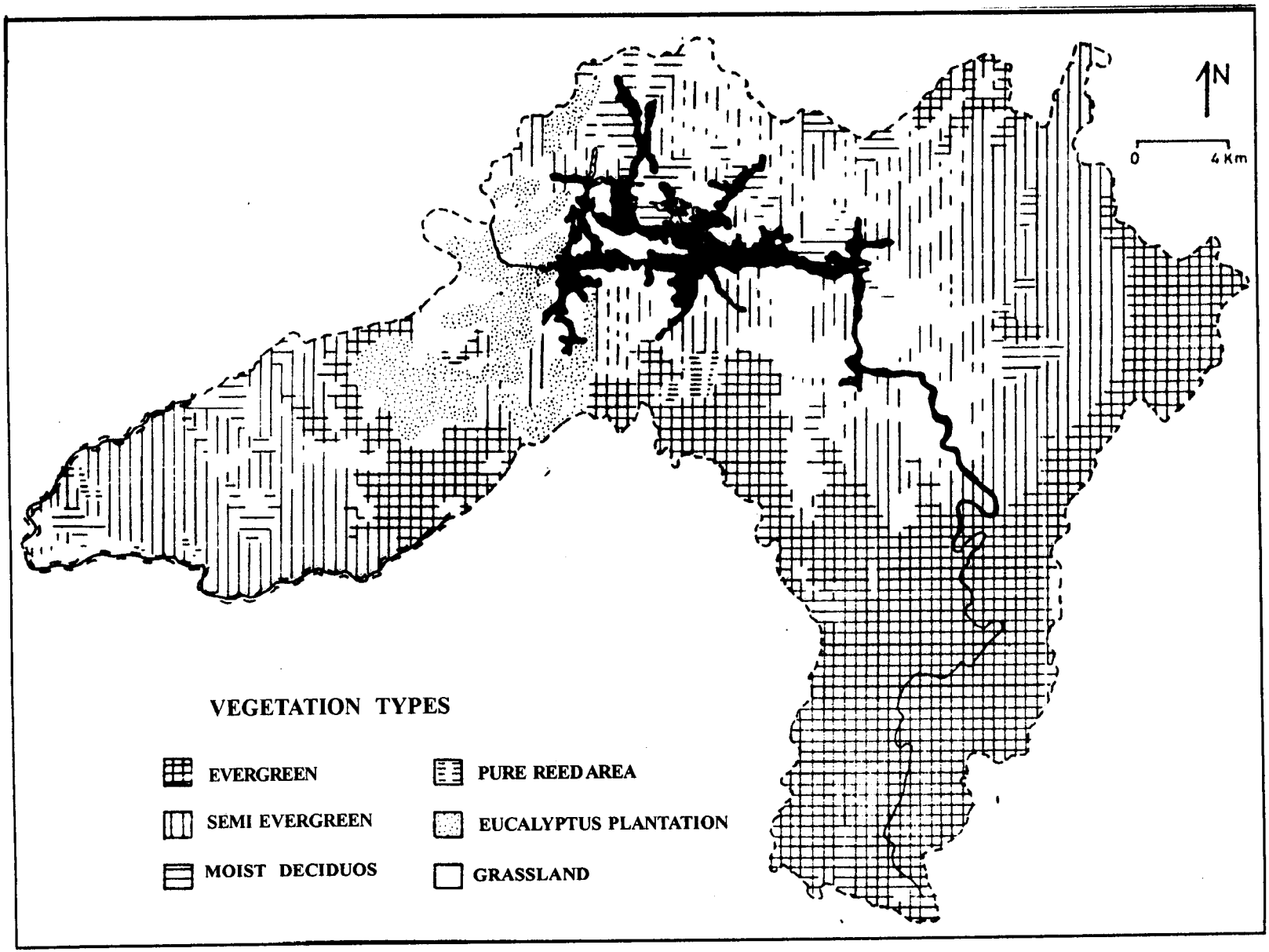


Fig. 4 - Periyar Tiger Reserve - Vegetation Map

II.5c. Moist deciduous forests (99 Sq. Km)

This type of vegetation is seen around places like Mullakkudy, Medhaganam, Karadikkavala, Pachakkadu, Edappalayam etc. Dominant species of trees found here are *Tectona grandis*, *Lagerstroemia lanceolata*, *Terminalia tomentosa*, *Terminalia paniculata*, *Terminalia chebula*, *Pterocarpus marsupium*, *Dalbergia latifolia* etc. The undergrowth consisted mainly of *Lantana aculeata* and other herbs.

II.5d. Grasslands (22 Sq. Km)

There are three types of grasslands. Some of the hilltops have short grasses like *Heteropogon contortus*, *Eragrastis bifaria* and *Panicum atrosanguineum*. On the lower slopes, the elephant grass *Cymbapogon confertiflorus* and *Cymbapogon coloratus* dominate. Marshes and lake shores have succulant grasses like *Panicum repens* and *Paspalum conjugatum*.

II.5e. Savannah (7 Km)

Most of the grasslands in periyar is secondary and are of Savannah type characterised by scattered trees which are usually fire resistant. Tree species such as *Grewia tiliaefolia*, *Emblica officinalis* etc. are fire resistant types.

II.5f. Reeds (10 Sq. Km)

Few patches of reeds *Ochlandra species* are found in areas like Ummikkuppan Lakhmippara, Thamara etc. This type of vegetation is seen exclusively in the evergreen vegetation.

II.5g. Eucalyptus plantation (55 Sq. Km)

Several plots of plantation of Eucalyptus grandis have been raised in the grasslands at Vallakkadavu, Kozhikkanam Pachakkanam, Aruvioda etc. from 1962 onwards. Regeneration of natural species can be observed in older plantations. This include species like *Actinodaphne hookeri*, *Cinnamomum sp.*, *Olea dioica*, *Grewia tiliaefolia*, *Mallotus albus* and *Maesa indica*.

II.6. Fauna

Little information is available on the wildlife of periyar in the past and that too only from hunting records. Chacko (1948) has listed 35 species of fishes in Periyar. Fishes of lower areas of the river Periyar were surveyed by Silas (1951). Fergusons (1903) list of Amphibians and Reptiles of Travancore and Boulengers (1923) list of Reptiles of Travancore include several species from this area. Bird survey conducted by Hume (1876) Bordillon (1878) Ferguson and Bordillon (1916) and Salim Ali (1935 - 37) have covered some

areas of the reserve. Srivasthava et.al,(1993) has provided with the current list of birds in the reserve.

The first scientific survey on the wildlife of the reserve with special reference to mammals was conducted by Dr. Kurup (1971) of Zoological Survey of India and he has listed 24 mammals. The second study on the wildlife of Periyar was carried out by the Kerala Forest Research Institute, Peechi (1977-82). As per the interim report of the study (1979) the elephant population of the reserve was estimated to be 588. There were 13 tuskers, 16 subadult tuskers and 42 calves. Their report included 49 gaur, 57 sambar with a maximum herdsize 10, declining population of wild boar, Tiger between 25 and 30, a good number of wild dogs, 89 troops of Nilgiri langur, 11 troops of Lion-tailed macaque and 7 troops of Bonnet macaque. A list of 35 mammals 181 species of birds, 2 species of reptiles and one species of amphibian were included in their report.

The final report of the K.F.R.I. (Peechi) study reported 1292 elephants in Periyar. The number of sambar was 294. There were 38 tigers during the period but no estimate was taken for Leopard and wild dogs though the latter was observed in packs of 2-14 and killed sambar occassionally.

The working plan (1986 - 87 to 96 - 97) has listed 15 species of amphibians, 44 species of reptiles and 58 species of mammals including 44 tigers, 24 leopards 40 sloth bears.

The first systematic and scientific ecological study on the wildlife of the reserve was iniated by a Research officer (1991-97). His report had updated list of mammals, birds, reptiles, amphibians, fishes, butterflies, spiders and plants in Periyar and provided information on predator-prey relations in the reserve (Zacharias, 1997).

II.7. Ecological Limiting factors

Though periyar is well protected, there are significant pressures against the wildlife and its habitat. These include poaching, ganja cultivation, annual forest fire, firewood collection, tourism, fishing etc.

II.7a. Poaching

Poaching was mainly aimed at male elephant (tuskers) though tiger, gaur, sambar, wild boar, nilgiri langur and nilgiri tahr were also often hunted. One subadult tiger was found dead in 1996 and one cannot discard a poaching attempt in this case. Elephant poaching is a very serious problem in periyar plateau. During this 3 year

study 6 adult tuskers, 2 subadult tuskers, and 2 juvenile males were killed. Poaching on gaur and other animals for meat was not uncommon. Among these animals gaur is much threatened.

II.7b. Ganja cultivation

Ganja cultivation usually leads to habitat destruction and succession in the forests. In the evergreen part of the core area such as Vattappara, Moolavaiga, Mukkar, Koruthodu, Vahilala etc. Ganja cultivation is still going on. The ganja cultivators kill a number of wild animals including gaur, sambar nilgiri langur, liontailed macaque, giant squirrel and great Indian hornbills.

II.7c. Forest fire

There was no incidence of natural fire in Periyar. The people entering the sanctury for various purposes put fire in the grasslands during the summer months. Major suspected group creating fire are poachers. The burnt grasses starts sprouting after the rain. This attract the herbivores to the area. This in turn help the poachers.

The annual forest fire seem to reduce the size of the sholas by destroying the marginal belt between evergreen forest and grassland.

II.7d. Collection of timber, firewood and minor forest products

The illegal collection of firewood and timber is severe in periyar. The collection of firewood deprive hole nesting birds of their nest sites and prevents the natural recycling in the soil. Illegal cutting of trees like *Dalbergia latifolia, Tectona grandis* etc. though not very common, is confined to the Tamil Nadu border and Vallakkadavu region. Other minor forest products collected include the barks of Cinnamon, cakes of Vateria, wax etc.

II.7e. Fishing and cattle grazing

Some of the tribals in and around the sanctury have been fishing for a long time in periyar river and the lake. This didn't seem to deplete the fishery resources. However cattle grazing is much more harmfull because the cattle getting inside the sanctury could transmit some diseases to the wild animals. Rinderpest transmitted to the gaur population in 1970's was a good example.

II.7f. Tourism

Millions of tourists visited Periyar every year. Density of larger mammals except barking deer and wild boar is much less in the tourist zone when compared to the rest of the sanctury. Animals such as Elephants, nilgiri langur, giant squirrel, flying squirrel and

bonnet macaques were frequently electrocuted in the tourist zone. Animals like sambar, wildboar, barking deer and brown palm civet etc. were run over by motor cars. The sambarimala sree Ayyappa temple located in the south west border of the reserve has been visited by millions of pilgrims every year. This exerts much pressures on the wildlife and its habitats in Periyar.

II.8. Tribals

Three groups of tribals inhabited the sanctury area viz the Mannans, the Paliyans and the Ooralies. All these groups once inhabited the interior of the forest and now settled in Kamily and Vallakkadavu, near to the sanctury. Most of these tribals are depending the sanctury for many purposes such as fishing, honey collection, fire wood collection etc., though they own agricultural lands. Another group of tribal called Malapandarams still inhabiting inside the forest near sabarimala are fewer in numbers.

METHODS

Abraham. C.J “Studies on large mammalian predators with special reference to wild dog, cuon alpinas (pallas) and their prey species in Periyar, South India” Thesis. Department of Zoology, St. Joseph's College Devagiri, University of Calicut, 2000

CHAPTER - III

METHODS

The main objective of this study was to understand the food habits of major predator's in Periyar. Impact of predation on sambar has been given special attention. Since Chital, the major prey species of mammalian predators in other parts of India is absent in Periyar, this aspect has much relevance here. To estimate the magnitude of predation by tiger, leopard and wild dog a comparative study of predation by all these species has been take up. Data on habitats, population density, biomass, territory etc. of both predators and prey species were also collected. In this study, data on the food habits were collected by direct and indirect methods. Predation by tiger and leopard were observed on very few occasions in the field, but that by wild dogs were regularly observed, every month in the field. Indirect evidences of predation such as kills and scats were noted and recorded during the field study.

The population of major predators were also estimated using direct methods and indirect methods. Similarly, the population of prey species such as sambar, nilgiri langur, barking deer, wild boar, porcupine and mouse deer were also estimated.

III.1. Field assistance

Two tribesmen (Mannan) served as field assistants throughout the study. They had a thorough knowledge of forest trails, various places in the interior of the forest and animal tracks and signs. They also had good knowledge of animal behaviour and experience in following various animals and locating the kills.

III.2. General method

The field study was conducted largely on foot. Inspite of certain difficulties, it provided excellent opportunities to know the microhabitats and the whole terrain. During the rainy days, the work on foot was full of difficulties because of the obstruction by elephants and leeches. Except on few occassions field trips during night were avoided on safety reasons.

Observations were carried out from 06.30 to 12 noon in the morning and from 2.30 to 6.30 PM in the evening. Study was conducted regularly in 5 days every week, throughout the year. Data obtained from the field were pooled monthwise.

III.3. Transect method

Studies were centred around 4 localities in periyar (Fig.1). These places were selected on the basis of habitat types. Four

transects each, were laid in the 3 localities and 2 in the fourth. These transects having an average length of 8 kilometers were monitored once everymonth. There were 4 transects, each at Thannikkudy, Medhaganam and Pachakkanam and 2 transects at Thekkady.

Forest treck paths were used as transects. While covering a transect direct sightings of tiger, leopard and wild dogs and indirect evidences of their occurrence such as pugmarks, kills, scats and claw marks were recorded. The direct sightings of other animals which could be the prey species of predators and indirect evidences of their occurrences were also recorded. While walking, alarm calls were listened and their possible causes investigated. This helped to get more information on predators and their prey.

While observing the kills, body parts of the prey such as teeth, antlers and horns were examined to determine the approximate age and health of the prey. Remains of prey species were weighed for caulculating the food intake or the biomass consumed by various predators. Scat samples from the transects were collected and preserved in 5% formaline for analysis of food.

Animals such as elephants sambar, wild boar gaur etc., met on the transects were recorded along with their number, sex, age class and the approximate perpendicular distance from the transect.

III.4. Estimation of biomas of prey species

The estimation of biomass of prey species such as sambar, gaur etc. were worked out from the transect count method. Firstly, population density was estimated by using the transect length, total number of animals observed and the perpendicular distance of each sighting from the transect line.

$$\text{Population density} = \frac{n}{2\,lw}$$

Where 'n' is the number of animals observed, 'l' is the transect length, and 'w' is the mean width.

Mean width is the mean of all perpendicular distances from the transect to the sites of animal occurrence.

From the population density figures of various transects covering different habitats added up, the mean denstiy could be estimated. Now population figures could be obtained by multiplying the total available area and this population figure which is then used to find the biomass of prey by multiplying with the average weight of that species.

III.5. Concentrating favourite areas of prey / predator

Areas where there were concentration of prey animals and regular occurrence of predators were selected for intensive

observations. Such areas were selected and visited after an initial reconnaissance throughout the area. Watch towers built by the forest department in several places helped to locate the kills made by dholes and tiger. Such "favourite" areas alarm calls of animals such as sambar, nilgiri langur and squirrels, birds such as jungle fowls, jungle crows, Brahminy kite, Jungle mynas etc. were listened and their possible causes investigated. The jungle crows and brahminy kites were of great help in locating dhole and their kills. Crows and brahminy kites were in groups and made calls while feeding on carcasses which was helpful to locate kills. The smell of carcasses also helped to locate the kill.

When a prey or predator was sighted, care was taken to observe them without moving further so that maximum observation could be possible.

Some members of the dhole pack having certain external abnormalities could be identified in the field. These includes cut ear, abnormal size of scrotum, limping leg etc. Once a pack was sighted it could be followed as far as possible. This helped to locate the kills, often in the open stream banks and lake beds. This type of follow up was unsuccessfull in the scrub.

During the study, it was evident that the dhole and the tiger prefered to follow particular trails and checking these trails by them

with the help of territory marking (Schaller 1967). This behvaiour helped to find out the direction in which they had gone. Whenever the predators were observed, the place, time, habitat, weather their behaviour etc. were recorded. The information on direct and indirect evidences of predators and prey from the local people, tourists and the forest staff was also recorded. This type of information helped us to search that area more and such searching has provided us with lot of information and chances to see a tiger. On two occassions tigers were sighted while searching for kills. The frequent elephant sighting often hindered the search for kills.

III.6. Kill studies and age determination of prey

By examining a kill it was possible to collect datas regarding approximate time of the kill, location of the kills and age and sex of prey. Dhole kills could be easily identified because the foot prints of dholes around. Dholes have the habit of drinking water while eating or soon after a kill (Johnsingh 1980). Hence most of the wild dog kill were observed near a water body. Tiger kills were distinguishes from leopard kills mainly by identifying the pugmarks. It was the habit of tiger to remove the stomach and intestine of its kill and to keep them away which is rarely done by the leopard (Johnsingh 1980).

Whenever possible the kill remains were weighed to estimate the amount of meat eaten. Antlers and teeth were checked. If the prey is a stag the nature of the antlers - hard or velvet was noted. Using the method suggested by Giles (1954), the age of the prey was estimated. For this eruption and wear of the premolar and molar teeth of the lower jaw were taken into account. Schaller (1967) classified sambar into young fawns (below 4 months) big fawns (4-6 months), yearlings and adults. In this study 6 age classes were identified. Class 1 consists of sambar fawn below 6 months, class II - young sambar between 6 month and 1 year, class III - between 1 and 2 years, class IV - inlcude subadults with age between 2 and to 4 years, class V - between 4 and 6 years and class VI - adults above 6 years.

III.7 Scat Collection & analysis

A regular and systematic collection of scats of tiger, leopard and wild dogs were made for hair analysis. In the case of dholes 2 pieces of scats were collected from 2 ends of the 'latrine sites' in order to get the sample at random. Mostly fresh scats were collected and it assured representation of the previous meal. Tiger and leopard usually defecated either in the central grassy strip of the forest roads or in the grass just bordering the road. Usually some scrapes were seen near the scat in the case of tiger, leopard and jungle cat.

Distinguishing fresh scats of tiger and leopard in the field is not difficult as the leopard scat has some sort of a beaded and coiled nature while the tiger scat is without such peculiarities and with large pieces of scats put together forming a heap. In dry season, scats were remained intact for many days unlike that in the rainy days.

The collected samples were labelled with date, name of place, habitat and predator.

Scat samples were preserved in 5% formaline and brought to the laboratory at Thekkady and analysed by using the method described by Adorjan and Kolenosky (1980) and Koppikkar and Sabnis (1976).

The scats were soaked in water and washed thoroughly so that the hairs, bones and other parts were separated. The hairs were washed well and dried in sunlight in the summer day's and in oven in rainy days. Hairs of animals such as sambar, elephant, porcupine etc differ in colour, length and thickness so that their identification was easy with naked eye (Schaller 1967). Hair samples of prey species and predators were collected from kills, and from zoo for preparing identification keys.

The impressions of the hair on the slide were made by using canada balsm. One or two drops of canadabalsm were taken on a clean slide. The canada balsm was smeared over the surface of the glass slide by the corner of an another slide. The smear was then dried for 30 seconds at the room temperature. The hair specimens washed in hot water and dried were passed through ether and then in xylol. The hair after taking from the xylol was placed on the candabalsm smear on the slide carefully and pressed with another slide placed over the hair in the smear so that impression of the medullary structure were made in the smear. After removing the second slide, the hair was carefully removed from the smear without making any disturbance in the impressions in the smear. This slide with the impression was put under the high power of a compound microscope. By using camera lucida, attached to the microscope the drawings of the structural pattern of the hair impressions were made. This identification key was later used for the identification of hairs obtained from scats. Hairs in the scats were properly washed and subjected to the same procedure. It was then compared with the identification key prepared.

Fawn and adult remains in the scat were visually differentiated by the nature of the hair, presence of hoof and teeth. In the case of wild dogs, presence of grass was taken in to account if it was

present in more than 50% by volume in the scat. Scats of tiger, wild dogs, leopard, jungle cat, and sloth bear were thus collected and their contents were analysed to assess their food habits.

III.8. Personal communication with the locals

Though not a standard method for estimating wild life population, information obtained from the tribals on wild life population and their movements in the study area were also recorded. More details of kills of predators were also obatained by the help of tribal people.

RESULTS

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CHAPTER - IV

RESULTS

IV.1 The Wild dog, *Cuon alpinus* (Pallas)

The wild dog or dhole (Cuon alpinas) was the most common predator in Periyar (Table-4). No scientific study has been done on the population density of wild dogs or its impact on pre-predator relations in Periyar. Ramachandran et. al, (1987) observed wild dogs in areas like Manakkavala, Edappalayam, Thekkady boat landing, Thannikudy, Mlappara, Paravalavu, Medhaganam, Cheriyakanam, Nellikkampetty, Anchuruli etc. Observations during this study has shown that in the Thekkady area the density of wild dogs varied from .08 to .16 animals per km^2 and in Thannikkudy it was .06 to .13 animals per km^2 (Table 5). The density of wild dog population in Bandipur varied from .22 animals/km^2 (Wesley, 1977), 1.74 animals/km^2 (Sharatchandra and Gadgil, 1975) to .35-.9 animals per km^2 (Johnsingh, 1983) (Table-6).

The density figures of African wild dog (*Lycaon pictus*) in Aitong, Southwest Kenya varied from .02 to .04 animals/km^2 (Fuller and Kat, 1989).

Table - 4

Sightings and kills of wild dog, Tiger and Leopard

Month and Year	Wild dog		Tiger		Leopard	
	Sightings	Kills	Sightings	Kills	Sightings	Kills
Jan. - 1992	4	4	-	-	-	-
Feb. "	2	6	-	2	-	-
Mar. "	3	10	1	-	-	-
Apr. "	7	3	1	-	1	1
May "	3	3	-	3	1	-
June "	1	5	-	1	-	-
July "	3	3	-	-	-	-
Aug. "	2	2	-	1	1	-
Sept. "	2	3	-	-	-	-
Octo. "	2	3	-	-	-	-
Nov. "	2	3	-	-	-	-
Dec. "	2	6	1	-	-	-
Jan. 1993	3	5	-	1	-	-
Feb. "	1	3	1	1	-	-
March "	4	8	-	1	-	-
April "	5	4	-	1	1	-
May "	3	5	-	-	-	-
June "	1	3	1			
July "	3	3	-	1	-	-
Aug. "	1	2	2	-	1	-
Sept. "	1	4	1	1	-	-
Oct. "	2	2	1	2	1	-
Nov. "	2	3	-	-	-	-
Dec. "	2	2	-	1	-	-
Jan 1994	1	4	-	1	-	-
Feb "	3	2	-	1	-	-
March "	5	2	-	1	-	-
April "	4	6	2	2	-	-
May "	4	4	-	-	1	-
June "	2	3	-	2		
July "	5	3	-	1		
Aug. "	4	4	-	-	-	-
Sept. "	4	2	1	-	-	-
Oct. "	5	1	-	1	-	-
Nov. "	4	3	-	1	-	-
Dec. "	6	2	-	2	-	-
Total	108	131	12	30	7	1
Percentage	85 (n=127)	80.9 (n=162)	9.4 (n=127)	18.5 (n=162)	5.5 (n=127	0.6 (n=162)

Table - 5

Population estimation of wild dogs in 400 Sq. Km area in Periyar (1992-94)

Pack	1992		1993		1994	
	Maximum pack size	Minimum pack size	Maximum pack size	Minimum pack size	Maximum pack size	Minimum pack size
Nellikkampetty	13	7	14	6	15	7
Thannikkudy	12	5	11	4	12	6
Vallakkadavu	9	5+	8	4	8	3+
Kalvari	6+	4+	7+	5+	5+	3+
Mlappara	5+	4+	4+	2+	6+	4
Total number of wild dogs in 400 Sq.km area	45	25	44	21	46	23
Average number of wild dogs in 400 Sq.km	35		32.5		34.5	
Density of wild dogs in 400 Sq.km	.09/km^2		.08/km^2		.09/kM^2	

IV.2 Homerange

In Periyar, intensive observations were carried out on two packs of wild dogs, one at Nellikkampetty and another at Thannikkudy. The first pack operated in places such as Nellikkampetty, Thekkady, Kavalappara, Dam site, Anchuruli, Edappalayam, Karadikkavala, Valiyakanam, Poovarasu, sero, Pachakkadu, Manakkavala etc. The second one operated in places such as Mullakkudy, Thannikkudy, Mullathodu, Kamarikulam, Mulakupara, Ummikuppan, Kathiramudi, Vaikkappadappu, Mlappara etc. The sighting of these packs were given in appendix 1 and 2.

The sighting ploted on the map has indicated that the homerange of the Nellikkampetty pack was around 80Km^2 and that of the Thannikkudy pack was around 90Km^2 (Table 7). The area of intense use by the Nellikkampetty pack included the lake beds from Thekkady boat landing right up to Mullapperiyar dam and that of the Thannikkudy pack lake bed from Mullakkudy to Thannikudy and the banks of the river Periyar beyond Thannikkudy (Fig.5).

In addition to these two packs there were evidently 3 more packs in the area. One pack of 6+ was sighted at Kalvarimala and this pack covered places like Methaganam, Mavady, Kalvari,

TABLE - 6

DENSITY ESTIMATE OF WILD DOGS IN PERIYAR AND BANDIPUR

Study area	Source	Area in km^2	Density/km^2
Bandipur	Wesley (1977)	-	.22 animals/km^2
	Sharathchandra and Gadgil (1975)	$23km^2$	1.74 animals/km^2
Periyar	Johnsingh (1984)	$32km^2$	0.35-0.9 animals/km^2
	Present study (1992-94)	Thekkady-$80km^2$	.08-.16 animals/km^2
		Thannikkudy-$90km^2$	.06-.13 animals/km^2

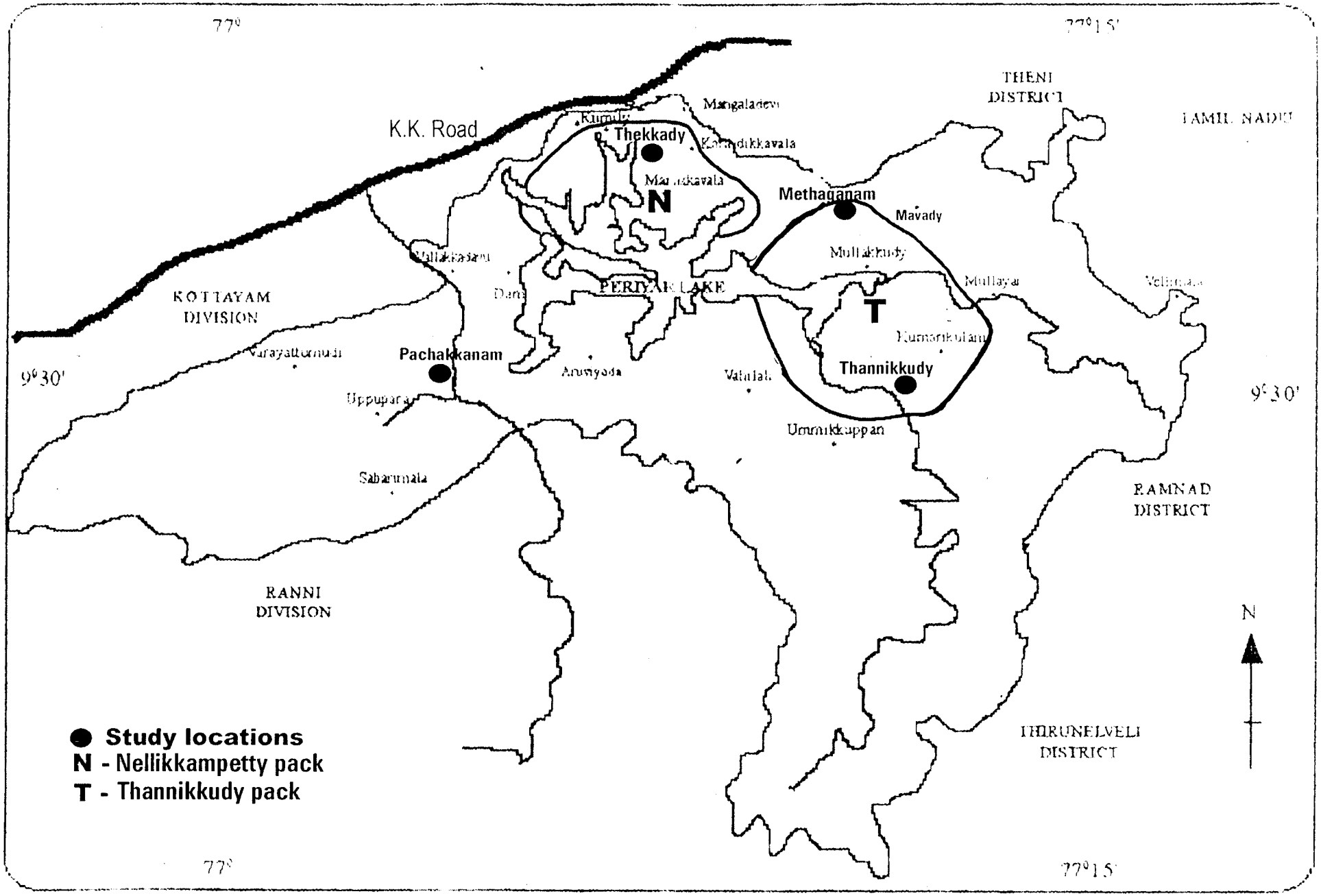

Fig.5 Home ranges of Nellikkampetty and Thannikkudy pack of wild dogs

Table - 7

Habitat use by wild dogs

Habitat	Nellikkampetty pack			Thannikkudy pack		
	Number of sighting	Percentage of sighting	Available habitat in the home range.km^2	Number of sightings	Percentage of sightings	Available habitat in the home range. km^2
Moist deciduous	38	58.5	40	16	37.2	35
Grassland	12	19.5	15	18	41.8	30
Semi-evergreen	14	21.5	20	6	14	15
Evergreen	1	1.5	5	3	7	10
Total	65	100	80	43	100	90

Vattappara, Kizhangupara, Manalar, etc. Very close to the Thannikkudy pack, another pack of 4 dogs was sighted at many places beyond Mlappara. A third pack of 4 dogs was observed at Kozhikkanam area during March, April and July 1992. Sighting and indirect evidences (Scats) have indicated that this pack covered areas like Vallakkadavu, Kozhikkanam, Aruvioda, Pachakkanam, 4th mile, Uppuppara, Chenthamara etc. Due to the lack of sufficient sightings, the homerange of these 3 packs could not ascertained. However it is evident that the homeranges of these packs were overlapping with that of the neighbouring packs.

In Bandipur, the maximum area covered by a dhole pack was around 40Km^2 (Johnsingh 1983) while the area of intense use was nearly 20Km^2. It has been reported that the wild dog packs cover larger areas in search of food (Davidar 1975, Krishnan 1975). According to Keller (1973) a pack could cover an area of 12Km^2 in a day. Waller (1972) postulated larger homeranges for the wild dogs except in breeding periods. The African wild dogs and wolves possessed larger homeranges and territories. The homerange of African wild dogs in the non - breeding season was 150 - 200km^2 (Kuhme, 1965) and 620-710km^2 (Schaller, 1972) and in the breeding season 42km^2 (Kuhme, 1965) and 110-210km^2 (Schaller, 1972). Kolensky and Johnston (1967) observed a home range of 18 to

Table - 8
Pack size of wild dogs in Periyar(1992-94)

Pack size	Nellikkampetty pack		Thanikkudy pack	
	Number of observation	Number of animals	Number of observation	Number of animals
15	1	15	-	-
14	2	28	-	-
13	4	52	-	-
12	7	84	3	36
11	6	66	8	88
10	7	70	6	60
9	9	81	5	45
8	10	80	6	48
7	6	42	6	42
6	5	30	4	24
5	3	15	2	10
4	3	12	1	4
3	1	3	1	3
2	1	2	-	-
1	0	-	1	1
Total	65	580	43	361
	Total pack seen = 65 Total number of wild dogs seen in the packs = 580 Average pack size = 8.9		Total pack seen = 43 Total number of wild dogs seen in the packs = 361 Average pack size = 8.4	

36km^2 and Joslin (1967) observed 65km^2 for the wolf in its breeding season. In the non breeding season the homerange of the wolf was 104-130km^2 (Pimlott et al, 1969), 130km^2 (Cowan, 1947) and 273-546km^2 (Mech, 1966). According to schaller (1972) and Van Lawick (1971) the need to follow migratory animals also compelled them to cover vast areas.

IV.3 Packsize

The pack is an extended family unit (Mech, 1970; Van Lawick, 1971). The number of dogs in the pack varied from place to place and from season to season (Appendix 3). Packsize is large in areas with high prey density. It has been reported that the size of the dhole pack may go upto 20-40 adults and 20 young (Brander 1927). Davidar (1975) reported that packs may have 40 individuals and according to him packs of 5-12 are common. Sharatchandra and Gadgil (1975) suggested that the dhole pack must have been fragmenting and coming together at different times. The packsize of wild dogs in Bandipur varied from 3-30 animals according to Sharatchandra and Gadgil (1975) and to 2-18 animals according to Johnsingh (1983). At Kanha the packsize was 2 to 12 animals (Schaller 1967). Johnsingh (1983) is of the opinion that packsize will be small in areas where food is scarce.

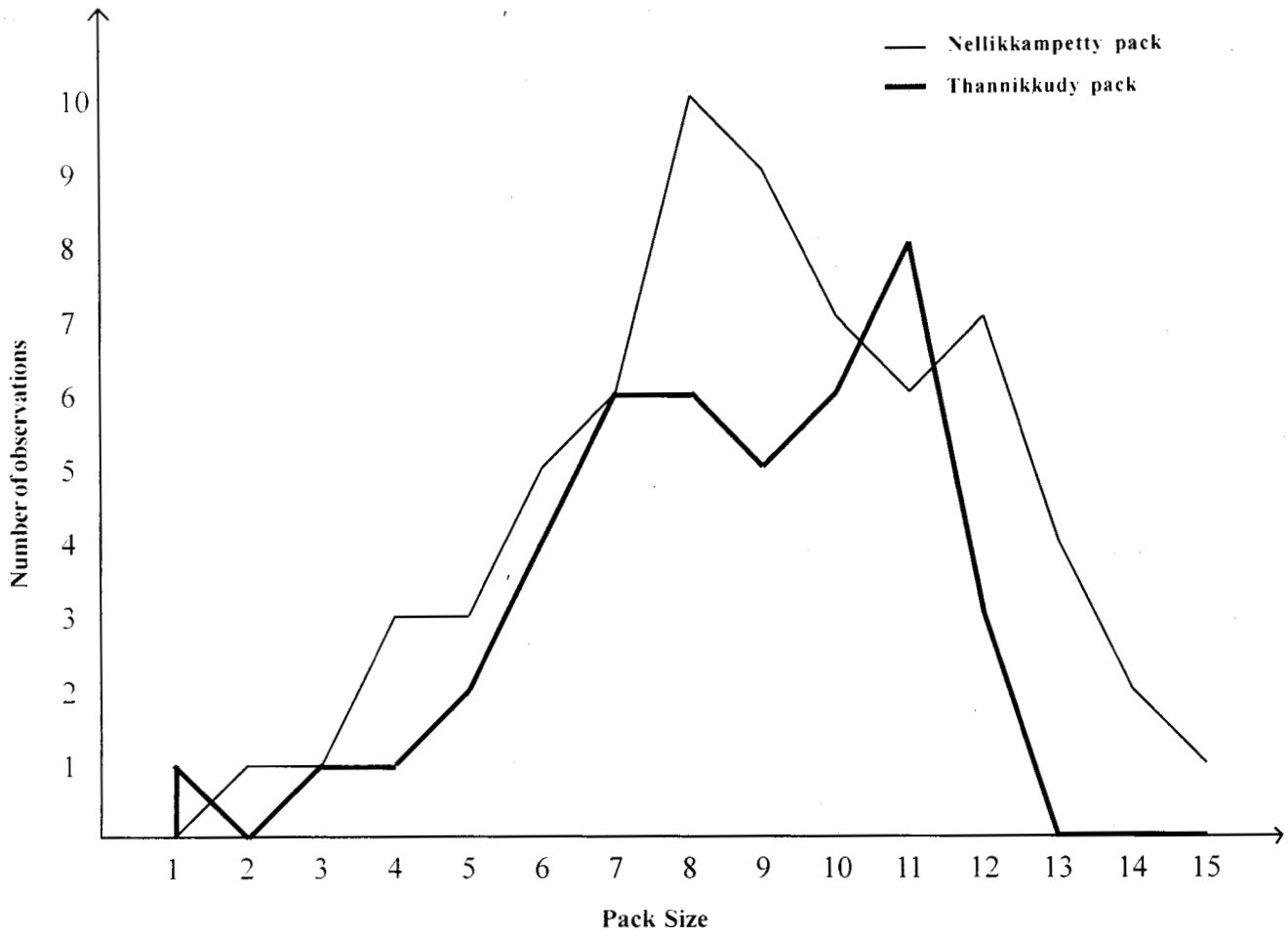

Fig.6 Pack size of Nellikkampetty and Thannikkudy pack of wild dogs

In Periyar, the packsize ranged from 2 to 14 animals (Ramachandran et al, 1985). During this study a pack size of 2-15 animals in the Nellikkampetty pack and 2-12 animals in the Thannikkudy pack was observed (appendix 4 and 5). The average packsize of Nellikkampetty pack and Thannikkudy pack was 8.9 and 8.4 respectively (Table 7). In Bandipur, the average packsize was 7.8 in the forenoon observations and 8.25 in the afternoon observations (Johnsingh, 1983).

The packsize variations was mainly caused by the birth of pups and emigration of some members from the packs. In January 1992, the Nellikkampetty pack had 13 animals including 4 pups but in may 1992 the packsize was reduced to 9 with 2 pups. On 7th February 1993 the packsize was 7 but it was 14 on 25th March 1993 with the appearance of 5 new pups (appendix-4). The percentage frequency of occurrence of wild dog sightings with various packsizes in Nellikkampetty and Thannikudy pack is shown in Fig.6.

IV.4 Habitat use

The habitat use by the wild dogs were determined by recording the sighting of the 2 packs at different habitats (Table-8). Percentages of sightings (n=65) of Nellikkampetty pack were 58.5

Table 9

Habitat preference of wild dogs based on scats (1993)

Months	Number of seats recorded	Habitat				
		Deciduous	Grass land	Semi ever green	Ever green	Eucalyptus plantation
January	15	4	8	2	1	-
February	16	4	7	3	1	1
March	21	7	11	1	2	-
April	17	4	8	2	2	1
May	20	3	10	4	1	2
June	13	4	7	1	1	-
July	9	3	5	1	-	-
August	15	3	8	2	1	1
September	16	3	8	3	2	-
October	18	5	9	2	-	2
November	15	4	7	3	-	1
December	20	3	13	2	1	1
Total	195	47	101	26	12	9
Percentage	-	24.105	51.78%	13.33%	6.15%	4.61%

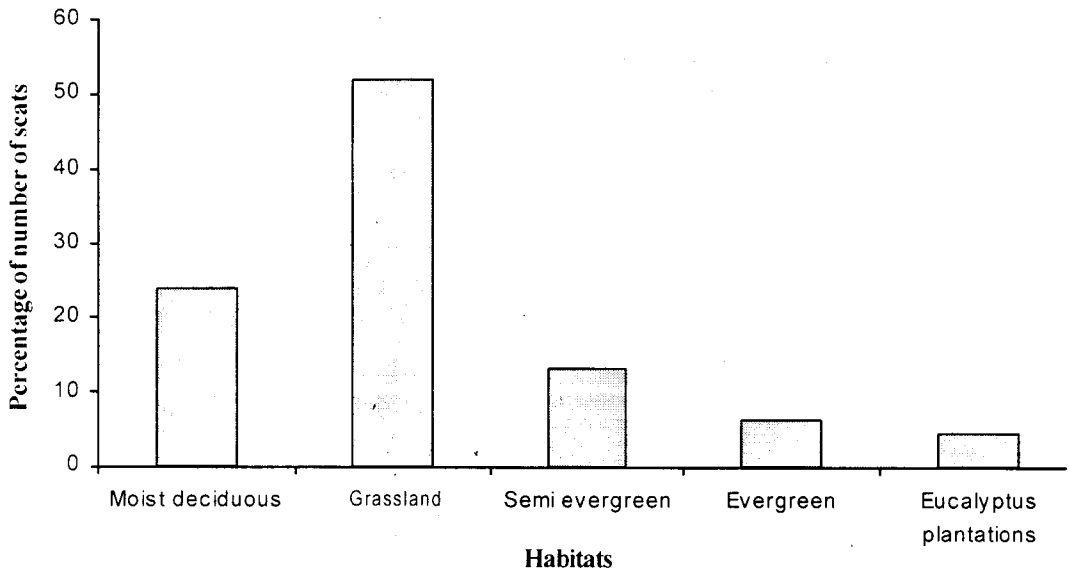

Fig. 7 - Habitat use of wild dogs in Periyar

in moist deciduous forests, 18.5 in grasslands, 21.5 in semi evergreen forests and 1.5 in evergreen forests. This seems to be related to the availability of sambar. Regarding the Thannikkudy pack, 37.2% of sighting (n=43) were in moist deciduous forests 41.8% in grassland, 14% in semi evergreen forests and 7% in evergreen forests. The percentage of sightings in each habitat was proportional to the available area of each habitat in the respective homeranges (Table 8).

However the distribution of wild dog scats observed in the field has indicated a different picture (Table 9); 51.8% scats (n=195) were observed in grasslands, 24.1% in moist deciduous forests, 13.3% in semi evergreen forests, 6.1% in evergreen forests and 4.6% in Eucalyptus plantations (Fig.7).

IV.5. Sex of wild dogs

The sex of wild dogs was not differentiated in all sightings. Only the sex of adult animals were used in computation. The sex ratio of 1:1.1 favouring males in Nellikkampetty pack and 1:1.34 favouring males in Thannikkudy pack was recorded (Table 10). African wild dogs also showed sex ratio favouring males (Schaller, 1972). In Bandipur males were slightly more in number than females in the wild dog population (Johnsingh, 1983).

Table - 10

Sex ratio of wild dogs in Periyar (1992-94)

Pack/Sex	Nellikkampetty pack	Thannikkudy pack
Number of wild dogs whose sex identified	217	164
Male	114	94
Female	103	70
Female: Male	1:1.1	1:1.34

IV.6. Prey species of wild dogs

As the wild dogs live in packs, they prey mostly on large animals as each dog is capable of eating 3-4Kg of meat and the minimum consumption rate per dhole per day is 1.86Kg. (Johnsingh, 1983). In Periyar, Sambar, *Cervus unicolor* the largest deer in South east Asia constituted the major prey of wild dogs and the average weight of adult male and adult female sambar is 220Kg and 150Kg respectively (Schaller, 1960). Out of the 131 kills observed, 125 (95.4%) were on sambar, 2 (1.5%) on barking deer, *Muntiacus muntjak* 3 (2.3%) were on mouse deer, *Tragulas meminna* and one on wild boar, *Sus scrofa* (Table 11). Inspite of this, the wild dogs as shown by the scat analysis (Table 12) feed on nilgiri langur *Presbytis johni*, Blacknaped hare, *Lepus nigricollis*, porcupine, *Hystrix indica* and rats.

The variation in the prey species used, apparently related with the geographical distribution of wild dogs. It is has been pointed out that nearly every species of forest animal has at one time or other served as prey for the dhole (Brander, 1927). In Bandipur, Chital formed the major prey of dhole followed by sambar and blacknaped hare and they occassionally feed on cattle (Johnsingh, 1983). In U.S.S.R the prey species of dholes included wild sheep, reindeer, wild goat and badger (Sosnovskii, 1967). The report of

Table - 11

Prey species of wild dogs from kills

Year	Number of kills observed	Sambar	Barking deer	Mouse deer	Wild boar
1992	50	49	1	-	-
1993	44	41	1	2	
1994	37	35	-	1	1
Total	131	125	2	3	1
Percentage	100	95.4	1.5	2.3	0.8

Table - 12

Frequency of occurrence of prey items in wild dog scats (1992-94)

Month & Year	Number of Scats Collected	Number of Scats with two items	Prey items							
			Sambar	Mouse deer	Barking deer	Nilgiri langur	Small rodents	Porcupine	Black naped hare	Grass
January	15	3	13	1	1	-	2	-	1	-
February	15	-	13	1	1	-	-	-	-	1
March	21	1	18	3	-	-	1	-	-	3
April	17	2	16	1	-	-	1	-	1	-
May	20	2	18	1	-	-	1	-	2	1
June	13	3	13	-	1	-	-	-	2	-
July	9	-	9	-	-	-	-	-	-	-
August	15	2	12	2	1	-	-	1	1	2
September	16	-	14	2	-	-	-	-	-	-
October	18	2	16	1	-	1	1	-	1	1
November	15	-	13	1	1	-	-	-	-	1
December	20	-	15	1	2	2	-	-	-	-
Total	194	15	170	14	7	3	6	1	8	9
Percentage	100	7.73	81.33	6.69	3.34	1.44	2.87	.48	3.82	4.63

dholes feeding on nilgiri langur (Adams, 1949) was confirmed in this study. In Sigur once a gaur calf was attacked by wild dogs (Fox, 1975). But in Periyar there were no evidences of wild dogs hunting gaur or not even an attempt. The study by Rice (1986) at Eravikulam has shown that wild dogs feed mainly on sambar and occassionally on barking deer, nilgir tahr and lizards or snakes. However there were no evidences of dhole feeding on nilgiri tahr in Periyar, though a small population of tahr inhabited isolated regions such as Mangaladevi, Arjunankotta and Varayattumudi.

Sharatchandra and Gadgil (1975) have shown that the wild dogs in Bandipur killed a domestic buffalo which was a bait for a tiger. Some scats of wild dogs as per them contained bird feathers. No bird remains were found in scats of dhole during this study.

A more detailed account of the prey consumed by dhole has been obtained by the analysis of the scats collected. Analysis of 194 seats collected from different sites in the 16 transects which represents the various types of habitats of the study area has identified seven prey animals (Table 12). As in the kills, sambar was evidently, the major prey animal in the scats analysed followed by mouse deer and blacknaped hare. Out of these 194 scats analysed, 170 scats (81.3%) had sambar remains, 14 (6.7%) had mouse deer remains and 8 (3.8%) had remains of blacknaped hare (Fig 8). Barking deer

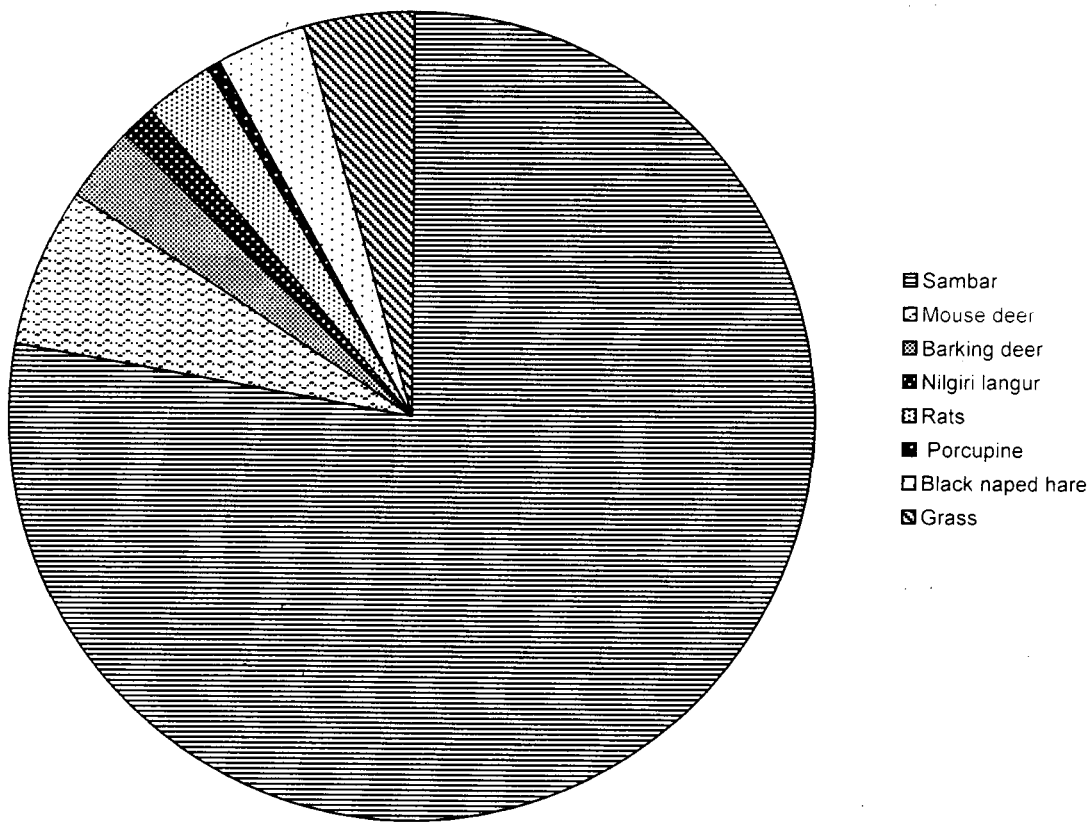

Fig.8 Frequency occurrence of prey items in wild dog scats (1992-94)

remains were found in 7 scats (3.3%), nilgiri langur in 3 scats (1.4%), rats in 6 scats (2.9%) and porcupine remains in 1 scat (.5%). Fifteen scats (7.7%) had remains of 2 species and grasses were found in 9 scats (4.63%).

The percentage composition of prey obtained from scat analysis in Bandipur showed a different result. As against sambar in Periyar, Chital (53%) formed the major prey at Bandipur followed by sambar (14%) blacknaped hare (14%) rats (6%), grass (7%) and miscellaneous (7%), (Johnsingh 1980). No scats had exclusively fresh grass though 9 scats had grasses and animal remaining. The grasses identified from the scats were *Cymbopogan* species and *Paspalam conjugatum*. There were no remains of domestic livestock in the scats although they came for grazing in the area.

The wild boar formed the second prey species of all the predators in this reserve according to Ramachandran, et.al (1987). But during this study no remains of wild boar were found in the scats. In 2 instances, wild dogs were driven by the scavenging wild boar when the dogs returned to their kill remains.

IV.7. Time of hunt

Wild dogs are predominantly diurnal and hunt in the mornings and evenings (Fig.9). Time was recorded for 91 kills

Table - 13

Time preference of wild dogs on sambar kill

Year	Total number of kills observed	Time Interwal							
		Morning			Noon		Evening		
		Before 7 AM	7 AM to 9 AM	9 AM to 11 AM	11 AM to 1 PM	1PM to 3 PM	3 PM to 5 PM	5 PM to 7 PM	Above 7 PM
1992	26	2	9	6	1	1	3	3	1
1993	32	3	10	6	2	2	5	4	-
1994	33	3	11	5	1	1	5	7	-
Total	91	8	30	17	4	4	13	14	1
%		8.79	32.97	18.68	4.39	4.39	14.29	15.38	1.10
		60.4%			8.8%		30.7%		

during this study. Of these, 55 kills (60.4%) were made in the morning, 8 (8.8%) in the noon (between 11AM-3PM) and 28 (30.7%) in the evening. Of the 55 kills observed in the morning 8 (8.9%) were made before 6.00 AM in the morning, 8 (8.9%) before 7 AM, 30 (32.9%) between 7 AM and 9 AM and 17 (18.7%) between 9 AM and 11 AM (Table 13). Of the 28 kills recorded in the evening, 13 (14.3%) were made between 3 PM and 5 PM and 14(15.4%) were made between 5PM and 7 PM. Two kills (3.6%) were made before sun rise and one (1.1%) after sun set (Appendix - 6).

At Bandipur, Johnsingh (1983) has recorded most of the kills in the morning (64.9%) and evening (35%). The percentage of kills observed in Bandipur by Johnsingh (1983) before sun rise was 14.6% and after sun set, 7.8%. This was slightly higher than the percentage of kills made during the respective timings in Periyar. In African wild dogs, hunting was mainly done during early morning (7 AM-9 AM) and late evening (7 PM-8 PM) (Fuller and Kat 1989). Sharatchandra and Gadgil (1975) observed the dholes usually hunting in the early mornings or in late evenings at Bandipur. At Periyar, wild dogs usually hunt in the morning in almost all months of the year and the number of kills in the evening was more during the summer months than winter months (Table 14).

Table - 14

Seasonal variation in wild dog predation time (1992-94)

Time / season	Morning (up to 11 AM)	Noon (Between 11 AM and 3 PM)	Evening (3 PM on wards)	Total
Winter	11	2	2	15
Summer	15	3	14	32
Monsoon	12	1	6	19
Post monsoon	17	2	6	25
Total	55	8	28	91

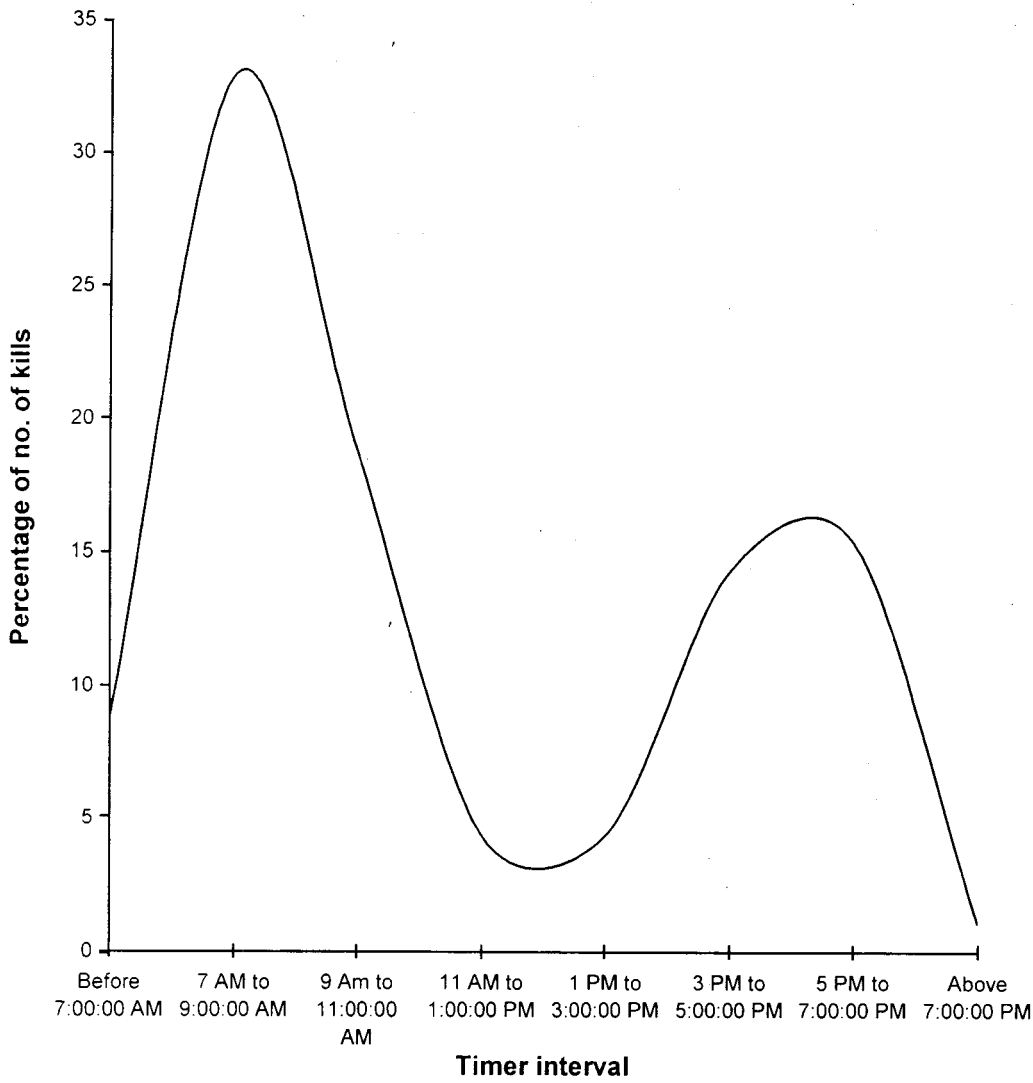

Fig.9 Time preference of wild dog predation

IV.8. Location of hunt

The vast open areas of the banks of the lake, rivers and streams in periyar were the main sites of wild dog hunting. Of the 123 kills recorded, 72 (58.5%) were on the lake bed, 37 (30%) on the banks of rivers and sterams, 6 (4.8%) in the open marshy grasslands, and 8 (6.5%) inside the forest (Table 15). Out of the 8 kills recorded inside the thick forest, 4 (3.3%) were in the semi evergreen forests, 2 (1.6%) in the moist deciduous forest and one (.81%) each in open grassland and Eucalyptus plantations (Fig.10).

The high percentage of kills on the lake bed may be due to the tendency of the prey (Sambar) to run towards water for escaping and also the tendency of the dogs to chase them down to the lake for killing; an evolutionary adaptation both for the predator and the pray. The exact location of kill was often in the water up to a depth of about 1m (71.8%, n=109). The location of the rest of the kills was in places between 1 and 2 meter away from the edge of water bodies (21.1%) and between 2-4 meter (6.4%).

IV.9. Prey location

Wild dogs have an excellant sense of smell and could locate their prey at a distance of more than 100m. According to Schaller (1967) wild dogs locate their prey by smell in scrub jungle where

Table - 15

Terrain and habitat of wild dog kills

Year	Number of kills	Habitat types								
		Lake bed	River or stream bed	Open marsh	S.E green	Deci-duous	Grass land	Euca-lyptus plantation	Ever green	Hill top
1992	49	27	15	3	2	-	1	1	-	-
1993	39	23	13	1	1	1	-	-	-	-
1994	35	22	9	2	1	1	-	-	-	-
Total	123	72	37	6	4	2	1	1	0	0
Percentage	100	58.5	30.08	4.87	3.25	1.62	.81	.81	-	

visibility was limited. At Periyar it seemed that in most cases wild dogs located their prey by vision in open areas and by smell inside the forest. However the data was insufficient to get a clear cut conclusion in this regard. Jerdon (1874) and Prater (1971) have pointed out that the wild dogs located their prey mostly by smell. Observations during this study have confirmed that when the alarmed prey runs, vision and hearing could aid the dogs to locate the direction and to chase the prey. Wild dogs sense of vision is quite good and they could see even from a distance of about 200 m. It is known that dholes could detect their prey at a distance of nearly 100m by prey scent (Johnsingh, 1983). The wolves could detect prey at a distance of about one kilometer or more (Mech, 1966).

IV.10. Rush and chase

When a prey is located the next step was to rush and chase. Wild dogs could run with much speed to catch the prey. During the early phase of the chase the dogs run faster than the prey. But the chase usually did not last long. Often the chase did not continue as beyond 500m from the starting point. All prey species except gaur, wild boar and occassionally adult sambar run when chased by dholes (Johnsingh, 1983). Observations have shown that even the adult sambar also run when chased by the dholes. Wild dogs

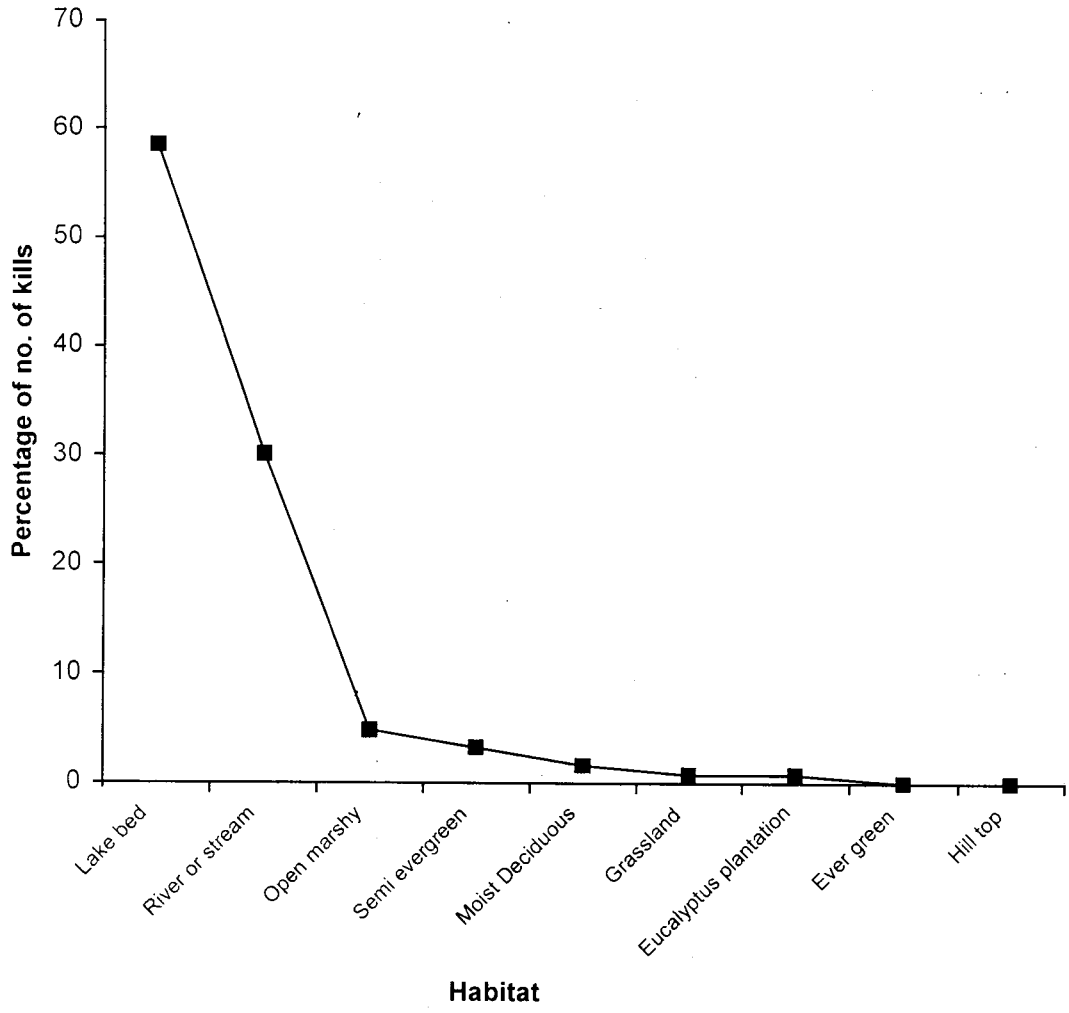

Fig.10 Terrain and habitat of wild dog kills (1992-94)

hunt in "relays" with short distances in closed habitats and members of the pack stand in different places to cover the prey in order to prevent them from escaping.

It was pointed out that the African Wild dogs hunt occassionally in brief relays (Kruuk and Turner, 1967, Schaller, 1972). On the contrary, the wolves are known to chase the prey for longer distance of about 5-8km (Mech, 1966). In Periyar, in most cases the prey when chased, finally reached the lake. In some cases the prey was killed before reaching water.

Wild dogs usually run parallel to the lake after flushing out the prey from cover towards the lake or to the river. The alarm calls of the prey and the 'whistling' calls of the predator was common while chasing. The repeated whistling call of the wild dogs was given as communication to other members of the pack probably to know the direction of chase and to surround the prey. Wild dogs, once aimed to kill a particular animal in a herd, would try to continue the effort on it and never attempted to kill other members of the herd. This was confirmed by many observation near the lake. On the evening 18th March 1992, a pack of 12 dholes near Edappalayam flushed out a subadult female sambar to the lake. The sambar stood in water nearly about 1 meter depth and the dogs

were found waiting in and around the edge of water. After few minutes 7 more sambar, may be the other members the herd, came to the lake bed walked here and there in the viscinity of the pack but the dogs did not bother to attack them. Finally the sambar in the water swam across the lake and escaped and no kill was observed on that day evening or night, in the area.

Generally when the sambar gets into water, the chances for it to escape are better. It could stand in water for long time, upto a depth of about 1.5 m. or swim across the lake. In such cases the wild dogs usually waited in the lake bed for some time and left the place.

IV.11. Attack and kill

Wild dogs begin to attack, as soon as the prey is caught and this may vary from one prey to another. Small animals especially sambar fawn may be caught on any part of the body as they run while larger animals are often attacked from back side. The usual point of attack is the rump and the flank. Wild dogs, while chasing are able to make serious wounds on any region of the body of the prey and as a result of continuous severe bitings on the body, even a large sambar may fall.

Table -16
Body parts of prey Attacked by wild dogs

Year	Number of Fresh kills	Attack on					
		Ear	Eye	Nose	Neck	Sorepatch on neck	Snout
1992	21	2	4	5	1	-	9
1993	16	1	2	3	1	1	6
1994	14	2	2	4	-	-	8
Total	51	5	8	12	2	1	23
Percentage		9.8	15.7	23.5	3.9	1.9	45

Table -17
Organs of prey eaten by wild dogs

Year	Number of Fresh kills	Attack on					
		Liver	Lungs	Ear	Eye	Sorepatch on neck	Heart
1992	21	17	15	4	10	1	21
1993	16	8	11	3	7	-	16
1994	14	9	7	3	5	-	14
Total	51	34	33	10	22	1	51
Percentage		66.6%	64.7%	19.6%	43.1%	1.9%	100%

As reported by Johnsingh (1980) the dhole could kill a small prey with a single head shake. As per observations made during this study, the point of attack on different parts of the body of sambar included flank rump, neck, nose, eye, ear etc., It was possible to examine 51 fresh kills for signs of injury on different parts of the body (Table 16). Of these, 12 (23.5%) had their nose injured, 8 (15.7%) had eyes injured 5 (9.8%) had ear injured, 3 (5.8%) had their neck injured and 23 (45%) had injury on their snout. Snout injury was comon in sambar stags with hard antlers. It was evident that larger prey like sambar with hard antlers which can cause lethal wounds on predators were caught by the snout.

Generally bite wounds, shock and loss of blood caused the death of prey. Observations have shown that fawns were killed within 2 minutes after the attack has began. Generally 10-15 minutes were taken in the case of adult sambar. On 4th April 1993 an adult female sambar was killed by 7 wild dogs within 7 minutes at Thannikkady. On another occassion at the Thekkady boat landing, on 28th May 1992, a pack of 9 wild dogs killed a sabadult male sambar in 15 minutes.

Killing was delayed when there were human interferences. The time taken by the wild dogs to kill prey animals was higher when compared to that of the Hyenas (average 6.3 minutes) to kill

wild beast (Kruuk, 1972) and Lion (average 8 minutes) to kill a zebra (Schaller, 1972). Tiger (Burton, 1925) and Lion (Schaller, 1972) have been reported to eat their prey alive but wild dogs did not eat their prey before killing.

Incidents of killing more than one animal a day were observed on 8 occassions. A pack of 15 wild dogs killed 2 fawns (both below 6 months of age) on the evening of 22nd April 1993 at manalmuni, Edappalayam. Fifty percent meat of both fawns were eaten in that evening and the dogs came on the next day morning for the remaining meat. On 25th March 1993 an adult female sambar was killed by the Nellikkampetty pack at 11.30 morning and 25% of its meat were eaten and the carcass was found deep in the mud. On that evening another adult female was also killed very near to the first kill by the same pack. It could be because the dogs could not get sufficient meat from the first kill as it was deep in the mud.

In the study area, usually the wild dogs after feeding some amount of meat from the kill came later for the rest of the meat. This was not reported by earlier workers. This continued for 2 or 3 days. But if kills were stolen by local people the dogs hunt another prey. In all the 6 cases of kills stolen by human beings, the wild dogs have killed another sambar on the same day.

IV.12. Sequence of eating carcass

Soon after killing, the wild dogs were seen pulling the prey to the lake bed if it was in the water. Often they started feeding immediately after killing. All members of the pack were not found feeding at a time. Two or 3 wild dogs were seen watching the surroundings while others feed. This 'division' of labour was shared by all the members of the pack except the pups. The first group which started feeding included the pups. They were seen drinking water between feeding intervals. After the first 'batch' had their first share, those dogs watching the surroundings came and started feeding. This rotation of feeding activity continued till the prey has been completely eaten or the pack had enough.

When the wild dogs started eating, they opened the belly and pulled the stomach and parts of the intestine to a distance and left them aside but in the case of fawns, these parts were also eaten. The internal organs such as liver and lungs were eaten in most of the kills. Out of the 51 kills, liver was eaten in 34 kills (66.6%) and lungs in 33 kills (64.7%) (Table 17). Of the 51 kills observed both eyes were eaten in 14 kills and one eye in 8 cases. Pinnae were eaten in 10 kills (19.6). Wild dogs were quite eager to eat the heart and it was eaten in all kills (100%).

Table - 18

Meat consumption rate of wild dogs (1992 Jan - 1993 Jan)

Sl. No.	Date	Age class and Sex of prey	Estimated weight of prey (in kg.)	Number of wild dogs	Percentage of meat eaten	Meat eaten per wild dog (in kg).
1	15.01.92	Adult female	110	7	25	4.5
2	18.01.92	Sub adult female	60	7	50	3.5
3	12.02.92	Sub adult female	90	5	25	4.4
4	22.02.92	Fawn	50	11	75	3.4
5	23.02.92	Fawn	30	7	90	3.8
6	07.03.92	Fawn	45	4+	10	1.1
7	18.03.92	Sub adult male	60	12	90	4.5
8	25.03.92	Fawn	35	14	90	2.3
9	14.04.92	Sub adult male	65	14	80	3.7
10	18.05.92	Sub adult female	70	14	85	4.3
11	28.05.92	Sub adult female	90	7+	25	3.2
12	15.06.92	Sub adult female	80	10+	45	3.6
13	29.06.92	Sub adult female	75	10	60	4.5
14	17.07.92	Fawn	40	8+	75	3.7
15	01.08.92	Fawn	65	6+	25	2.7
16	02.09.92	Adult male (velvet)	150	5+	15	4.5
17	04.09.92	Sub adult female	120	9	25	3.3
18	29.10.92	Adult female	145	8+	20	3.6
19	31.01.92	Fawn	40	8+	80	4.0
20	10.11.92	Fawn	35	9	90	3.5
21	16.11.92	Fawn	45	8+	80	4.5
22	21.11.92	Sub adult female	85	8+	45	4.7
23	11.12.92	Fawn	55	8	50	3.4
24	02.12.92	Fawn	50	8	60	3.7
25	18.12.92	Fawn	35	7+	80	4.0
26	21.12.92	Adult male	140	5+	15	4.2
27	30.12.92	Fawn	40	8	60	3.0
28	09.01.93	Fawn	45	8	75	4.2
29	16.01.93	Fawn	40	7	90	5.1
30	21.01.93	Fawn	35	3	25	2.9
					Average	3.73

43 B

Plate 1- A Sambar herd at Ayyappankurukku

Plate 2 - Wild dogs feeding on Sambar

When a fawn was killed, only the skeletal parts were left around the kill site. The vertebral column with partially eaten ribs and the skull remained at the kill site. The limb bones, lower jaw and the pectoral girdles were usually seperated. Skin was left with the head in the case of larger prey. In the case of fawns, all body parts including the skin and the head were often eaten leaving only the limb bones, vertebral column, skull and some times, the rumen.

IV.13. Rate of meat consumption by wild dogs

The amount of meat eaten by the dhole seemed to depend on the size of the pack and the size of the prey. The rate of meat consumption by wild dogs was recorded in 30 kills. The percentage of meat eaten in different kills varied from 10% - 90% and the amount of meat eaten by a single dog varied from 1.1kg meat/dhole to 5.1kg/dhole with an average of 3.73kg meat per dhole (Table 18). Wild dogs in Bandipur was capable of eating 3-4kg of meat where the minimum consumption rate per dhole per day was 1.86kg (Johnsingh, 1983).

Though the consumption rate of pups and adults varied, it was not possible to calculate the amount of meat eaten by them separately. In the case of larger prey the dogs did not eat the meat completely; at a single stretch. In such cases they came back on

Table - 19

Sex composition of sambar killed by wild dogs

Year	Number of kills recorded	Number of fawns	Number of kills of sambar whose sex was identified	Number of females	Number of males			
					Stag and fawn	Velvet	Antler shed	Total male
1992	49	20	37	22	12	1	2	15
1993	39	11	36	20	9	3	4	16
1994	35	9	31	21	9	-	1	10
Total	123	40	104	63	30	4	7	41
Percentage		32.5		60.6	28.8	3.8	6.7	39.4

Male: Female = 1:1.53 or 65 male : 100 female

the same day or in the successive one or 2 days and consumed the rest of the meat, if available. The speed of eating the meat was noteworthy. Once in Thekkady boat landing area, the Nellikkapetty pack with 12 dogs completed a fawn within an hour. If the prey was larger, eating usually lasted for 1 to 2.5hrs. The speed of eating was found quicker near human settlements.

IV.14. Predation and sex of prey

During this study, 104 wild dog kills on sambar in which the sex of the prey was identified, showed marked differences in the proportion of males and females sambar killed by dholes. The ratio in the kill was 65 male: 100 female (Table 19). Out of the 104 kills, 63 (60.6%) were females and the 41 (39.4%) males. Of the 41 males killed, 30 (73.1%) were either fawn or stag, 7 (17.1%) were antler shed and 4 (9.8%) were in velvet (Fig.11 and appendix 7).

The sex composition of prey killed in Bandipur was quite different from that observed in Periyar. According to Johnsingh (1983) male sambar were more succeptible to predation and the sex ratio in the kills was 112.5 male: 100 female (n=17). During his study, all males killed were yearlings or sub adults which suggests that their solitary habits could have made them vulnerable to

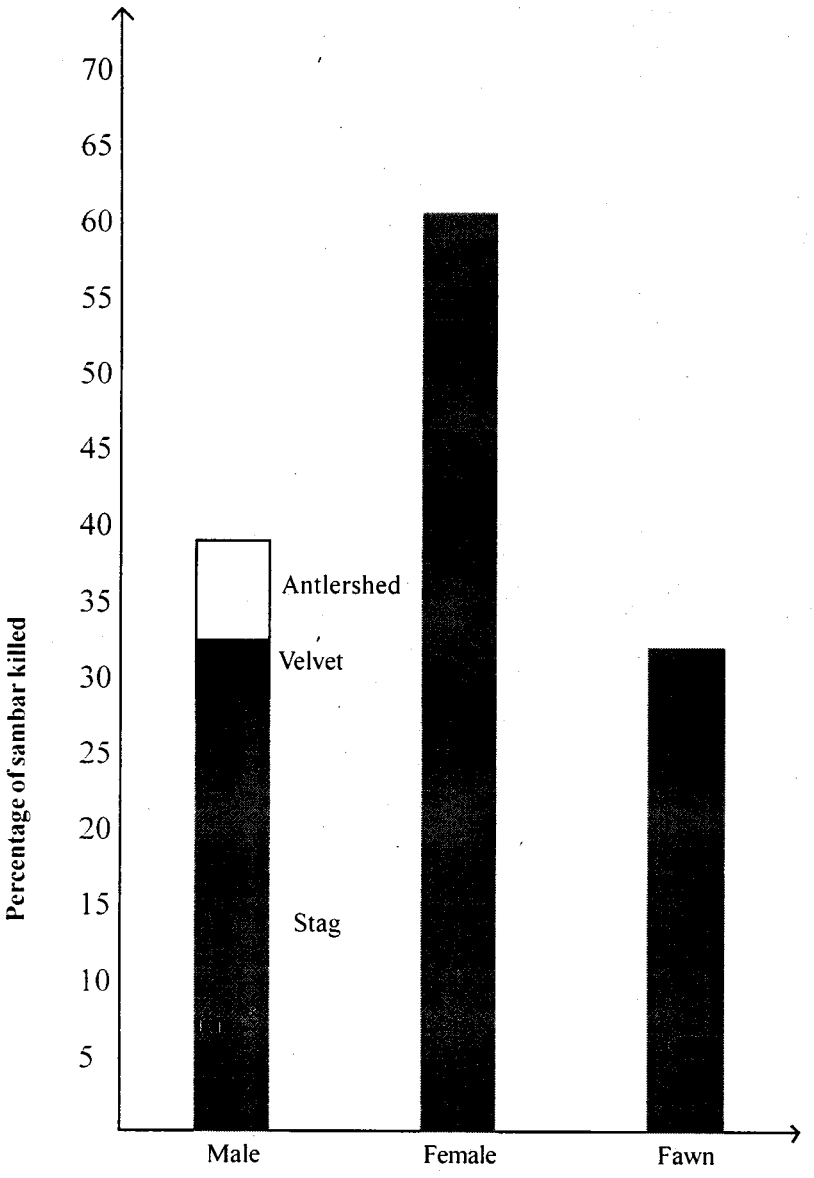

Fig.11 Sex composition of sambar killed by wild dogs (1992-94)

predation. Schaller (1967) found a sex ratio of 120 male; 100 female (n=11). It is important to note that 40 kills (32.5% n=123) were fawns in this study.

IV.15. Predation and age of prey

Age of sambar killed by wild dogs were calculated by examining the wear of premolars and molars as described by Giles (1954) and Schaller (1967). The age of 125 sambar killed has shown a greater affinity of the wild dogs towards young ones especially fawns below 6 months. Forty two kills (33.6%) were of class I (1-6 months), 28 kills (22.4%) of class II (6 months-1 year), 26 kills (20.8%) of class III (1 year-2 year), 15 kills (12%) of class IV (2 year-4 years), 11 kills (8.8%) of class V (4 years-6 years) and 3 kills (2.4%) were of class VI (Above 6 years) categories (Table 20).

Fiftysix percent (70 kills) of kills on sambar were below one year of age. Fawns and yearlings were the main target group of the wild dogs during this study. The number and the percentage of kills have decreased as the age of prey increased (Fig.12). Wild dogs usually killed young ones of larger animals and adults of smaller animals (Schaller, 1967). In this study, the age composition of sambar killed by wild dogs was found agreeing with the view of schaller.

Table - 20

Age class of sambar killed by wild dogs

Year	Number of Sambar killed by wild dogs	Age class					
		I 1-6 month	II 6-12 month	III 1 to 2 yr	IV 2 to 4 yr	V 4 to 6 yr	VI Above 6 year
1992	49	16	9	10	7	6	1
1993	41	15	10	9	4	2	1
1994	35	11	9	7	4	3	1
Total	125	42	28	26	15	11	3
Percentage		33.6	22.4	20.8	12.0	8.8	2.4

IV.16. Mortality of wild dogs

Mortality of predators could be due to predation, fight with other predators and some prey animals, disease and persecution by man. Wild dogs are occassionally killed in encounters with the leopard (Morris, 1925) and the tiger (Connell, 1944). There were no evidences of wild dog death due to the encounter with other predators in Periyar though encounters with wild boar was observed on a number of occassions over kills.

On 3rd April 1993 an adult male wild dog was found dead in water near the shutter at Thekkady check post. There were several porcupine quills struck on the neck and head of the victim. This could be the result of an attempt of wild dogs to hunt porcupine. Another adult female wild dog was seen dead in the lake near Mulakupara, Thannikkudy in February 1994 and the cause of death was unknown. There was no injury on its body.

The mortality of pups was found to be more than that in other age group. A high mortality in pups of both the packs of Nellikkampetty and Thannikkudy was observed during this study. On 21st Feb 1994 there were 7 pups and 8 adults in the Nellikkampetty pack and the number of pups was reduced to 3 in August 1994 (in 6 months) (appendix-2).

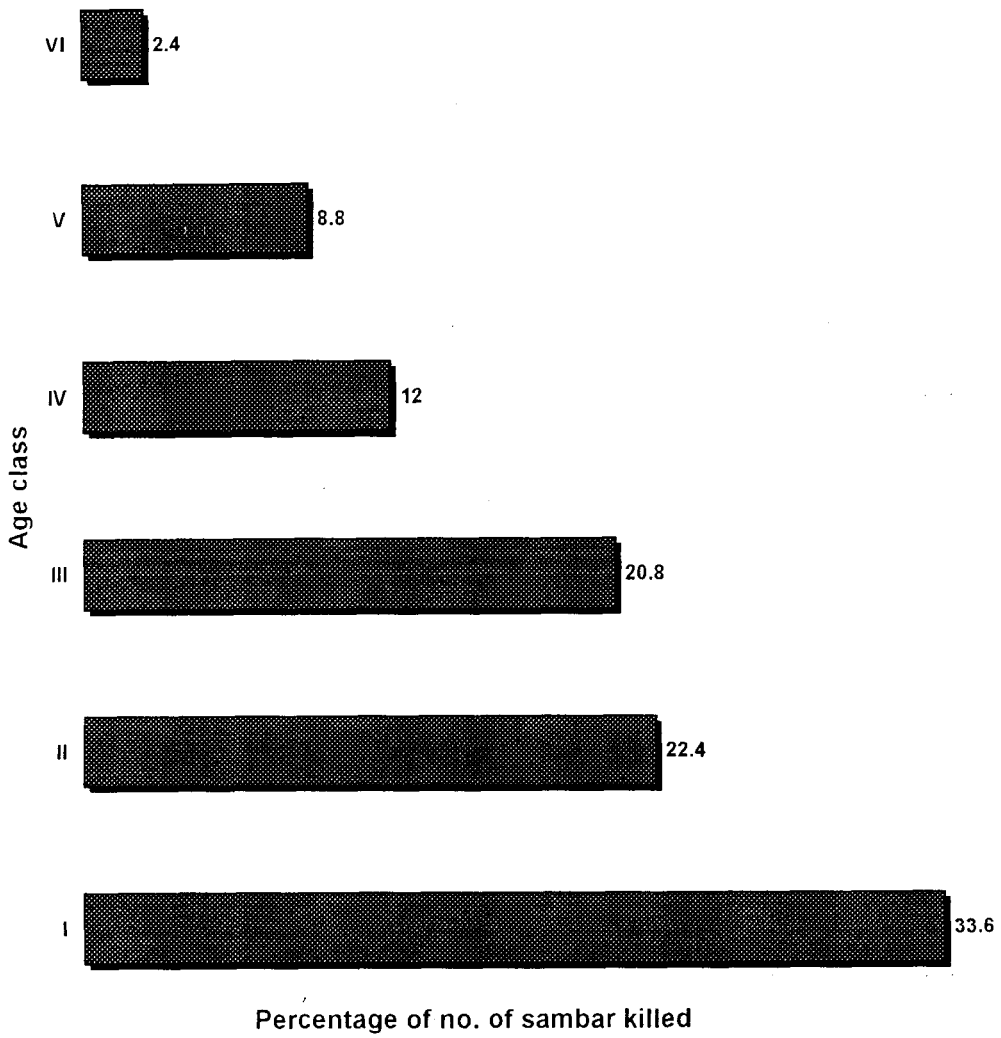

Fig.12 Age class of sambar killed by wild dogs (1992-94)

In the Thannikkady pack, on 6th February 1994, there were 4 pups and 8 adults. On November 1994 the number of pups was reduced from 4 to 2 with the loss of 3 adults in 9 months (appendix 3) and the pack size came down to 7.

OTHER PREDATORS

Abraham. C.J “Studies on large mammalian predators with special reference to wild dog, cuon alpinas (pallas) and their prey species in Periyar, South India” Thesis. Department of Zoology, St. Joseph's College Devagiri, University of Calicut, 2000

CHAPTER - V

OTHER PREDATORS

V.1. THE TIGER, *Panthera tigris*

V.1a. Distribution and Status

Tiger, *Panthera tigris* is found in all major forest types in India, thorn scrub, and dry, moist deciduous, semievergreen and evergreen forests (Schaller, 1967). It also occurs in the mangrove swamps (Pocock, 1936) and grassland-scrub forest mosaic (Dang, 1962).

In Periyar, the tiger inhabits all parts of the reserve, at altitudes ranging from 400 - 2200m and in all forest types. The preferred habitats were the moist deciduous forests and the savannah type grasslands. There were 12 tiger sightings during this study; 4(33.3%) were in moist deciduous forests 3 (25%) in grasslands, 2 (16.7%) in semi evergreen forests, one (8.3%) in ever green and 2(16.7%) in Eucalyptus plantations (Table 21 and 23).

The tiger kills and the other indirect evidences of tigers occurrence such as scats, pugmarks and scratches encountered in different habitats of the study area (Appendix - 8) have also indicated that the tiger in periyar had a preference for moist deciduous forests

Table - 21

Tiger Sightings In Periyar 1992-94

No	Date	Time	Place and Habitat	Adult			Cub			
				♂	♀	?	♂	♀	?	Total
1	21.03.92	12.10 PM	Deer island (Grassland)					1		1
2	05.04.92	7.30 AM	Sivaloda (Moist deciduous)	-	1					1
3.	23.12.92	11.20AM	Aruvioda (Semi evergreen)			1				1
4	14.02.93	4 PM	4th mile uppupara (E. plantation)			1				1
5.	07.06.93	12.45 PM	Thannikkudy (Grass land)	1	1				1	3
6.	04.08.93	11.15 AM	Kokkara (Moist deciduous)		1					1
7.	04.08.93	240 PM	Kokkara (Moist deciduous)		1			1		2
8.	15.09.93	9.30 AM	Pachakkanam E. Plantation			1				1
9.	13.10.93	8.15 AM	Damsite (Grass land)			1				1
10.	06.04.94	3.20 PM	Thannikkudy (Moist deciduous)		1					1
11.	16.04.94	5.45 PM	Sivaloda (Semiever green)				1			1
12.	03.09.94	6.30AM	Vellimala (Evergreen)	1						1
Total				2	5	4	1	2	1	15

♂ : ♀ = 1:2.3

Table - 22

Habitat Preference of Tiger based on scats

Year	Number of scats	Moist deciduous	Grass land	Semi ever-green	Ever green	Eucalyptus plantation
1992	46	21	13	5	3	4
1993	31	12	8	6	4	1
1994	43	23	10	4	6	-
Total	120	56	31	15	13	5
Percentage	100	46.7	25.8	12.5	10.8	4.2

Table - 23

Habitat of Tiger Sightings (1992-94)

Habitat	Number of sightings	Percentage of sightings
Moist deciduous	4	33.3
Grassland	3	25
Semi evergreen	2	16.7
Evergreen	1	8.3
Eucalyptus plantation	2	16.7
Total	12	100

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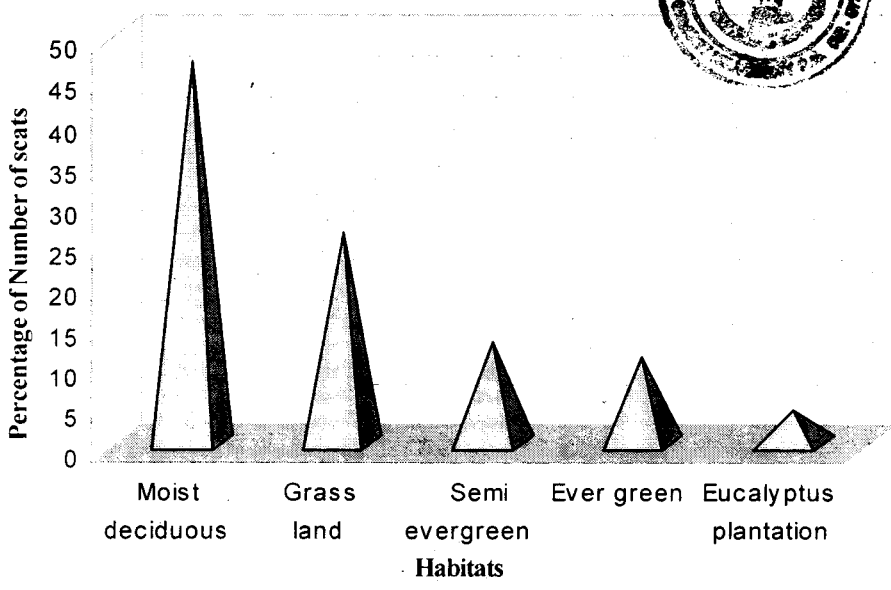

Fig.13 Habitat preference of Tiger based on scats (1992-94)

Table - 24

Habitat preference of Tiger based on kill data

Habitat / prey	Moist deciduous	Grass land	Semi ever green	Ever green	Eucalyptus plantation	Cultivated land	Total	%
Sambar	4	4	5	-	1	-	14	46.7
Gaur	4	-	-	2	-	-	6	20
Mouse deer	1	-	-	-	-	-	1	3.3
Domestic cattle	1	2	-	-	-	1	4	13.3
Domestic buffalo	-	-	1	-	-	-	1	3.3
Porcupine	-	1	-	-	-	-	1	3.3
Wild boar	2	-	-	-	-	-	2	6.6
Varanus	1	-	-	-	-	-	1	13.3
Total	13	7	6	2	1	1	30	100
Percentage	43.3	23.3	20.0	6.7	3.3	3.3	100	

and grasslands. Out of the 30 kills recorded during the study, 13(43.3%) were in moist deciduous forests, 7(23.3%) in grasslands, 6(20%) in semi evergreen forests, 2(6.7%) in evergreen forests and 1(3.3%) each in Eucalyptus plantations and cultivated land (Just outside the reserve) (Table - 24). Out of the 120 tiger scats observed during the study, 56(46.7%) were in moist deciduous forests, 31(25.8%) in grasslands 15(12.5%) in semievergreen forests, 13(10.8%0 in evergreen forests and 5(4.2%) in Eucalyptus plantations (Table 22 - and Fig.13).

The first attempt to estimate the number of tigers in periyar was done by Varghese (1975). According to his report a total of 30 tigers (11 males, 5 females, 8 subadult males, 3 subadult females and 3 cubs) were present in the reserve in early seventies. The number of tigers has evidently increased to 38 in 1981 with 16 adult males, 10 adult females, 8 sub adults and 4 cubs (Varghese, 1981). In 1982 there were about 25-30 tigers in periyar (Ramachandran et al 1985). As per this study, the number of tigers in periyar was aproximately in between 30 and 36 (6-8 adult males, 14-16 adult females and 10-12 cubs) in the year 1993. The density of tigers in periyar appeared to be .04 - .05 tiger per km^2 or one tiger per 21.6 - 25.9 km^2 area which was little less when compared to the density of .08 - .12 per sq. mile (excluding cubs) at Kanha (Schaller, 1967)

and slightly higher than that of .04 per sq. mile at Mysore (Sanderson, 1912).

V.1b. Groupsize and sex

Tigers are usually solitary, though groups of 2-7 are rarely seen (Schaller, 1967). Groups are common in breeding season and when they are with the growing cubs. At Periyar, solitary individuals and groups were seen during the study. Out of the 12 tiger sightings, 2(16.6%) were in groups and 10(83.3%) solitary (Table 21). Maximum groupsize observed was 3 (one observation - 1 male, 1 female and 1 cub). The littersize ranged from 1 -2 during this study. At Kanha it was 1-4 (Schaller, 1960).

Regarding the sex, a ratio of 4:1 favouring females was observed at Kanha (Schaller 1960) and 1:1.2 also favouring females was reported from Malaya (Locke, 1954). The sex ratio obtained from the tiger sightings during this study was 1:2.3 favouring females (Table 21). A ratio of 1:3.2 favouring females was evident from the analysis of the pugmarks in the area (Table 25). A total of 169 pugmarks were recorded during this study. Out of the 143 pugmarks, where sexes were identified, 34 (23.8%) were males and 109 (76.2%) females (Fig.14).

Table - 25

Sex ratio of Tiger from pugmarks(1992-94)

Year	Number of Pugmarks recorded	Sex of Tiger		
		Male	Female	Unknown
1992	63	13	42	8
1993	57	9	37	11
1994	49	12	30	7
Total	169	34	109	26
Percentage	100	23.8	76.2	

Sex ratio = Male: Female = 1:3.2

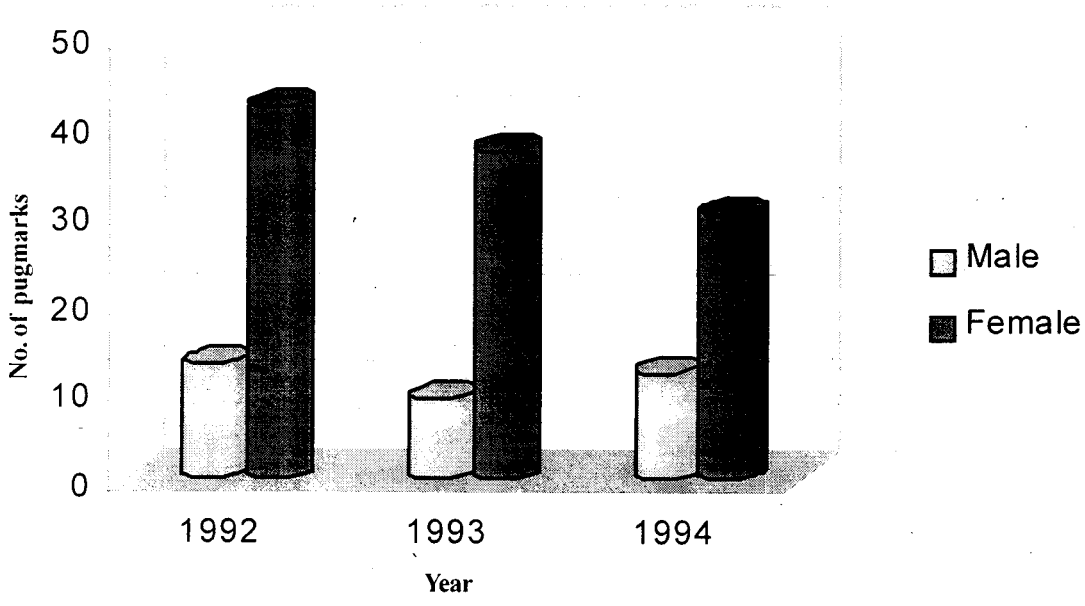

Fig.14 Sex ratio of tiger from pugmarks

V.1c. Prey species of tiger

Major prey species of tiger consisted of chital, sambar, barasingha, hogdeer, barking deer, gaur, nilgai, wild boar, domestic cattle, porcupine, domestic buffalo and domestic pig in India (Schaller 1960), moose, pig, manchurian wapiti, musk deer, roedeer, and sika deer in the Soviet Far East (Abramov, 1962) and pig in Central Asia (Novikov, 1962). Minor prey species of tiger inlcuded horses (Taylor, 1956) donkeys, camels (Novikov, 1962) goats (Anderson, 1954) elephants (Sanderson 1912; Baze, 1957; Johnsingh 1983) and frog, eggshell and termite (Schaller, 1967). In Periyar, sambar was the major prey species of tiger though it took wild boar and porcupine (Ramachandran et al, 1987).

During the present study 8 prey species of tiger were identified in periyar from tiger kills. They were the sambar, the gaur, the mouse deer, the domestic cattle, the domestic buffalo, the wild boar, the porcupine and the monitor lizard (Appendix-8). Thirty tiger kills were recorded during this study. Of these, 14 (46.7%) were sambar 6(20%), gaur 4(13.5%) domestic cattle, 2(6.6%) wild boar and one (3.3%) each mouse deer, domestic buffalo, porcupine and varanus (Monitor Lizard) (Table-24). The results obtained from the analysis of 120 tiger scats samples have identified 13 prey species

Table - 26

Frequency of Occurrence of food items in Tiger scats (1992-94)

Food item	No. of scats with the remains of	Percentage	Percentage of the total food items
Sambar	73	60.8	55.7
Porcupine	26	21.7	19.8
Rats	7	5.8	5.3
Mouse deer	3	2.5	2.3
Nilgiri langur	2	1.7	1.5
Small lndian civet	2	1.7	1.5
Blacknaped hare	1	0.8	0.8
Varanus	2	1.7	1.5
Gaur	1	0.8	0.8
Wild boar	1	0.8	0.8
Elephant	1	0.8	0.8
Domestic cattle	1	0.8	0.8
Grass	11		8.4
Total	120 (Excluding grass)	99.99	100

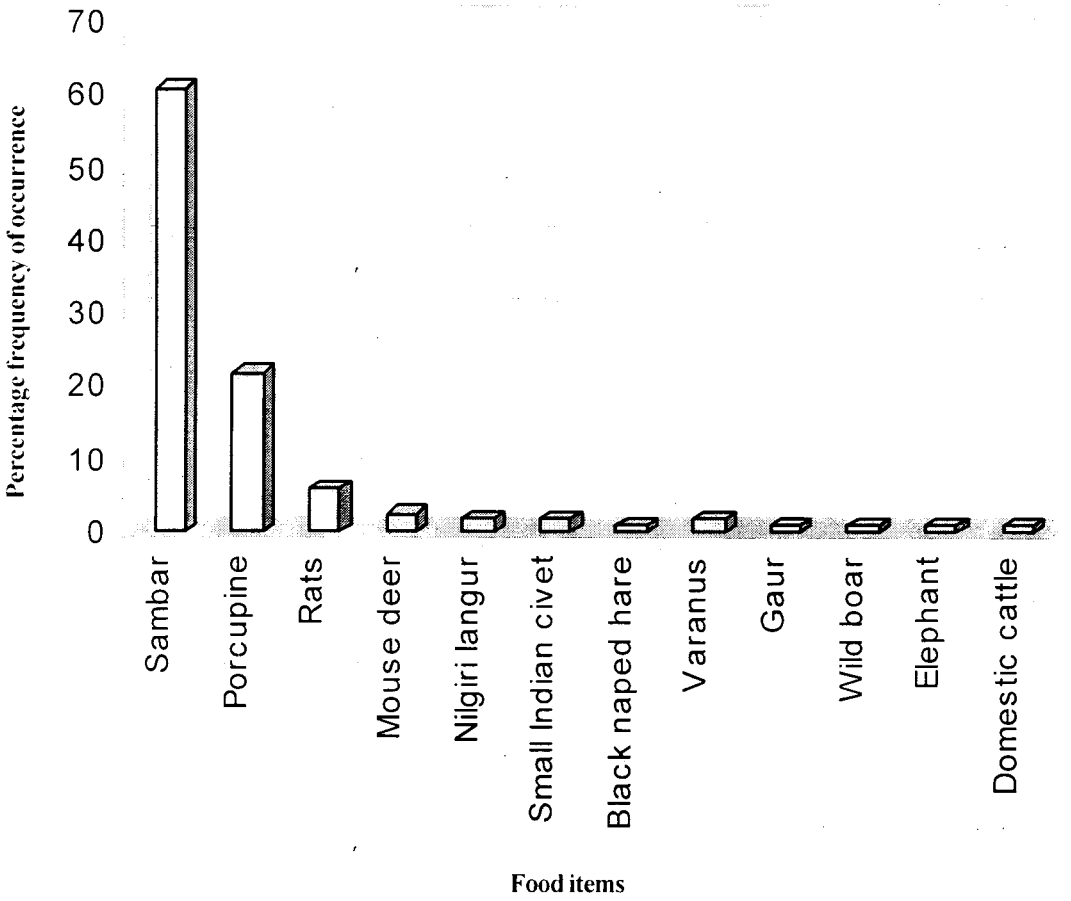

Fig.15 Frequency occurrence of food items in tiger scats (1992-94)

of tiger in periyar. The prey species other than those identified from kills included rats, nilgiri langur, small indian civet, blacknaped hare and elephant.

The most important prey species of tiger in periyar was sambar followed by porcupine (Fig.15). In 18 scats there were remains of more than one prey species. Sambar comprising 55.7% of the total items, was detected in 73 scats (60.8%) (Table-26). The second major prey species was the porcupine comprising 19.8% of the total items, detected in 26 scats (21.6%). The third major prey species of tiger seemed to be rats comprising 5.3% detected in 7 scats (5.8%). Minor prey species included mouse deer comprising 2.5% (3 scats), nilgiri langur, small indian civet and varanus comprising 1.7% (2 scats) each and gaur, wildboar, elephant and domestic cattle comprising 0.8% (1 scat) each. Grasses were found in 11 scats and this formed 8.4% of the total items detected (Table 26).

Davidar (1975) has reported nilgiri tahr remains in tiger scats, but there was no report of tahr hair in tiger scats at Eravikulam (Rice, 1986) and in this study. Tigers habit of eating birds at Soviet Far East (Abramov 1962; Allen 1960) and soil (Powel 1957; Schaller 1967) were not observed during this study.

V.1d. Age and sex of prey

Tigers are usually known to hunt more adults than young ones (Schaller, 1967). An age class ratio of adults and fawns of prey species of tiger in Bandipur recorded was 1:5 in favour of adults (Johnsingh, 1983). At periyar the ratio of different age classes of prey species by tiger was worked out from 28 kills. The ratio of Adult: subadult: youngones was 8.5:4.5:1 favouring adults followed by subadults. Adults constituted 60.7% subadults 32.1% and youngones 7.1% of the prey (Appendix-8).

The sambar killed by tiger in periyar were usually adults and subadults. Out of the total 14 kills observed, 11(78.6%) were adults and 3(21.4%) subadults and there were no evidences of fawn predation by tiger (Table.27). All the adults killed were of more than 5 years old and the subadults were more than 2.5 years old.

The tiger in periyar preferably killed males of various prey species. Out of the total 21 kills recorded where the sex of the prey was known, thirteen (61.9%) were males and 8(38.1%) females, giving a ratio of 1:1.6 favoring males (Table-28). Regarding the sex of sambar killed by tiger, 10(71.4%) out of 14 were males and 4(28.6%) females giving a ratio of 1:2.5 favouring males (Table-27). Nine (90%) out of the 10 males were adults and 1 subadult

Table - 27

Age class and sex of sambar killed by Tiger

No	Age class of sambar killed	Male	Female	Total	Percentage
1	Adult	9	2	11	78.6
2	Subadult	1	2	3	21.4
3	Young ones	-	-	-	-
	Total	10	4	14	
	Percentage	71.4	28.6	-	100

Male - Adult : Subadult = 9:1 ♂ : ♀ = 2.5 :1

Female - Adult : Subadult = 1:1

Table - 28

Sex of prey killed by Tiger

Prey species	Male	Female	Total
Sambar	10	4	14
Domestic cattle	-	3	3
Domestic Buffalo	-	1	1
Gaur	3	-	3
Total	13	8	21
%	61.9	38.1	100

♂ : ♀ = 1.6 : 1

(10%) giving a adult subadult ratio of 1:9 favouring adults. In the females a 1:1 ratio was obtained for adults and subadults.

V.1e. Characteristics of tiger kill

Very little information was obtained from the tiger kills. During this study, direct sightings of tiger with its kill were only on 2 occassions. Tiger usually dragged the prey into safe places, preferably under thick cover after it has been killed as reported by Burton (1936) and Schaller (1967). The distance observed in dragging the carcass varied with each kill, seemed to be based on the nature of the terrain and vegetation. Tiger kills in periyar unlike that of the dhole were not near the river or lake. Out of the 30 kills recorded, 18 away from water bodies.

On 4th August 1993 I had a chance to see a tigress feeding on an adult female sambar with an approximate weight of 150 Kg at 11.40 AM at Kokkara near Thekkady. It was in a moist deciduous habitat and nearly 250m away from the forest guard station. On the same day evening at 3.15 PM, the tigress was observed along with her cub feeding the remaining meat. The meat was completely eaten by the third day and only the hard skeleton including the skull was left. Nearly 50 Kg of meat was eaten on a day by the tigress and her cub.

On another occassion a subadult female sambar with an approximate weight of 100Kg was killed by a subadult tiger at Sivaloda near Thekkady boat landing. This tiger was observed eating the meat at the evening. The meat was fully eaten by the 4th day after the kill has been made. The carcass was found dragged into the thick semievergreen undergrowth, upto a distance of about 150m.

In Thekkady and Vallakkadavu areas tigers have evidently killed more livestock (appendix-8). This was done either inside the sanctury area where the cattles and buffalo's came for grazing or in the settlement areas and estates just outside the reserve.

V.1f. Interactions with wild dogs

The wild dog was known to fight with tigers and even kill them (Burton 1940). In periyar, 2 cases of tigers engaged in fight with the wild dog packs were reported by the forest department staff and the Kerala Tourism Development Corporation Staff in one case injuring a dog, and in the other, without any casualities. However I couldn't see any fight between the tiger and wild dogs.

V.2. **THE LEOPARD, *Panthera Pardus* (Linnaeus)**

V.2a. **Status and distribution**

The Leopard, *Panthera Pardus* considered to be the third major predator in Periyar, had a wide distribution in the reserve. Both the spotted and black phases of leopards were observed (Table-29). Leopards in periyar preferred evergreen and semi evergreen forests. Out of the 7 sightings, 3(42.9%) were in evergreen habitats 2(28.6%), each in semievergreen and deciduous habitats and none in the grasslands or Eucalyptus plantations in the study area (Table 30). Indirect evidences of the occurrence of Leopards such as pugmarks and scats were mostly recorded from semi evergreen forests followed by evergreen and moist deciduous forests (Fig.16). Out of the total 95 scats observed 32 (33.7%) were in semi evergreen, 28(29.5%) in evergreen 23(24.2%) in moist deciduous, 9(9.5%) in Eucalyptus plantations and 3(3.2%) in the grasslands (Table-31). Further, the occurrence of leopard seemed to be more in areas where the nilgiri langur, the major prey species of leopard occurred in good numbers. This langur was commonly seen in semi evergreen and evergreen forests, though they occurred in other habitats except the grasslands.

Leopards probably used an area of 8-10 Km^2 at Wilpattu National Park, Srilanka (Eisenberg and Lockhart, 1972) and in

Table - 29

Leopard sightings in Periyar (1992-94)

No.	Date	Time	Place and Habitat	Number of Leopard
1	20.05.92	6.10 PM	Ummikkuppan (Ever green)	1 S
2	04.04.92	9.50 AM	Aamayoli (Moist deciduous)	1 B
3	07.04.93	2.25 PM	Ayyappankurukku (Moist deciduous)	1 S
4	29.08.93	11.15 AM	Aruvioda (Ever green)	1 S
5	11.08.92	12.30 PM	Sivaloda (Semi ever green)	1 S
6	03.10.93	4.30 PM	(Vaikkappadappu (Semi ever green)	1 S
7	06.05.94	5.10 PM	Mlappara (Evergreen)	1 S
	Total			7

S = Spotted phase

B = Black phase

Table - 30

Habitat use by Leopard based on sightings (1992-94)

Habitat	Number of sightings	Percentage
Ever green	3	42.9
Semi-ever green	2	28.6
Moist deciduous	2	28.6
Grass land	-	-
Eucalyptus plantations	-	-
Total	7	100

Table - 31

Habitat preference of Leopard based on scats

Year	Number of scats observed	Moist deciduous	Grass-land	Semi ever-green	Ever-green	Eucalyptus plantations
1992	49	9	2	18	16	4
1993	25	8	1	6	7	3
1994	21	6	-	8	5	2
Total	95	23	3	32	28	9
%	100	24.2	3.2	33.7	29.5	9.5

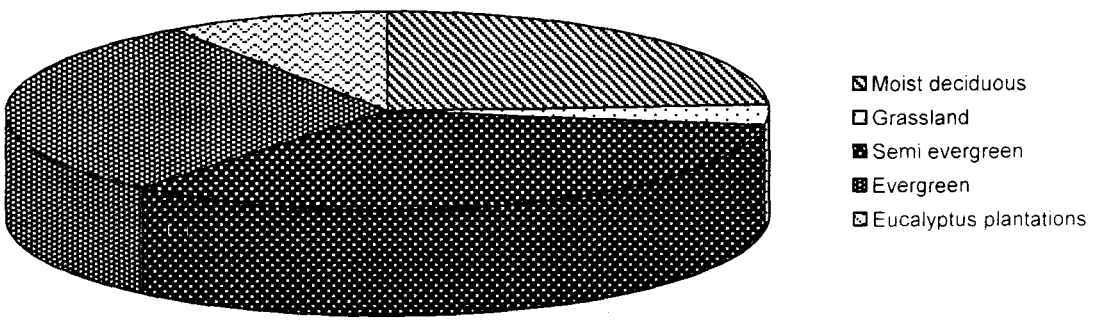

Fig.16 Habitat use of leopard based on scats (1992-94)

Chitwan National Park, Nepal (Sidensticker, 1976) and this area size didn't seem to be applicable in periyar. Based on direct sightings and indirect evidences of their occurrences such as scats, pugmarks, etc. population of leopard in periyar could be estimated to be about 40 in this 777 Sq.Km area. Leopoards tend to be abudant where tigers are probably scarce and vice versa according to Anderson (1961). This may be the reason for the absence of leopards in the grasslands and moist deciduous habitats, which are favoured habitats of tiger in Periyar.

V.2b. Prey species of Leopard

Prey species of the leopard varied in different habitats in India (Schaller, 1967). Chital and langur monkey appeared to be the main prey species of leopard at Kanha (Schaller, 1967), nilgiri tahr, sambar, nilgiri langur, barking deer and gaur at Eravikulam National park (Rice, 1986) and chital and sambar in Bandipur where cattle, langur blacknaped hare etc., were also taken in small quantities (Johnsingh 1983).

Since no sufficient number of leopard kills were obtained in periyar, the only method to know their prey species was through the analysis of their scats. A total of 95 scat samples of leopard were collected and analysed. Nilgiri langur appeared to be the major

Table - 32

Frequency of occurrence of prey remains in 95 Leopard scats (1992-94)

No.	Food item	Frequency of occurrence	
		Number of seats with the remains of	Percentage
1	Nilgiri langur	77	71.96
2	Sambar	18	16.8
3	Rats	2	1.9
4	Flying squirrel	3	2.8
5	Mouse deer	5	4.7
6.	Small Indian civet	2	1.9
	Total	107	100

prey species of leopard comprising 71.96% (77 scats) (Table-32). Other prey species comprised rats (1.9%), flying squirrel (2.8%), mouse deer (4.7%) and the small indian civet (1.9%) (Fig-17).

Only one leopard kill was observed during this study which was a nilgiri langur, at Medhaganam. The carcass was found on a tree. Often it was very difficult to locate a leopard kill as the whole meat was usually eaten in case of small prey such as nilgiri langur, mouse deer, flying squirrel etc.

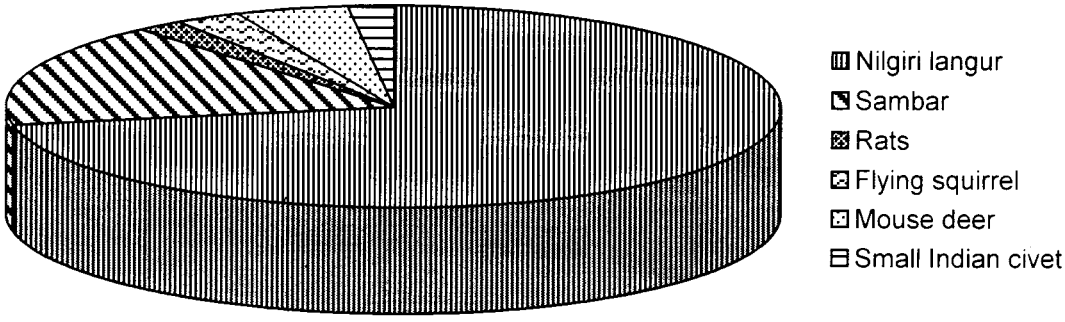

Fig.17 Frequency occurrence of prey remains in Leopard scats

V.3. The Jungle cat, *Felis chaus* (Gildenstaedt)

There were only 3 sightings of the Jungle cat (*Felis chaus*) in Periyar during this study, one each in grassland, semi evergreen and moist deciduous forests. Of the 3 sightings, 2 were in september and october 1992 and one in August 1993 which was similar to that in Kanha (Schaller, 1967). The jungle cats were more diurnal here.

V.3a. Distribution

The Jungle cats have a wide distribution in periyar and inhabited all types of habitats. Scats were common in all parts of the reserve and more frequently in forest treck paths, roads and rocks and they seemed to have the habit of defecating in open areas like the tiger, leopard and wild dogs.

The most preferred habitat of Jungle cat seemed to be open grasslands followed by moist deciduous forests. There were 376 scats recorded from the study area. Out of this, 142 (37.8%) were from grasslands, 138 (36.7%) from moist deciduous forests 46(12.2%) from semi evergreen forests 28(7.4%) from evergreen forests and 22 (5.9%) from Eucalyptus plantations (Table.33 and Fig.18).

Table - 33

Habitat preference of Jungle Cat based on scats

Month	Total number of scats	Ever-green	Semi-ever green	Moist deciduous	Grass-lands	Eucalyptus plantations
January	42	4	4	16	16	2
February	35	3	5	12	14	1
March	39	2	6	13	15	3
April	40	2	3	17	14	4
May	30	5	4	11	10	-
June	28	3	2	13	9	1
July	26	1	3	8	12	2
August	28	2	4	10	11	1
September	35	3	6	9	14	3
October	22	1	4	8	7	2
November	32	2	3	12	13	2
December	19	-	2	9	7	1
Total	376	28	46	138	142	22
%	100	7.4	12.2	36.7	37.8	5.9

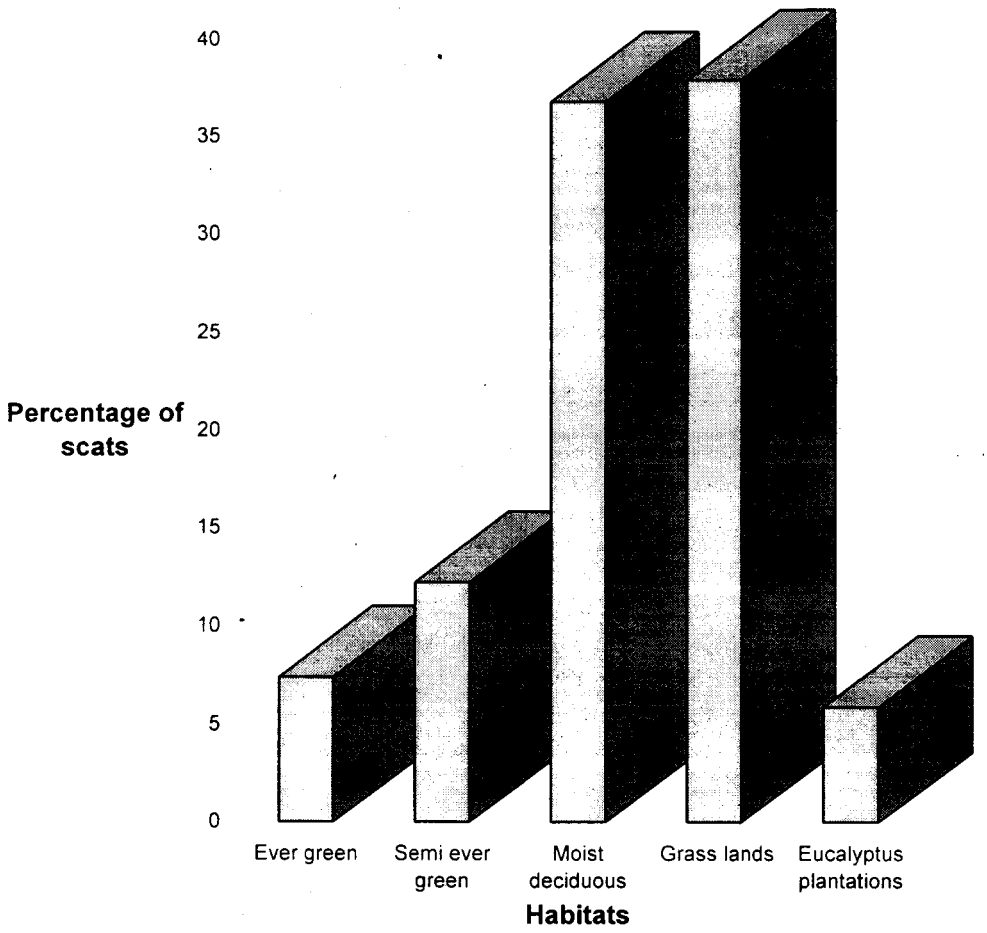

Fig.18 Habitat preference of jungle cat based on scats

V.3b. Food of Jungle cat

Jungle cats are considered as potential predators of chital fawns, small rodents and other smaller vertebrates (Schaller, 1967; Johnsingh, 1983)

Analysis of 32 jungle cat scats were carried out during this study and 12 different food items were identified. Some of the scats had more than one item. Analysis showed that rats and mice formed 24.6% (16 scats), birds 20% (13 scats), beetle 16.9% (11 scats), small Indian civet 13.8% (9 scats), giant squirrel 1.62% (4 scats), mabuya 4.6% (3 scats), toody cat 3.1% (2 scats), grass 4.6% (3 scats), mouse deer, barking deer (fawn), varanus and seeds of unknown plants formed 1.5% (1 scats) each of the total food items (Table-34 and Fig.19)

Of the 12 different food items identified from scats of jungle cats, 5 items namely giant squirrel, toddy cat, mouse deer, barking deer and varanus were not reported earlier as food items of the jungle cat.

Table - 34

Frequency of occurrence of food items in 32 jungle cat scats

No.	Food item	Frequency of occurrence	
		Number of scats with the remains	Percentage
1	Rat and mice	16	24.6
2	Birds	13	20
3	Beetles	11	16.9
4	Small Indian civet	9	13.8
5	Giant squirrel	4	6.2
6	Mabuya	3	4.6
7	Grass	3	4.6
8	Toddy cat	2	3.1
9	Mouse deer	1	1.5
10	Barking deer	1	1.5
11	Varanus	1	1.5
12	Seeds	1	1.5
	Total	65	100

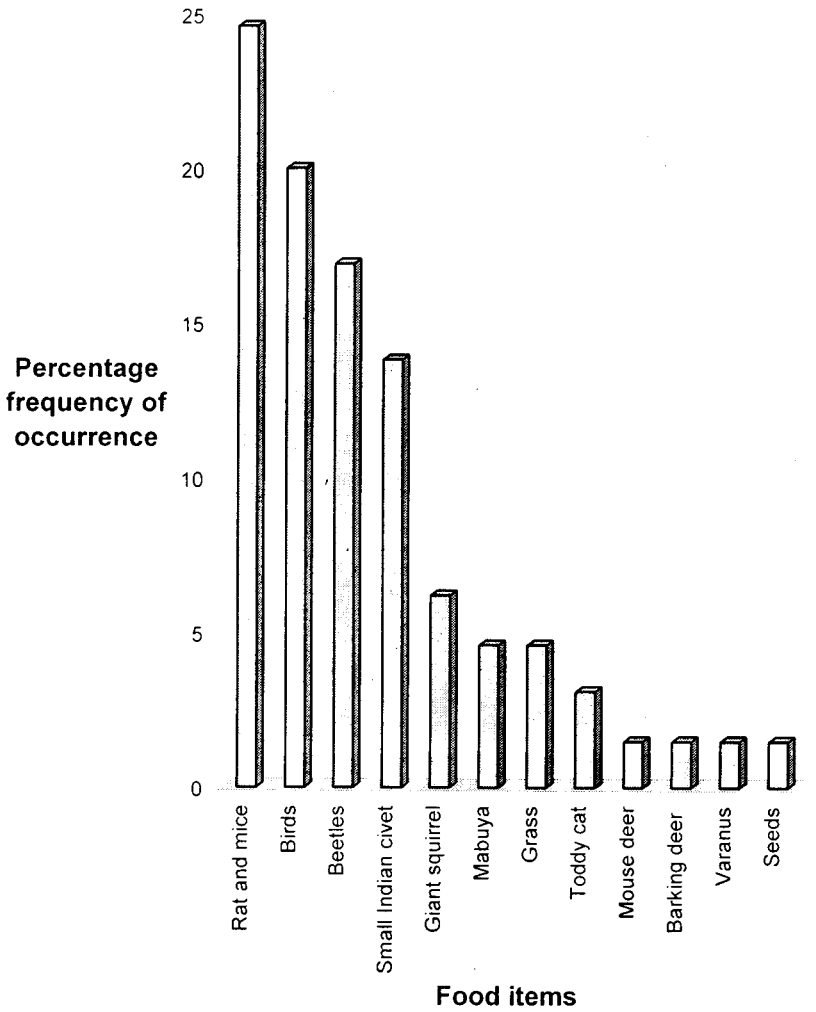

Fig.19 Frequency of occurrence of food items in jungle cat scats

V.4. The Sloth Bear, *Melursus ursinus* (Shaw)

The Sloth bear (*Melursus ursinus*), though not a predator, differs from the other species of bears in having highly specialized morphological adaptations for feeding on insect prey (Laurie and Sidensticker 1977). This bear was not very common in periyar and encountered on 8 occassions during this study. The 8 sightings in the full day light may disagree with the observations of Schaller (1967) who reports that the bears are almost wholly nocturnal.

At periyar, bears were sighted on the grassy hills, mostly during the rainy season and in the valleys during the summer when several kinds of fruit ripened.

V.4a. Distribution of Bear

In Periyar, bears were mostly found in grasslands and moist deciduous habitats. Out of the 8 sightings 4 (505) were in grasslands 2(25%) in moist deciduous forests and 1(12.5%) each in evergreen forests and Eucalyptus plantations (Table 35).

During 1992-93 period, 243 bear dropping were observed and recorded in the study area. Fiftythree percent (129 droppings) of the droppings were recorded from the grasslands, 27.2% (66 droppings) from moist deciduous forests, 9.1% (22 droppings) from semi evergreen forests, 1.6% (4 droppings) from evergreen

Table - 35

Groupsize and Habitat of sloth bear from sightings (1992-94)

Group size	Number of of observa-tions	%	Habitat					
			Grass land	Moist deci-duous	Semi ever green	Ever green	Eucaly-ptus plantations	Number of bears
1	4	50	2	1	-	-	1	4
2	3	37.5	2	1	-	-	-	6
3	1	12.5			-	1	-	3
Total	8	100	4	2	-	1	1	13
%			50	25	-	12.5	12.5	

Table - 36

Habitat use of sloth bear based on droppings (1992-93)

Month	No. of droppings recorded	Grass land	Moist deciduous	Semi ever green	Ever green	Eucalyptus plantation
January	18	8	7	1	-	2
February	21	14	5	2	-	-
March	32	16	9	3	2	2
April	28	17	6	2	2	1
May	17	6	5	3	-	3
June	12	5	3	2	-	2
July	9	3	4	-	-	2
August	18	11	5	2	-	-
September	10	5	3	-	-	2
October	26	13	10	2	-	1
November	32	18	6	5	-	3
December	20	13	3	-	-	4
Total	243	129	66	22	4	22
%	100	53.1	27.2	9.1	1.6	9.1

forests and 9.1% (22 droppings) from the Eucalyptus plantations (Table - 36 and Fig.20).

V.4b. Groupsize of Bear

Four (50%) out of 8 sightings of bear in the study area were solitary animals (Table 35). Groups of 2 were observed on 3(32.5%) occassions and 3 only once (12.5%). The sighting of the group with 3 bears included an adult male, adult female and a young one. On the streambed of Churakotta near Vahilala in 15th April 1995, I encountered a female bear which gave birth to her young, approximately an hour before, fighting with an adult male may be to protect the young. The female bear frequently rushed to the male and roarings at intervals when the male tried reach the young. This lasted for nearly 30 minutes till the male had left. This observation supports the chance of cannibolism in bears as in tiger (Sanderson 1912 and Brander 1927).

V.4c. **Food of Sloth bear**

Bears usually took termites and ants together with large quantities of soil at Kanha (Schaller, 1967) and at Bandipur (Johnsingh, 1983). Laurie and Seidensticker (1977) has reported that at Chitwan National park, the major food of bears was insects such as termites, red ants, black ants, beetles crickets and fruits of *Grewia asiatica* and *Zizyphus jujuba*.

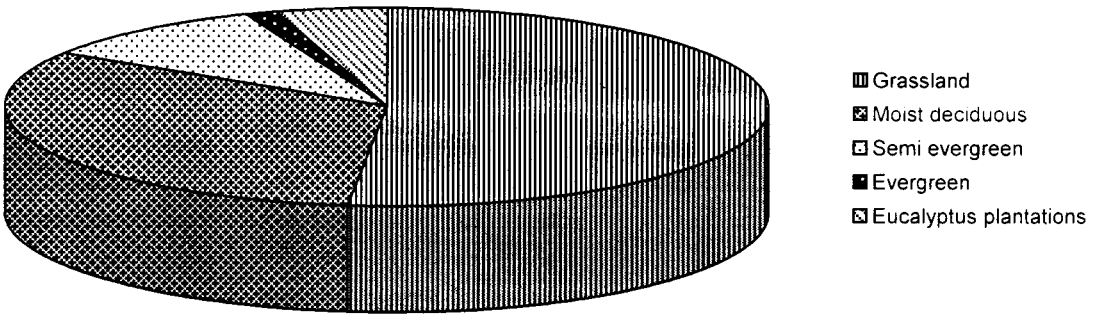

Fig.20 Habitat use of Sloth bear based on droppings (1992-93)

A total of 196 bear droppings were collected and analysed during this study, from september 1992 to August 1993. The major food of bear consisted of ants and termites which constituted 61.9% (in 176 droppings) of the total items detected (n = 284) and found throughout the year. The second major food item was honey which formed 10.9% (in 31 droppings) of total items and found in the droppings collected in February, March, April May and August. The third major food item was the fruit of *Mangifera indica* which formed 8.5% (in 24 droppings) and was confined to month of May, June and July (Table-37).

Other food items of sloth bear in Periyar included beetles (1.1%) and fruits of *Rhamnus witti, Diospirus paniculata, Glochidion sps., Terminalia chebula, Gnetum ula, Pittosporum sps., Syzigium sps., Lantana aculeata, Maesa perrotettiana, Zizyphus rugosa, Chrysophyllum roxburghianum, Erya nitida, Isonandra lanceolata, Ficus sps., Cullenia exarillata* (flower's and fruits) and *Artocarpus heterophyllum*. Sambar hairs were found in two droppings and this may due to scavenging on kills of any predators as reported by Sanderson (1912). Soil was found in 4 droppings which also contained the honey remains. A seasonal variation was observed in the diet of bear in periyar which may be mostly due to the flowering and fruiting seasons of trees.

Table - 37

Food of sloth bear in Periyar (1992 Sept. - Aug. 1993)

Food items	1992 Sept.	Oct.	Nov.	Dec.	1993 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total	%
Ants and termites	16	4	4	21	38	23	29	15	9	2	6	9	176	61.9
Beetles	-	-	1	1	-	1	-	-	-	-	-	-	3	1.1
Rhamnus witti	4	1	1	1	-	-	-	-	-	-	-	-	7	2.5
Diospirus paniculata	-	-	1	2	-	-	-	-	-	-	-	-	3	1.1
Glochidion sps.	-	-	1	-	-	-	-	-	-	-	-	-	1	0.4
Terminalia chebula	-	-	-	1	-	-	-	-	-	-	-	-	1	0.4
Gnetum ula	-	1	-	-	-	-	-	-	-	-	-	-	1	0.4
Pittosporum sps.	-	1	-	-	-	-	-	-	-	-	-	-	1	0.4
Mangifera indica	-	-	-	-	-	-	-	-	9	11	4	-	24	8.5
Syzigium sps.	-	-	-	-	-	-	-	-	6	-	-	-	6	2.1
Lantana aculeata	-	-	-	-	3	4	1	-	-	-	-	-	8	2.8
Ziziphus rugosa	-	-	-	-	-	-	-	-	2	-	-	-	2	0.7
Chrysophyllum-roxburghianum	-	-	-	-	-	-	1	2	-	-	-	-	3	1.1
Erya nitida	1	-	-	-	-	-	-	-	-	-	-	-	1	0.4
Ficus sps.	-	-	-	-	-	-	-	1	-	-	-	-	1	0.4
Cullenia exarillata	-	-	-	-	-	-	-	3	-	-	-	-	3	1.1
Maesa perrottetiana	-	1	-	-	-	-	-	-	-	-	-	-	1	0.4
Artocarpus-heterophyllam	-	-	-	-	-	-	-	3	-	-	-	-	3	1.1
Isonandra lanceolata	-	-	-	-	-	-	-	2	-	-	-	-	2	0.7
Honey	-	-	-	-	-	3	6	19	2	-	-	1	31	10.9
Soil	-	-	-	-	-	-	2	1	1	-	-	-	4	1.4
Sambar hairs	-	-	-	1	1	-	-	-	-	-	-	-	2	.7
Total	21	8	8	27	42	31	39	46	29	13	10	10	284	100

PREY SPECIES IN PERIYAR

Abraham. C.J “Studies on large mammalian predators with special reference to wild dog, cuon alpinas (pallas) and their prey species in Periyar, South India” Thesis. Department of Zoology, St. Joseph's College Devagiri, University of Calicut, 2000

CHAPTER - VI

PREY SPECIES IN PERIYAR

VI.1. The Sambar, *Cervus unicolor*

The sambar, *Cervus unicolor* the largest deer in South east Asia, has adapted itself to a wider variety of forest habitats and environmental conditions than any other ungulates in India (Schaller, 1967). In all protected areas of the Indian subcontinent where studies on the predator - prey relations have been carried out, sambar is second only to Chital as the major prey species (Schaller, 1967; Johnsingh, 1983). But in Periyar, Chital is absent as it is a wet forest habitat hence sambar is the major prey species of tiger and wild dogs here.

VI.1a. Distribution of samabr

Sambar is widely distributed in the study area though its abundance varied in different habitats. Two major factors, water and dense cover influenced the distribution and abundnace of sambar (Johnsingh, 1980). Observations of sambar in 1992-93 have indicated that the sambar preferred grasslands and moist deciduous habitats (Fig.21). Fiftyone percent of its sighting was from grasslands, 32% from moist deciduous forest, 9.8% from semi

Table - 38

Habitat preference of sambar based on sightings (1992-93)

Month	Total number of sambar	Habitat				
		Grass land	Moist deciduous	Semi ever green	Ever - green	Eucalyptus plantations
January	32	16	9	5	-	2
February	73	42	23	8	-	-
March	140	83	48	3	6	-
April	93	47	33	9	2	2
May	68	31	20	12	-	5
June	46	22	16	4	1	3
July	75	59	12	2	-	2
August	112	44	33	19	4	12
September	140	68	56	11	-	5
October	78	26	32	14	-	6
November	59	30	18	7	2	2
December	86	51	22	5	-	8
Total	1002	519	322	99	15	47
%	100	51.7	32.1	9.8	1.5	4.7

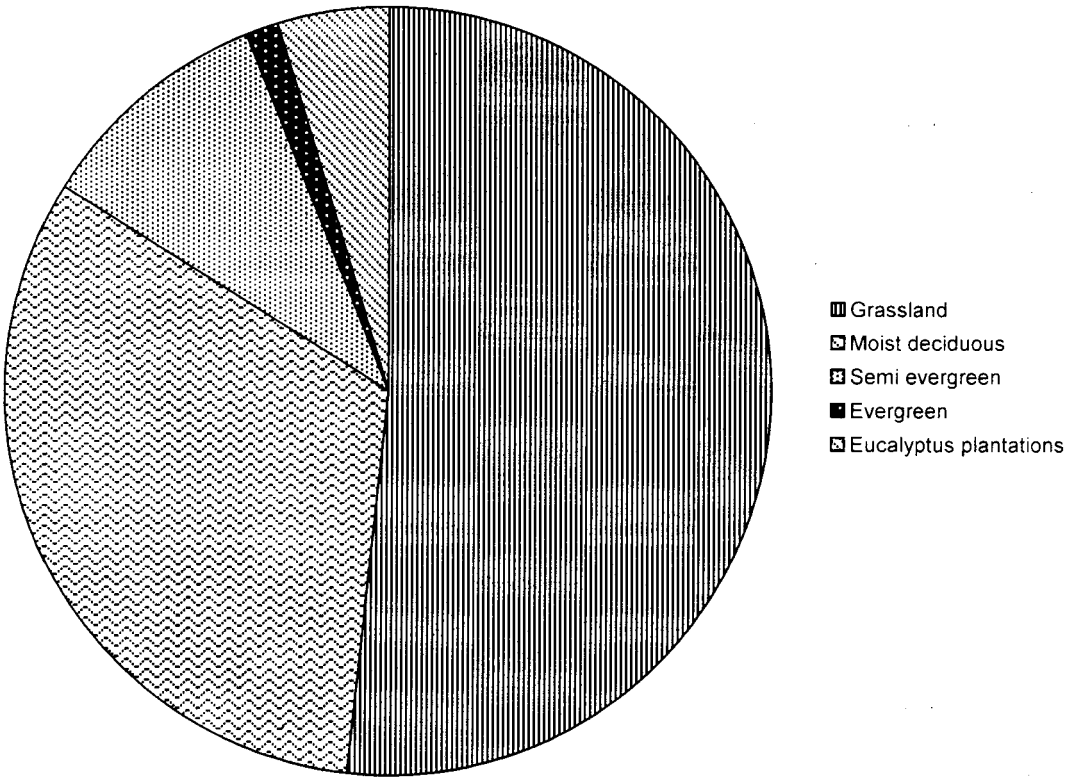

Fig.21 Habitat preference of sambar based on sightings

evergreen forests, 4.7% from Eucalyptus plantations and 1.5% from the evergreen forests (Table 38). Since sambar is a browser and grazer like the gaur, it could utilise grasslands, deciduous and evergreen forests. Major portion of the sambar popoulation in Periyar occurred near and around the Mullapperiyar lake, especially from Thekkady boad landing to the Mullapperiyar dam. During summer months especially in the fire season samabr usually avoided grasslands and entered the neighbouring deciduous and semi evergreen forests. Large aggregations were observed at Edappalayam and Ayyappanthuruthu.

VI.1b. Groupsize and sex ratio

The sambar was observed as solitory individuals and in groups of up to about 60 individuals. Out of the 285 observations on this species 31.6% (90) were solitary 25.3% (72) with 2 individuals 22.5% (64) in groups of 3-5, 13% (37) in groups of 6-10, 3.9% (11) in groups of 11-15, 1.8% (5) in groups of 16-20 and 2.1% (6) above 20 individuals (Fig.22). According to Ramachandran et.al (1987) 30-50% of sambar sighted were solitary and the rest with groupsize in between 1-10 in periyar. According to Sarathchandra and Gadgil (1975) the groupsize of sambar in Bandipur was 1-10. Johnsingh (1980) has reported that 36% of sambar in Bandipur were solitory and 31% in groups with two individuals. The groupsize

Table - 39

Herdsize and sex ratio of sambar from sightings (1992-94)

Sambar	Solitary		2		3-5		6-10		11-15		16-20		Above 20		Total	Percentage
	Number (N)	%	N	%	N	%	N	%	N	%	N	%	N	%		
Number of sightings	90	-	72	-	64	-	37	-	11	-	5	-	6	-	285	-
Percentage	31.6	-	25.3	-	22.5	-	13	-	3.9	-	1.8	-	2.1	-	-	-
Male	47	52.8	36	26.9	40	17.5	31	14.4	19	17.92	13	19.7	31	20.1	217	21.83
Female	42	47.2	98	73.1	189	82.5	185	85.6	87	82.08	53	80.3	123	79.9	777	78.17
Unknown sex	1	-	10	-	23	-	60	-	34	-	18	-	61	-	207	17.01
Total number	90		144	-	252	-	276	-	140	-	84	-	215	-	1217	-
Sex ratio - Male: Female	1:0.89		1:2.72		1:4.72		1:5.96		1:4.58		1:4.08		1:3.97		1:3.58	

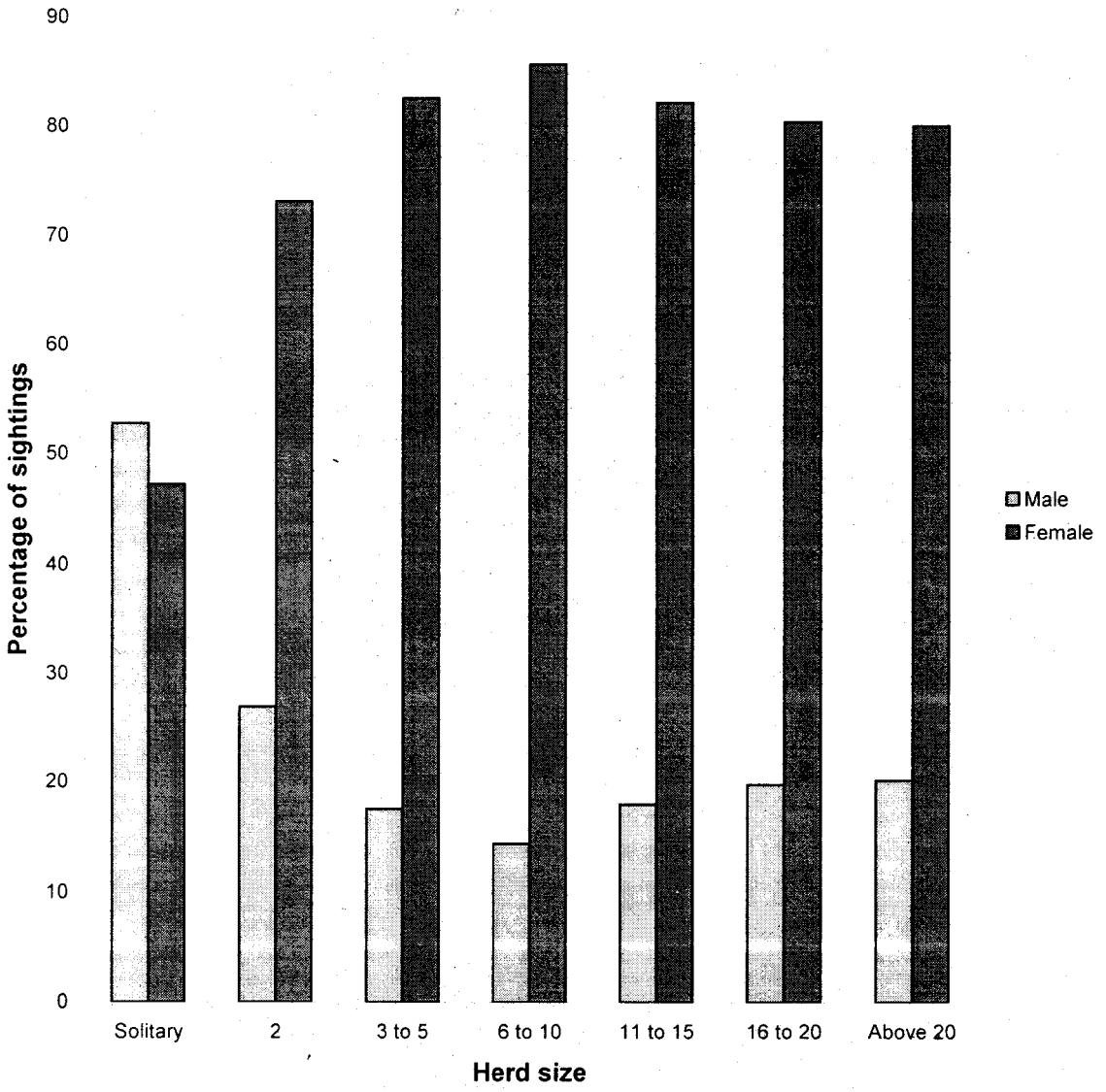

Fig.22 Heresize and sex ratio of sambar (1992-94)

of sambar ranged from 1-5 in Gir, where 50% of total sambar observed were solitary (Khan et al, 1995). A groupsize of 1-9 was observed at Kanha by Schaller (1967).

In the present study the male/female ratio was 1:0.89 biased in favour of males, in solitary sambar sighted, 1:2.72 favouring females in groups of two, 1:4.72 in 3-5 group class, 1:5.96 in 6-10 1:4.58 in 11-15, 1:4.08 in 16-20 and 1:3.97 in groups with more than 20 animals all favouring females (Table 39). Most of the male sambar were either solitary or in groups of two individuals. As the groupsize increased, the proportion of males considerably decreased (Fig.22).

The average sex ratio of 1:3.58 favouring, females was obtained from the sighting of sambar in periyar. A male/female ratio of 1:2.4 was observed at Bandipur by Johnsingh (1983), 1:3 in periyar by Ramachandran et.al, (1987), 1:3.3 at Kanha by Schaller, (1967), 1:3.03 at Gir National Park by Berwick and Jordan, (1974) and 1:1.83 at Gir by Khan, et.al (1995), all favouring females.

VI.1c. Population density and Biomass of sambar

Population density of sambar was calculated from the transect counts made during the dry and wet seasons of 1992 and 1994.

Table - 40

Estimation of biomass from population density of sambar

Year	Seasons	Density per km^2	Number of sambar in 400 Sq.km	Estimate of male	Estimate of female	Estimate of fawn	Biomass of male (in kg)	Biomass of female (in kg)	Biomass of fawn in (in kg)	Total biomass of sambar in 400 Sq.km (in kg)	Biomass per km^2 (in kg)
1992	Dry season (in May)	3.76	1504	288	1040	176	288x175 =50400	1040x150 =156000	176x50 =8800	215200	538.0
	Net season (in August)	3.64	1456	279	1007	170	279x175 =48825	1007x150 =151050	170x50 =8500	208375	520.9
	Average	3.7									529.47
1994	Dry season (April)	3.43	1372	263	949	160	263x175 =46025	949x150 =142350	160x50 =8000	196375	490.9
	Wet season (September)	3.59	1436	276	992	168	276x175 =48300	992x150 =148800	168x50 =8400	205500	513.8
	Average	3.51									502.3

In the dry season (during May) 1992, a density of 3.76 sambar per km^2 (Appendix-9) and in the wet season (during August) a density of 3.64/sq.km (appendix-10) were obtained with an average density of 3.7/Sq.km for the year 1992 (Table-40). In 1994, a dry season (April) density of 3.43 animals per Km^2 (Appendix-11) and a wet season (September) density of 3.59 sambar per sq.km (Appendix-12) were obtained with an average density of 3.51 animals per km^2 (Table-40). Bandipur had a density of 8-9/Km^2 in Wet season and 7/Km^2 in dry season (Johnsingh 1983). The related figures at Kanha was 1.6-2.3 sambar per Km^2 (Schaller, 1967) and at Willpattau National park, Sirlanka it was 1.17 animals per km^2 (Eisenberg and Lockhart, 1972).

The dry season density of Sambar in 1992 gave a total biomass of 215200 kg per 400 km^2 of the sanctuary or 538 kg per km^2, while in the wet season it was 208375 kg/400 Sq.km or 520.9 kg/km^2 with an average biomass of 529.47 kg/Sq.km. In the year 1994 the dry season density of sambar gave a total biomass of 196375 kg per 400 Sq.km or 490.9 kg/km^2 and in the wet season it was 205500 kg/km^2 or 513.8 kg/km^2 with an average biomass of 502.3kg/km^2 (Table-40). In Bandipur the wet season density of 8-9/km^2 gave a biomass of 1244 - 1399 kg per km^2 (Johnsingh, 1983). The biomass of Sambar in the Willpattu national park, Srilanka

Table - 41

Sex and age class of sambar from sightings (1992-94)

Year	Male					Female				Fawn	
	Total Male	Stag	Spike	Velvet	Antlershed	Adult	Sub adult	Yearling	Total Female		Ground Total
1992	86	47	23	9	7	116	91	23	230	49	365
1993	71	38	18	7	8	130	103	30	263	40	374
1994	60	32	18	6	4	138	112	34	284	43	387
Total	217	117	59	22	19	384	306	87	777	132	1126
%	19.3	53.9	27.1	10.1	8.8	49.4	39.4	11.2	69	11.7	

Spike : Stag = 1:1.98

Male : Female = 1:3.58

Fawn : Female = 1:5.89

was 158 kg/km^2 (Eisenberg and Lockhart, 1972) and in Chitwan it was 4.43 kg/km^2 (Seidensticker 1976).

VI.1d. Age class of sambar

Both male and female sambar were grouped as per their age. However fawns were put in a single class. Age and sex of 1126 sambar were recorded in this study. Ninteen percent (217) were males, 69% (777) female and 11.7% (132) fawn (Table-41).

Out of the 217 males, 53.9% (117) were stags 27.1% (59) spike, 10.1% (22) velvet and 8.8% (19) antlershed. Among the 777 females, 49.4% (384) were adults, 39.4 (306) subadults and 11.2% (87) Yearlings (Fig.23). This observations gave a fawn/female ratio 1:5.89 biased in favour of females and spike/stag ratio of 1:1.98 biased in favour of stag.

A fawn/female ratio of 1:8.06 favouring females was observed at Gir National Park (Khan et; al 1995). The corresponding ratio was 1:3.13 at Bandipur (Johnsingh, 1983) and 1:1.81 at Gir (Berwick and Jordan, 1974). All these had high proportion of fawns.

VI.1e. Antipredator behaviour

Wild dogs and tiger were the major predators of sambar in periyar. The first response on seeing the wild dogs or a tiger was

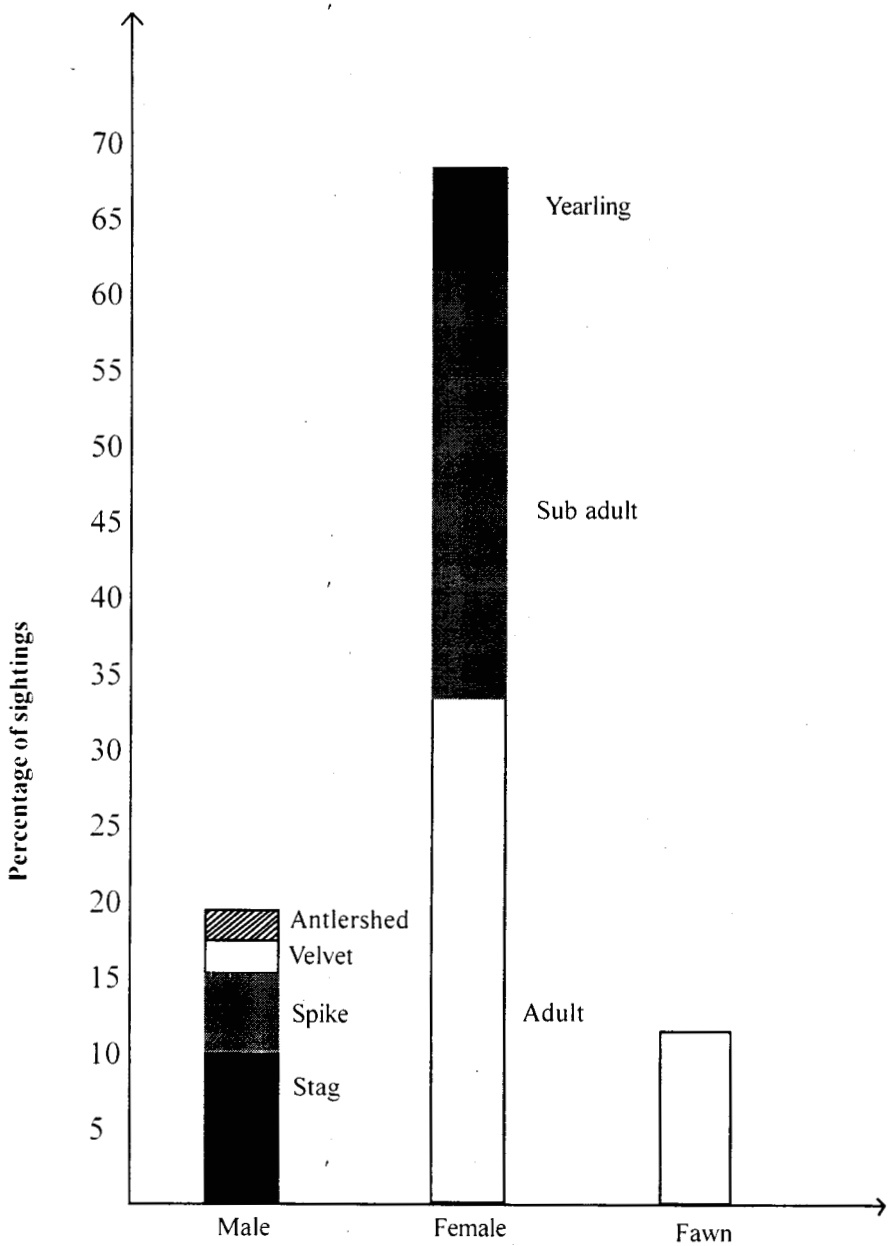

Fig.23 Sex and age class of sambar (1992-94)

an alarm 'dhank' (Krishnan, 1972), a loud, hoarse and brief call (Schaller, 1967). Usually the animal, when see a predator wait for a minute and watch and then run away. In self defence and or in defending a fawn from wild dogs the sambar lowered its head, muzzle and neck stretched forward and rushed at the dogs. At times the sambar slowed down the movement towards the dog but kicked at it with its forelegs. As mentioned earlier, the pursued sambar took refuge in water and the dogs followed. In the lake the sambar repeatedly splashed water with it forelegs at the dogs.

VI.1f. Mortality of sambar

Predation, disease, poaching, electrocution and hit by motor vehicles were the factors causing mortality of sambar in periyar. Kurup (1971) has recorded clear signs of heavy predation on sambar by wild dogs in early 1970's. More than 90% of total kills recorded in periyar during this study were on sambar. Five sambar died in and around the study area during the study period due to unknown reasons. The respiratory and digestive tract of one of these dead specimens were full of Amphistomes. There was no sign of Rinderpest disease, though several cattle and buffalos graze in the tourism zone of the reserve. One sambar died of some disease with symptoms resembling rabies.

Only one incident of poaching was recorded during the study period. In this case one sambar was reportedly trapped and killed by a local man. On several occassions, shooting sounds were heard from the Kurisumalai and Anchuruli areas and the tribals had informed that sambar was the target. Indirectly, tourism has caused death of sambar on two occassions. One sambar was run over by a motor vehicle at Thekkady and another broke its leg. The second animal died after a few days at Edappalayam. A third one was hit by a Jeep but escaped with injury. One sambar was electrocuted near pachakkanam, in the Vallakkadavu range (After the period of study in 1996.

Table - 42

Percentage sightings of Gaur in different habitats (1992-93)

Month	Number of sightings	Total number of animals sighted	Habitat				
			Grass land	Moist deciduous	Semi ever green	Ever green	Eucalyptus plantation
January	2	10	1	1	-	-	-
February	1	16	-	1	-	-	-
March	4	47	2	1	1	-	-
April	5	58	3	1	1	-	-
May	10	96	4	3	1	1	1
June	4	50	-	3	1	-	-
July	2	14	2	-	-	-	-
August	8	95	7	-	-	-	1
September	12	113	5	2	1	2	2
October	5	18	2	3	1	-	-
November	3	23	3	-	-	-	-
December	8	60	5	2	1	-	-
Total	64	600	34	16	7	3	4
Percentage	100%		53.13%	25.0%	10.93%	4.68%	6.25%

Average group size = 9.4 animals

VI.2. The Gaur, *Bos gaurus*

Gaur is one of the common large mammals in Periyar and widely distributed in the grasslands and moist deciduous habitats. The species was usually seen singly or in herds. Lone bulls were rarely seen. The largest herd observed, consisted of 28 animals. During 1992 and 93 there were 64 sightings of the species in the study area and a total of 600 animals with an average groupsize of 9.4 animals (Table-42). Thirtyfour (53.14%) sightings were recorded from grasslands, 16(25%) from moist deciduous forests, 7 (10.9%) from semievergreen forests, 3 (4.6%) from evergreen forests and 4 (6.25%) from Eucalyptus plantations (Table-42). The average density of gaur in periyar was estimated to be 1.6 animals per Km^2 (Table-43).

VI.3. The barking deer, *Muntiacus muntjack*

Barking deer was seen singly or in groups up to 3 individuals in the study area. They were usually found in the semievergreen and moist deciduous forests, but showed a preference to the premises of human habitation in the reserve unlike Bandipur where it was never seen close to human habitation (Johnsingh, 1983).

Out of the 36 sightings of muntjac, 26 (72%) were recorded from semievergreen and moist deciduous forests, 5 (13.9%) from

Table - 43
Densities and Biomass of prey species (excluding) porcupine, Mouse deer, Elephant, Blacknaped Hare and small rodents) and predator's in 400 km² at Periyar (1993)

Prey species and predators	Population estimates in 400 Sq - km	Density Nos/km²	Average unit weight	Average biomass kg/km²	Total standing Biomass in 400 km² kg
Sambar	1480	3.7	113.6	420.3	168128
Gaur	640	1.6	545	872.0	348800
Wild boar	1400	3.5	25.8	90.3	36120
Barking deer	120	.3	18	5.4	2160
Nilgiri langur	560	1.4	15	19.5	7800
Total				1407.5	563008
Tiger	28	.07	150	10.5	4200
Leopard	20	.05	45	2.25	900
Wild dog	40	.1	18	1.8	720
Total				14.55	5820

The average unit weight for the species is selected from Schaller (1967) for gaur & wild boar; Prater (1971) for sambar, barking deer, nilgiri langur, tiger and leopard and Johnsingh (1983) for wild dog.

Table - 44

Percentage sightings of Barking deer in different habitats (1992)

Month	Number of sightings	Total number of animals sighted	Habitat				
			Semi ever green	Ever-green	Moist deciduous	Grass-land	Eucalyptus plantation
January	4	5	3	1	1	-	-
February	3	4	3	1	-	-	-
March	2	2	1	1	-	-	-
April	3	4	1	-	1	1	-
May	1	1	1	-	-	-	-
June	0	0	-	-	-	-	-
July	2	2	1	-	1	-	-
August	4	5	-	-	1	-	3
September	9	10	2	1	6	-	-
October	2	2	1	-	-	-	1
November	0	0	-	-	-	-	-
December	4	5	2	1	1	-	-
Total	36	40	15	5	11	1	4
Percentage	100%		41.66%	13.88%	30.55%	2.77%	11.11%

evergreen, 4 (11.1%) from Eucalyptus plantations and only one (2.7%) sighting was recorded from grasslands (Table-44). The average density of barking deer in Periyar was estimated to be 0.3 animals per Km^2 (Table-43). Two kills by dhole were recorded and 7 scats of the dhole had barking deer remains. One scat of the jungle cat also had its remains.

VI.4. The Mouse deer, *Tragulus meminna*

There were 2 direct sightings of mouse deer in the study area and one animal was collected dead during this study. The droppings and tracks of the species were common in semievergreen and moist deciduous habitats and grasslands with tall grasses. Nearly 5% of leopard scats, 2.5% tiger scats and 6.7% wild dog scats had mouse deer remains in them. Three wild dog kills and one tiger kill on mouse deer were recorded during this study.

VI.5. Nilgiri langur, *Presbytis johni*

Nilgiri langur was the major arboreal mammal in periyar. They were usually found in the moist deciduous, evergreen and semi evergreen forests. Out of the 133 sightings of Nilgiri langur, 58 (43.6%) were recorded from semi evergreen forests, 27(20.3%) from evergreen, 45(33.8%) from moist deciduous and 3(2.3%) from Eucalyptus plantations (Table-46). No sightings were recorded from

Table - 45

Percentage sightings of Wild boar in different habitats (1992)

Month	Number of sightings	Total number of animals sighted	Habitat				
			Moist deciduous	Semi ever-green	Evergreen	Grass-land	Eucalyptus plantation
January	4	65	2	-	-	2	-
February	3	28	3	-	-	-	-
March	2	26	1	-	-	-	1
April	5	51	3	2	-	-	-
May	3	43	2	-	-	1	-
June	14	188	8	2	1	3	-
July	11	139	5	2	1	2	1
August	8	120	4	3	-	1	-
September	9	74	5	1	-	3	-
October	12	184	7	3	1	-	1
November	6	52	3	2	-	1	-
December	5	66	2	2	1	-	-
Total	8	1036	45	17	4	13	3
Percentage	100%		54.87%	20.73%	4.87%	15.85%	3.65%

Average group size = 12.6 animals

grasslands. Nilgiri langur was the major prey for the leopard and minor prey for the tiger and wild dogs.

VI.6. The wild boar, *Sus scrofa*

The wildboar, like the barking deer, mainly inhabited the moistdeciduous and semievergreen forests in periyar and was common in areas near human habitation. Eightytwo sightings of wild boar with a total of 1036 animals having an average groupsize of 12.6 animals were recorded during this study. Sixtytwo (75.5%) sightings were recorded from moist deciduous and semievergreen forests, 4 (4.8%) from evergreen forests, 13 (15.8%) from grasslands and 3 (3.7%) from eucalyptus plantation (Table-45). The largest group had 40 animals. The density of wildboar in a 400 Sq.km area was 3.5 animals per km^2 (Table-43). Two tiger kills and one dhole kill on wild boar were recorded during this study.

VI.7. The Elephant, *Elephas maximus*

The Elephants were fairly common in all habitat types in the study area and was not a common prey species of the predators though its hairs were present in one tiger scat. There were 155 sightings of elephants in 1992-93. The largest herd observed during this study had 59 elephants. Most of the sightings were in grasslands and moist deciduous forests.

Table - 46

Percentage sightings of Nilgiri langur in different habitats (1992-93)

Month	Number of sightings	Total number of animals sighted	Habitat				
			Semi ever green	Ever-green	Moist deciduous	Grass-land	Eucalyptus plantation
January	20	57	5	9	5	-	1
February	13	40	5	1	7	-	-
March	10	56	6	2	2	-	-
April	10	45	3	3	4	-	-
May	7	34	5	2	-	-	-
June	8	36	3	2	2	-	1
July	11	32	8	1	1	-	1
August	22	103	10	2	10	-	-
September	11	44	3	2	6	-	-
October	8	22	4	-	4	-	-
November	10	46	4	2	4	-	-
December	3	17	2	1	-	-	-
Total	133	532	58	27	45	0	3
Percentage	100%		43.60%	20.30%	33.83%	0	2.25%

VI.8. The Porupine, *Hystrix indica*

There were 6 direct sightings of porcupine in the study area, all during the night. Tracks and droppings of the species were commonly seen in forest treckpaths, roads and rocky slopes of hills in the study area. Grasslands and moist deciduous habitats were mostly preferred by the species though it was not rare in other habitats. Twentyone percent of tiger and 0.5% of wild dog scats had porcupine quills.

VI.9. The Blacknaped Hare, *Lepus nigricolis*

The number of blacknaped hare was fairly good in the study area. No estimate has been made on its population density. The distribution of droppings has indicated that the hare was common in hilly terrain with short grasses. Blacknaped Hare formed 2% of the food items of tiger in periyar. Thirteen percent of Leopards scats had hairs of blaçknaped hare in Bandipur (Johnsigh 1983) but no remains of hare were noted in Leopard scats collected in periyar.

VI.10. Rats

Hairs of rats were found in 5.8% of tiger scats, 1.9% Leopard scats and 2.9% wild dog scats and 50% of the junlge cat scats. Hairs of bandicoots seemed to be represented in the contents of scats.

DISCUSSION

Abraham. C.J “Studies on large mammalian predators with special reference to wild dog, cuon alpinas (pallas) and their prey species in Periyar, South India” Thesis. Department of Zoology, St. Joseph's College Devagiri, University of Calicut, 2000

DISCUSSION

All the 3 major predators in Periyar; the dhole or wild dog, the tiger and the leopard have shown similar ecological adaptations though each predator possessed unique characteristics especially in their feeding habits, to avoid competition. The factors such as habitat utilization, size of home range or territory, groupsize, prey selection with regard to sex and age class, mode of feeding etc. seemed to help these predators to co-exist in the same area without competition.

1. Habitat utilization by predators

Wild dogs, tiger and leopard seemed to inhabit the same area though the use of different habitat within the area by these predators considerably varied. The two packs of wild dogs, the Nellikkampetty pack and the Thannikkudy pack inhabited all the habitats within their respective home ranges. However they showed a slight preference to the moist deciduous forests and the grasslands (Table-8). In periyar, wild dogs usually seemed to hunt in the open deciduous forests and grasslands. On the contrary, tiger prefered more closed forests which was evident by the percentage of direct sightings, distribution of scats, pugmarks and kills. This indicates that the tiger needed enough cover in its habitat. Most of the tiger kills were observed either in closed forests or in tall grasses.

Evidently, leopards in periyar were much abundant in moist deciduous semi evergreen and evergreen forests (Fig-16). They usually avoided the grasslands. Tiger, wild dogs and leopard showed a similarity in using the moist deciduous and the semi evergreen habitats. However wild dogs and tiger were less abundant in evergreen forests and leopards in grasslands.

2. Size of homerange and territory

The wild dog packs roamed over a wider area than tigers or leopards. The homerange observed for the Nellikkampetty and Thannikkudy packs were 80 km^2 and 90 km^2 respectively (mentioned in section IV.2). This area was larger when compared to that at Bandipur where the area of wild dogs homerange was nearly 40 km^2 (Johnsingh 1983). The smaller homerange of wild dogs in Bandipur may be due to the availability of two major prey species viz, the Chital and the Sambar in the focal area. On the contrary, the lack of a major prey species viz, the Chital in periyar may be the reason for the large homerange of wild dogs here. The larger home range of wild dogs and the absence of a second major prey like chital in periyar seemed agree with Davidar (1975) and Krishnan (1975) that the wild dogs could cover larger areas in search of food.

The density of tigers in periyar appeared to be .04 - .05 animals /km^2. The territory of a tiger in the study area was nearly in between 22.2 - 25.7 km^2 which included almost closed forests where wild dogs were quite rare. Leopards in periyar seemed to have a much larger territory than the tiger. The difference in the size of homerange and territory to a certain extent enabled the predators to co-exist in the area without much encounters (Schaller, 1967).

3. Groupsize

Unlike the tiger and the leopard the wild dogs lived in packs and hunt frequently. The packsize of wild dogs in periyar varied between 2-15 in Nellikkampetty pack and 2-12 in Thannikkudy pack. Since the packsize is large in areas with high prey density (Johnsingh, 1983) there may be chance of competition with other predators. However the less number of encounters recorded between these predators in high prey density areas and the lack of sufficient number of kills and scats of tiger and leopard had indicated lesser competition among these animals. This also supports the view that the solitary predators like tiger and leopard avoided areas, frequently visited by wild dogs.

4. Prey selection

In periyar, the wild dogs and tigers preferably preyed on sambar. Eightyone percent of wild dog scats and 61% of tiger

scats had sambar remains in them (Table 12 and 26). Scat analysis has shown that the wild dogs had 8 prey species, tiger had 13 prey species and leopard had 6 prey species in periyar during the period of study. This has indicated that the tiger took more number of prey species than the wild dogs or the leopard. Again, tiger was the only predator in periyar, hunting domestic livestock. As mentioned in section V - the second major prey species of tiger, the porcupine which was widely distributed in the study area was rarely taken by wild dogs and was totaly avoided by the leopard.

The major prey species of leopard in periyar was the nilgiri langur (Section V.2b) which formed 72% of the leopards diet. Remains of nilgiri langur were found only in 3 wild dog scats and in 2 tiger scats. In Bandipur 50% of the leopards diet was chital, 14% sambar and 13% blacknaped hare (Johnsigh, 1983). Nilgiri tahr was the major prey species of leopard at Eravikulam where nilgiri langur was a minor prey (Rice, 1986). Like the high percentage of leopard hunting, on chital at Bandipur and on nilgiri tahr at Earavikulam a high percentage of leopard hunting on Nilgiri langur was recorded in periyar during this study. The wide variety of prey selection and different rate of hunting on each prey species has also avoided competition among the 3 major predators in periyar.

5. Sex of prey

The sex ratio of sambar killed by wild dogs in periyar was 1:1.53 (Section IV.13) favouring females while the sex ratio of sambar population in the study area was 1:3.58 (Section VI.1b). No correlation could be worked out between the high percentage of female sambar killed by predators and the higher number of females in sambar population. The sex ratio of sambar in dhole kills and in the population of Bandipur was 1:2.3 favouring males (n = 10) and 2:2.4 favouring females respectively (Johnsigh, 1983).

In the case of tiger kills on sambar in periyar, a sex ratio of 1:2.5 favouring males was recorded (section V.1d and Table-27). Sex ratio of sambar killed by tiger and wild dogs together however was 1:1.31 favouring females (n = 118). Sex ratio of sambar at birth appeared to be 2:3 favouring females when 35 births were recorded in captivity by Acharjyo and Padhi (1972). Though sambar kills by leopard was not observed in the study area, the habits of leopard hunting with regard to sex was assumed to be similar to tiger. This underlined the possibility of leopard hunting more male sambar like the tiger. Sambar was the second major prey species of leopard in the study area (section V.2b). The high proportion of females in sambar population may be due to the following 3 reasons as discussed earlier.

a. Sex ratio of sambar killed by tiger was found to be 1:2.5 favouring males.

b. Sex ratio of sambar at birth was 1;1.5 favouring females (Acharjyo and Padhi, 1972).

c. Possibility of more male sambar kill by the leopard like the tiger.

6. Age of prey

Wild dogs prefered to kill the young ones of sambar and the tiger the adults and sub adults (Section IV.13 and V.1d). Fiftysix percent of wild dog kills were on sambar below 1 year (class I and II) and this agreed with the opinion of Schaller (1967) that the wild dogs usually kills young ones of large animals and adults of smaller animals. The number of wild dog kills on sambar above 4 years (adults or class V and VI) was 14 (11.2%) and this low percentage has indicated that the adult sambar, both male and female had some sort of antipredatory strategies against the wild dogs which ensured their escape from wild dog predation.

The tiger in periyar, as mentioned earlier, usually killed adults of the prey species. Sixty one percent of its kill were on adults, 32.1 percent on sub adults and 7.16 % on young ones (n = 28) with an adult:subadult: young ratio of 8.5:4.5:1. This seemed to be

different from the adult young one ratio of 5:1 favouring adults observed at Bandipur by Johnsingh (1983).

All the sambar killed by tiger were adults (79%) or subadults (21%) and there were no evidence of any kill on sambar below 2.5 years old. Thus wild dog predation on sambar was maximum in the age class I and II while that of tiger was in age class V and VI.

7. Prey availability

Sambar is the major prey species of the mammalian predators in periyar. Other prey species consisted of gaur, barking deer, mouse deer, porcupine, wild boar, nilgiri langur, blacknaped hare, small Indian civet, porcupine, wild boar, and rats and all of these were fairly abundant in the study area. The density of sambar was estimated to be 3.7 animals per km^2. The densities of other prey species such as gaur, wild boar, barking deer and nilgiri langur were 1.6, 3.5, 0.3 and 1.4 animals per km^2 respectively (Table-43). The distribution of droppings of porcupine, mouse deer and blacknaped hare has indicated their high abundance in the study area.

8. Prey predator ratio

The total prey biomass excluding porcupine, mouse deer, elephant, blacknaped hare and rats was estimated to be 563008 kg/

400 km^2 or 1407.5 kg/km^2 (Table-43). This inlcuded the biomass of sambar (168128) kg or 420.3 kg/km^2) gaur (348800 kg or 872 kg/km^2), wild boar (36120 kg or 90.3 kg/km^2), nilgiri langur (7800 kg or 19.5 kg/km^2) and barking deer (2160 kg or 5.4 kg/km^2).

The total predator biomass excluding jungle cat and sloth bear was estimated to be 5820 kg or 14.6 kg/km^2 (Table). This included the biomass of tiger (4200 kg or 10.5 kg/km^2), leopard (900 kg or 2.25 kg/km^2) and wild dogs (720 kg or 1.8 kg/km^2). The total predator biomass (excluding jungle cat and sloth bear) and prey biomass showed a ratio of 1:96.7 in this study. A predator - prey biomass ratio of 1:124 (including chital, sambar, gaur, wild boar, barking deer, nilgiri langur, blacknaped hare, porcupine and peafowl) was recorded at Bandipur (Johnsingh, 1983) and 1: 250-300 at Serengetti (Schaller, 1972).

9. Effect of predation on sambar

As already mentioned, sambar formed the major prey species of wild dogs and tiger and the second major prey of the leopard in periyar (Section IV.6, V.1c and V.2b). Since a high predation pressure on sambar was expected in the study area, its population density was estimated in the dry and wet seasons of 1992 and 1994. In 1992, the average density of sambar in the two seasons was

estimated to be 3.7 animals per km^2 and in 1994 it was 3.51 animals per km^2. This showed neither increase nor any considerable decrease in the sambar population in periyar in two years. This has shown that the effect of predation by the 3 major predators wild dogs, tiger and leopard on sambar population during the study period was not significant. The slight decrease in the density of the species in 1994 may be due to the effect of several unnatural death occured during that period.

SUMMARY

Abraham. C.J “Studies on large mammalian predators with special reference to wild dog, cuon alpinas (pallas) and their prey species in Periyar, South India” Thesis. Department of Zoology, St. Joseph's College Devagiri, University of Calicut, 2000

SUMMARY

A study has been conducted on the status, distribution and feeding habits of dholes (wild dogs) and other predators in the 777 km^2 periyar tiger reserve from December 1991-1994. Five packs of wild dogs were sighted in the study area. Altogether 40 wild dogs were present. The largest pack, operated in the Nellikkampetty area had a maximum size of 15, having 8 adults and 7 pups. Average packsize of wild dogs was 8.9 in Nellikkampetty area and 8.4 in Thannikkudy area. Home range varied between 80-90 km^2 in these packs. Average density of wild dogs in periyar was between .06 - .13 animals per km^2.

The wild dogs preferred moist deciduous forests and savannah type grasslands in periyar. Sex ratio varied between 1:1.1 to 1:1.34 favouring males. Major prey species of dholes in the study area was sambar. Minor prey species included mouse deer, barking deer, blacknaped hare, nilgiri langur, wild boar, porcupine and rats. No evidence of live stock was found in their diet.

Dhole kills in periyar were observed more in early morning and in the evening. Few kills were observed during night. Hunting was often observed on the banks of the lake and rivers. The dogs located prey by vision in open areas and by smell and hearing in

closed areas. Chasing of prey was in short relays. Usual point of attack was the rump and the flank of the prey. Snout injury was common in sambar stags with hard antlers. Killing of more than one animal was rare. Meat consumption rate ranged between 1.1kg to 5.1 kg/dhole. Fawns and yearlings were mostly hunted. Sex ratio of the prey killed was 1:1.5 favouring females. One wild dog was found killed by porcupine during the study period.

Tiger popoulaiton in periyar ranged between 30 and 36 with a sex ratio of 1:3.2 favouring females. Tiger density was more in moist deciduous forests and grasslands. Maximum groupsize of tiger observed was 3. Major prey species of tiger consisted of sambar followed by porcupine. Minor prey species included rats, mouse deer, gaur, nilgiri langur, small indian civet, varanus, wild boar, elephant, blacknaped hare and domestic cattle. The tiger usually hunt more adults with a preference for males. There were no evidences of sambar fawn being killed. Most of the tiger kills were away from water holes.

Leopard's density in Periyar was more in semievergreen, evergreen and moist deciduous forests. All leopard sightings were solitary. Both spotted and black phases (one bservation of black panther) were present. Major prey species of leopard in periyar comprised nilgiri langur followed by sambar. Minor prey species included mouse deer, flying squirrel, small indian civet and rats.

Density of jungle cat was more in grasslands and moist deciduous forests. The major prey species of jungle cat in Periyar were rodents, birds, beetles and small indian civet. Minor prey species consisted of mabuya, toddy cat, mouse deer, barking deer (fawn), varanus and giant squirrel.

Sloth bear was observed mostly on grassy hills during rainy season and in valleys during summer. Density of sloth bear was more in grasslands and moist deciduous forests. Bears were seen singly or in groups of up to 3. Major food of the species consisted of termites and ants. Other food items included honey, fruits of *Mangifera indica* and various other plants, beetles, etc.

Sambar formed the major prey for wild dogs and tiger. It showed a preference for grasslands and moist deciduous habitats. Sambar was seen in valleys and hilly terrain, singly or in groups of upto 60 animals. Sex ratio in the samabr population was 1:3.58 favouring females. Density of the species was 3.7 animals/km^2 in 1992. Other prey species which were abundant in the reserve included gaur, wild boar, Nilgiri langur, barking deer, porcupine, blacknaped hare, squirrels and rats.

Appendix - 1
Wild dog sightings - Nellikkampetty Pack

Sl. No.	Date	Place		Vegetation (Habitat)	Number and sex of wild dogs		
					Adult	Pup	Total
1	04.01.92	Edappalayam	L	Deciduous	9 (5♂ 4♀)	4	13
2	18.01.92	Boat landing (thekkady)	L	"	8+	3+	11+
3	18.03.92	Thoothippara	L	"	9 (5 ♂4♀)	3+	12+
4	06.04.92	Manakkavala	L	S.E.green	7+	3+	10+
5	12.04.92	Deer island	L	Grass land	8+(4♂ 4♀)	4	12
6	14.04.92	Boat landing	L	Deciduous	6+	2+	8+
7	15.04.92	Koonommavu	L	S.E. Green	8+(4♂ 4♀)	3+	11+
8	16.04.92	"	L	"	6+	2+	8+
9	18.04.92	Paravalavu	L	Deciduous	8	2+	10+
10	18.05.92	Thampuranthuruthu	L	"	7 (4♂ 3♀)	2	9
11	28.05.92	Boat landing	F	"	7 (4♂ 3♀)	2	9
12	29.07.92	Kavalappara	L	Grass land	6 (3♂ 3♀)	2	8+
13	01.08.92	Ayyappankurukku	F	Deciduous	4 (2♂ 2♀)	-	4+
14	04.09.92	Koonammavu	L	S.E. green	6+	-	6+
15	31.10.92	Edappalayam	L	Deciduous	7 (4♂ 3♀)	-	7
16	02.12.92	Ayyappankurukku	L	"	6+(3♂ 3♀)	-	6+
17	09.01.92	Edappalayam	L	"	5+(3♂ 7♀)	-	5+
18	16.01.93	Boat landing	L	S.E. green	5 (3♂ 2♀)	2	7+
19	07.02.93	Ayyappankurukku	F	Deciduous	5 (3♂ 2♀)	2	7
20	25.03.93	Kavalappara	L	Grass land	9 (4♂ 5♀)	5	14
21	25.03.93	Kavalappara	L	"	7+	5	12+
22	30.03.93	Edapalayam	L	Deciduous	9 (4♂ 5♀)	5	14
23	21.04.93	Manakkavala	F	S.E. green	9 (4♂ 5♀)	4	13
24	23.04.93	Thampuranthuruthu	L	Deciduous	7+	4	11
25	28.05.93	Ayyappankurukku	L	Deciduous	4+	4	10+

(Appendix - 1 continued)

Sl. No.	Date	Place		Vegetation (Habitat)	Number and sex of wild dogs		
					Adult	Pup	Total
26	02.06.93	Edappalayam	L	Deciduous	7 (3 ♂4♀)	3+	10+
27	26.07.93	Deer island	L	Grass land	7 (3 ♂4♀)	4	11+
28	18.08.93	Boat landing	L	Deciduous	5+	2+	7+
29	20.11.93	Kavalappara	L	Grass land	4+	-	4+
30	23.12.93	Koonammavu	L	S.E. green	6+	-	6+
31	16.01.94	Karadikkavala	F	S.E. green	6	-	6
32	04.02.94	Boat landing	L	Deciduous	8+(4♂4♀)	2+	10+
33	21.02.94	Sivaloda	F	"	8+(4♂4♀)	7	15
34	07.03.94	Edappalayam	F	"	6+	7	13+
35	18.03.94	Poovarasu	F	"	7 (4♂3♀)	5+	12
36	24.03.94	Udumpara	L	"	7 (4♂3♀)	6	13
37	29.03.94	Nellikkampetty	F	"	6+	6	12+
38	12.04.94	Kavalappara	L	Grass land	5 (3♂2♀)	4+	9+
39	19.04.94	Boat landing	L	Deciduous	7	5	12
40	20.04.94	Edappalayam	F	"	7 (4♂3♀)	5	12
41	28.04.94	Boat landing	L	S.E. green	6+	2+	8+
42	14.05.94	Panamkala	F	Deciduous	7	1+	8+
43	20.05.94	Sivaloda	L	"	7	4	11
44	10.06.94	Damsite	F	Grass land	6+	4	10+
45	13.07.94	Paravalavu	L	Deciduous	7 (4♂3♀)	3+	10+
46	24.07.94	Anchuruly	F	S.E. green	6+	3+	10+
47	07.08.94	Thampuranthuruthu	L	Deciduous	7 (4♂3♀)	4	11
48	12.08.94	Kavalappara	L	Grass land	3+	4	7+
49	26.08.94	Thothippara	L	Deciduous	6+	3+	9
50	27.08.94	Koonammavu	L	S.E. green	6 (3♂3♀)	3	9

(Appendix 1 continued)

Sl. No.	Date	Place		Vegetation (Habitat)	Number and sex of wild dogs		
					Adult	Pup	Total
51	11.09.94	Poovarasu	F	Deciduous	6 (3 ♂3♀)	3	9
52	12.09.94	Zero bridge	F	Deciduous	4+	3	7+
53	21.09.94	Pachakadu	L	Deciduous	7 (3 ♂4♀)	3	9
54	07.10.94	Anchuruli	F	S.E. green	6+	3	9+
55	12.10.94	Boat landing	L	S.E. green	5+	3	8+
56	18.10.94	Edappalayam	L	Deciduous	5 (3♂2♀)	3	8
57	26.10.94	Edappalayam	L	Deciduous	5	3	8
58	13.11.94	Damsite	L	Grass land	5 (3♂2♀)	3	8
59	18.11.94	Kavalappara	L	Grass land	2+	-	2+
60	27.11.94	Valiyakanam	F	E. green	5+	-	5+
61	09.12.94	Edappalayam	F	Deciduous	4+	-	4+
62	14.12.94	Koonammavu	L	Deciduous	6+	-	8+
63	22.12.94	Boat landing	L	Deciduous	5+	-	5+
64	26.12.94	Thamparathuruthu	L	S.E. green	6 (3♂3♀)	-	6
65	29.12.94	Damsite	F	Grass land	3+	-	3

Appendix - 2
Wild dog sightings - Thannikkudy Pack

Sl. No.	Date	Place	Habitat	Number and sex of wild dogs		
				Adult	Pup	Total
1	08.01.92	Anakkallu	Grass land	3+	-	3+
2	15.01.92	Thannikkudy	Deciduous	5 (3♂ 2♀)	-	5
3	12.02.92	Thannikkudy	Deciduous	1+	-	1+
4	13.02.92	Kumarikulam	Grass land	5+(3♂ 2♀)	-	5+
5	03.03.92	Anakkallu	Grass land	8+(4♂ 4♀)	4	12
6	07.03.92	Thannikkudy	Deciduous	5+(3♂ 2♀)	4	9+
7	09.04.92	Thannikkudy machan	Grass land	8+(4♂ 4♀)	3+	11+
8	06.05.92	Mulakupara	Deciduous	6+	4	10+
9	09.06.92	Ummikkuppan	E. green	7+	4	11
10	04.07.92	Vaikappadappu	S.E. green	7+(4♂ 3♀)	4	11
11	29.08.92	Mulakupara	Deciduous	7+(4♂ 3♀)	3	10
12	11.08.92	Pandyan tharakan	S.E. green	6	2+	8+
13	28.09.92	Thannikkudy	Grass land	5+	2+	7+
14	29.10.92	Vengalappara	Grass land	6+(3♂ 3♀)	3	9
15	05.11.92	Mullakkudy	Deciduous	5+	3	8+
16	13.11.92	Mullathodu	S.E. green	5+(3♂ 2♀)	3	8
17	07.12.92	Thannikkudy	Deciduous	4+	-	4+
18	09.01.93	Mulakupara	Deciduous	6	-	6
19	16.03.93	Ummikkappan	E. green	7+(4♂ 3♀)	4	11
20	04.04.93	Ottamaram	Deciduous	6+	4	10+
21	05.04.93	Thannikkudy	Deciduous	7+(4♂ 3♀)	4	11
22	06.04.93	Kumarikulam	Grass land	5+	3+	8+
23	03.05.93	Vaikkappadappu	S.E. green	6+(4♂ 2♀)	4	10
24	07.05.93	Paloda	Grass land	5+(3♂ 2♀)	4	9
25	11.07.93	Mulakupara	Grass land	4+	4	8+

(Appendix - 2 continued)

Sl. No.	Date	Place	Habitat	Number and sex of wild dogs		
				Adult	Pup	Total
26	21.07.93	Mullakkudy	S.E. green	4 (3 1)	3+	7+
27	09.10.93	Swamikayan	Grass land	3+	4	7+
28	07.10.93	Ottamaram	Deciduous	4	3	7
29	17.10.93	Methaganam oaly	Deciduous	7 (4♂3♀)	-	7
30	14.11.93	Mavady	Deciduous	6+(3♂3♀)	-	6+
31	05.12.93	Vaikkappadappu	S.E. green	6 (3♂3♀)	-	6
32	06.02.94	Mlappara	E. green	8+(5♂3♀)	4	12+
33	11.03.94	Mullakkudy	Deciduous	8 (5 ♂3♀)	4	12
34	13.05.94	Kumarikulam	Grass land	7+(4♂ 3♀)	4	11
35	19.05.94	Swamikayam	Grass land	8	3	11
36	08.06.94	Kottakkarala	Grass land	7+(4♂3♀)	3	10+
37	07.07.94	Thannikkudy	Deciduous	6+	3	9+
38	08.07.94	Mulakupara	Grass land	8 (5♂3♀)	3	11
39	14.07.94	Adappukallumoola	Deciduous	7+(4♂3♀)	3	10
40	09.09.94	Nelipparakandam	Grass land	7	2	9
41	08.10.94	Paloda	Grass land	6 (3♂3♀)	2	8
42	13.11.94	Mullakkudy	Deciduous	5 (3♂2♀)	2	7
43	07.12.94	Churakkotta	Grass land	4+(2♂2♀)	2	6+

Appendix - 3

Dhole pack size reported in literature

Sl. No.	Pack size	Region	Source
1	6, 12-16, 2 25, 12, 20	Poona, Chanda, North Canara, upper Nilgiris, Madumalai	Adams 1949
2	26	Sigur	Anderson 1954
3	40	Central provinces	Brander 1927
4	2 adults, 7 pups	?	Burton 1925
5	5, 10, 12, 40	Sigur	Davidar 1975
6	5, 20, 26	Sigur	Fox 1977
7	8	Mudumalai	Krishnan 1965
8	23, 30-40	Burma	Milner 1921
9	7 or 8	Biligiri rangan hills	Morris 1925
10	6	Similipal	Padhi 1971
11	12	Kala Kadu hills	Peploe 1947
12	25	Central provinces	Pitman 1924
13	3, 10, 30	Bandipur	Sharatchandra and Gadgil 1975
14	18, 21	Periyar	Sankhala, 1977
15	15	Bandipur	Spillet 1966
16	16	Sigur	Waller 1972
17	4	Cordamom hills	Williams 1935
18	11-12	Upper Nilgiris	Ware 1919
19	20-24	Central provinces	Wright 1890
20	7-18	Bandipur	Johnsingh (1983)

Appendix - 4

Wild dog pack size: Variation inNellikkampetty pack (1992 - 94)

Month and year	Number of Observation	Pack size					
		Solitary	2 - 4	5 - 7	8 - 10	11 - 13	14 and above
January 92	2					2	
March "	1					1	
April "	6				4	2	
May "	2				2		
July "	1				1		
August "	1		1				
September "	1			1			
October "	1			1			
December "	1			1			
January 93	2			1	1		
February "	1			1			
March "	3					1	2
April "	2					2	
May "	1				1		
June "	1				1		
July "	1					1	
August "	1			1			
November "	1		1				
December "	1			1			
January 94	1			1			
Feruary "	2				1		1
March "	4					4	
April "	4				2	2	
May "	2				1	1	
June "	1				1		
July "	2				2		
August "	4			1	2	1	
September "	3			1	2		
October "	4				4		
November "	3		1	1	1		
December "	5		2	2	1		
Total	65	-	5	13	27	17	3
			7.69%	20%	41.54%	26.15%	4.6%

Appendix - 5

Wild dog pack size: Variation in Thannikkudy Pack (1992 - 94)

Month and year	Number of Observation	Pack size				
		Solitary	2 - 4	5 - 7	8 - 10	11 - 13
January 92	2		1	1		
February "	2	1		1		
March "	2				1	1
April "	1					1
May "	1				1	
June "	1					1
July "	2				1	1
August "	1				1	
September "	1			1		
October "	1				1	
November "	2				2	
December "	1		1			
January 93	1			1		
March "	1					1
April "	3				2	1
May "	2				2	
July "	2			1	1	
September "	1			1		
October "	2			2		
November "	1			1		
December "	1			1		
February 94	1					1
March "	1					1
May "	2					2
June "	1				1	
July "	3				2	
September "	1				1	
October "	1				1	
November "	1			1		
December "	1			1		
Total	43	1	2	12	17	11
		2.3%	4.6%	27.6%	39.1%	25.5%

APPENDIX - 6

TIME OF WILD DOG KILLS ON SAMBAR

Month & Year		Before 7 AM	7 AM to 9 AM	9 AM to 11 AM	11 AM to 1 PM	1 PM to 3 PM	3 PM to 5 PM	5 PM to 7 PM	Above 7 AM	Total
1992	Jan	-	-	1	-	-	1	-	-	2
	Feb	1	1	-	-	-	-	-	-	2
	March	-	1	1	-	-	1	-	1	4
	April	-	-	-	-	-	-	1	-	1
	May	-	-	-	1	1	-	1	-	3
	June		1	1	-	-	-	-	-	2
	July	-	1	-	-	-	-	-	-	1
	Aug.	1	-	-	-	-	-	-	-	1
	Sept.	-	1	-	-	-	-	-	-	1
	Oct.		1	-	-	-	-	-	-	1
	Nov.	-	-	2	-	-	-	1	-	3
	Dec.	-	3	1	-	-	1	-	-	5
1993	Jan	-	2	1	-	1	-	-	-	5
	Feb	-	2	-	-	-	-	-	-	2
	March	-	2	1	1	-	-	1	-	5
	April	-	1	-	-	-	2	1	-	4
	May	1	1	1	-	-	-	-	-	3
	June	1	-	-	1	-	-	-	-	2
	July	-	-	1	-	-	1	-	-	2
	Aug	1	-	-	-	-	-	-	-	1
	Sept.	-	-	-	-	-	1	-	-	1
	Oct.	-	1	1		1	-	-	-	3
	Nov.	-	-	1	-	-	1	1	-	3
	Dec.	-	1	-	-	-	-	1	-	2
1994	Jan	1	-	2	-	1	-	-	-	4
	Feb	-	-	-	-	-	1	-	-	1
	March	-	-	-	-	-	-	2	-	2
	April	-	3	1	-	-	1	1	-	6
	May	-	2	-	-	-	1	1	-	4
	June	-	1	1	-	-	1	-	-	3
	July	-	2	-	-	-	-	1	-	3
	Aug.	1	-	-	-	-	1	2	-	4
	Sept.	-	1	-	1	-	-	-	-	2
	Oct.	-	-	-	-	-	-	-	-	-
	Nov.	1	-	1	-	-	-	-	-	2
	Dec.	-	2	-	-	-	-	-	-	2
	Total	8	30	17	4	4	13	14	1	91
	Percentage	8.79	32.96	18.68	4.39	4.39	14.28	15.38	1.09	100

Appendix - 7

Sex composition of Sambar Killed by Wild Dogs

Month & Year	Number of kills recorded	Number of fawns	Number of kills of sambar whose sex identified	Number of females	Number of males			
					Stag including spike and fawn	Velvet	Antler shed	Total Male
1992 Jan	4	-	4	3	1	-	-	1
Feb	6	2	4	2	2	-	-	2
March	10	5	7	4	3	-	-	3
April	3	2	2	1	1	-	-	1
May	3	1	2	2	-	-	-	-
June	3	2	1	1	-	-	-	-
July	3	2	2	1	1	-	-	1
Aug.	2	1	2	1	1	-	-	1
Sept.	3	2	3	2	-	1	-	1
Oct.	3	1	2	1	1	-	-	1
Nov.	3	-	3	2	-	-	1	1
Dec.	6	2	5	2	2	-	1	3
1993 Jan	5	2	4	2	2	-	-	2
Feb	2	-	2	1	1	-	-	1
March	8	2	8	5	2	1	-	3
April	4	1	4	1	-	1	2	3
May	3	1	3	2	-	1	-	1
June	3	1	3	2	1	-	-	1
July	3	1	2	1	1	-	-	1
Aug	2	1	2	1	-	-	1	1
Sept.	2	1	2	1	1	-	-	1
Oct.	2	1	1	1	-	-	-	-
Nov.	3	-	3	2	-	-	1	1
Dec.	2	-	2	1	1	-	-	1
1994 Jan	4	1	3	2	1	-	-	1
Feb	2	-	2	2	-	-	-	-
March	2	1	2	1	1	-	-	1
April	6	2	5	3	2	-	-	2
May	4	1	3	3	-	-	-	-
June	3	1	2	1	1	-	-	1
July	3	1	3	2	1	-	-	1
Aug.	4	1	4	2	2	-	-	2
Sept.	2	-	2	1	-	-	1	1
Oct.	1	1	1	1	-	-	-	-
Nov.	2	-	2	1	1	-	-	1
Dec.	2	-	2	2	-	-	-	-
Total	123	40	104	63	30	4	7	41
Percentage	-	32.5%	-	60.6%	28.8%	3.8	6.7	39.4

Appendix - 8

Tiger - Kill data

No	Month & Year	Place	Habitat	Prey	Sex of prey	Age class of prey		
						Adult	Sub adult	Young one
1.	18.02.92	Nellikkampetti	Deciduous	Domestic cattle	?	-	x	-
2	14.05.92	Vaikkappadappu	Semi ever green	Sambar	Male	x	-	-
3.	07.06.92	Poovarasu	Deciduous	Varanus	?	-	-	-
4.	29.08.92	Kavalappara	Gross land	Sambar	Male	x	-	-
5.	26.01.93	4th mile uppupara	E. Platation	Sambar	Female	-	x	-
6.	12.03.93	Manakkavala	Deciduous	Wild boar	?		-	x
7	17.04.93	Anchuruly	Semi ever green	Sambar	Male	x	-	-
8	11.07.93	Pachakkadu	Deciduous	Mouse deer	?	-	-	-
9	12.09.93	Thannikkudy	Grass land	Sambar	Female	x	-	-
10	05.10.93	Vallakkadavu	Grass land	Domestic cattle	Female	x	-	-
11.	23.10.93	Vallakkadavu	Semi ever green	Domestic Buffallo	Female	x	-	-
12.	16.12.93	Methaganam	Deciduous	Gaur	?	-	x	-
13	03.01.94	Nellikkampetty	Deciduous	Sambar	Female	-	x	-
14	11.01.94	Vallakkadavu	Grass land	Domestic cattle	Female	x	-	-
15	04.08.93	Kokkara	Deciduous	Sambar	Male	x	-	-
16	08.03.94	Thannikkudy	Grass land	Sambar	Female	x	-	-
17	16.04.94	Thannikkudy	Grass land	Porcupine	?	x	-	-
18	30.06.94	Manakkavala	Deciduous	Sambar	Male	x	-	-
19	21.07.94	Vellimala	Ever green	Gaur	?	-	x	-
20	12.10.94	Tribal settlement kumily	Cultivation	Domestic cattle	Female	-	x	-
21.	06.11.94	Randattinkara	E. green	Gaur	?	x	-	-
22.	03.12.94	Anchuruli	S.E. green	Sambar	Male	x	-	-
23	17.12.94	Thekkady	Deciduous	Wild boar	?	-	-	x
24	10.05.92	Pachakkadu	Moist deciduous	Gaur	Male	-	x	-
25	10.05.92	"	"	"	Male	x	-	-
26	13.06.94	Kavalappara	Grass land	Sambar	Male	x	-	-
27.	02.02.92	Anchuruli	S.E. green	Sambar	Male	x		
28.	03.02.93	Ayyappankurukku	Moist deciduous	Sambar	Male	x		
29	16.01.94	Koonanmavu	Semi ever green	Sambar	Male		x	
30	08.04.94	Nellikkampetty	Moist deciduous	Gaur	Male		x	
	Total					17	9	2
	%					60.7	32.1	7.1

Adult: Sub adult: young ones = 8.5: 4.5:1

Appendix - 9

Transect count of sambar and estimation of density(May 1992)

TRANSECTS		Transect length in km	Number of Sambar recorded	Total perpendicular distances from the transect line in metre	Number of of observation	Mean width in metre	Sample area in Sq.m	Population density in Sq.km
Thannikkudy	- Kumarikulam	5	13	75	1	75	750000	17.3
"	- Mlappara	9	6	340	2	170	3060000	1.9
"	- Thekkady	24	52	750	4	187.5	9000000	5.7
"	- Mulakupara	4	14	80	1	80	640000	21.8
"	- Ummikkuppan	8	2	40	1	40	640000	3.1
Methaganam	- Mullakkudy	9	4	225	2	112.5	2250000	6.2
"	- Kalvarimala	8	2	130	1	130	2080000	.9
"	- Pachakkadu	7	28	250	2	125	1750000	16.0
"	- Karadikkavala	6	1	100	1	100	1200000	.8
"	- Kalyanappara	4	3	50	1	50	400000	7.5
Thekkady	- Anchuruli	5	2	110	2	55	550000	40.0
"	- Manakkavala	4	11	375	3	125	1000000	11.0
Pachakkanam	- Aruvioda	8	3	250	1	250	4000000	.7
"	- Chenthamara	3	4	475	2	237.5	1425000	2.8
"	- Kozhikkanam	4	-	-	-	-	-	0
4th mile	- Uppuppara	7	-	-	-	-	-	0
							Mean Population density	3.76 /Sq.km

Appendix - 10

Transect count of sambar and estimation of density (August 1992)

TRANSECTS		Transect length in km	Number of Sambar recorded	Total perpendicular distances from the transect line in metre	Number of of observation	Mean width in metre	Sample area in Sq.m	Population density in Sq.km
Thannikkudy	- Kumarikulam	5	2	150	1	150	1500000	1.33
"	- Mlappara	9	1	60	1	60	1080000	.92
"	- Thekkady	24	40	200	2	100	4800000	8.3
"	- Mulakupara	4	6	460	3	153.3	1226640	4.8
"	- Ummikkuppan	8	6	330	3	110	1760000	3.4
Methaganam	- Mullakkudy	9	2	425	2	212.5	4250000	.4
"	- Kalvarimala	8	3	70	1	70	1120000	2.6
"	- Pachakkadu	7	17	550	4	137.5	1925000	8.8
"	- Karadikkavala	6	2	80	1	80	960000	2.0
"	- Kalyanappara	4	3	400	2	200	1600000	1.8
Thekkady	- Anchuruli	5	7	250	2	125	1250000	5.6
"	- Manakkavala	4	6	275	4	68.75	550000	10.9
Pachakkanam	- Aruvioda	8	0	-	-	-	-	-
"	- Chenthamara	3	2	150	2	75	450000	4.4
"	- Kozhikkanam	4	1	40	1	40	320000	3.1
4th mile	- Uppuppara	7	0	-	-	-	-	-
							Mean Population density	3.64 /Sq.km

Appendix - 11

Transect count of sambar and estimation of density(April 1994)

TRANSECTS		Transect length in km	Number of Sambar recorded	Total perpendicular distances from the transect line in metre	Number of of observation	Mean width in metre	Sample area in Sq.m	Population density in Sq.km
Thannikkudy	- Kumarikulam	5	13	350	3	116.6	1166600	2.5
"	- Mlappara	9	4	150	2	75	1350000	2.9
"	- Thekkady	24	25	450	2	75	3600000	6.9
"	- Mulakupara	4	11	300	2	150	1200000	9.1
"	- Ummikkuppan	8	4	125	1	125	2000000	2.0
Methaganam	- Mullakkudy	9	8	60	1	60	1200000	6.6
"	- Kalvarimala	8	6	200	3	66.66	1066560	5.6
"	- Pachakkadu	7	5	160	2	80	1120000	6.2
"	- Karadikkavala	6	0	-	-	-	-	-
"	- Kalyanappara	4	2	70	1	70	560000	1.7
Thekkady	- Anchuruli	5	3	75	1	75	750000	1.3
"	- Manakkavala	4	12	450	4	112.5	900000	4.4
Pachakkanam	- Aruvioda	8	4	180	2	90	1440000	1.3
"	- Chenthamara	3	1	60	1	60	360000	2.7
"	- Kozhikkanam	4	-	-	-	-	-	-
4th mile	- Uppuppara	7	2	80	1	80	1120000	1.7
							Mean Population density	3.43 /Sq.km

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Appendix - 12

Transect count of sambar and estimation of density(September 1994)

TRANSECTS		Transect length in km	Number of Sambar recorded	Total perpendicular distances from the transect line in metre	Number of observation	Mean width in metre	Sample area in Sq.M	Population density in Sq.km
Thannikkudy	- Kumarikulam	5	2	250	1	250	2500000	.8
"	- Mlappara	9	3	70	1	70	1260000	2.3
"	- Thekkady	24	19	325	4	81.25	3912000	4.8
"	- Mulakupara	4	4	200	1	200	1600000	2.5
"	- Ummikkuppan	8	9	350	3	116.66	1866560	4.8
Methaganam	- Mullakkudy	9	2	60	1	60	1200000	1.6
"	- Kalvarimala	8	9	275	3	91.66	1466560	6.1
"	- Pachakkadu	7	6	240	2	120	1680000	3.5
"	- Karadikkavala	6	-	-	-	-	-	0
"	- Kalyanappara	4	1	70	1	70	560000	1.7
Thekkady	- Anchuruly	5	8	185	3	61.66	616600	12.9
"	- Manakkavala	4	2	450	4	112.5	900000	2.2
Pachakkanam	- Aruvioda	8	-	-	-	-	-	0
"	- Chenthamara	3	5	125	2	72.5	435000	11.4
"	- Kozhikkanam	4	-	-	-	-	-	0
4th mile	- Uppuppara	7	7	340	2	170	2380000	2.9
						Mean Population density		3.59 /Sq.km

Appendix - 13

Age of sambar killed by wild dogs (1992-94)

Age class / Month & Year		1 to 6 month	6 month to 1 Year	1 year to 2 year	2 year to 4 year	4 year to 6 year	Above 6 year	Total
1992	Jan	1	-	-	2	-	-	3
	Feb	3	-	1	1	1	-	6
	March	4	2	2	-	2	-	10
	April	1	1	1	-	-	-	3
	May	1	1	1	-	1	-	4
	June	-	-	1	-	-	-	1
	July	1	1	-	1	-	-	3
	Aug.	-	-	2	-	-	-	2
	Sept.	-	1	-	2	1	-	4
	Oct.	1	1	-	1	-	-	3
	Nov.	1	2	1	-	-	-	4
	Dec.	3	-	1	-	1	1	6
1993	Jan	3	1	1	-	-	-	5
	Feb	5	1	-	-	-	-	6
	March	2	-	-	1	-	-	3
	April	1	-	-	-	-	-	1
	May	1	-	-	2	1	-	4
	June	-	1	1	-	-	-	2
	July	-	1	1	-	-	1	3
	Aug	1	-	1	-	1	-	3
	Sept.	-	1	2	1	-	-	4
	Oct.	-	2	2		-	-	4
	Nov.	1	1	-	-	-	-	2
	Dec.	1	2	1	-	-	-	4
1994	Jan	3	-	-	-	-	-	3
	Feb	-	2	1	-	1	-	4
	March	2	-	1	1	-	-	4
	April	1	2	-	1	-	-	4
	May	2	-	-	-	2	-	4
	June	1	-	1	-	-	-	2
	July	-	-	2	-	-	-	2
	Aug.	1	2	-	-	-	-	3
	Sept.	-	-	1	1	-	-	2
	Oct.	1	1	-	-	-	-	2
	Nov.	-	2	1	-	-	1	4
	Dec.	-	-	-	1	-	-	1
	Total	42	28	26	15	11	3	125

BIBLIOGRAPHY

Abramov, V. 1962. A contribution to the biology of the Amur tiger, *Panthera tigris* longipilis (fitzinger 1868) Vestn. *Cesk Spolecnosti Zool.*, 26: 189-203.

Acharjyo, L.N. and Padhi, G.S. 1972. Some observations on distribution of Zoobirths among common wild animals. *J. Bombay Nat. Hist Soc:* 69(1): 175-178.

Adams, E.G.P. 1927. Wild dogs in Mysore. *J. Bombay Nat. Hist. Soc.* 31(4): 1024-29.

Adams, E.G.P. 1949 Jungle memories: Part IV. *Ibid* 48(4):645-655.

Adorjan, A.S. and Kolenosky, B. 1980. A Manual for the Identification of hairs of selected Ontario mammals. Research report (wildlife) No.90, Ministry of Natural Resources Ontario.

Ali, S. 1962. How do wild dogs kill their prey. *J. Bombay. Nat. Hist. Soc.* 31(3): 813.

Allen, H. 1960. The lonely tiger. London.

Anderson, K. 1954 Nine man eaters and one rogue London. 251 pp. (cited from Schaller, 1967).

Anderson K. 1961. The call of the Man eater. London.

Arjansingh 1973. Tiger Haven. Macmillan Ltd. London. 232 PP.

Barrette, C. 1991. The size of Axis Deer Fluid Groups in Wilpattu National park, Srilanka. *Mammalia* 1:55; 2: 207-220.

Base, W. 1957. Tiger! tiger! London.

Berwick, S.H. and Jordan, P.A. 1991 First Report of the Yale - Bombay Natural history society studies of Wild ungulates at the Gir Forest, Gujarath, India. *J. Bombay Nat. Hist. Soc.* 68(2).

Brander, A.D. 1908. The effect of Strychnine on wild dogs. *J. Bombay Nat. Hist. Soc.* 18(2): 487-488.

Brander A.D. 1927. Wild animals in Central India. Edward Arnold Co., London, 296 PP.

Brander, A.D. 1928. How wild dogs kill their prey. *J. Bombay. Nat. Hist. Soc.* 32(3): 591-592.

Bordillon 1893: A report on the forests of Travancore, Government Press, Trivandrum.

Bourliere, F. 1963 Specific feeding habits of African Carnivores. *Afr. Wildl.* 17: 21-27.

Burton, R.W. 1925. Panther and wild dogs. *J. Bombay Nat. Hist. Soc.* 30(4): 910-911.

Burton, R.W. 1936. The tiger hunters. London

Burton, R.W. 1940 The Indian wild dog. *J. Bombay Nat. Hist. Soc.* 41(4): 691 - 715.

Chandrasekharan, C. 1962. Forest types of Kerala State (3). *Indian Forester*. 88: 837 - 847.

Cohan, J.A.,Fox, M.W., Johnsigh, A.J.T. and Barnett, B.D. 1978. Food habits of the dhole in South India. *J. Wildl. Mgmt.* 42(4): 933-936.

Connel, W. 1944. Wild dogs attacking a tiger. *J. Bombay Nat. Hist. Soc.* 44(3): 468-470.

Cowan, I.M. 1947. The timber wolf in the Rocky mountain National Parks of Canada. *Can. J. Res.* 25: 139-174.

Dang, H. 1962. The future of the tiger. *Cheetal*, 5(1): 46-47.

Davidar, E.R.C. 1965. Wild dogs (*Cuon alpinus*) and village dogs. *J. Bombay. Nat. Hist. Soc.* 62(1): 147-148.

Davidar, E.R.C. 1973. Dhole or Indian wild dog (*Cuon alpinus*) mating. *Ibid.* 70(2): 373-374.

Davidar, E.R.C. 1974 - Observations at the dens of dhole or Indian wild dog (*Cuon alpinus*). *Ibid* 71(2): 373-374.

Davidar E.R.C. 1975. Ecology and behaviour of the dhole or Indian Wild dog (*Cuon alpinus*). PP. 109-119.

Eisenberg, J.F. Lockhart, M. 1972, An ecological reconnaissance of wildpattu National park, Srilanka Smithsonian Contribution to Zoology No.101. 118 PP.

Fox, M. and Johnsingh A.J.T. 1975. Hunting and feeding in wild dogs. *J. Bombay Nat. Hist. Soc.* Vol. 72(2).

Fox, M. 1977. In Search of wildness and whisting jungle dogs. cited from Johnsigh (1980).

Fuller, T.K and Kat, P.W. 1989. Movements, activity and prey relationships of African wild dogs (*Lycaon pictus*) near Aitong, South western Kenya. *Afr. J. Ecol.* Vol. 28, P.330-350.

Hirst, S.M. 1967. Ecological aspects of big game predation. *Fauna and Flora*, 16: 3-15.

Jerdon, T.C. 1874. The mammals of India. John Wheldon, London. 319 PP.

Johnsingh, A.J.T. 1980 Ecology and behaviour of the dhole or Indian wild dog, *Cuon alpinus* (Pallas) 1811, with special reference to predator - prey relations at Bandipur. Ph.D Thesis Madura Kamaraj University.

Johnsigh, A.T.T. 1983. Large Mammalian prey predators in Bandipur. *J. Bombay Nat. Hist. Soc.* 80(1): 1-57.

Joslin, P. 1967. Movements and homesites of Timber wolves in Algonguin Park. *Amer: Zool.* 7: 279-288.

Joslin, P. 1973. Factors associated with decline of the Asiatic Lion. In: R.L. Eaton (Ed.), *The world's cats*, I: 127-141.

Karanth, K.U. 1988. Analysis of Predator - Prey balance in Bandipur Tiger Reserve with reference to census reports.

Karanth, K.U. 1993. Predator prey relations among large mammals of Nagarhole National Park, (India) Ph.D. thesis - Mangalore University.

Keller, R. 1973. Finige Beobachtungen Zum verhalten des Dekkan Rothundes *Cuon alpinus* dukkunensis (sykes) in Kanha National park. Vierteljahrssechrift der Naturforschenden Gesells Chafts in Zurich 118 (1): 129-135., (English translation by Cohen, J.A.).

Khan, J.A., Chellam, R. and Johnsingh A.J.T. 1995. Group size and Age-sex composition of three major ungulate species Gir Lion sanctury, Gujarath, India. *J. Bombay Nat. Hist. Soc.* Vol.92 No.3.

Klein, D. 1965. Ecology of deer range in Alaska *Ecol. Monogr.* 35: 259-284 (cited from G.B. Schaller, 1972).

Kolensky, G.B. and Johnsten, D.H. 1967. Radio tracking wolves in Algonquin Park. *Amer. Zool.* 7: 279-288.

Koppikar, B.R. and Sabnis, J.H. 1976. Identification of hairs of some Indian mammals. *J. Bombay Nat. Hist. Soc.* 73 (1): 5-20; 74(1): 50-59.

Krishnan, M. 1965. Wild dogs. *J. Bombay Nat. Hist. Soc.* 62(3): 543-545.

Krishnan, M. 1975. A guide to the tourism zone of the Bandipur tiger reserve. 18 PP.

Kruuk, H. and Turner, M. 1967. Comparative notes on predation by Lion, Leopard, Cheetah and wild dog in the Serengeti area, East Africa. *Mammalia*, 31(1): 1-27.

Kuhme, W. 1965. Freiland studien Zur Sociologic des Hyanen hundes *Lycaen pictus lupinus* (Thomas, 1902). Zeitschrift fur Tierpsychologic, 22: 495-541. (English translation by Mrs. A. Baker).

Kurup, G.U. 1971. A preliminary Ecological study of periyar wildlife sanctury, Kerala, *Cheetal* 13(2) 5-18.

Laurie, A and Seidensticker J. 1977. Behavioural ecology of the Sloth bear (*Melursus ursinus*), *J. Zool.* Lond. (1977) 182, 187-204.

Van Lawick 1971. Wild dogs. In: Innocent killers. Houghton Miffin Co. Boston.

Locke, A. 1954. The tiger's of Trengganu - London.

Mc Dougal, C. 1977. The Face of tiger, Livingstone Books.

Mech, L.D. 1966. The wolves of Isle Royale U.S. Natl. Park. *Serv. Fauna Ser.* No. 7:1-210.

Mech, L.D 1970. The Wolf: ecology and behaviour of an endangered species. *Double day*, New york N-Y. 384 PP.

Mincher, C.E.1921. Wild dogs in Burma. *J. Bombay. Nat. Hist. Soc.* 28(1): 266-267.

Morris, R.C. 1925. Wild dogs and jungle tragedies. *Ibid* 30(3): 691-693.

Novikov, G. 1962. Carnivorous mammals of the fauna of the U.S.S.R. Israel program for scientific translations, Washington D.C.

Padhi, G.S. 1971. Dhole (Indian wild dog) behaviour. *Indian Forester* 97(2): 114-115.

Paine, R.T. 1966. Food web complexity and species diversity. *Am. Natur.* 100: 65-75.

Panwar, H.S. 1979. Some aspects of population dynamics and land tenures of tigers in Kanha National Park. *Tiger paper*, 6(2-3): 12-15.

Pimlott, D.H., Shannon, J.A. and Kolenosky, G.B. 1969. The ecology of the timber wolf in Algonquin Park. Ont. Dept. Lands For. 90 PP.

Peploe, W.C.G., 1947. Field notes on the mammals of South Tirunelvely, South India. *J. Bombay Nat. Hist. Soc.* 46(4): 629-644.

Pitman, C.R.S. 1924. In the haunts of the Indian wild dog (*Cuon dukhunensis*) *J. Bombay Nat. Hist. Soc.* 29(4): 1046-1048.

Pocock, R.I. 1936. The Asiatic wild dog or Dhole (*Cuon javanicus*) *Proc. Zool. Soc.* London., 1912, 33-35.

Powell, A. 1957. Call of the tiger London.

Prater, S.H. 1971. The Book of Indian animals. Bombay Natural History Society, Bombay, 324 PP.

Ramachandran, K.K., Vijayakumaran Nair, P and Easa, P.S. 1987. Ecology of larger mammals of periyar wild life sanctury. *J. Bombay Nat. Hist. Soc.* 83: 502-524.

Rice, C.G. 1986. Observations on predators and prey at Eravikulam National park, Kerala *J. Bombay Nat. Hist. Soc.* 83(2): 283 - 305.

Rosenzweig, M.C. 1966. Community structure in sympatric carnivora. *J. Mammal* 47(4): 602-612.

Sanderson, G. 1912. Thirteen years among the wild beasts of India. Edinburgh.

Sankhala, K. 1977. Tiger: The story of the Indian tiger. Simon and Schuster, Newyork, 220 pp.

Schaller, G.B. 1967. The Deer and the Tiger. The University of Chicago press, Chicago and London. 370 pp.

Schaller, G.B. 1972. Serengetti Lion: A study of predator - prey relations. University of Chicago press, Chicago.

Seidensticker, J. 1976. On the ecological separation between tigers and leopards. *Biotropica* 8: 225-234.

Sharatchandra, H.C. and Gadgil, M. 1975. A year of Bandipur. *J. Bombay. Nat. Hist. Soc.* 72(3): 625-647.

Sinha, N.H. 1975. Some observations on the wild dog in the Kanha National park. *J. Bombay Nat. Hist. Soc.* 72(1): 198.

Slobodkin, L.B. 1961. Growth and regulation of Animal populations. Holt, Rinehart and Winston, Newyork. 184 pp.

Smith, M.J. 1905. Wild dogs hunting. *J. Bombay Nat. Hist. Soc.* 16(4): 751.

Sosnovskii, J.P. 1967. Breeding the red dog or dhole, *Cuon alpinus* at Moscow Zoo. *Int. Zoo. Yearb.*, 7: 120-122.

Spillet, J. 1966. A report on wild life surveys in South and West India. *J. Bombay Nat. Hist. Soc.* 65(2): 296-322.

Srivastava, K.K; Zacharias, V.J; Bhardwaj, A.K; Jafer, M and Abraham, C.J. 1993. Large mammalian redators and their prey species in periyar. *Procd. Int. Symp. on tiger.* 1993 India.

Srivastava, K.K; Bhardwaj, A.K; Abraham, C.J. and Zacharias, V.J. 1996. Food habits of Mammalian predators in Periyar tiger reserve, South India. *Indian Forester* Vol.122 No.10.

Sunquist, M.E. 1981: The social organization of tigers (*Panthera tigris*) in Royal Chitwan National park. *Smith sonian contrib. Zoo.* 3364 1-98.

Taylor, M. 1956. The tigers claw. London.

Varghese, R. 1975. Statistical survey of wild life (Phase I) Tiger and their natural prey project report, Dept. of mathematics, Union Christian College, Alwaye.

Varghese, R. 1981: Statistical survey of wild life (Phase II) Tiger and their natural prey. project Report, dept. of Mathematics, U.C.C. Alwaye.

Vijayan, V.S; Balakrishnan, M and Easa, P.S. 1979. Periyar Tiger Reserve. A reconnaissance report.

Waller, R.H. 1972. Observations of the wild life sancturies of India. *J. Bombay. Nat. Hist. Soc.* 69(3): 574-590.

Ware, F. 1919. Wild dogs (*cuon dukkunensis*) and sambar. *J. Bombay Nat. Hist. Soc.* 26(3): 837-838

Wesley, D.G. 1977. Census of wild animals in Bandipur Tiger Reserve. *My forest*, 13(1): 15-19.

Williams, J. (1935). Wild dog (*Cuon dukhunensis*) killed by domestic dogs. *J. Bombay Nat. Hist. Soc.* 37(4): 949-950.

Williams, J.L.H. 1971. Notes on the Nilgiri tahr. *J. Bombay Nat. Hist. Soc.* 68(3): 824-827.

Wright, B. 1960. Predation on big game in East Africa. *J. Wildl. Mgmt.* 24(10: 1-15.

Zacharias, V, J. 1977. Status and food habits of tiger with reference to Predator-prey relations in periyar tiger reserve. Research Report submitted to the forest dept., Govt of Kerala.

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