KFRI Research Report 105

PREY PREDATOR STUDIES IN ERAVIKULAM NATIONAL PARK

P.S. Easa

KERALA FOREST RESEARCH INSTITUTE
PEECHI, THRISSUR

December 1995 Pages: 58

CONTENTS

ABSTRACT

A study was conducted in Eravikulam National Park in the High Ranges of Western Chats to identify the prey species of large mammalian predators. Hair structure of thirty sewn mammalian species were studied Distribution and abundance ofprey-species in the urea were estimatedfrorn Point Count and Direct Sighting Methods. Scats of the predators were collected in different seasons and analysed for identification ofprey species from the hair remains.

Hair structure of thirty sewn mammals, at proximal. middle, and distal parts were studied and a key prepared for identification. Analyses of the scats indicate that sambar deer formed the major prey species of wild dogs and tiger. Nilgiri tahr waspreyed upon mostly by panther. The abundance of prey species and predation are not positively correlated There had been seasonal difference in the presence of prey species evidences in the scats. However, there is no conclusive data to arrive at such a conclusion. Morphological adaptations and predator avoidance behaviour of the prey species seem to be the major factors determining the prey predator relations in Eravikulam National Park.

1. INTRODUCTION

Modern concepts of wildlife management calls for an understanding on the prey-predator relationshlp and utilization of prey species by predators has always been a subject of interest to wildlife biologists. Predators have played an important role in preventing the monopolization of the major environmental requisites by a single prey species (Paine. 1966). Further, predation isconsidered to be capable of preventing extinctions in compelilive situations. It is also pointed out that predator removal could lead to local extinction of prey species.

Several studies have been conducted'on prey-predator relations (Wright, 1960; Bourliere, 1963: Rosenzweigh. 1966; Seidensticker. 1976). In India, Schaller (1967) described prey-predator relation in Kanha National Park. Johnsingh (1983 & 1993) reported different aspects of large mammalian predators in Bandipur Tiger Reserve. Karanth (1993) made an intensive study on prey-predator relationships in Nagarhole Nalional Park. Rice (1986) reported his observations on predators and prey in Eravikulam National Park.

Hair is often relatively undamaged in the faeces of carnivores and identification of the hair is a useful aid in determining diet of carnivorous animals. Faecal analyses for hair structure has thus become a widely used technique in food habit studies. Studies on mammalian hair, 'trichology', plays an important part in several branches of science including animal ecology, wildlife biology and forensic science.

Studies on mammalian hair date back to that of Brewster (1837). Later, McMurtrie (1886) reported different patterns of the cuticular surface of animal hair. However, the first significant contribution on the morphological structure was that of Hausman (1920, 1924 & 1930). He described the morphological structure of 166 fur-bearing mammals. Malhiak (1938) produced a key to the identification of hairs of mammals of Southern Michigan and Williams (1938). of moles and shrews. A number of studies followed (Lyne & McMahon, 1951: Benedict. 1957; Day, 1966 and Adorjan & Kolenosly, 1969). Brunner & Coman (1974) published a book elaborating various aspects of mammalian hair structure and Teerink (1991) brought out an atlas and identification key for the hair of West-European

Studies on the hairs of Indian mammals are rather few. Koppiker and Sabnis (1976 & 1977) reported the structural patterns of hairs of a few Indian mammals. Sabnis (1980) contributed to the information on hair characteristics of Indian bats. Koppiker and Sabnis (1981) studied the cuticular structure of certain mammals. Rajaram and Menon (1986) studied keratins of some Indian animals with the help of Scanning Electron Microscope and Balakrishnan (1988) reported the hair structure of Indian hare from various parts of its body. However, preliminary observations on hair structure indicated disagreement with the observations of Koppiker and Sabnis (1976, 1977 & 1981). The observations were further strengthened by the figures in Brunner and Coman (1974).

The present study was conducted in Eravikulam National Park wilh the objectives of studying the hair structure of mammalian species and lo prepare a key for their identification, and to identify prey species of large mamalian predators of the area.

2. STUDYAREA

Eravikulam National Park falls in the High Ranges of Western Ghats in Idukki District, Kerala. (10 15'N and 77 5' E) and covers an area of about 97 Km^2 The Park is bordered on the north by the Grass Hills of Tamil Nadu, west by the Reserve Forests and rest by tea eslates (Fig.1).

The park is of undulating terrain comprising a high rolling plateau area. wilh a base elevation of about 2.000 m.Most of the peaks rise about 100-300 m above this. The main plateau is split from north west lo south east by the Turners valley. Anamudi. with an elevation of 2,690 m is the highest point south of the Himalayas and falls in the southern part of the Park.

Rice (1984)has given a detailed description of EravikulaumNational Park. The plant communities could be subdivided into grassland, shrubland and forests. The terrain above 2000 m is covered primarily by the grasslands wilh small patches of forests in gullies and hollows. Shrub lands are found along the bases of the cliffs and intersperse in rocky areas. The shola forests, classified as Southern Montane Wet Temperate Forest (Chandrasekharan, 1962) are located mostly in the valleys. Shetty and Vivekananlhan (1971) described the flora of lhe area.

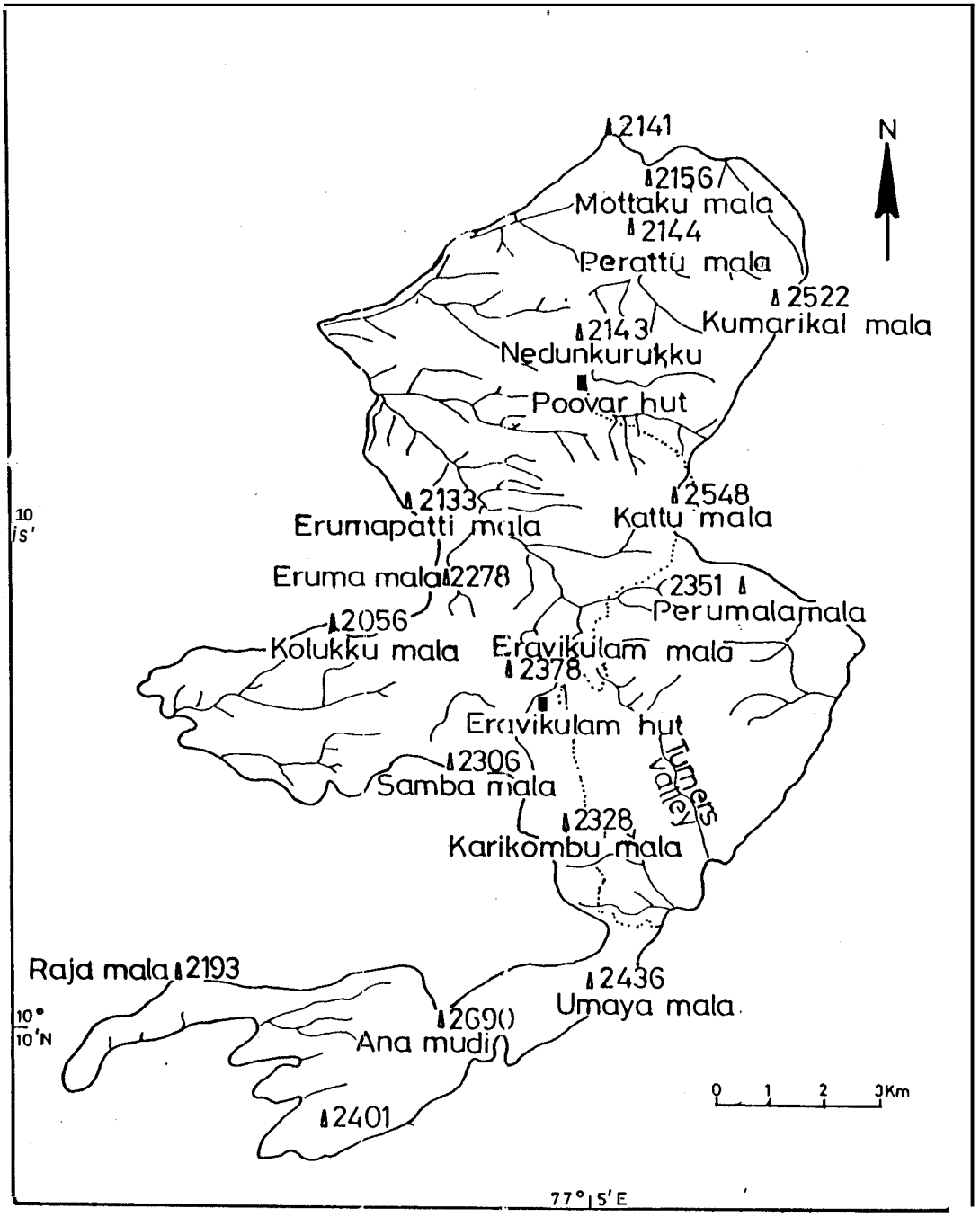

Fig. 1 Area map of Eravikulam National Park

Sixteen mammalian species are reported from the study area. These include Nilgiri tahr *(Hemitragus hylocrius).* gaur *(Bos gaurus).* eIephant *(Elephas maximus).* barking deer *(Muntiacus muntjak).* mouse deer *(Tragulus meminria).* Nilgiri langur *(Presbytis johni).* Malabar giant squirrel *(Rutufa indica).* tiger *(Panthera tigris).* panther *(Panthera pardus).*wild dog *(Cuon alpinus).* jackal(*Canis aureus),* jungle cat *(Felis bengalensis),* stripe necked niongoose *(Herpestes vitticollis).* Ruddy mongoose *(H. Smithi)* and Nilglri marten *(Martes gwatkinsi).* In addition lo these. an elusive cal species locally known as 'Pohayan" is also sighted during the sludy period. The smoky coloured cat. with the size of a jungle cat was observed near Eravikulam. Kolukkumalai and Kattumalai areas.

Rainfall arid leitiperalure data for 1993 and 1994 are summarised in Figures **2** arid **3.** Based on the weather parameters. Rice (1984) identified four seasons in Eravikulam National Park and is followed in the present study. They are:

1 Winter (Fromi December to February)
2 Pre-monsoon (From March to May)
3 Monsoon (From June to August)
4 Post-monsoon (From September to November)

3. METHODS

The present study concentrated on the characteristic features of the cortex and medulla of hairs collected from 37 mammalian species. Hair samples were collected from different regions of the body of the animals for preparation of reference slides. Hair samples were collecled from the dorsal, ventral, head and tall portions in general. However, samples were collected from all possible parts as far as possible. While collecting. care was taken to get the maximum accessible length of each hair. Guard hairs. especially the primary ones exhibit the most dingnostically useful features and hence are of paramount importance in hair identification (Brunner & Coman. 1974). Hence guard hairs were selecled for the present study.

The hair was washed in hol waler. cleaned in 70% alcohol and mounted in DPX. Tliese were studied under microscope for characteristic features of the cortex and medulla. A number of such samples were examined in each species for selecting the uniform characteristics and recording variations. If

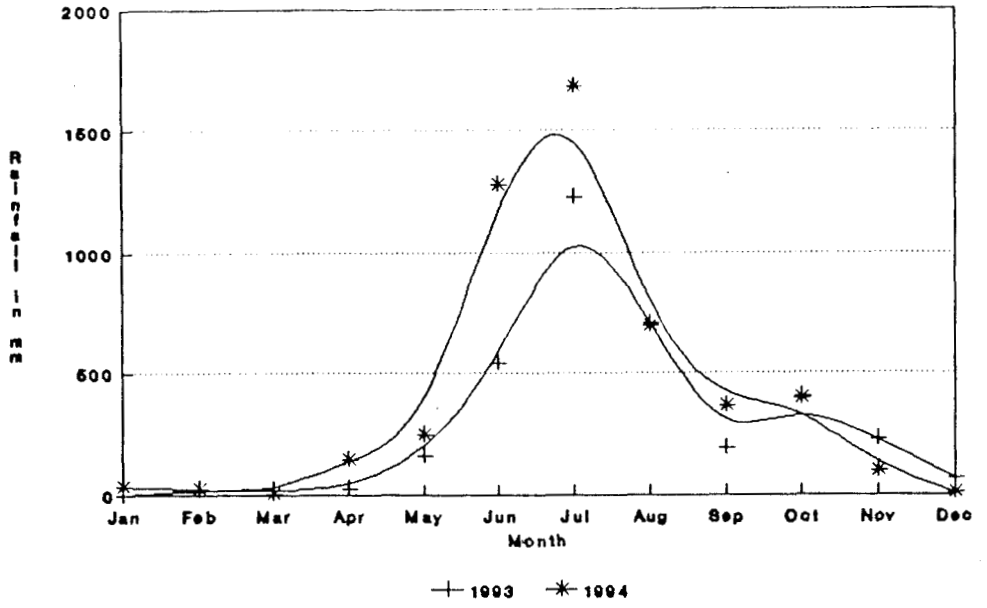

Fig. 2 Monthly Rainfall of Eravikulam
(1993 - 1994)

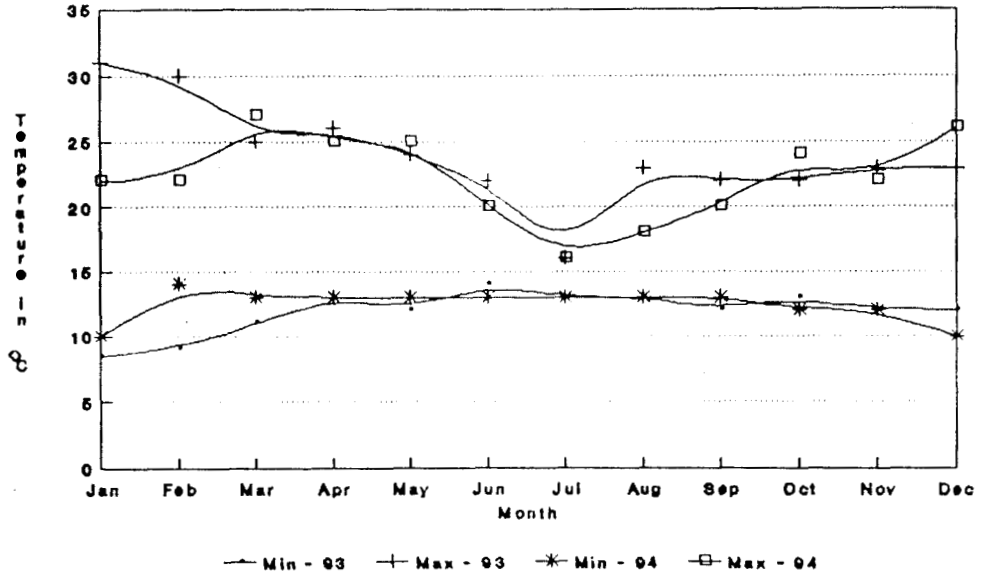

Fig. 3 Temperature variations in
Eravikulam National Park
(1993-1994)

Total length of a number of hair samples were measured. Measurements were also made at the proximal middle and distal portion of the hair for the width of cortex and medulla. Colour from the external appearance was also noted.

Based on the general shape and arrangement of both air spaces and medullary material. Brunner and Coman (1974) idenlified four major structural groups of hair medullae. These could be further subdivided into a number of medulla types. The classification of Brunner and Coman (1974) are adapted and supplemented for the classification of medullary types in the present study. Thus, the following types of medullary pattern are identified (Fig. 4).

a. Wide lattice
b. Narrow lattice
C. Wide aeriform lattice
d. Narrow aeriform lattice
e. Mulliserial ladder
f. Uniserial ladder
g. Wide simple
h. Narrow simple
i. Beaded interrupted
j. Chain like

The slides prepared were used as references.

The park area was perambulated every month and scats of predators were identified and collected. The collected samples were washed in water and sieved with a net of fine mesh size. The undigested materials such as hairs, bones and, animal and plant materials were sorted out. A sample of hairs thus sorted were selected for microscopic studies. These were compared with the reference slides prepared and prey species idenlified.

Kills and pugmarks sighted in the field were also recorded and predators idenlified. Sightings of animals in lhe study area were recorded along with the group size and composition in the case of herds/packs. Further, vantage points in Sankumalai, Anamudi, Rajamalai, Bheemanoda and Kolukkumalai were selected for observation of the animals. These points were visited every month and observations made in the morning and evening recording the animals sighted from the area. These observations were used to get indices on the seasonal abundance of prey species in different areas.

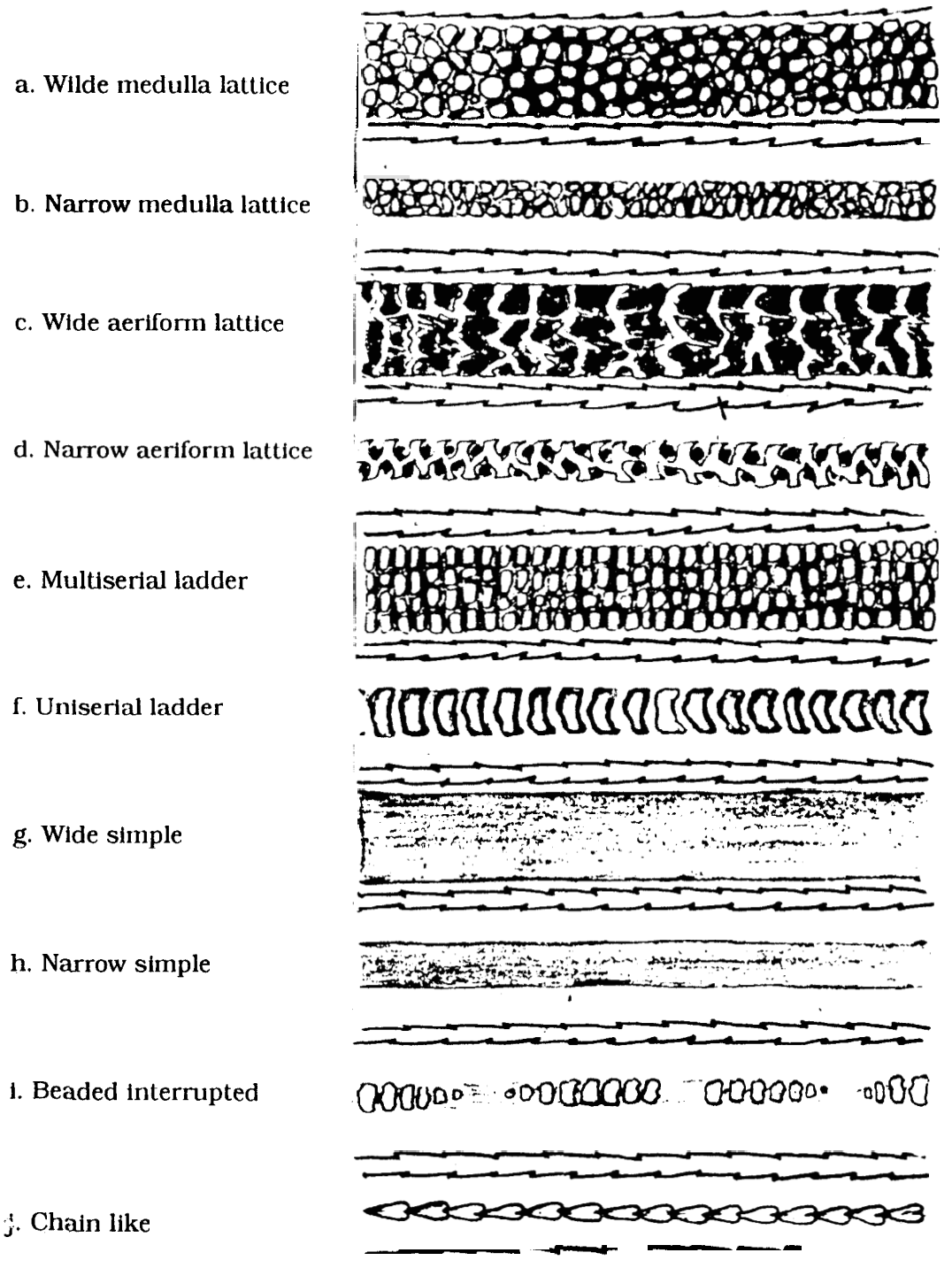

Fig. 4 Types of medullary structure

4. RESULTS

4.1 PREDATORS

4.1.1 Tiger, *Panthera tigris*

Tiger was sighted thirleen times in different parts of Eravikulam National Park during the present study (Table 1). However, the pugmarks were encountered only ten times (Fig.5).The locations of tiger scats collected in different seasons are given in Figures 6-9. Measurments of the pugmarks, their locations and number of scats collected indicate a maximum of five tigers in Eravikulam National Park.

Table 1. Details of predators sighted in Eravikulam National Park during the study period

Sl. No.	Name of the animal	No. of sighting	No. of animals
1.	Tiger	13	13
2.	Panther	4	5
3.	Black panther	1	1
4.	Un-identified Cat ('Pohayan')	3	3
5.	Wild dog	8	46
6.	Jackal	1	1

4.1.2 Leopard, *Panthera pardus*

Frequency of direct sightings and number of pugmarks were comparatively few. Panther was sighted only four times (Fig.5) and include a black panther seen near Eravikulam hut (Table 1).The number of panther in the area could be only four.

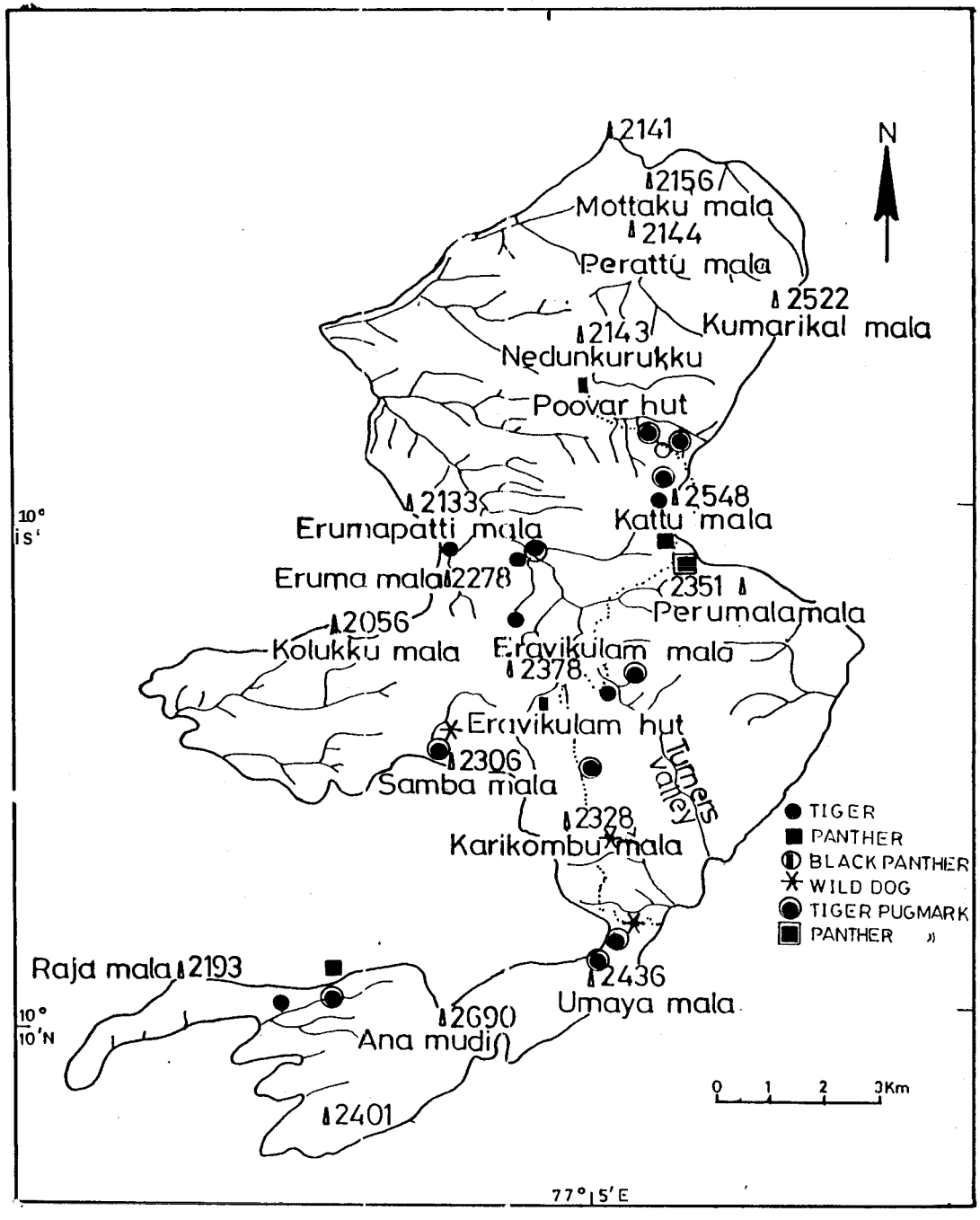

Fig. 5. Locations of sightings and evidences of predators in Eravikulam National Park

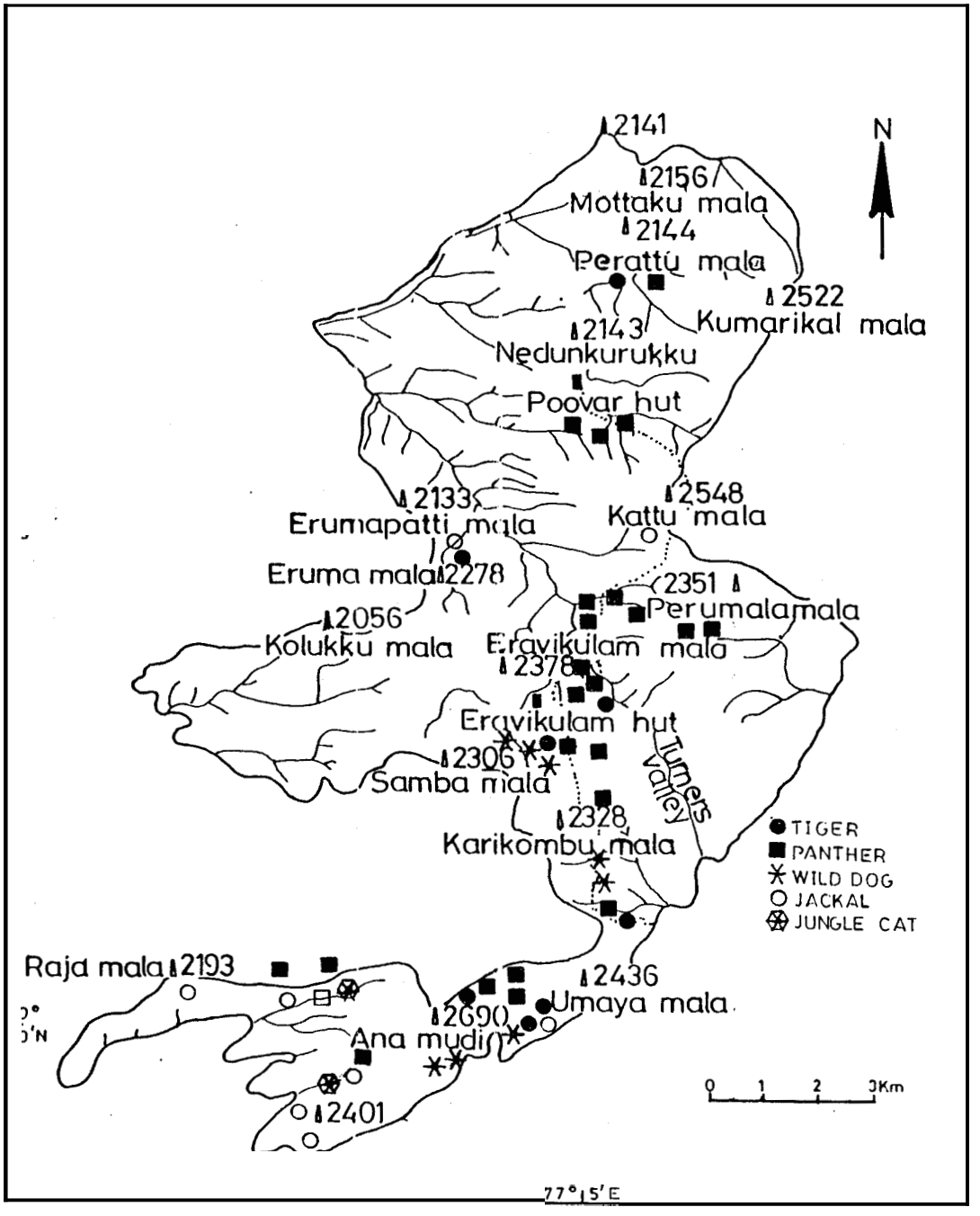

Fig. 6. Locations of scats collected from National Park in pre monsoon

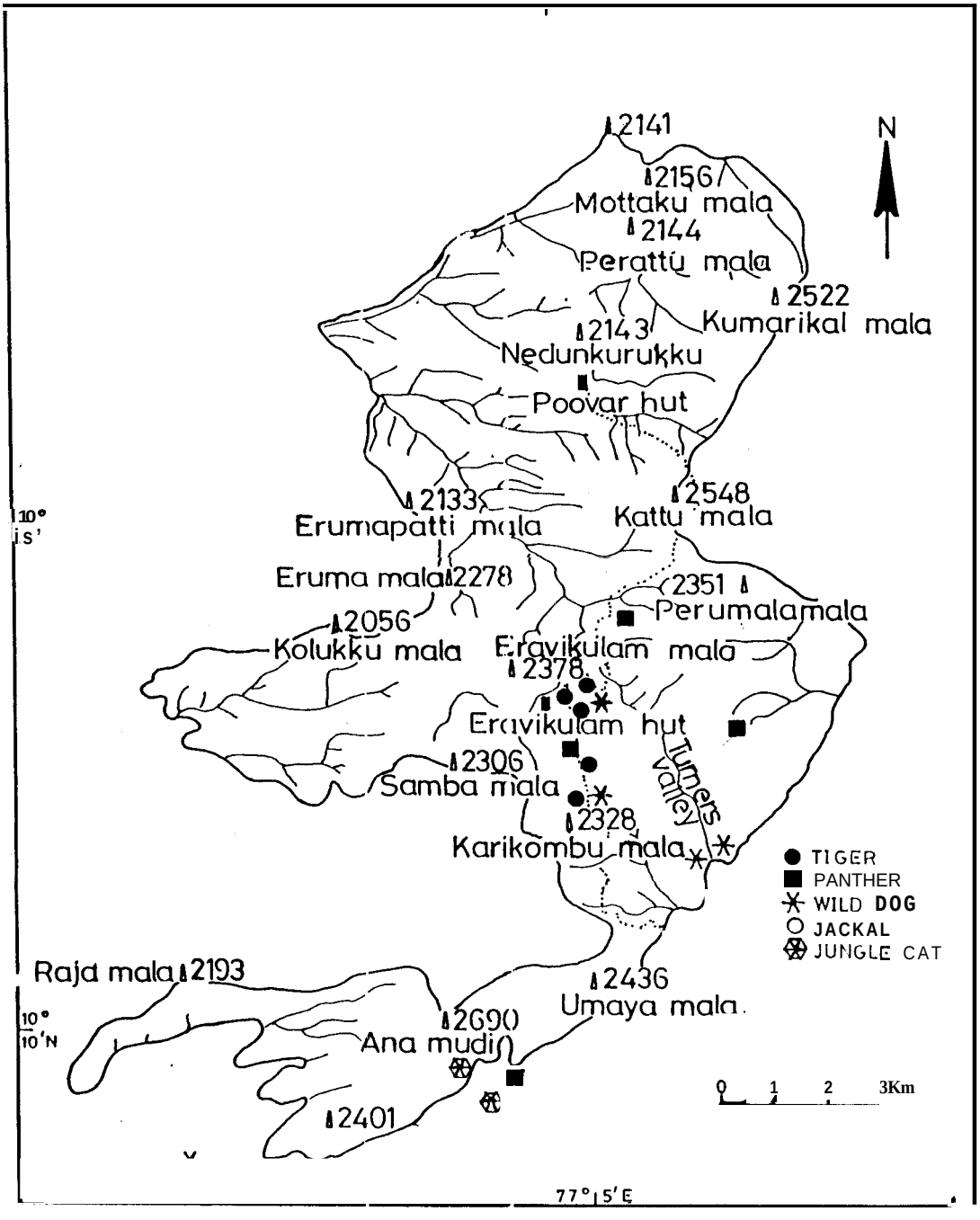

Fig. 7. Locations of scats collected from Eravikulam National Park in monsoon

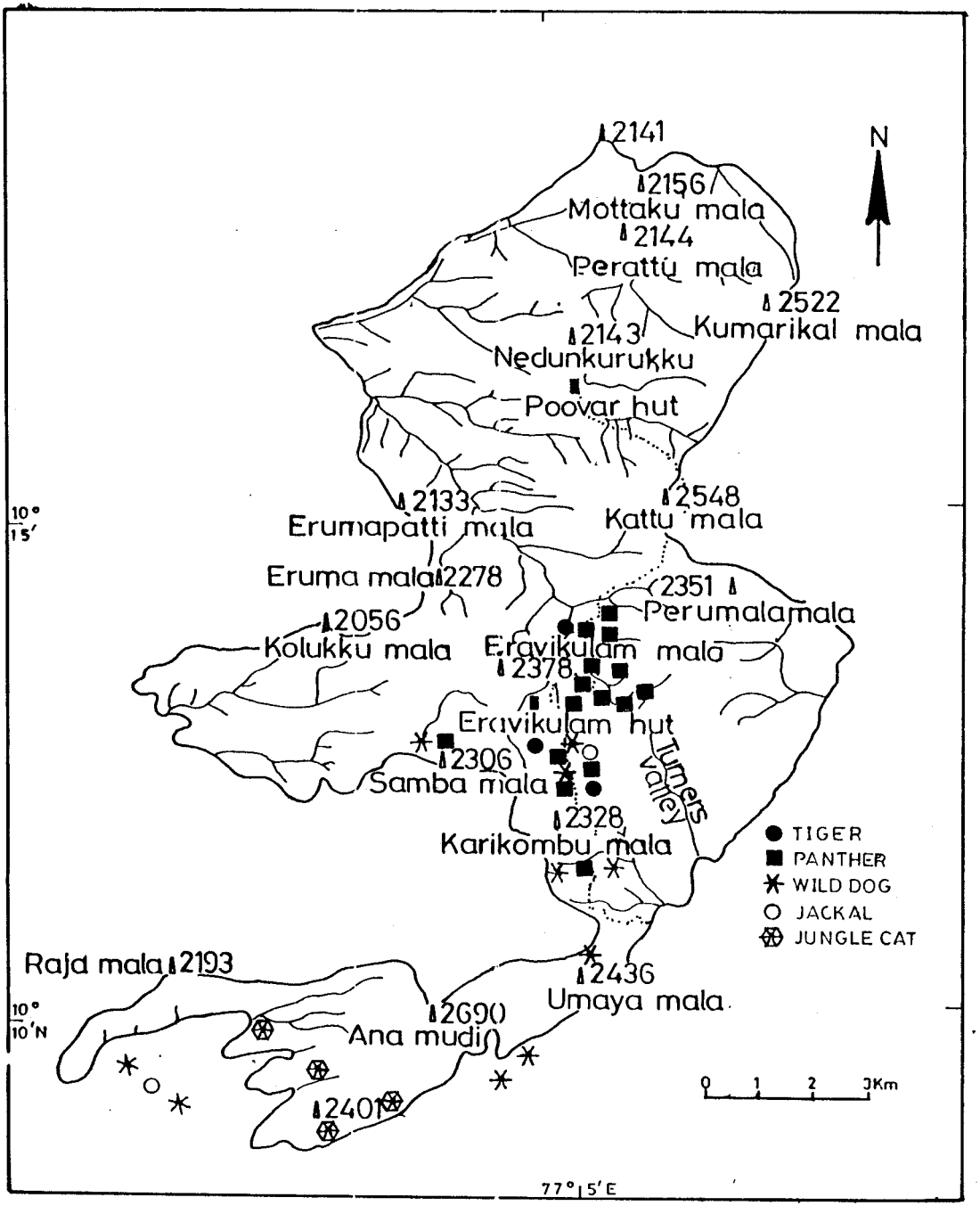

Fig. 8. Locations of scats collected from Eravikulam National Park in post monsoon

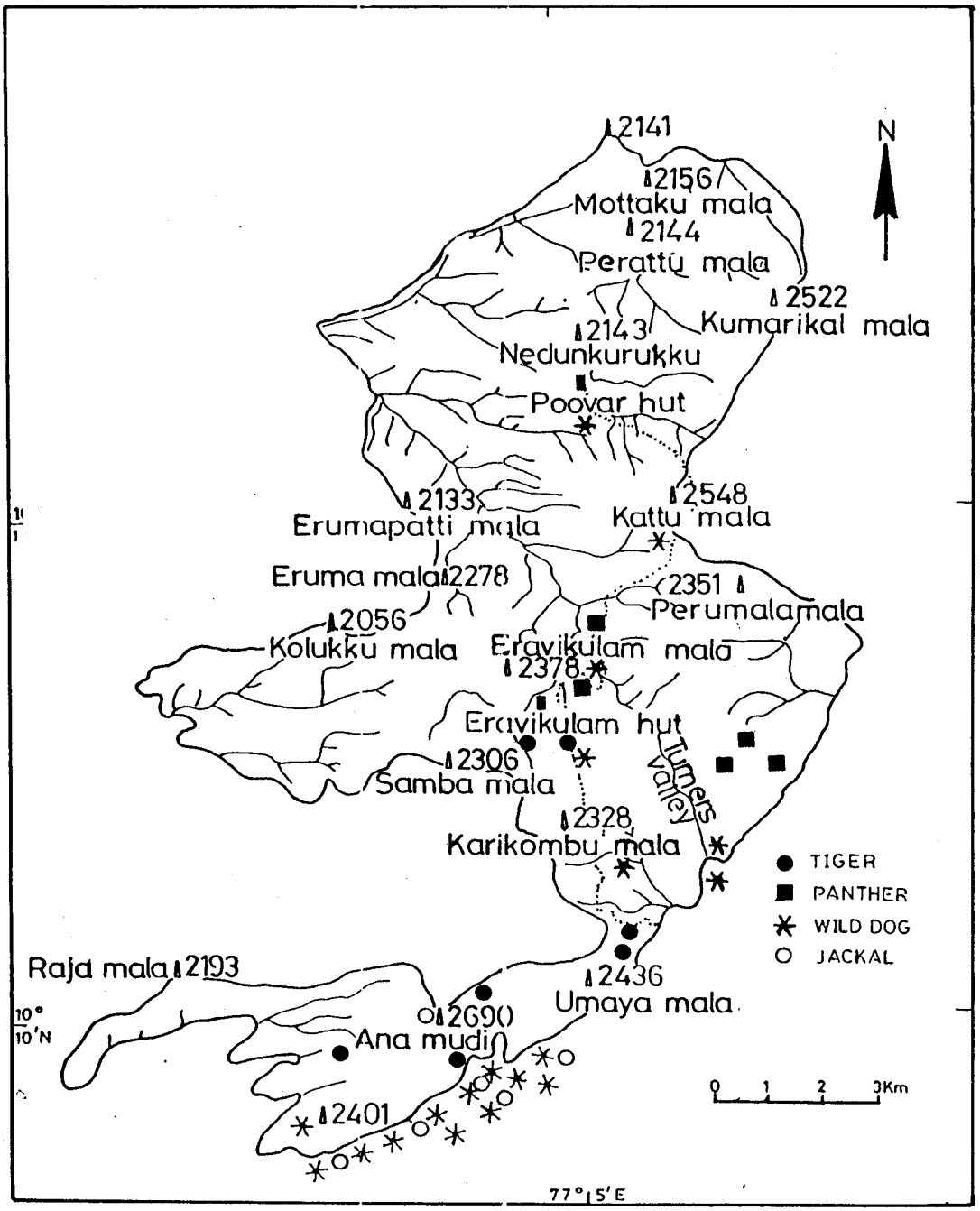

Fig. 9. Locations of scats collected from Eravikulam National Park in winter

4.1.3 Wild dogs, *Cuon alpinus*

A total of forty six animals were counted during the eight sightings (Table 1 and Fig.5). Approximate locations of scat collected during different seasons are given in Figures 6 - 9. Rice (1986)indicated that wild dogs are not resident in Eravikulam National Park. However, the records of High Range Association for the last few years and seasonwise distribution of scats collected during the present study suggests that at least a pack of wild dog is resident in the area. This view is further strengthened by observation of wild dogs with pups in a den near Rajamalai.

4.1.4 Other carnivores

Jackal, leopard cat. jungle cat and the unidentified 'pohayan' were the other predators met with in the area. However, no attempt was made to estimate their number.

4.2 PREY SPECIES

4.2.1 Nilgiri tahr, *Hemitragus hylocrius*

The wildlife census, 1993 reported an estimated population of about 890 animals in the area. Group composition of Nilgiri tahr. based on sightings during the study period is given in Figure 10.The results of observations for indices of animal (tahr and sambar) abundance from different locations are presented in Figures 11 and 12. There were considerable seasonal variation in the number of Nilgiri tahr sighted in different locations (Fig.11). It was sighted in all the areas in post monsoon. However, it was recorded only from Rajamalai throughout the year.

Distribulion of Nilgiri tahr in Eravikulam National Park in different seasons, based on total sightings are given in Figures 14-17. The number of Nilgiri tahr was high in Rajamalai areas in all seasons except post monsoon. Eravikulam areas had the maximum number in post monsoon season.

4.2.2 Sambar deer. *Cervus unicolor*

Sambar deer forms one of the major prey species in Eravikulam National Park. However, only a lolal of fifty two sightings of this animal could be made during the study period. Group composition of the animals sighted (Fig.13) indicates that solitary animals formed a major part of the population. The results of observations for indices from selected vantage points are

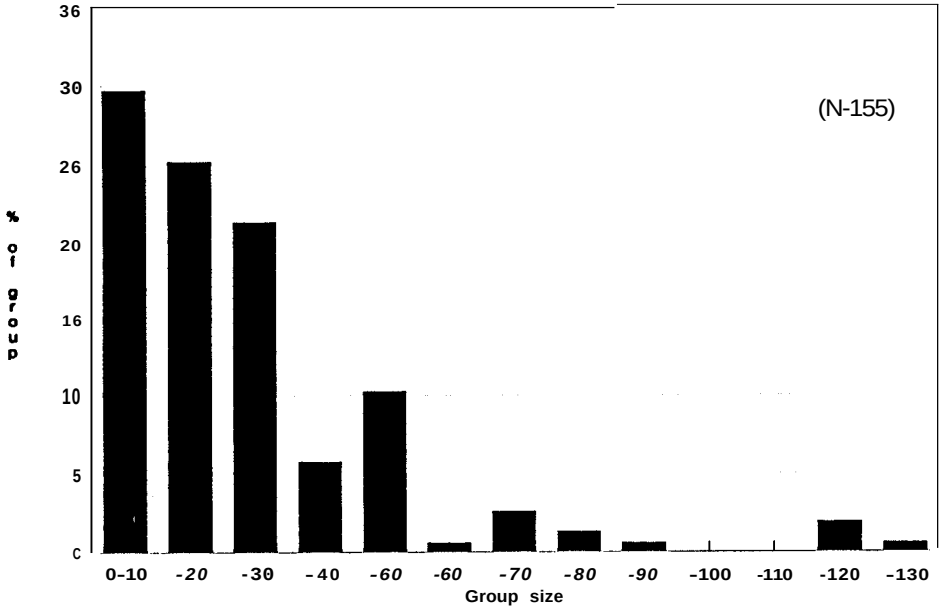

Fig. 10 Group composition of Nilgiri Tahr in Eravikulam National Park

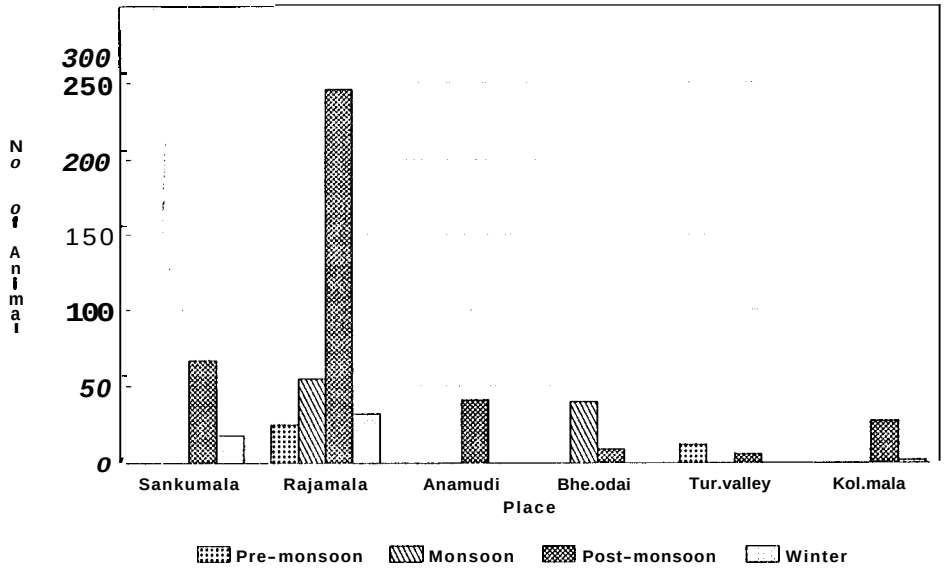

Fig. 11 Nilgiri Tahr recorded through point count method in different seasons of Eravikulam National Park

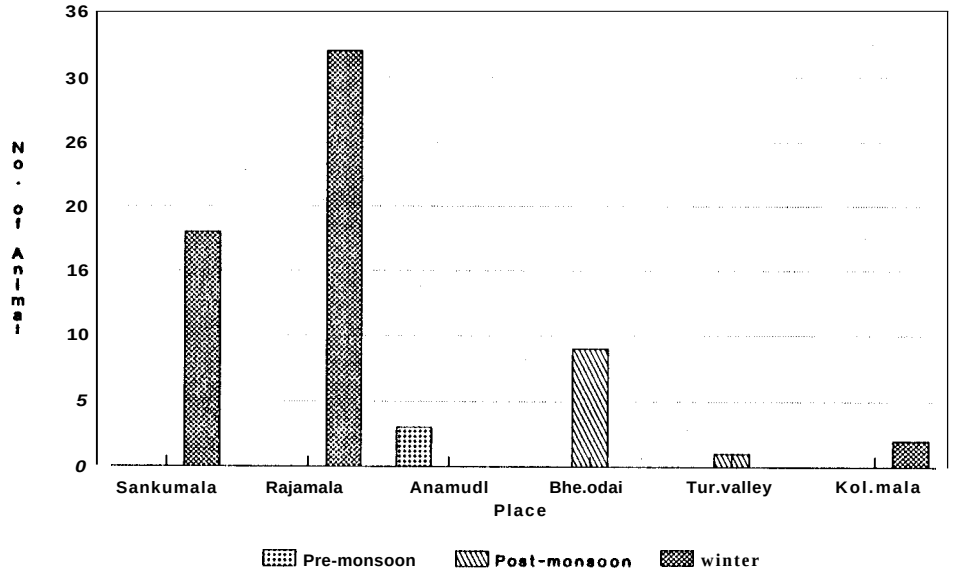

Fig. 12 Sambar recorded through point count method in different seasons of Eravikulam National Park

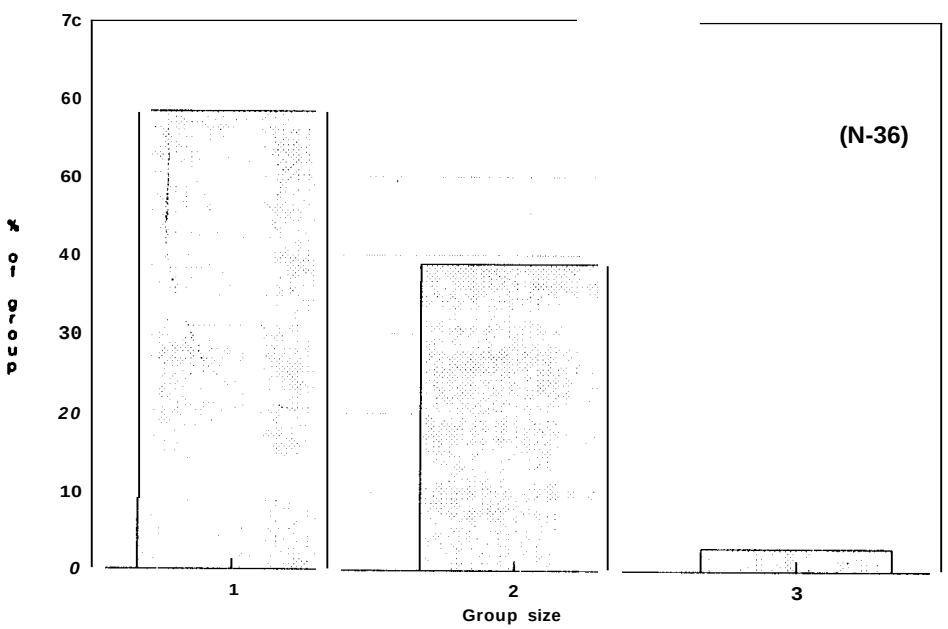

Fig. 13 Group composition of Sambar in Eravikulam National Park

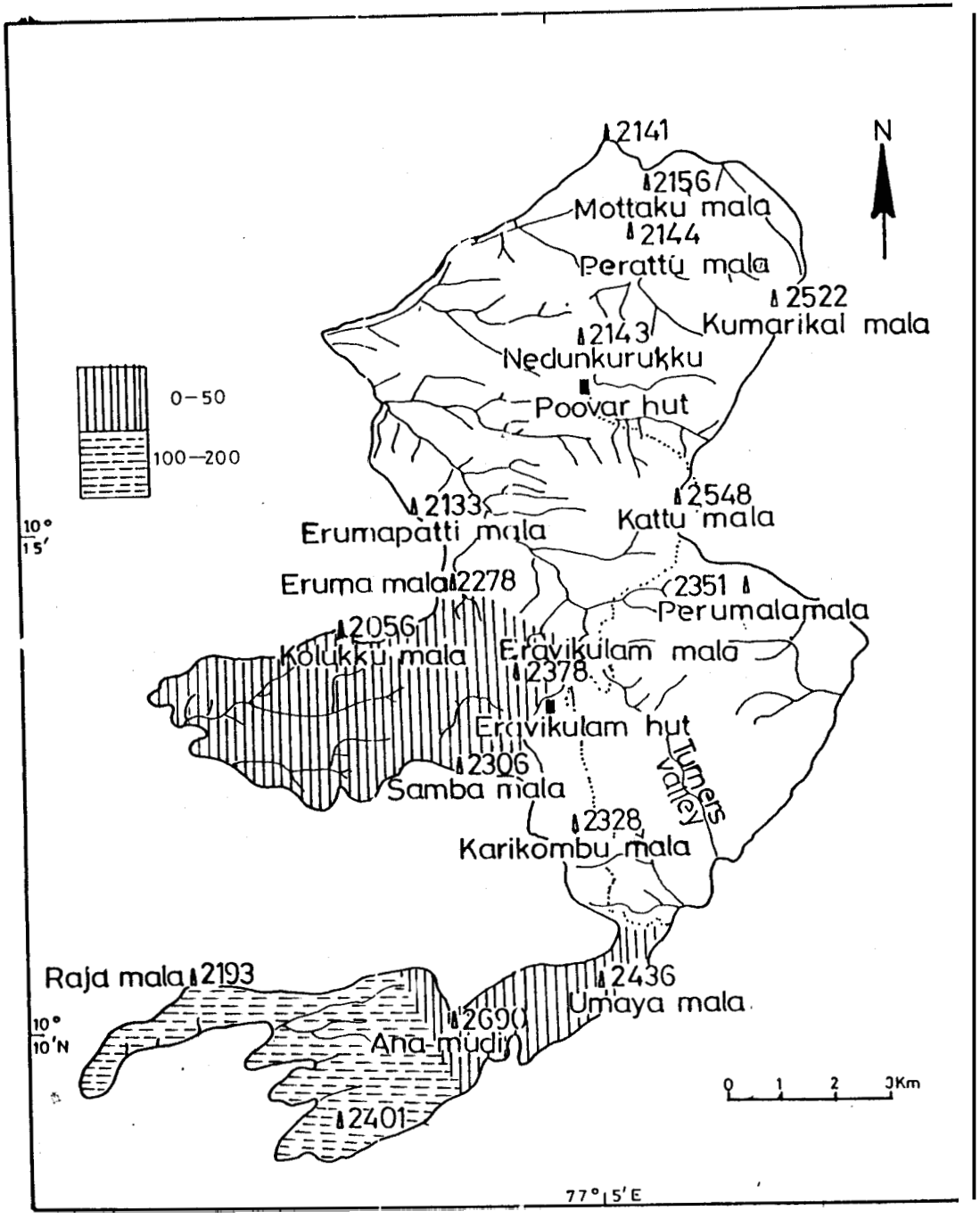

Fig. 14. Distribution of Nilgiri Tahr in Eravikulam National Park during pre-monsoon

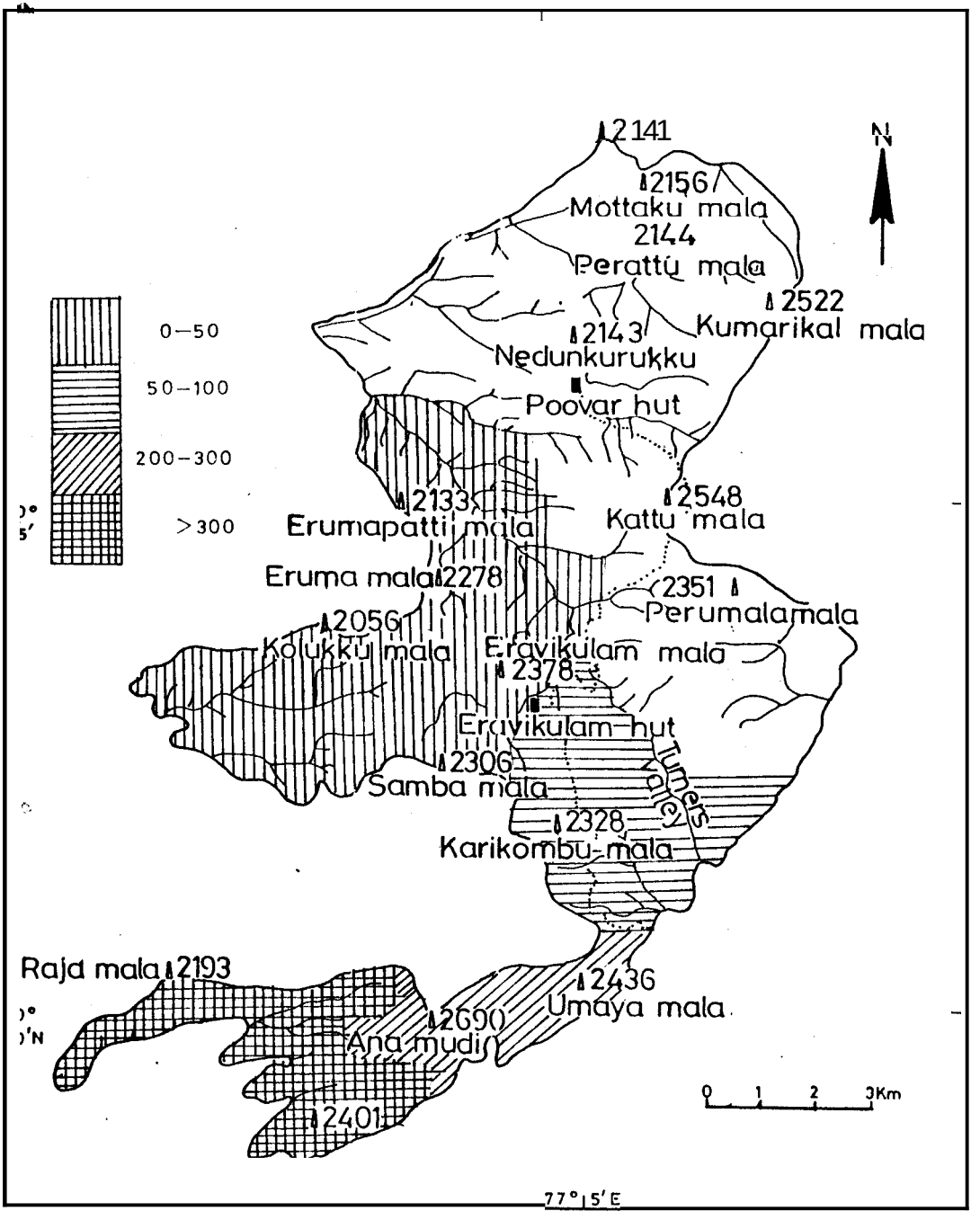

Fig. 15. Distribution of Nilgiri Tahr in Eravikulam National Park during monsoon

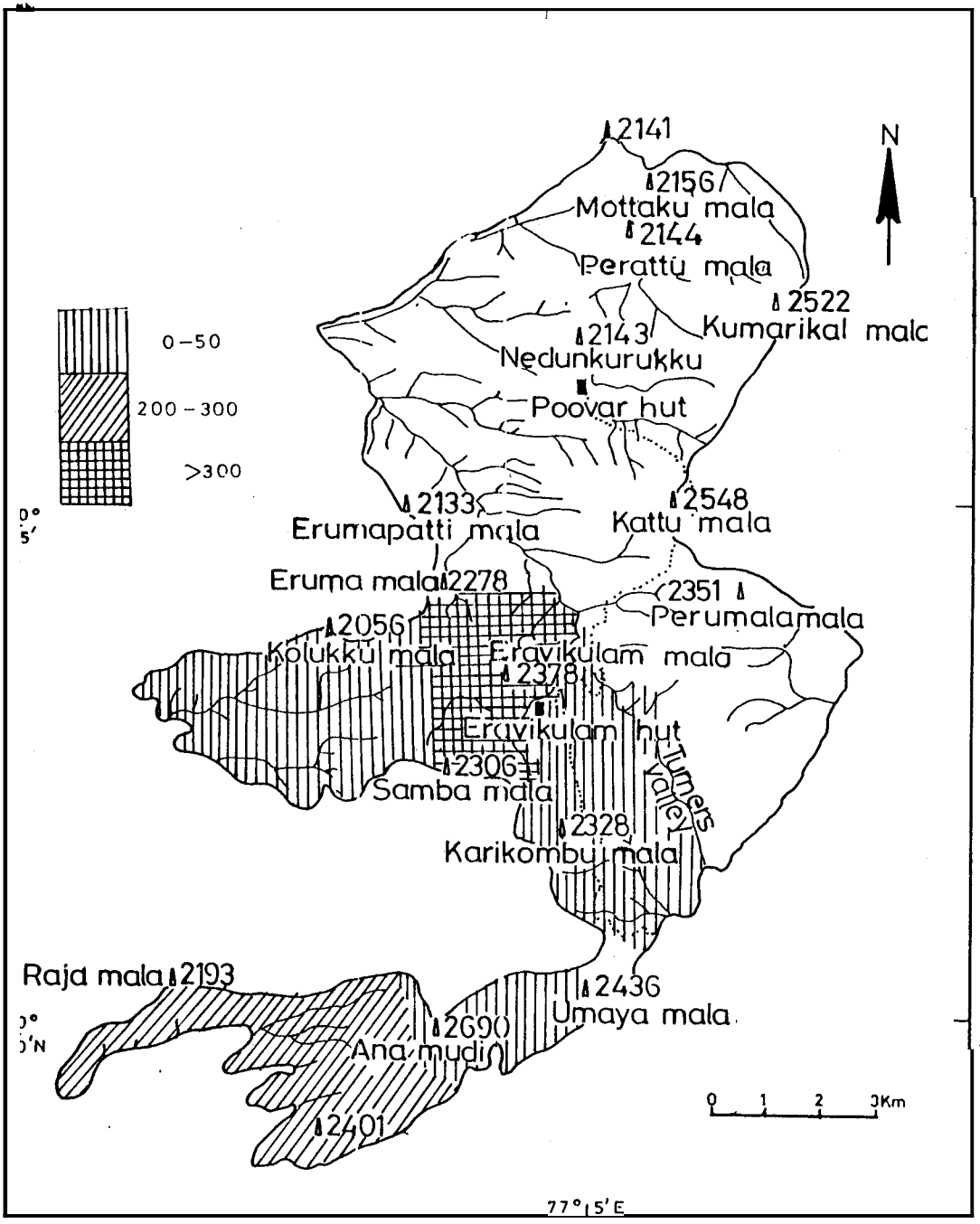

Fig. 16. Distribution of Nilgiri Tahr in Eravikulam National Park during post monsoon

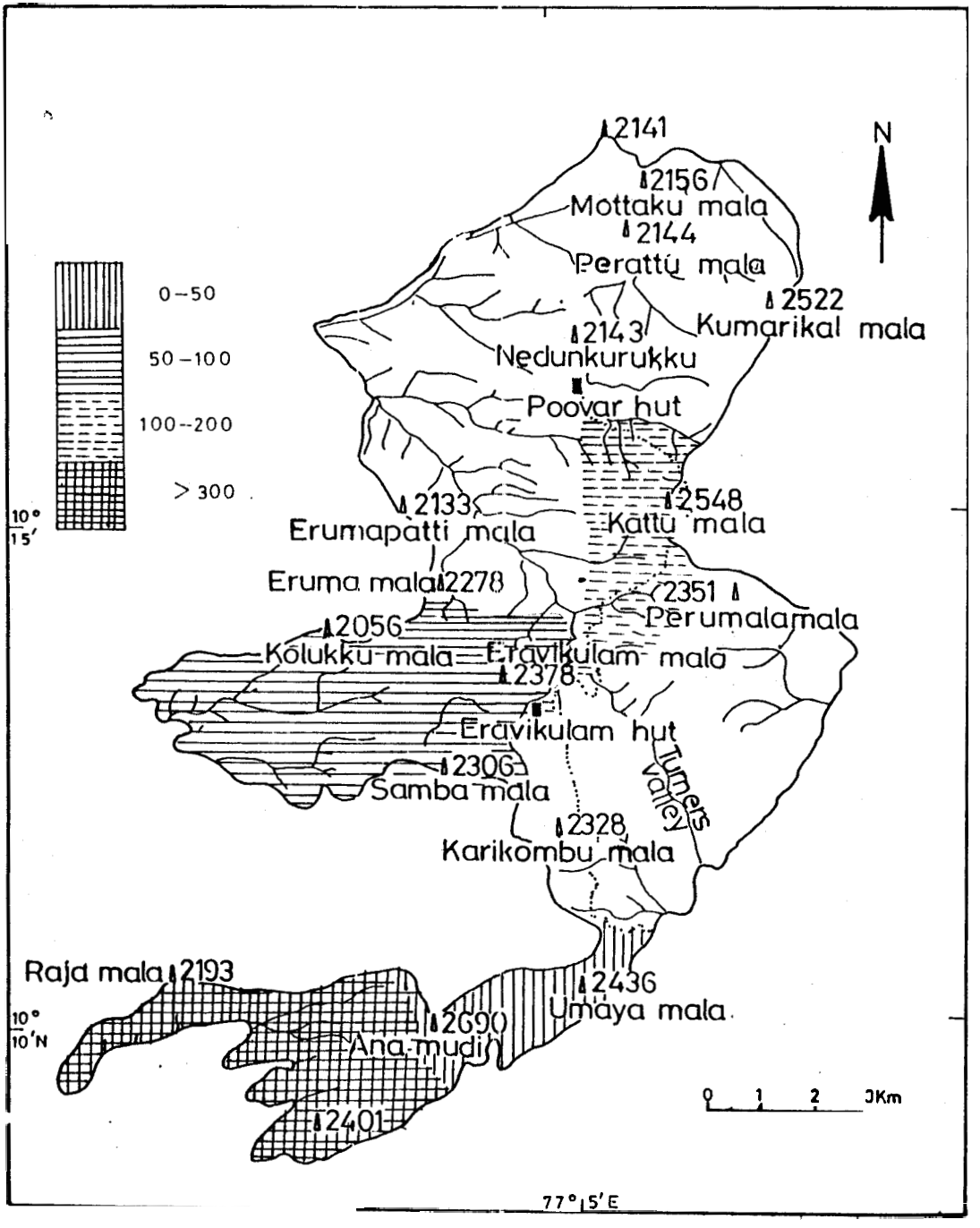

Fig. 17. Distribution of Nilgiri Tahr in Eravikulam National Park during winter

summarised in Figure 12. Sambar deer was observed in Sankumalai, Rajamalai and Kolukkumalai areas only in winter season, in Anamudi in pre-monsoon and Bheeman oda and Turner's Valley in post monsoon season (Fig.12).There was no observation of the animal during monsoon season.

4.2.3 Gaur, *Bos gaurus*

Gaur was sighted only twice during the post monsoon. These were near Erumamala. Indirect evidences also indicate that the species is comparatively few and probably only a seasonal visitor.

4.2.4 Other species

Other prey species include Nilgiri langur, Barking deer, Mouse deer, Wild boar and the rodents. All these were comparatively few in numbers in the Park.

4.3 HAIR STRUCTURE

The characteristic features of hair structure of thirty seven mammalian species are given in Table 2. The structure of hair at proximal, middle and distal are dealt separately as there were marked variation from proximal to distal.

The averages of cortical and medullary width from a number of samples are also included in Table 2. The hair structure of most of the animals did not show much variation in medullary pattern in different body parts. However, wherever variations have been observed. such changes are also included in Table 2. The most reliable and Consistent characters of hair were used for preparing a key for identification of the thirty seven mammalian species (Table 3).

The patterns of arrangements of the medullary cells of the following thirty seven mammalian species are presented in Figures 18-54.

1. Bonnet macaque *(Macaca radiata)*
2. Lion-tailed macaque *(Macaca silenus)*
3. Common langur *(Presbylis entellus)*
4. Nilgiri langur *(Presbytis johni)*
5. Loris *(Loris tadigradus malabaricus)*

6. Painted bat *(Kerivoula picta)*
7. Tiger *(Panthera tigris)*
8. Leopard *(Panthera pardus)*
9. Leopard cat *(Felis bengalensis)*
10. Rusly-spotted cat *(Felis rubiginosa)*
11. Jungle cat *(Felis chaus)*
12. Wild dog *(Cuon alpinus)*
13. Jackal *(Canis aureus)*
14. Palm civet *(Paradoxurus hermaphroditus)*
15. Small Indian civet *(Viverricula indica)*
16. Sambar deer *(Cervus unicolor)*
17. Spotted deer *(Axis axis)*
18. Barking deer *(Muntiacus muntjak)*
19. Mouse deer *(Tragulus meminna)*
20. Gaur *(Bos gaurus)*
21. Nilgiri tahr *(Hemitragus hylocrius)*
22. Wild boar *(Sus scrofa)*
23. Black-naped hare *(Lepus nigricollis)*
24. Stripe-necked mangoose *(Herpesles vitticollis)*
    Grey musk shrew *(Suncus murinus)*
26. Malabar giant squirrel *(Ratufa indica)*
27. Grizzled giant squirrel *(Ratufa macroura)*
28. Flying squirrel *(Petaurista petaurista)*
29. Palm squirrel *(Funambulus palmarum)*
30. Bandicoot rat *(Bandicota indica)*
31. Field mouse *(Mus booduga)*
32. Common house rat *(Rattus rattus)*
33. Spiny dormouse *(Platacanthomys lasiurus)*
34. Indian bush rat *(Golunda ellioti)*
35. White-tailed woodrat *(Rattus blanfordi)*
36. cow
37. Goat

4.4 SCAT ANALYSES

A season-wise distribution of scats collected along with the species is given in Table 4. A total of one hundred and fifty six scat samples were collected from different areas of the Park. Number of scat samples in monsoon was very few obviously due to the heavy rains washing down the scats, especially in the undulating terrains of Eravikulam National Park. More samples were obtained in winter followed by pre-monsoon seasons. Wild dog scats dominated in the total number of scats.

Animal	Length in cm		Width in μ									Colour (External appearance)	Cortex and Medulla pattern		
			Proximal			Middle			Distal						
	Ave	Range	C&M	M	C	C&M	M	C	C&M	M	C		Proximal	Middle	Distal
Bonnet macaque	2.75	2-3.22	6.63	3.43	2.21	8.25	6.00	2.25	3.49	1.88	1.62	Black with small yellow portion after the middle.	Cortex slightly serrated. No clear distinction into cortex and medulla due to black striation. Medulla beaded and interrupted.	Cortex slightly serrated. Medulla beaded, interrupted. On either sides of the beads black striation. In the yellow portion after the middle part, the medulla is very clear. Cortex is white.	Cortex slightly serrated. N distinction into cortex an medulla. Brown striation.
Lion tailed macaque	8.74	5 - 11	7.50	5.25	2.25	9.75	7.13	2.63	4.13	2.25	1.88	Full Black/Full White.	Cortex slightly serrated and narrow. Medulla starts away from the base. In black hair only black or brown striation. In white hair, the medulla is beaded and interrupted.	Cortex slightly serrated and clear in the white hair. Medulla beaded and interrupted in white hair. Medulla not clear in black hair. Only black striation.	Cortex serrated. Tip long an brown or yellow coloured.
Common langur	2.05	1.4 - 2.5	4.75	4.48	0.30	6.50	6.25	0.25	3.12	2.98	0.15	Black with small white portion after the middle part.	Cortex serrated and very narrow. Medullary cells narrow, disc shaped and, interrupted. On either sides of beads black striations.	Cortex serrated and narrow. Medullary cells narrow, beaded, disc shaped black striations. In the white region medulla is very clear and yellow coloured.	Cortex serrated and narrow. Ti long with full brown striation.
Nilgiri langur	4.09	1.4 - 6	3.55	0.25	3.3	3.65	0.38	3.35	2.49	0.35	2.14	Full white or Full Black or Grey (Head)	Cortex serrated. Blank base and brown colouration starts from the base. Medulla beaded, interrupted in grey hairs of head and tail. The rest with striations.	Cortex serrated. Cortex narrow in ventral and forelimb hair. Ful brown with beaded interrupted medulla in head and tail hair. I some full black. In black hairs the medulla is wide and simple.	
Loris	1.4	0.6 - 1.9	1.48	0.58	0.90	1.63	0.94	0.69	1.88	0.87	1.01	Full Black.	Cortex serrated. Medulla uniserial ladder in dorsal and ventral hair. Chain like narrow medulla in head and forelimb.	Cortex serrated. In some medulla full black. Beaded chain like structure in most.	Cortex serrated. Tip is very long brown or clear. In dorsal an ventral hair medulla uniseria ladder or beaded and brow coloured.
Painted bat	2.3	2 - 2.5	5.01	2.29	2.71	5.58	3.3	2.28	5.52	3.56	1.96	Alternate Cream & Brown (Cream portion is greater)	Cortex serrated and clear. Medulla wide lattice type. In some medulla is very dark and not clear.	Cortex serrated. Medulla wide lattice.	Brown or yellow tip. Narro lattice medulla, not clear.
Tiger	3.30	2 - 5.5	6.49	5.00	1.5	10.50	8.0	2.50	5.00	3.24	1.75	Full White/Full Yellow/Cream-Brown-Black.	Cortex serrated. Cortical width is greater than that of medulla. Cortex is clear and white. Medulla narrow simple.	Cortex serrated In white hair, the cortex is wide and very very narrow. Medulla in the white region is narrow simple. In black region medulla wide and simple.	Cortex serrated. Brown or clea tip.
Leopard	2.36	1.4 - 3.5	4.96	1.76	3.2	4.99	2.35	2.64	4.71	3.56	1.15	Pale Yellow White-Brown	Cortex serrated. Medulla closely arranged spindle cells, interrupted. In ear hair, medulla simple. In dorsal, ventral and tail-medulla closely packed and spindle shaped.	Cortex serrated clear or yellow. Medulla simple with serrated margin and possess globular white patches at regular intervals. Dull white patches in ear.	Disc shaped structure. Brow or clear tip.

Animal	Length in cm		Width in μ									Colour (External appearance)	Cortex and Medulla pattern		
			Proximal			Middle			Distal						
	Ave	Range	C&M	M	C	C&M	M	C	C&M	M	C		Proximal	Middle	Distal
Leopard cat	1.83	0.9-2.5	3.83	1.9	1.93	5.54	3.88	1.74	5.15	3.51	1.64	Full Yellow Yellow-dark Brown, Brown-Cream-Black.	Cortex highly serrated and clear. Medulla lattice type.	Cortex serrated and possess brown dots or colour. Medulla lattice type. Width increases before the tip.	Cortex serrated. Medulla uniserial ladder. Yellow, brown black colour.
Rusty spotted cat	1.15	0.3-2.1	3.11	1.84	1.27	4.29	2.35	1.94	3.51	2.41	1.1	Alternate Brown & Cream Brown-White. White region behind the Brown tip.	Cortex serrated with brown dots or colour. Medulla connected beaded for a short distance and then narrow lattice. In some connected beaded for a long distance.	Cortex serrated and clear in the cream region. In forelimb hair wide medulla. Medulla often narrow lattice and in some wide lattice. In ear brown colour throughout the hair with narrow medulla.	Cortex serrated. Medulla uniserial ladder. Brown on clear tip.
Jungle cat	2.09	0.9-3.2	3.84	2.25	1.59	3.43	2.03	1.4	3.89	2.36	1.53	Full White White-Brown-Yellow-Brown Alternate Cream & Brown.	Cortex highly serrated. Medulla uniserial ladder for a short distance and then closely arranged slender structure.	Cortex serrated in the cream region. Alternate black and cream colour. In some hair medullary structure is same as the base. Globular chite patches in some hair.	Full brown and black with uniserial ladder. In some, no distinction between cortex and medulla.
Wild dog	2.9	2.3-3.9	5.98	3.37	2.61	6.76	5.1	1.66	5.17	3.81	1.36	White with Brown tip. White-alternate White-Brown.	Cortex highly serrated. Closely arranged spindle shaped cells.	Cortex highly serrated. Closely arranged spindle shaped cells with white patches. Globular white patches in some hair.	Black or brown tip. Uniserial ladder.
Jackal	2.63	0.7-5.5	5.50	2.4	3.1	8.09	4.36	2.73	5.74	2.62	3.12	Full White White-Yellow Alternate Cream & Brown.	Cortex serrated. In brown region the cortex is very narrow. Medulla uniserial ladder for a short distance and then simple with wavy margin. In tail hair uniserial or simple structure throughout.	Cortex serrated and yellow. Medulla simple.	Cortex serrated. Medulla uniserial ladder. Brown colouration.
Palm civet	2.68	0.8-4.3	3.5	1.08	2.42	5.51	2.31	3.19	4.45	1.63	2.82	Full Brown or Full Black Alternative Brown & White.	Cortex serrated and brown or clear. Medulla uniserial ladder.	Cortex serrated. Cortical width is greater than that of medulla. Medulla uniserial ladder.	Cortex serrated, brown or yellow, medulla uniserial ladder.
Small Indian civet	1.9	0.6-2.7	3.65	1.93	1.72	5.14	3.19	1.95	4.54	2.27	2.27	Full Brown or Full White or Yellow-Brown.	Cortex serrated and clear. At first interrupted black dots and the uniserial ladder. Closely arranged vertically elongated medullary cells.	Cortex serrated. Medulla uniserial ladder.	Cortex serrated. Closely arranged uniserial medulla. Brown or clear interrupted tip (Tail).
Sambar	3.3	1-6.9	14.94	11.2	3.7	14.99	12.07	2.92	7.16	5.84	1.32	Full Brown Full White or White-Light Brown-Black or Yellow-Dark-Brown.	Cortex serrated, clear or Yellow. Medulla starts in conical fashion, nearer to the base. Wide lattice. Medulla narrow lattice in some full brown hair.	Cortex serrated. Medulla wide lattice in thick hair while in full brown hairs medulla narrow lattice. Hair from inside of the thigh have comparatively narrow medulla.	Cortex serrated. Medulla connected uniserial, very narrow single line medulla. Extreme tip brown, yellow or clear. Tip does not narrow and abruptly ends in shoulder hair.

Animal	Length in cm		Width in μ									Colour (External appearance)	Cortex and Medulla pattern		
			Proximal			Middle			Distal						
	Ave	Range	C&M	M	C	C&M	M	C	C&M	M	C		Proximal	Middle	Distal
Spotted deer	2.02	1.3-4.3	7.62	5.37	2.25	9.34	7.19	2.15	5.69	3.97	1.72	Full White or White Brown or Light Brown	Cortex serrated. Medulla starts in conical fashion. slightly away from base.	Cortex serrated. clear or brown. Medulla wide or narrow lattice. Medulla is not clear in inner thigh hair.	Cortex slightly serrated. Medulla connected. beaded or narrow lattice. Brown or clear long tip.
Barking deer	1.56	0.5-3.5	11.37	8.41	2.96	11.72	9.51	2.21	6.19	4.64	1.54	Full Brown or Full White or White-Brown	Serration is not very clear. Medulla starting from the very base in the head hair. In tail and head hair medulla is narrow lattice. Rest wide lattice. (Polygonal cells of same size).	Cortex is slightly serrated. In head hair, the cortex is brown coloured and in rest it may be light brown or clear. Medulla narrow lattice in head while in rest wide lattice.	In head hair, very long tip with narrow lattice and uniserial ladder. Rest, narrow lattice and tip not long as in head. Brown striations and colouration.
Mouse deer	2.28	1-3.1	8.27	6.15	2.12	9.06	7.26	1.8	5.66	4.12	1.54	Full White or Full Brown or Yellow-Yellow-Brown	Cortex serrated and clear. Medulla wide lattice but a scale like arrangement.	Cortex serrated. yellow or brown coloured. Medulla wide lattice. not very clear due to black colour.	Cortex serrated. Medulla narrow lattice. In neck. medulla interrupted and narrow lattice. Extreme tip yellow or brown with striation.
Gaur	1.36	0.8-3	7.79	2.04	5.75	9.37	4.05	5.32	5.56	3.26	2.3	Full Black	A brown colouration starts from the base and it darkens towards the tip. Medulla simple.	Brown coloured cortex. Medulla simple. In dewlap hair medulla interrupted.	Black or dark brown blunt tip. Medulla simple.
Nilgiri tahr	2.92	1.3-5.1	6.13	3.03	3.1	7.56	5.31	2.25	6.77	5.76	1.01	Yellow-Brown Extreme tip Yellow/Black	Cortex serrated and yellow. Medulla starts at the base and closely arranged wide or narrow lattice.	Cortex serrated and brown. Medulla closely arranged wide or narrow lattice.	Cortex striated. Medulla closely arranged narrow lattice structure. Brown striation.
Wild boar	2.4	2.2-2.9	19.03	6.05	12.98	15.37	5.64	9.53	9.00	3.66	5.34	White-Black Yellow-Brown	Cortex serrated and clear. Medulla starts from near the base and simple with wavy edges.	Cortex serrated and clear. Simple medulla.	Tip round or split. In some brown coloured.
Black naped hare	1.44	0.7-2.8	3.83	1.9	1.93	5.54	3.88	1.74	5.15	3.51	1.64	Full White or Black-Yellow-Black or Light Black-Clear or White, extreme tip Black.	Cortex serrated. Medulla biserial or uniserial ladder for a long distance in some. In tail hair, medulla uniserial or multiserial.	Cortex serrated. Medulla multiserial ladder.	Cortex serrated. Uniserial ladder at the extreme. Tip clear or brown.
Stripe necked mangoose	1.4	0.8-4	5.01	2.79	2.22	10.17	6.99	3.18	6.81	3.93	2.88	Full White Alternate Brown & Cream	Cortex slightly serrated and clear. Medulla starts away from the base as uniserial ladder. Then narrow lattice.	Cortex slightly serrated. Medulla lattice with alternate cream and brown cortex.	Cortex serrated. Medulla uniserial ladder. Tip brown or black and broom like.
Grey musk shrew	0.64	0.2-1.3	2.36	0.68	1.68	3.66	1.99	1.67	2.73	1.69	1.04	Full Black or Full Grey	Cortex is serrated in some hairs. Medulla uniserial ladder. In tail hair, medulla is very narrow and discontinuous.	Cortex clear or with brown colour. Medulla narrow aeriform lattice or uniserial ladder.	Cortex slightly serrated. Uniserial ladder and interrupted medulla in some. Tip very long but in some short.

	cm		Proximal			Middle			Distal			appearance)			
	Ave	Range	C&M	M	C	C&M	M	C	C&M	M	C		Proximal	Middle	Distal
Malabar giant squirrel	3.5	2.1-5.2	3.57	1.48	2.09	4.27	2.79	1.48	3.69	2.27	1.42	Black or Grey	Cortex serrated. Medulla uniserial ladder, appears as full black in some.	Cortex serrated. Medulla lattice type, appears full black in some. Uniserial ladder shaped in ventral.	Cortex serrated. In ventral hair clear cortex. Medulla uniserial ladder in some and rest full black.
Grizzled giant squirrel	2.916	1.8-4.7	8.66	5.47	3.19	9.58	6.08	3.5	5.74	3.11	2.63	Yellow-Brown Yellow-Brown-Yellow.	Cortex serrated, clear or yellow coloured. Medulla uniserial ladder in the beginning and then wide lattice.	Cortex serrated, yellow coloured. Medulla wide lattice.	Cortex serrated, medulla uniserial ladder. Brown, yellow or clear tip.
Flying squirrel	1.66	0.6-2.7	1.94	0.96	0.98	2.54	1.64	0.9	1.82	1.125	0.69	Black & Grey	Cortex yellow and highly serrated. Brown colouration in the base. Medulla uniserial ladder.	Cortex serrated with brown colouration. Uniserial ladder, in hindlimb hair wide aeriform lattice at the centre.	Uniserial ladder and brown colour.
Palm squirrel	1.01	0.4-2.6	2.53	1.39	1.14	3.84	3.2	0.64	2.29	1.36	0.93	Full White Full Grey Brown-Yellow-Brown	Cortex serrated with brown colour in the cortical region. Medulla uniserial ladder.	Cortex serrated with brown colour. First narrow aeriform lattice, then wide aeriform lattice.	Cortex serrated. Uniserial ladder. Black and long tip with brown striation.
Bandicoot	1.84	0.4-3.5	7.67	3.57	4.1	13.08	8.6	3.68	6.87	3.86	3.01	Full White or Full Brown White-Black	Cortex serrated. Brown colouration in some. Medulla starts as uniserial ladder.	Cortex serrated. Brown colouration in some. Wide aeriform lattice. In forelimb narrow aeriform lattice.	Cortex serrated. Medulla uniserial ladder. Tip clear or brown.
Field mouse	2.27	0.9-1.6	1.86	1.08	0.78	4.14	3.75	0.39	3.94	3.3	0.64	White-Black White (Ventral hair)	Cortex serrated. First uniserial ladder and then narrow aeriform lattice.	Wide aeriform lattice.	Uniserial ladder. Black towards the tip and extreme tip clear.
House rat	1.48	0.4-1.4	2.15	1.32	0.83	4.83	3.45	1.38	3.02	2.29	0.73	Light Brown or Light Brown-Black	Cortex highly serrated. Medulla first uniserial ladder and then aeriform lattice and medulla is not clear in moustache hair.	Cortex serrated and possess brown dots. Medulla wide aeriform lattice (Black colouration). In hind limb hair medulla uniserial ladder.	Black towards the tip. Uniserial ladder. Extreme tip brown.
Spiny dormouse	0.88	0.7-1.2	10.01	9.88	0.13	14.72	14.39	0.33	9.8	9.76	0.04	Full White or White-Black	Cortex not very distinct. Short and narrow base. Medulla starts in conical fashion. Ladder type (Connected beads on either side with interconnecting threads)	Cortex not distinct and has brown dots. Medulla ladder type (sides of the medulla black).	Cortex not distinct. Full black. uniserial ladder.
Indian bush rat	0.95	0.3-1.5	3.37	2.16	1.21	6.98	6.08	0.9	4.36	3.46	0.9	Full Yellow or Full White or White-Black	Cortex is not very distinct. Slender base. Uniserial ladder and then narrow aeriform lattice.	Cortex clear or with brown colour. Medulla wide aeriform lattice.	Cortex not distinct. Uniserial ladder. Extreme tip brown but clear in ventral hair.
White tailed wood rat	1.2	0.8-1.6	1.33	1.01	0.32	3.14	3.05	0.09	3.47	2.28	1.19	Ash Pale-Brown or Black	Cortex not very distinct. very long and slender base. Uniserial ladder at first then narrow aeriform lattice.	Cortex not very distinct. Medulla wide aeriform lattice.	Medulla uniserial ladder. Extreme tip brown but clear in ventral.

Table 2 Contd.

Animal	Length in cm		Width in μ									Colour (External appearance)	Cortex and Medulla pattern		
			Proximal			Middle			Distal						
	Ave	Range	C&M	M	C	C&M	M	C	C&M	M	C		Proximal	Middle	Distal
Cow	0.9	0.5-1.6	6.75	4.05	1.62	7.05	3.00	4.05	4.50	1.50	3.00	Full White	Cortex are clear. Medullary width is less than cortical width. Medulla simple.	Cortex serrated with clear scales. Medulla simple.	Cortex serrated. Medulla simple and interrupted. Tip clear.
Goat	4.2	3.2-5.3	8.79	5.40	4.30	11.49	7.20	3.79	7.50	4.39	3.60	Yellowish Cream alternate with White Full Black.	Cortex serrated. Medulla lattice type. appears to be simple with serrated edges.	Cortex serrated. Medullary width is greater than cortex. In black medulla appears as black and cortex not very distinct.	Cortex serrated. Medulla appears as simple. Tip clear or brown.

Table 3. Key for Identification of mammalian hair samples

1.	Hair spine like, not flexible	- Spiny dormouse
	Hair not spine like, flexible	- 2
2.	Hair long, average length 8.74 cm (5-11)	- Lion-tailed macaque
	*Hair not so long, average length less than 5cm (0.2-5.5)	- 3
3.	Cortex scaly	- 4
	Cortex not so scaly	- 5
4.	Average length of the hair lessthan 1 cm	- Cow
	Average length of the hair greater than 2.5 cm	- Goat
5.	Tip of the hair rounded or split into lwo	- Wild boar
	Tip of the hair pointed	- 6
6.	Medulla lattice type	- 7
	Medulla simple,ladder or aeriform	- 16
7.	Medulla with narrow lattice	- 8
	Medulla with wide lattice	- 9
8.	Medulla starts away from the base	- Mangoose
	Medulla starts near to the base	- Rusty spotted cat
9.	With polygonal cells	- 10
	Without polygonal cells	- 13
10.	Long thick hair with maximum width of cortex arid medulla 14.94 µ	- Sambar deer
	Hair not so long and thick, Maximum widlh of corlex and medulla less than 12 µ	- 11
11.	Lattice scaly, cream cloured portion just behind the Up	- Mouse deer
	Lattice not scaly, no distinct colour pattern at the tip	- 12
12.	Average widlh of cortex and medulla 11.37 m	- Barking deer
	Average width of cortex arid medulla lesslhan 8 µ	- Spolled deer
13.	Cortex highly serrated in the proximal region	- 14
	Cortex feebly serrated	- Painted bal

Tab 3 contd.

14.	Medulla starts in a conical fashion	- Leopard cat
	Medulla starts beaded connected structure	- 15
15.	Cortex yellow brown	- Grizzled giant squirrel
	Cortex black or gray	- Malabar giant squirrel
16.	Medulla simple in the middle Medulla	- 17
	ladder or aeriform lattice in the middle	- 21
17.	Medulla simple wilh globular white patches at regular intervals	- Leopard
	Medulla simple without globular white patches	- 18
18.	Cortical width less than that of Medulla	- Nilgiri tahr
	Cortical width greater than that of medulla	- 19
19.	Medulla uniserial ladder in the proximal region	-Jackal
	Medulla simple in the proximal region	- 20
20.	Hair black throughout and the blackness increases towards the tip	- Gaur
	Hair yellow white or with alternate cream and black	- Tiger
21.	Medulla ladder shaped	- 22
	Medulla aeriform	- 29
22.	Medulla multiserial ladder	- Black naped hare
	Medulla uniserial ladder	- 23
23.	Medulla beaded in the middle portion	- 24
	Medulla spindle shaped cells	- 27
24.	Medulla beaded chain like hair very narrow	- Slender loris
	Medulla not chain like hair not narrow	- 25
25.	A yellow portion before the tip of the hair	- Bonnet macaque
	No yellow portion before the tip of the hair	- 26
26.	A white portion before the tip of the hair	- Common langur
	Hair throughout black or white	- Nilgiri langur

Tab 3 conld.

27.	Cortex feebly serrated	- Civets
	Cortex highly serrated	- 28
28.	White patches between the spindle cells; maximum width more than 6	- Wild dog
	No white patches between the spindle cells; and maximum width less than 4	- Jungle cat
29.	Medulla with alternate narrow and wide aeriform lattice in the middle	- Palm squirrel
	Medulla either wide or narrow in the middle, no allernalion	- 30
30.	Medulla narrow aeriform lattice alternate with disc shaped cells	- Flying squirrel
	Medulla without alternating disc shaped cells in the middle	- 31
31.	Medulla narrow aeriform lattice	- Grey musk shrew
	Medulla wide aeriform lattice	- 32
32.	Cortex not distinct	- 33
	Corlex distinct	- 34
33.	Maximum cortical width greater than 6μ	- Indian bush ral
	Maximum cortical width less than 4 μ	- White-tailed woodrat
34.	Medulla starts away from the base	- Field rat
	Medulla starts near to the base	- 35
35.	Maximum width of the cortex and medulla greater than 12 μ	- Bandicoot
	Maximum width of cortex and medulla less than 5 μ	- House rat

* Maximum length exceeding 5 is observed rarely In tiger, Malabar giant squirrel and jackal.

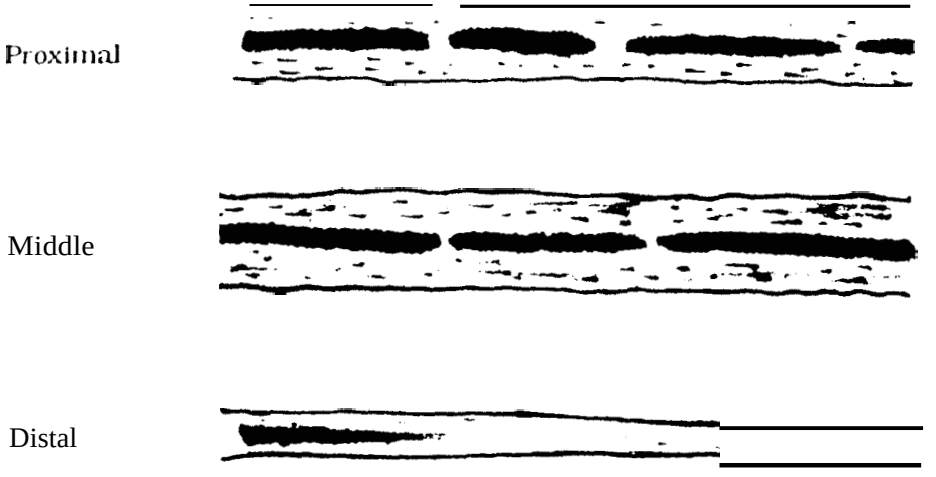

Fig.18 Schematic diagram of hair structure of Bonnet Macaque ***Macaca radiata***

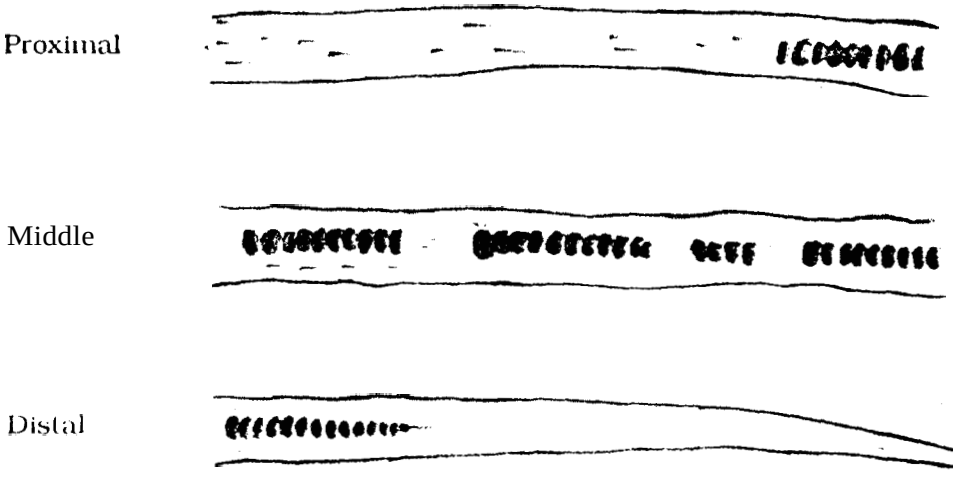

Fig.19 Schematic diagram of hair structure of Lion-tailed Macaque ***Macaca silenus***

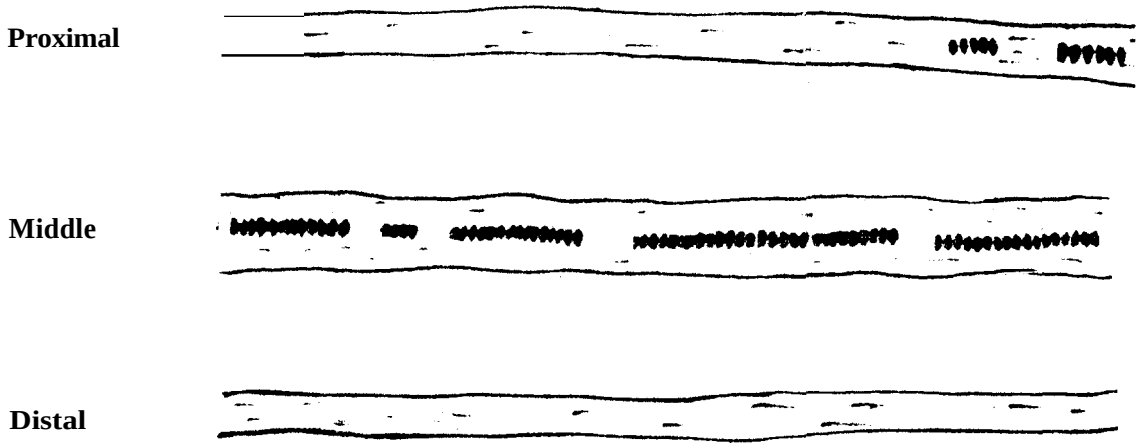

Fig.20 Schematic diagram of hair structure of Nilgiri Langur *Presbytes johni*

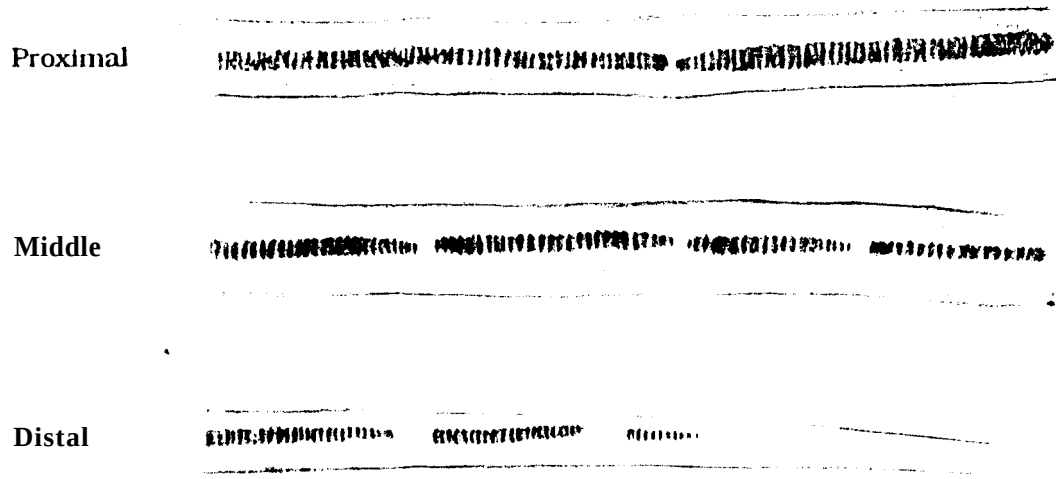

Fig.21 Schematic diagram of hair structure of Common Langur *Presbytes*

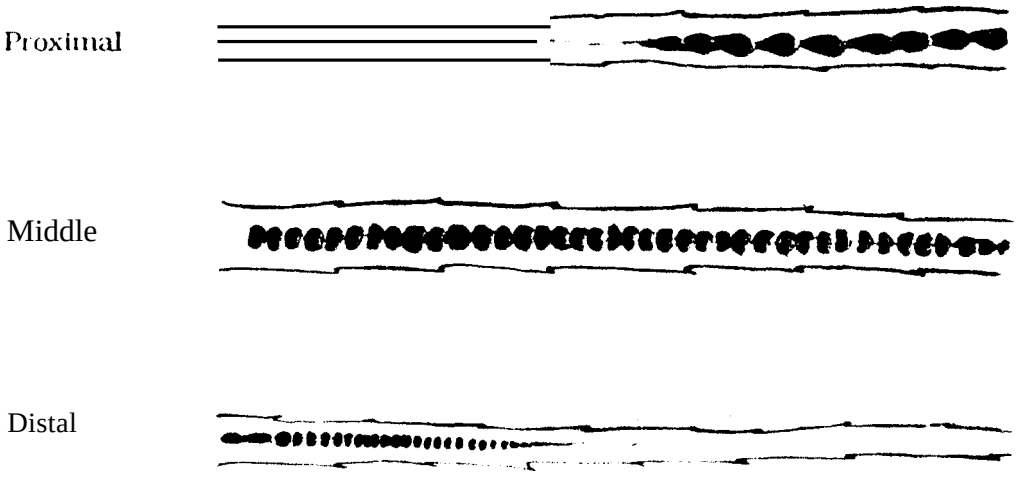

Fig.22 Schematic diagram of hair structure of Loris
Loris tadigradus malabaricus

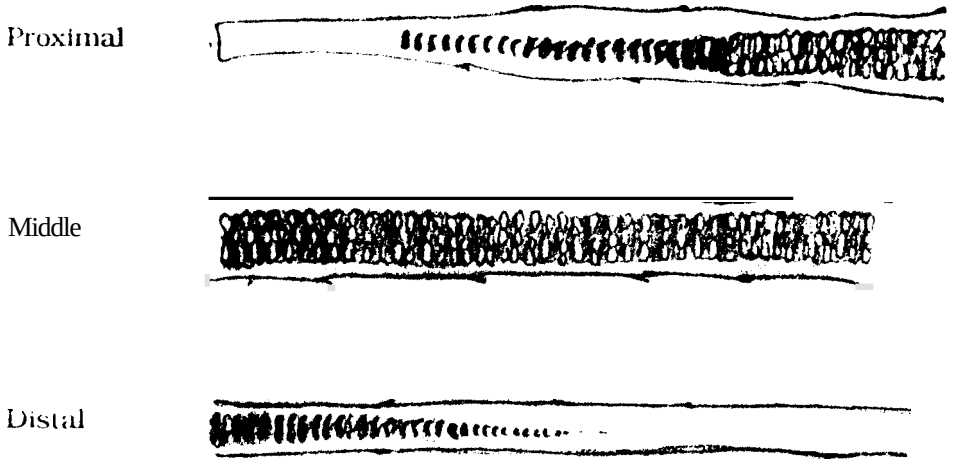

Fig.23 Schematic diagram of hair structure of Painted bat *Kerivoula picta*

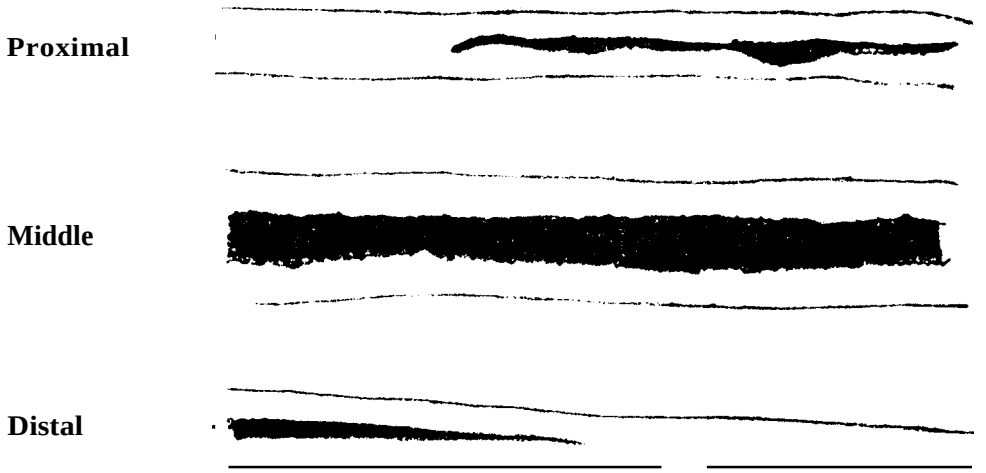

Fig.24 Schematic diagram of hair structure of Tiger *Panthera tigris*

Fig.25 Schematic diagram of hair structure of Leopard *Panthera pardus*

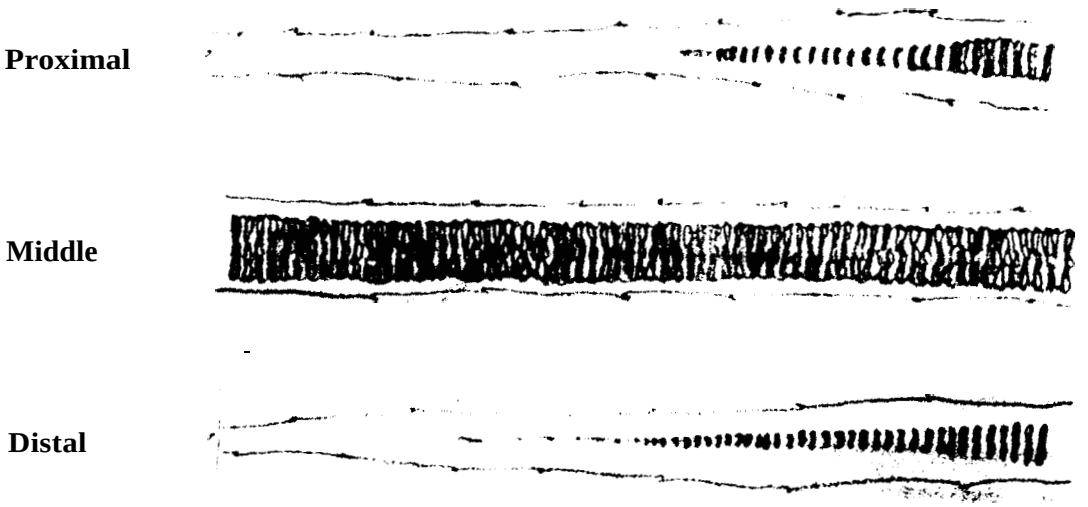

Fig.26 Schematic diagram of hair structure of Leopard Cat *Felis bengalensis*

Fig.27 Schematic diagram of hair structure of Rusty-spotted Cat *Felis rubiginosa*

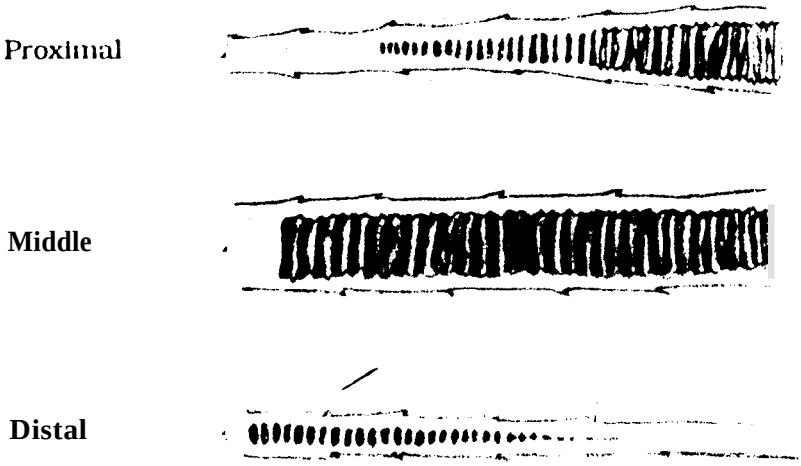

Fig.28 Schematic diagram of hair structure of Jungle Cat *Felis chaus*

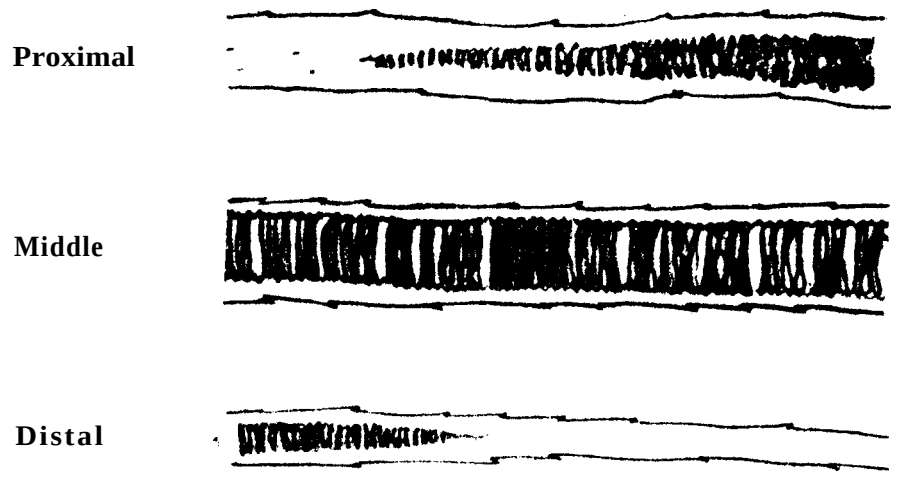

Fig.29 Schematic diagram of hair structure of Wild Dog *Cuon alpinus*

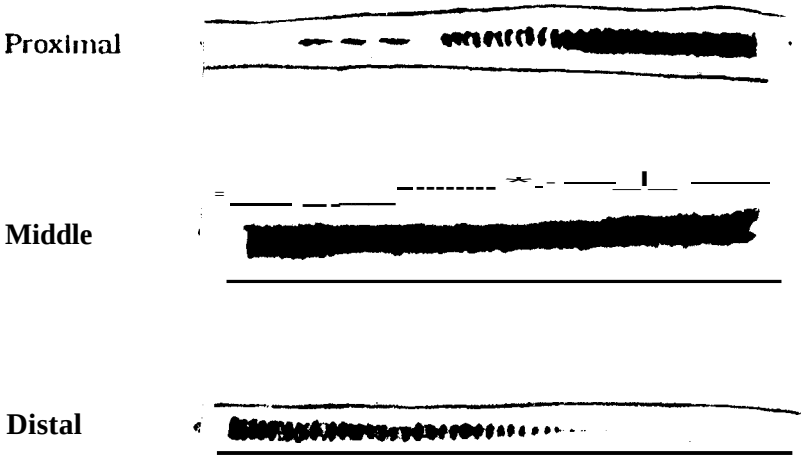

Fig.30 Schematic diagram of hair structure of Jackal *Canis aureus*

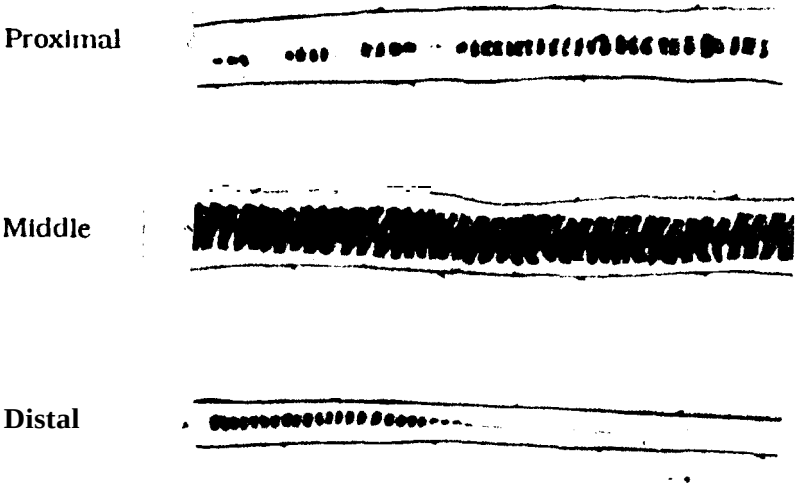

Fig.31 Schematic diagram of hair of Palm Civet *Paradoxurus hermaphroditus*

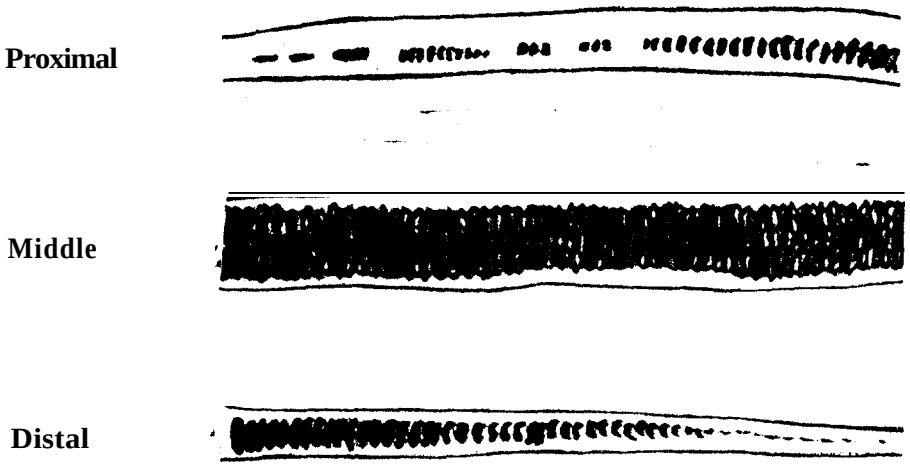

Fig.32 Schematic diagram of hair structure of Small Indian Civet *Viverricula indica*

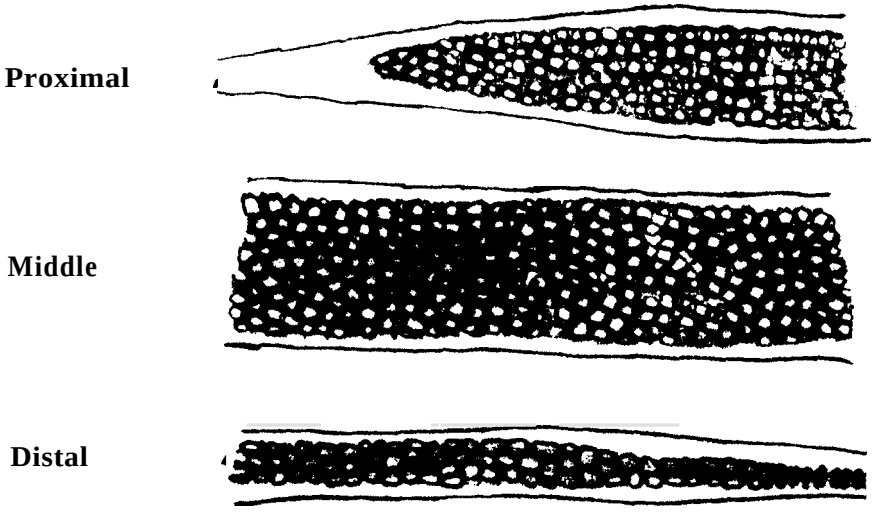

Fig.33 Schematic diagram of hair structure of Sambar deer *Cervus unicolor*

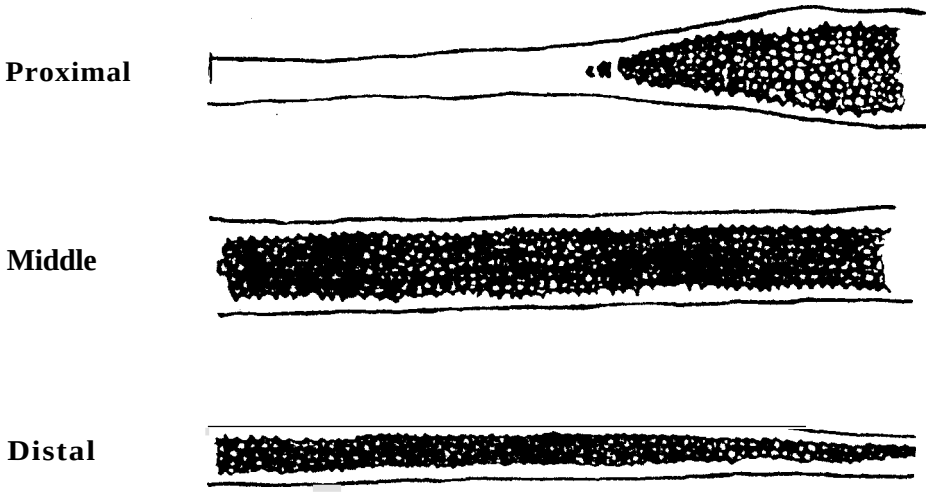

Fig.34 Schematic diagram of hair structure of Spotted deer *Axis axis*

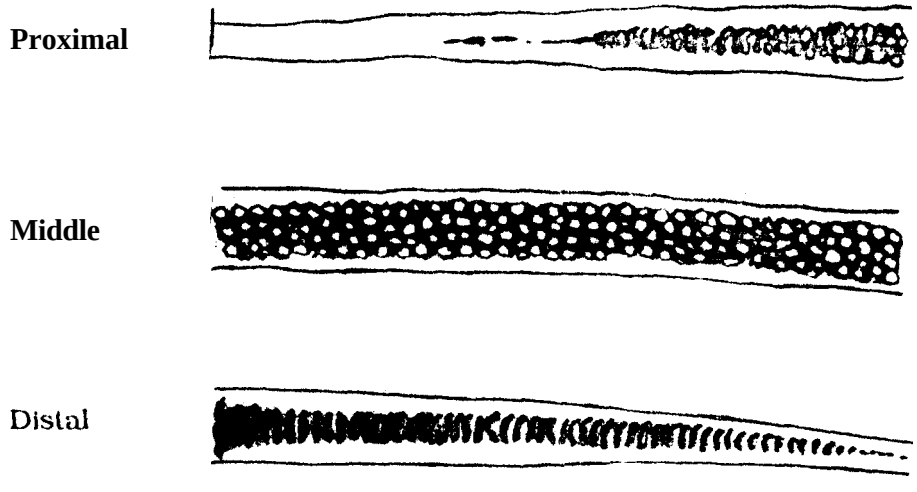

Fig.35 Schematic diagram of hair structure of Barking deer *Muntiacus muntjak*

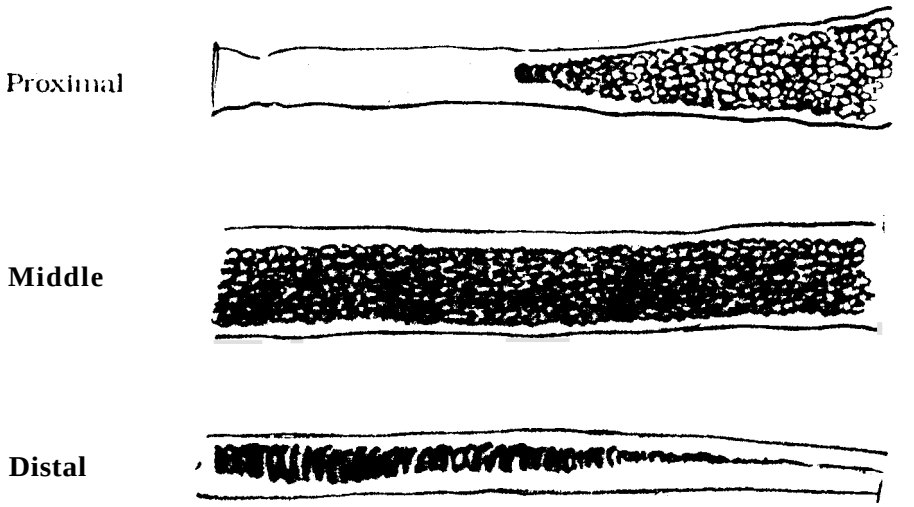

Fig.36 Schematic diagram of hair structure of Mouse deer *Tragulus meminna*

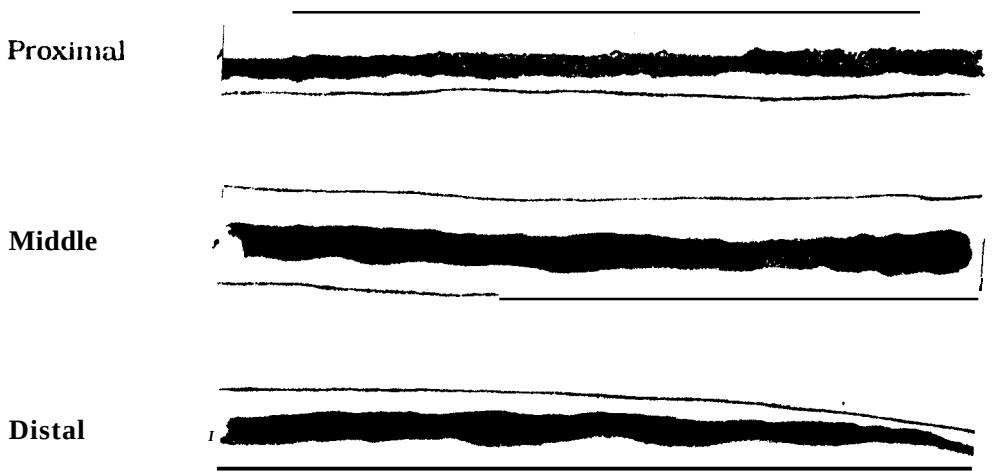

Fig.37 Schematic diagram of hair structure of Gaur *Bos gaurus*

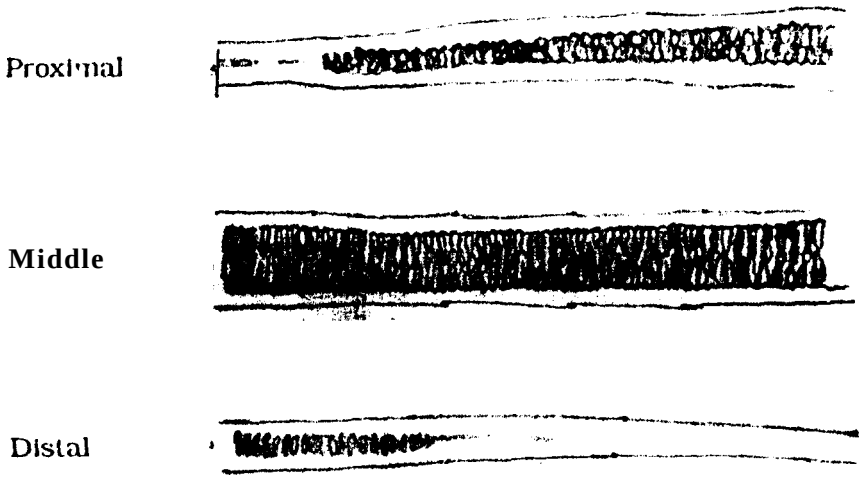

Fig.38 Schematic diagram of hair structure of Nilgiri Tahr *Hemitragus hylocrius*

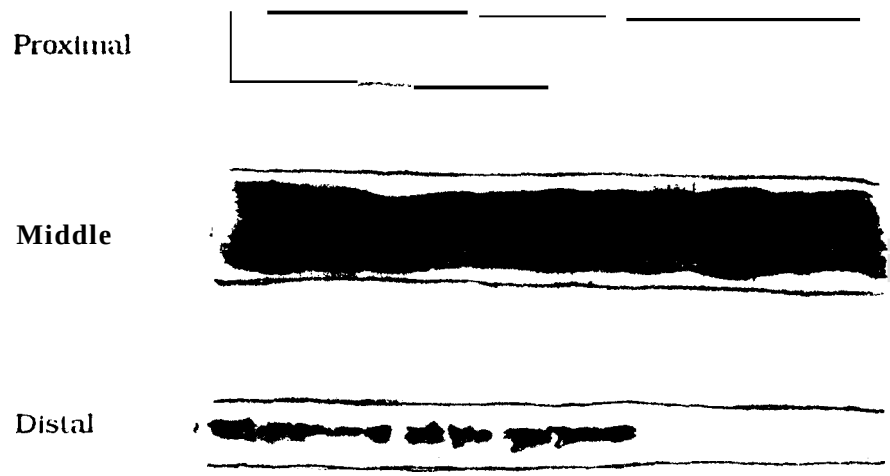

Fig.39 Schematic diagram of hair structure of Wild Boar *Sus scrofa*

Fig.40 Schematic diagram of hair structure of Black-naped hare *Lepus nigricollis*

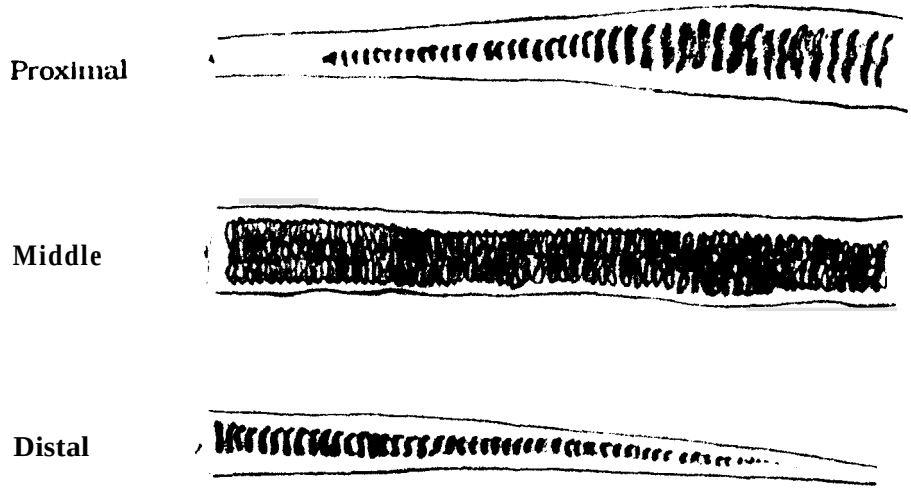

Fig.41 Schematic diagram of hair structure of Stripe-necked Mangoose *Herpestes vitticollis*

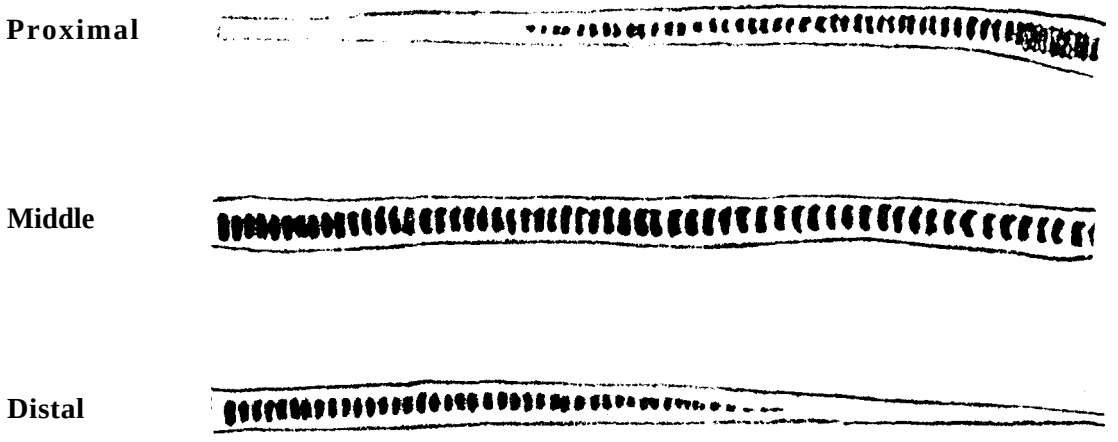

Fig.42 Schematic diagram of hair structure of Grey musk Shrew *Suncus murinus*

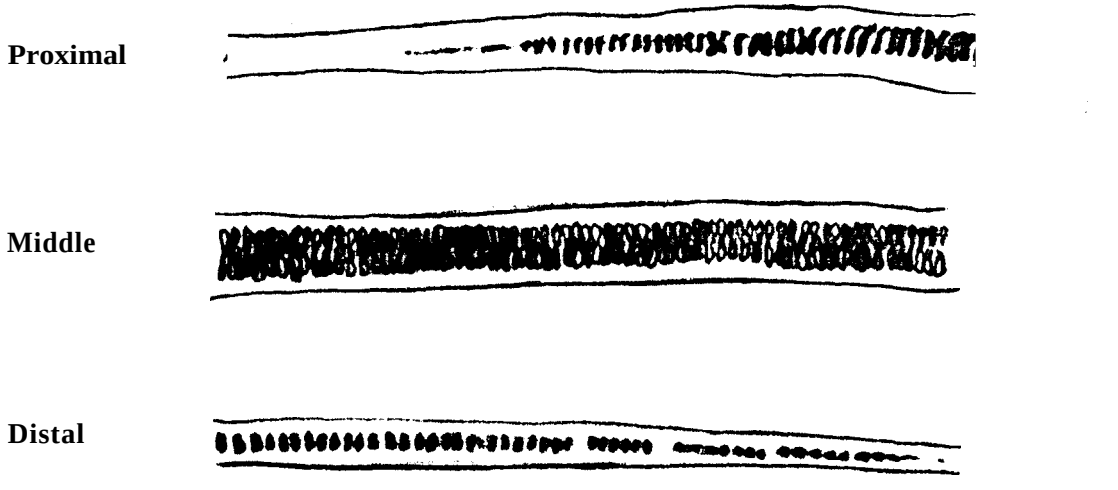

Fig.43 Schematic diagram of hair structure of Malabar Giant Squirrel *Ratufa indica*

Fig.44 Schematic diagram of hair structure of Grizzled Giant Squirrel *Ratufa macroura*

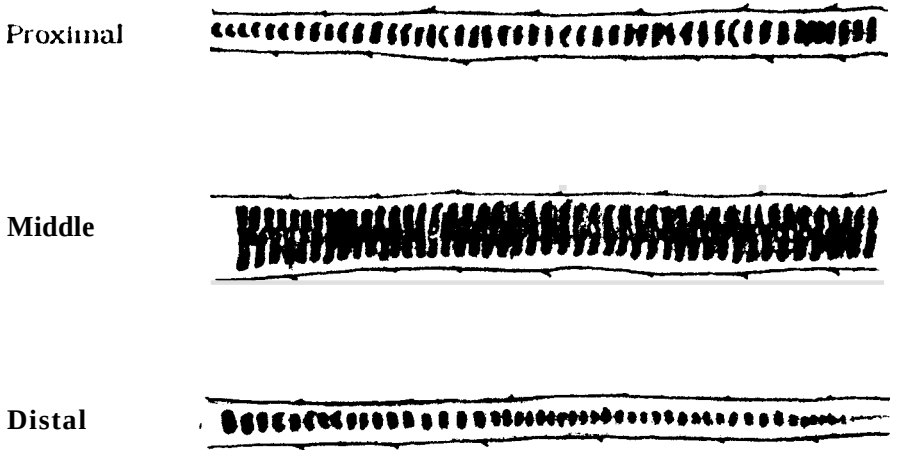

Fig.45 Schematic diagram of hair structure of Flying Squirrel *Petaurista petaurista*

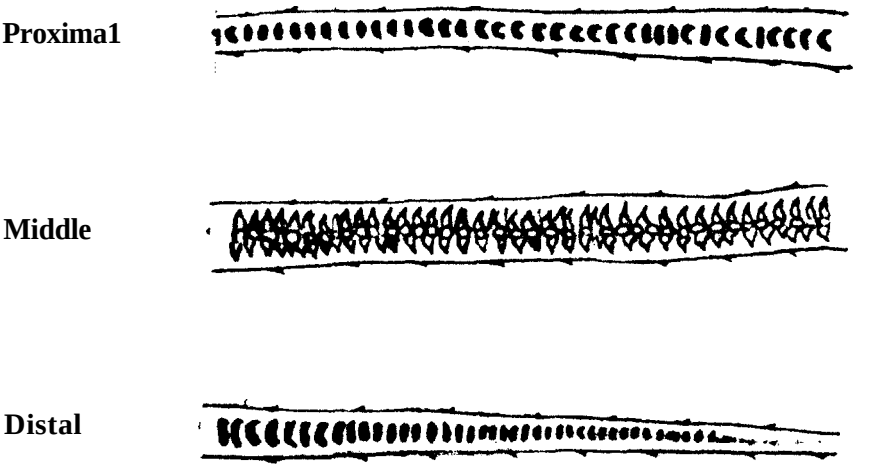

Fig.46 Schematic diagram of hair structure of Palm Squirrel, *Funambulus palmarum*

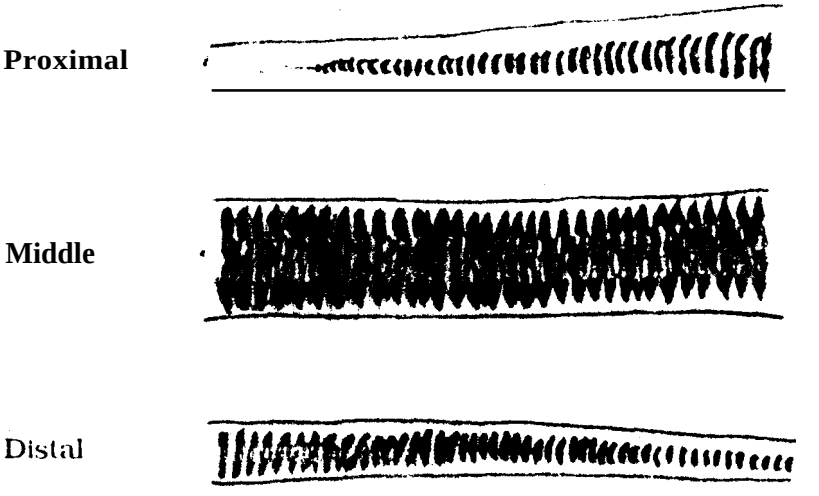

Fig.47 Schematic diagram of hair structure of Bandicoot Rat, *Bandicota indica*

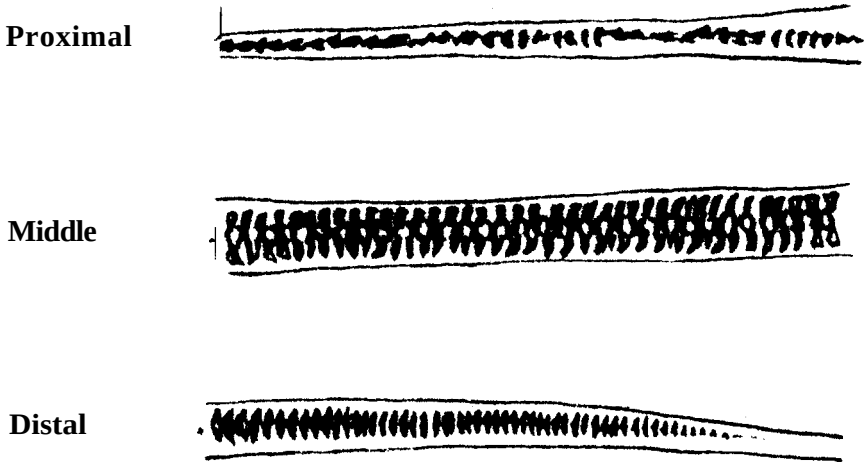

Fig.48 Schematic diagram of hair structure of Field Mouse, *Mus booduga*

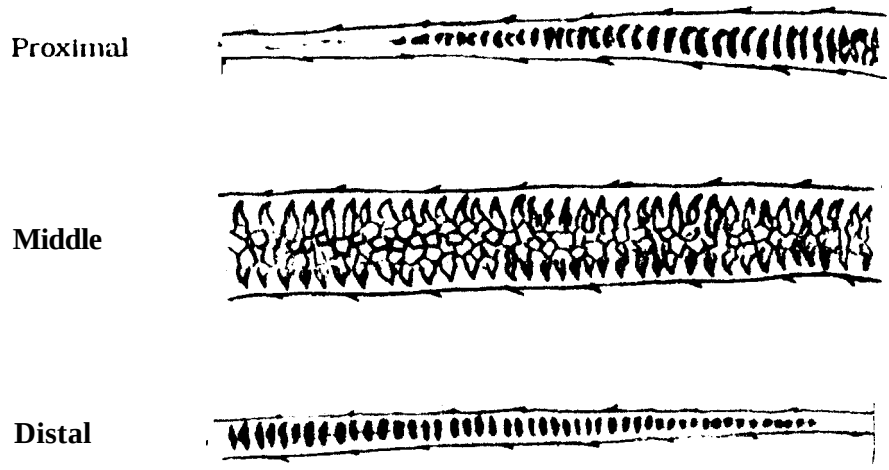

Fig.49 Schematic diagram of hair structure of Common House Rat, *Rattus rattus*

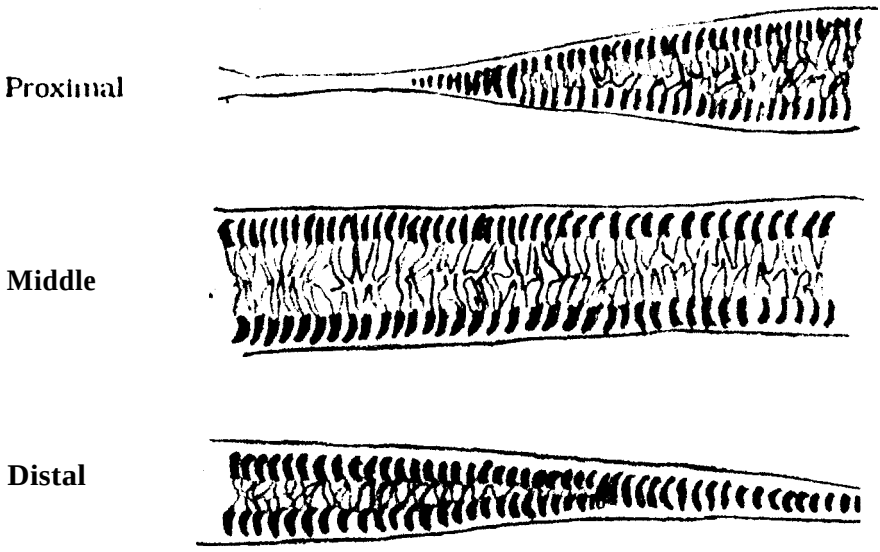

Fig.50 Schematic diagram of hair structure of Spiny Dormouse, *Platacanthomys lasiurus*

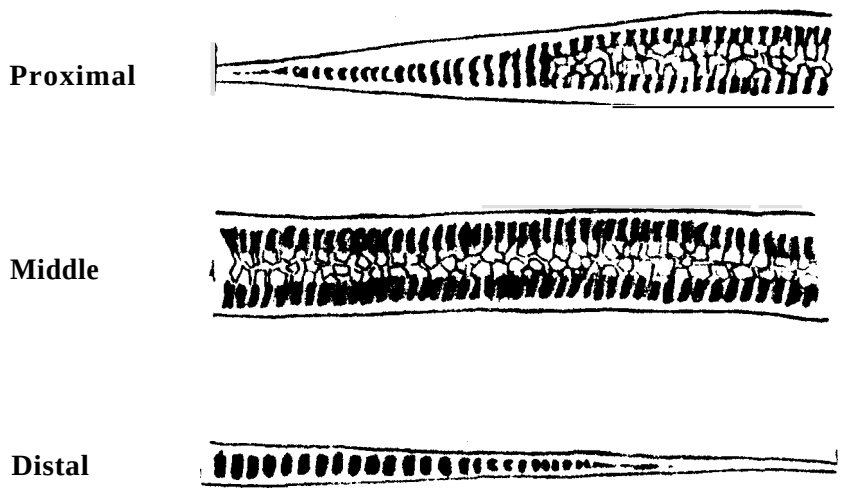

Fig.51 Schematic diagram of hair structure of Indian Bush Rat, *Golunda ellioti*

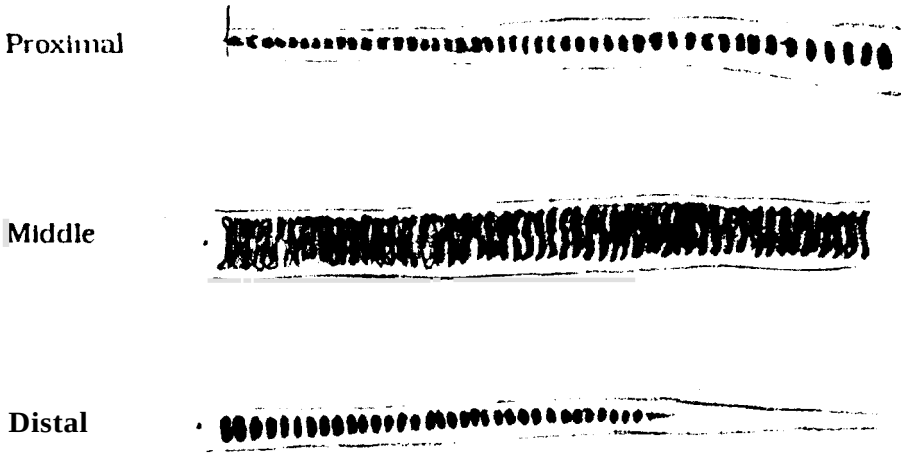

Fig.52 Schematic diagram of hair structure of White-tailed Woodrat, *Ratfus blanfordi*

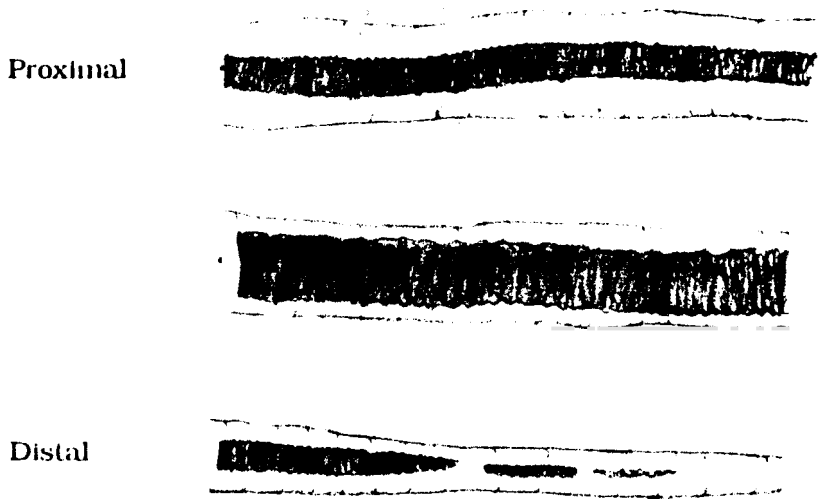

Fig.53 Schematic diagram of hair structure of Goat

Fig.54 Schematic diagram of hair structure of Cow

Table 4. Season-wise distribution of scats collected from Eravikulam National Park

Predator	Winter	Pre-monsoon	Monsoon	Post monsoon	Total
Tiger	12	7	1	5	25
Leopard	7	31	1	—	39
Wild dog	39	10	1	7	57
Jackal	20	10	—	—	30
Jungle cat	2	3	—	—	5

Results of the analyses of scats of different predators are summarised in Table 5. Sambar deer was the major prey species of wild dog and tiger. The large predators in the park. the wild dogs. tiger and leopard utilized a number of prey species. The percentages in Tables 5 - 8 exceed hundred in many cases because of the presence of more than one prey species in a single scat sample itself.

Table 5. Results of the analyses of scats in Eravikulam National Park

Prey\Predator	Wild dog	Jackal	Tiger	Leopard*	Jungle cat
Sambar	43 (75)	2 (6.6)	14 (56)	6 (15.38)	—
Caur	—	2 (6.6)	1 (4)	2(5.13)	1 (20)
Barking deer	9 (15.7)	—	3 (12)	4 (10.25)	—
Mouse deer	2 (3.5)	—	2 (8)	3 (7.69)	—
Nilgiri tahr	1(1.7)	—	4 (16)	9 (23.08)	—
Nilgiri langur	1 (1.7)	—	2 (8)	3 (7.69)	—
Wild boar	1(1.7)	—	—	—	—
Bandicoot	2 (3.5)	26 (86.6)	—	3 (7.69)	4 (80)

Figures in parantheses denote percentage.

* No hair was present in 9 cases. In two cases, only grasses were found.

Nilgiri tahr was the dominant prey species of leopard. Interestingly, bandicoot formed about 86% of the prey species of jackal in the Park. Gaur was fed only by tiger, leopard and jackal, Season-wise results of scat analyses of each predator species are given in Tables 6 to 10.

Table 6. Results of season-wise analyses of Wild dog scat in Eravaikulam National Park

Predator	Winter	Pre-monsoon	Monsoon	Post monsoon
Sambar	32 (82.05)	6 (60)	1 (100)	4 (57.14)
Barking deer	7 (17.94)	1 (10)	—	1 (25)
Mouse deer	—	2 (20)	—	—
Nilgiri tahr	—	1 (10)	—	—
Nilgiri langur	—	—	—	1 (25)
Wild boar	1 (2.56)	—	—	—
Bandicoot	1 (2.56)	—	—	1 (25)

Figures inparantheses denote percentage.

Table 7. Results of season-wise analyses of Tiger scat in Eravikulam National Park

Species	Winter	Pre-monsoon	Monsoon	Post monsoon
Sambar	6 (50)	5 (71.42)	—	3 (60)
Gaur	—	1 (14.28)	—	—
Barking deer	1 (8.33)	1 (14.28)	1 (100)	—
Mouse deer	—	—	—	2 (40)
Nilgiri langur	1 (8.33)	1 (14.28)	—	—
Nilgiri tahr	4 (33.33)	—	—	—

Figures in parantheses denote

Table 8. Results of season-wise analyses of Leopard scat in Eravikulam National Park

Species	Winter	Pre-monsoon	Monsoon	Post monsoon
Sambar	1(14.28)	4 (12.90)	1(100)	—
Barking deer	1 (14.28)	3 (9.67)	—	—
Nilgiri tahr	1 (14.28)	8 (25.80)	—	—
Mouse deer	—	3 (9.67)	—	—
Bandicoot	2 (28.57)	1 (3.22)	—	—
Gaur	1 (14.28)	1 (3.22)	.	—
Nilgiri langur	1 (14.28)	2 (6.44)	—	—

Figures in parantheses denote percentage.

Table 9. Results of season-wise analyses of Jackal scat in Eravikulam National Park

Species	Winter	Pre-monsoon	Monsoon	Post monsoon
Sambar	1 (5)	1 (10)	—	—
Gaur	2 (10)	—	—	—
Bandicoot	17 (85)	9 (90)	—	—

Figures in parantheses denote percentage.

Table 10. Results of season-wise analyses of Jungle cat scat in Eravikulam National Park

Species	Winter	Pre-monsoon	Monsoon	Post monsoon
Bandicoot	2 (100)	2 (66.66)	—	—
Grey musk shrew	—	1 (33.33)	—	—

Lack of enough scat samples in monsoon made a meaningful comparison between seasons difficult. However, season-wise analyses of the results indicate that sambar deer was the major prey species of wild dog and tiger throughout the year. Nilgiri tahr, sambar deer and barking deer dominated among the prey species of leopard. Details of the kills recorded in Eravikulam National Park during the study period is given in Table 11. Most of the observations of the kills were of wild dogs in which sambar were the prey species in 90% of the cases. The record of domestic goat killed by panther was collected from the nearby Muduva colony.

Table 11. Details of kills recorded in Eravikulam National Park during the study period

Name of the predator	Sambar	Nilgiri tahr	Gaur	Domestic goat
Wild dog	9	1	—	—
Tiger	—	—	1	—
Panther	—	—	—	3
Natural death	—	1	—	—

5. DISCUSSION

The present study on the hair structure of major mammalian species gives a clear picture of the cortex and medullary characters in the proximal, middle and the distal parts. The findings do not agree completely with the drawings of Koppiker and Sabnis (1977). However, this could be due to the colour variations observed among the mammalian species in different parts of the country and also the scales drawn overlapping with the cortex and medullary structure. The key for identification of the species from the hair structure could be helpful only to a certain extent. The key (Table 3) along with the characters given in Table 2 alone would confirm the identification of the species. Further studies on the cuticular patterns and transverse sections of the medullary structure would be required to classify the structural characteristics into different orders and families.

Results of the scat analyses indicate substantial overlap of prey species in Eravikulm National Park, This result, irrespective of the differences in body size among the major three predators, do agree with the observations on neotropical felids by Emmons (1987) and on the predators of Nagarhole National Park by Karanth & Sunquist (1995). This also agrees with the observations of Rice (1986) in Eravikulam. Schaller (1972) had opined that the competition for limited prey resources is normally avoided by occupying different habitats or same habitat at different times. Seidensticker (1976) reported from the studies in Chitwan National Park that tiger and leopard tended not to frequent the same area. However, both tiger and leopard are active throughout the day. But tiger seemed to be more susceptible to the heat than the leopard. Size difference in the prey species is also reported to provide a potential means for co-existence of similar species of carnivores. Johnsingh (1983) indicated that tiger and wild dogs kill large prey species. Predation is also influenced by availability. density, palatabilily and experience (Schaller. 1972: Ewer, 1973).

Biomass of large herbivores is often considered as an index of the available prey to large predators. The present study, however, does not agree with this observation. Nilgiri tahr, the most abundant prey species in Eravikulam has been preyed upon by the leopard and tiger only to a lesser extent. Sambar deer which was comparatively less abundant was the major prey species in the area. Tiger and leopard are known to have all the features typical of

stalkers (Estes. 1967a&b) where as wild dogs are excellent coursers with capability to kill in the scrub, water and open land. Large cats such as tiger (Schaller, 1967) and lion (Wright. 1960) rarely kill prey animals on short grass and open habitat.

In Eravikulam, morphological adaptations of the predators and predator avoidafice mechanisms of the prey species seem to be important factors determining prey-predator relationship. The herding behaviour of Nilgirl tahr (Fig.10) provide better security with several animals watching for the predators and other dangers. This explains the fewer percentage of Nilgirl tahr evidences in the scats in Eravikulm National Park. However, the dominance of Nilgirl tahr hair in the scats of leopard could be due to the 'tolerance' of tahr to the presence of leopard (Rice. 1986) and also the ability of the predator to stalk them even on steep slopes. Moreover, the season-wise analyses indicate predation on tahr predominatly in winter and pre-monsoon. This coincides with the peak birth season of tahr which is in January and February (Rice. 1986).It could be possible that it was the young ones and the yearlings that fall prey to the predators.

Considering the smaller herd size of sambar deer in Eravikulam National Park (Fig.13) and they being often solitary present predators with more contacts due to isolation and reduced ability to sense danger. Barking deer, though solitary, due to its antipredatory behaviour of running in zig-zag (Barrette. 1977) and concealment (Brander, 1927) formed only the second major prey species of the pack hunting wild dogs.

The season-wise results of the scat analyses do not give an unblased picture of the situation due to the fewer number of scats in monsoon. Further, the climatic conditions in Eravikulam varies considerably in different seasons making a uniform effort for observations of animals for distribution study rather difficult due to factors like mist. Hence, a meaningful comparison between the distribution of prey species and scat analyses results is not attempted. However, this also follows the general pattern of predation.

REFERENCES

Adorjan. A.S. and Kolenosky. C.B. 1969. A manual for the identification of hairs of selected Ontario mammals. Department of lands and Forests. Research Report, 90.

Balakrishnan, M. 1988. Structure of *Lepus nigricollis* hair from various body regions with scanning electron microscopy. *Z. Saugetierkunde.* 53: 69-75.

Barrette. C. 1977. Some aspects of the behaviour of the muntjacs in Wilpattu National Park. Mammalia 41:1-29.

Benedict. F.A. 1957. Hair structure as a generic character in bats. Uni. Calif Pub. Zool.. 59: 285-548.

Berwick, S. 1974. The community of Wild Ruminants in the Cir Forests Ecosystem. India Ph.D. Dissertation, Yale University.

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

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

Brewster, 1837. Treatise on the microscope (cited by Tupinr, 1973).

Brunner. H. and Coman. B. 1974. The identification of mammalian hair Inkata Press, Melbourne.

Chandrasekharan. C. 1962. Forest types of Kerala Stale (3). Indian For. 88: 837-847.

Day. M.C. 1966.Identification of hair and feather remains in the gut and faeces of Stoats mid Weasels. *J. Zool.* (Lond) 48: 201-217.

Emmons, L.H. 1987.Comparative feeding ecology of felids in a neotropical rainforest. Behavioral Ecology and Sociobiology, 20:271-281.

Estes. R. 1967a.Predators and Scavengers. *Nat. Hist..* 76:20-29.

Estes, R. 1967b.Predators and Scavengers. *Nat. Hist..* 76:38-47,

Ewer, R.F. 1973. The carnivores. Cornell Universily Press, lthaca, N.Y

Hausnian, L.A. 1920. Further studies of the relationships of the structural characters of mammalian hair. *Am. Nat.* 496-523.

Hausnian. L.A. 1924. Further studies on the relationship of structural characters of mammalian hair. *Am Nat.* 58:544-557.

Hausman, L.A, 1930. Recent studies of hair structure relationships. *Scient. Monthly.* 30:258-277.

Johnsingh, A.J.T. 1983. Large mammalian prey-predators in Bandipur. *J, Bombay nat. Hist. Soc.* 80:1-59.

Johnsingh, A.J.T. 1993. Prey selection in three large sympatric carnivores in Bandipur. *Mammalia* 56:517-526.

Karanth, K.U. 1993. *Predator prey relationships among large mammals of Nagarahole National Park, (India)* .Ph.D. thesis. Mangalore University.

Karanth, K.U. and Sunquist, M.E. 1995. Prey selection by tiger. leopard and dhole in tropical forests. *J.Anim. Ecol.* 64:439-450.

Koppiker. B.R. arid Sabnis. J.H. 1976 Identification of hairs of some Indian mammals. *J. Bombay. nat. Hist. Soc.* 73: 5- 20.

Koppiker. B.R. and Sabnis. J.H. 1977. Further studies on the identification of hairs of some indian mammals. *J. Bombay. nat. Hist. Soc.* 74: 50-59.

Koppiker. B.R. and Sabnis, J.H.1981. Aids to the identification of Artiodactylian hairs with general comments on hair structure. *J. Bombay. nat. Hist. Soc,* 78:,299-303.

Lyne. A.C. and McMahon. T.S. 1951. Observations on the surface structure of hairs of Tasmanian monotremes and marsupials. *Pup. Roy. Soc. Tasmania* 1950:71-84.

Mathiak, H.A. 1938. A key to the hairs of the mammals of Southern Michigan *J. Wild. Manage.* 2:257-268.

Mc Murlrie. W. 1886. *Report on an examination of wools and other mammalian fibres.* U.S1. Agri., Washington

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

Rajaram. A.and Menon. R.K. 1986. A scanning electron microscope study on the hair keratins of some animals of the Indian subcontinent - a preliminary report. *J.Bombay. nat. Hist. Soc.* 83:427-429.

Rice, C.C. 1984.*The behaviour and ecology of Nilgiri tahr (Hemitragus hylocrius Ogliby,* 1838). Unpbl. dissertation. Texas A&MUniv.

Rice. C.C. 1986. Observations on predators and prey at Eravikulam National Park Kerala. *J.Bombay nat. Hist. Soc.* 83:283-305.

Rosenzweigh, M.C. 1966. Community Structure in Syiripalric Carnivora. *J. Mammal.* 47:602-612.

Sabnis, J.H. 1980. Studies on the characteristics of hair in some Indian bats (Mammalia: chiroptera). *J. Bombay nat. Hisl. Soc.* 77: 413-424.

Schaller, C.B. 1967. *The Deer and the Tiger.* University of Chicago Press, Chicago.

Schaller, C.B. 1972. *The Serengeti Lion.* University of Chicago Press, Chicago.

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

Shetty. B.V. and Vivekananthan. K. 1971. Studies on the vascular flora of Anamudi and the surrounding regions, Kottayam District. Kerala. *Bull. Bol. Surv. India* 13: 16-42.

Teerink. B.J. 1991. *Hair of West European Mammals.* Cambridge University Press, Cambridge.

Williams. C.S. 1938. Aids to the identification of mole and shrew hairs with general comments on hair structure and hair determination. *J. Wildl. Manage.* 2:239-250.

Wright. F. 1960. Predation on big game in East Africa. *J. Wild.Manage.*24 1-15.