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HABITAT UTILIZATION BY LARGER MAMMALS IN CHINNAR WILDLIFE SANCTUARY

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ABSTRACT

Habitat utilisation by larger mammals in Chinnar Wildlife Sanctuary was studied during the years 1992 - 1995. Vegetation of the sanctuary is composed of tropical dry deciduous forest, dry deciduous scrub and dry tropical riverine forest. Most of the larger mammals (twenty seven species) found in Kerala were recorded from the sanctuary . High density of elephant was observed during the words: months. No similar increase in the density was found in the case of other herbivores. Dry deciduous forest and dry deciduous scrub showed equal density of herbivores. No substantial difference in the availability of fodder was observed among the areas. Width of riverine vegetation which is the main habitat of the grizzled giant squirrel is thin on Kerala side along the bank of Chinnar river.

Key words: Habitat use, larger mammals, Chinnar Wildlife Sanctuary, Kerala, India

1. INTRODUCTION

Precise knowledge of the habitat requirements of larger mammals is necessary for proper management of Chinnar Wildlife Sanctuary. An insight into the habitat use of herbivores like, elephant *(Elephas maximus),* sambar *(Cervus unicolor),* spotted deer *(Axis axis),* gaur *(Bos gaurus),* and wild boar *(Sus scrofa)* is a must for this.

Chinnar Wildlife Sanctuary was declared in the year 1984. A management plan for the sanctuary was prepared in 1989 (Ramesan, 1989). The sanctuary is unique in having the only grizzled giant squirrel *(Ratufa macroura)* population in Kerala (Ramachandran, 1989). Similarly, starred tortoise *(Geochelone elegans)* was also reported from this area for the first time (Jayson, 1993). One important feature of Chinnar Wildlife Sanctuary, which differs from the other wildlife sanctuaries in Kerala, is the occurrence of dry deciduous scrub and dry deciduous forest types. Mammals above the size of mouse deer *(Tragulus meminna)* is considered as 'larger mammals' for the purpose of the study.

Only few studies were conducted in the Chinnar Wildlife Sanctuary earlier. Kerala Agricultural University had conducted a study on the ecodevelopment of the area with emphasis on tribals (Aravindakshan *et al.* 1986). A detailed study on the status and distribution of mammals in the sanctuary was done by Nair *et al.* (Unpublished). Use pattern of natural salt licks by mammals was studied by Ramachandran *et al.* (1995). Vegetational studies were carried out by Sebastine and Vajravelu (1967). A detailed status survey of grizzled giant squirrels and their distribution was conducted by Ramachandran (1993). A note on feeding of the black drongo *(Dicrurus adsimilis* Vieillot) of the area was also published (Jayson and Ramachandran, 1994). Many similar studies were carried out in other wildlife sanctuaries of Kerala (Nair and Jayson,1988; Ramachandran *et al.,* 1986). Ecology of larger mammals was studied in the dry forests of Nagerhole by Karanth and Sunquist (1992).

The objectives of the study were:

1. To find out spatio - temporal aspects of habitat use by larger mammals.
2. To document the abundance of plant resources in the area.
3. To monitor the endangered grizzled giant squirrel population in the area

Study area

Location

Situated in the rain shadow region of the Western Ghats, Chinnar Wildlife Sanctuary comes under Devikulam Taluk of Idukki District, Kerala State. It is located between 10º15' to10º 22'N latitude and 77º 05' to 77º 17'E longitude. Northern and eastern sides are bordered by the Amaravati Reserved Forests of Indira Gandhi Wildlife Sanctuary of Tamil Nadu State. Eravikulam National Park is on the western side and southern border merges with the Kudakkad Reserved Forest and Vannanthurai sandal wood reserves (Fig.1). The area can be approached both from Udumalpet and Munnar. The extent of the sanctuary is 90.44 km^2 and the altitude varies from 440 m to 2372m.

Climate

Being situated in a rain shadow region, the main rainfall is from the North-east monsoon lasting from October to December. Dry, hot climate prevails in all other months. Rainfall recorded in the Chinnar check post area during the period of study is given in the Table 1. No data is available regarding the previous rainfall and temperature.

Table 1. Pattern of rainfall in Chinnar area during the period of study (mm).

Months	1992	1993	I994
January	-		4.5
February	-	19	2
March	-		
April	-		54
May	-	21	107
June		51	28
July	16	28	60
August		21	12
September	182	13	98
October	29	310	I85
November	318	488	260
December	47	98	17
Total	591	1049	826

(-) = nil

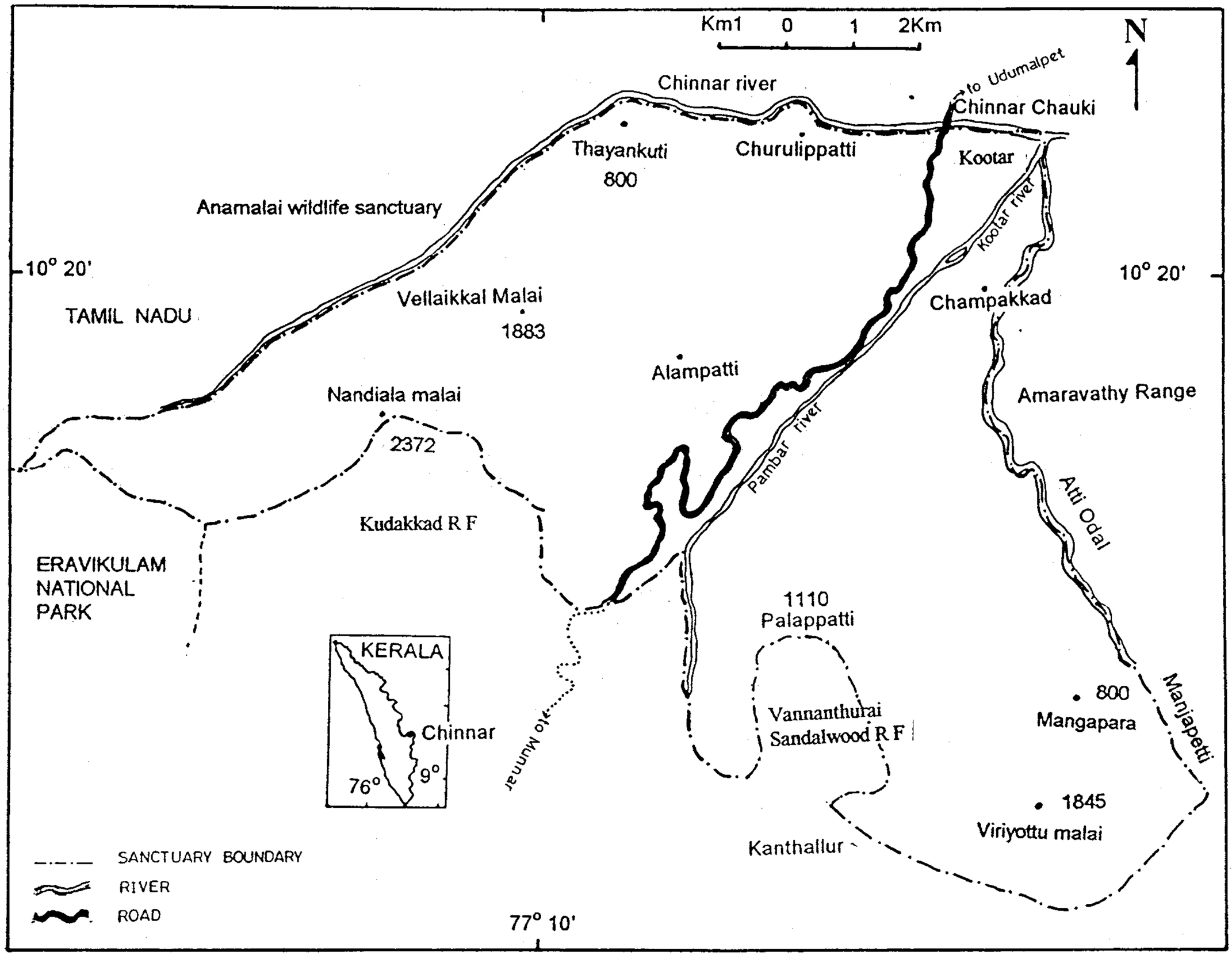


Fig. 1. Location of the study area.

Vegetation

Main vegetation type of the sanctuary is southern tropical dry deciduous forest. Apart from this, dry deciduous scrub which is a degraded stage of dry deciduous forests, shola forests, dry tropical riverine forest and grass lands are also found in the sanctuary (Ramesan, 1989).

2. METHODS

2.1. Habitat use

From the previous study (Nair *et al.*, Unpublished) 'it was obvious that only few areas in Chinnar Wildlife Sanctuary are abundant in larger mammals. These areas are having two prominent vegetation types namely, dry deciduous forest and dry deciduous scrub. Keeping this fact in mind, three areas were selected for the intensive study namely, Churulippetty, Kootar, and Chambakkad. Apart from this the whole sanctuary was surveyed and sighting of animals were recorded.

Density of larger mammals in each of the three intensive study areas were estimated each month, using the line transect method (Buckland *et al.,* 1993). Three line transects of 2 km each were lade and covered every month. The density was computed using the software "DISTANCE" (Laake *et al.,* 1994). The steps in density estimation by Fourier series is described in Buckland *et al.* (1993). Density of larger herbivores were calculated for the two seasons and presented. To arrive at an accurate estimate, three observations were taken from each transect in each month. Altogether 54 observations were made from each area. Estimation of density was done for a period starting from July 1993 to December 1994.

2.2. Habitat structure

Vegetational studies were carried out to document and to correlate the occurrence and habitat use of larger mammals with the vegetation. Vegetation profile, girth class distribution of trees and estimation of fodder were done. Details of each method is given below.

Vegetation profile

A schematic diagram which resembles the physiognomy of the stands of forest is shown in the form of a profile diagram. Richards (1952) has described this method. A 5m x 50m strip of forest stand was demarcated and from this, position of each tree was marked on a graph paper. Girth at breast height (GBH) and total height were recorded. Crown shape of individual trees were drawn on a graph paper in the field. Using all these pictorial and quantitative data, a profile diagram was constructed with measurements to scale. Profile of three vegetation types were drawn namely, riverine vegetation at Kootar, dry deciduous scrub at Kootar plains and dry deciduous forest at Alampetty.

Girth class distribution of trees

Trees with GBH l0cm and above were enumerated using the point-centered quadrat method. Distance to the four nearest trees in four quadrats from the centre was measured. Like this 50 plots were measured at an interval of 10m in each of the study area. From this data relative density, relative dominance, relative frequency, relative importance value and rank of each species, based on 'importance value' were calculated (Ellenberg and Mueller- Dombois, 1974).

Availability of fodder

Transects with a length of 250m were selected in the three study sites. Data were collected around the points situated at 10m intervals (Nair and Jayson,1988). The plants were grouped into categories based on their height like, less than one meter, one to two meters, two to three meters, and more than three meters. In the case of grasses and forbs (group l), a radius of 1 meter around the point was sampled. Two, three and five meters radius were used for herbs, shrubs and trees (group II, III, and Ⅳ.

Grass, herbs and shrubs in lm x lm plots were harvested for estimating the abundance of the fodder species from the three selected study areas. Each plot was at 10 m intervals on a line transect. Fifty such samples were collected from each area. Each species was separated and dried in an electric oven at a temperature of 50°C until there was no more loss of weight. Plants were then weighed.

2.3 Analysis of grizzled giant squirrel habitat

A detailed analysis of grizzled giant squirrel habitat was attempted. Along with these, phenology of important trees were also recorded. As the grizzled giant squirrel was seen only in the riverine habitat, this habitat was thoroughly analysed. Trees on the either side of the river Chinnar were numbered from Churulippetty to Kootar (GBH more than 10 cms) in 100 m blocks. Each of these trees were identified and GBH and height were measured. Distance from the middle of the river to the outer edge of the riverine vegetation was measured at four points namely 25^{th}, 50^{th}, 75^{th} and 100^{th} m. From this data, width of the riverine vegetation was plotted and a schematic diagram of riverine belt was prepared. This analysis was meant for identifying the gaps in the riverine vegetation.

Phenology

Phenology of trees in the riverine habitat was recorded each month. Different phenological stages like, presence of flower, fruit, green leaves, yellow leaves, sprouting and shedding of leaves were observed on 14 species of trees. Observations were recorded from 67 marked trees situated along the Churulippetty - Kootar riverine belt.

3. RESULTS

3.1. Habitat use

Chinnar Wildlife Sanctuary has a wide variety of animals. Most of the peninsular Indian forms were found in the sanctuary. A list of mammals recorded from the sanctuary during the period of study is given in the Appendix - I. To understand the habitat use of major herbivores their population structure and density in each month were monitored in three intensive study areas.

Elephant, *Elephas maximus* (Linnaeus)

Being the largest herbivore in the area, elephant had a major role in utilizing the habitat. They were found to feed on grass, shrubs, herbs, trees and also on the bark of the trees. Some of the plant species fed by elephants were *Dichrostachys cinerea, Albizia amara, Prosopis juliflora, Zizyphus xylopyrus* and *Acacia* sp.. Density of elephants recorded from the three intensive study areas is given in the Table 2. A total of 278 elephants were seen during the study. Out of this 37 were adult males, 179 females, 30 sub-adults and 32 juveniles (Fig. 2). Male to female ratio was 1:5 (n = 216).

Table 2. Density of elephants in the intensive study areas (Elephants/km^2)

Seasons	Churulippetty Density(%CV)	Kootar Density(%CV)	Chambakkad Density(%CV)
Summer (Jan. - Aug.)	150(57.29)	3.04(90.91)	.0 l(75.34)
North - East Monsoon (Sep. -	No sighting	2.09(66.14)	4.24(100)

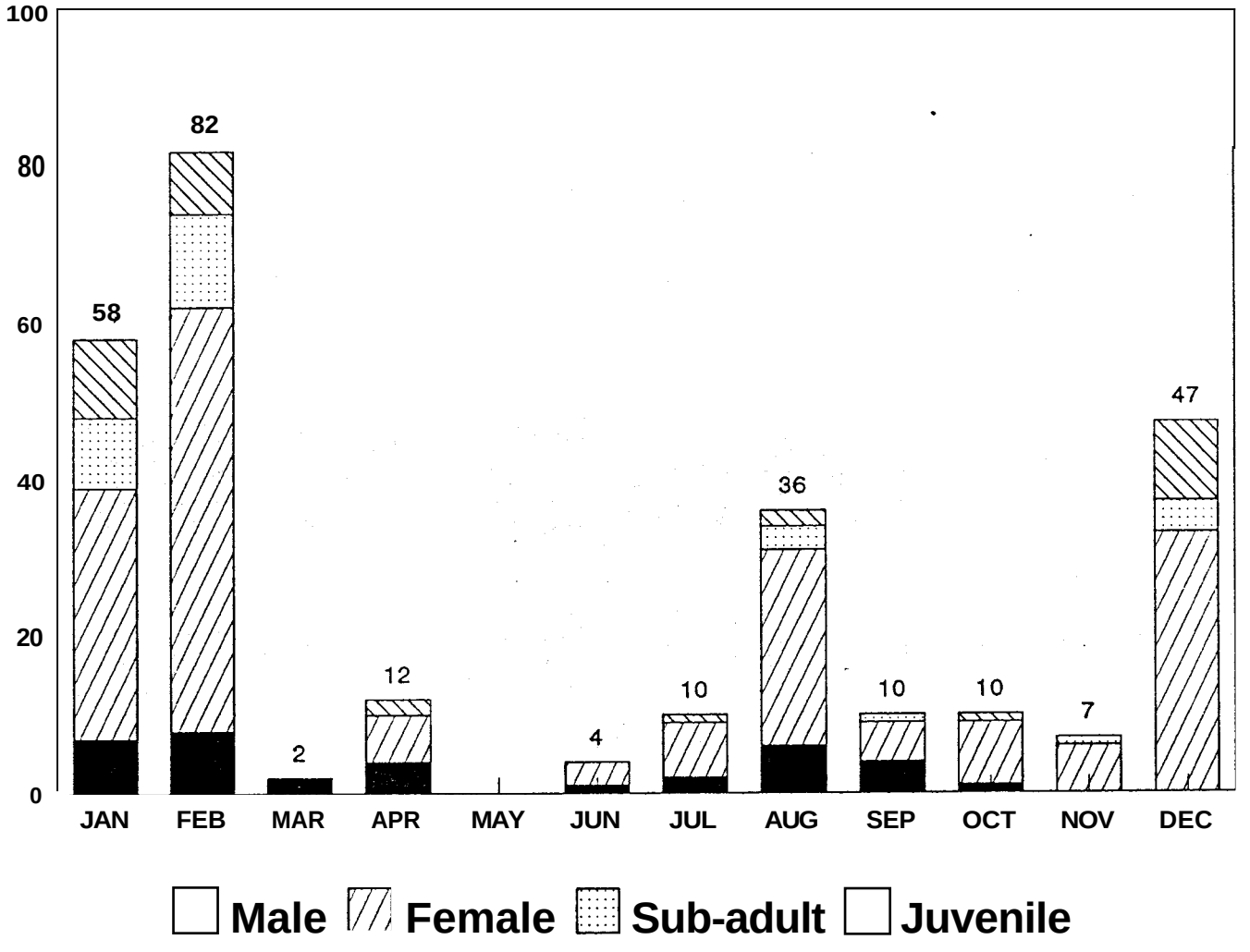


Fig. 2. Population structure of elephants in different months

High density of elephants were seen in the Kootar plains followed by Chambakkad in summer months. No elephants were seen in the study areas from March to July. Distribution of elephants in the two habitats is given in the Table 3. Mean value shows that maximum number of elephants were seen in the dry deciduous scrub, followed by dry deciduous forest. No elephants were sighted in Churulippetty except in the month of January.

Table 3. Number of elephants sighted in two habitats.

Months	Dry deciduous scrub	Dry deciduous forest
January	54	- -
February	4	75
March	3	- -
April	12	-
May	--	--
June	--	4
July	5	5
August	36	--
September	10	--
October	10	--
November	8	--
December	49	--
Mean	15.92	7

(--) = nil

Gaur or Indian bison *Bos gaurus* H. Smith

Gaur is the second largest herbivore in the Chinnar Wildlife Sanctuary. Maximum sighting of gaur was from the Churulippetty followed by Chambakkad and Kootar. As in the case of elephants, maximum population of gaur was sighted in dry deciduous scrub forest (x=17.67), followed by dry deciduous forest (Table 4). A total of 287 gaurs were sighted during the study. Male to female ratio was 1:3. Thirty six individuals were juveniles and 30 were calves (Fig. 3).

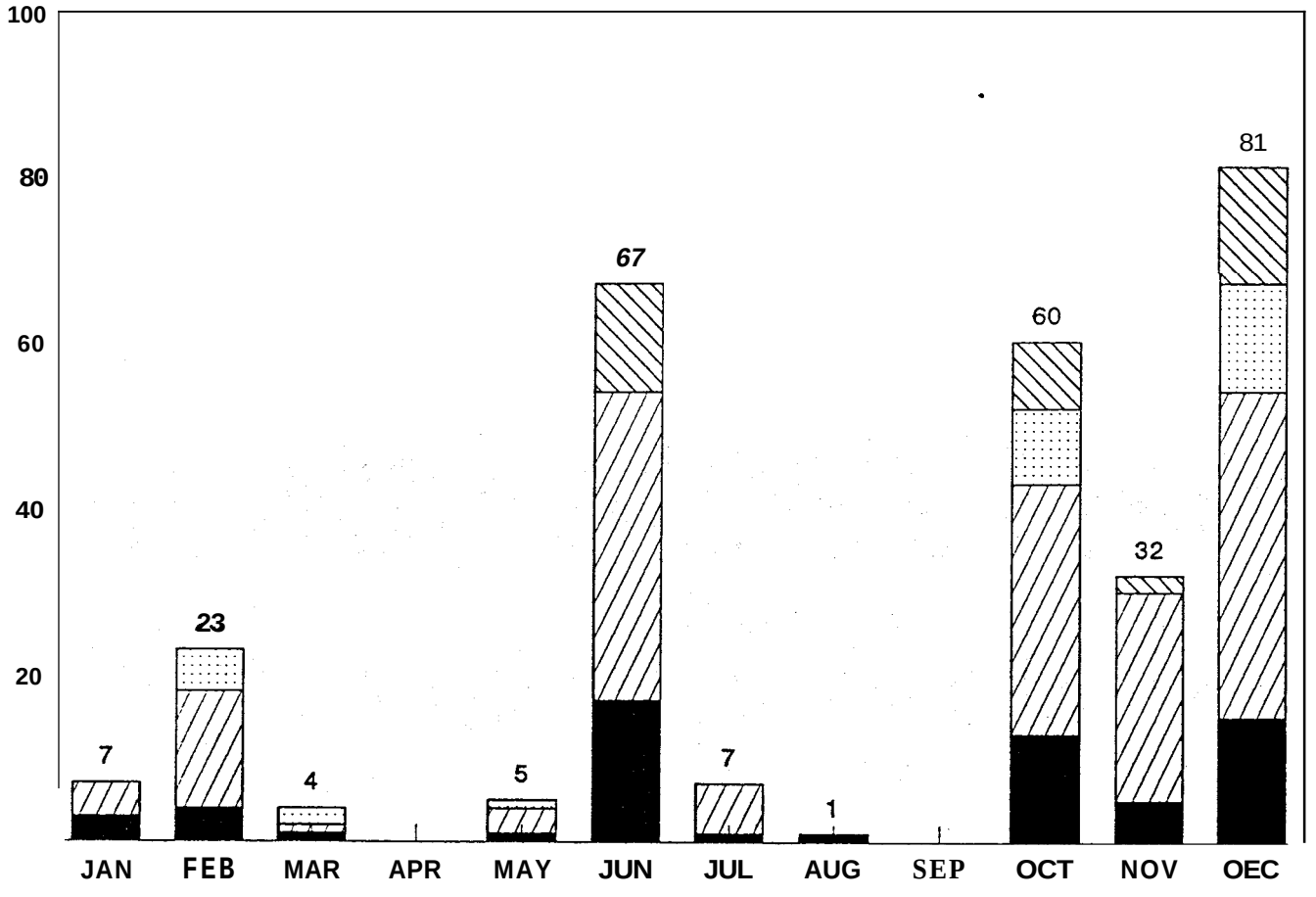


Fig. 3. Sighting of gaur in different months

Table 4. Number of gaur sighted in two habitats.

Months	Dry deciduous scrub	Dry deciduous forest
January	--	7
February	3	20
March	4	--
April	--	--
May	--	--
June	26	41
July	7	--
August	1	--
September	--	--
October	58	--
November	32	--
December	81	--
Mean	17.67	5.67

Sambar *Cenrvus unicolor* Kerr

Among the three intensive study areas, highest density of sambar was observed from Kootar. This was followed by Churulippetty and Chambakkad.

Table 5. Density of sambar in the study sites (Animals/km^2)

Seasons	Churulippetty Density(%CV)	Kootar Density(%CV)	Chambakkad Density(%CV)
Summer (Jan. - Aug.)	14.64(63.26)	26.42(32.40)	1.47(62.92)
North-East Monsoon (Sep.-Dec.)	11.97(31.04)	20.27(33.13)	0.68(57.74)

Density of sambar was highest in the summer season in all the areas (Table 5). During the study 1010 sightings were made. Male to female ratio was 1:2. Thirty one sub adults and 15 juveniles were also sighted during the study (Fig. 4).

Sambar was feeding on species like *Priva cordifolia, Justicia tranquebarensis, Acalypha paniculata, Hibiscus lobatus, Blepharis* sp., *Bauhinia* sp., *Randia dumetorum, Canthium coromendalicum, Dichrostachys cinerea, Cardiospermum* sp., *Atlantia monophylla, Aerva lanata, Achyranthes aspera, Gmelina* sp., *Strychnos potatorum, Tephrosia* sp., *Sida retusa, Boerhaavia diffusa, Euphorbia hirta, Ipomea pilosa* and *Pachygone ovata.*

Eventhough the highest number of sambar was sighted in the dry deciduous forest, uniform distribution of sambar in all the months was from the dry deciduous scrub vegetation (Table 6).

Table 6. Number of sambar sighted in two habitats

Months	Dry deciduous scrub	Dry deciduous forest
January	17	21
February	8	56
March	28	85
April	9	30
May	23	108
June	3	195
July	56	_-
August	101	--
September	74	--
October	23	--
November	8	--
December	21	--
Mean	30.92	41.25

(--) = nil

Spotted deer *Axis axis* (Erxeleben)

A total of 2218 sighting of spotted deer were made during the study and male to female ratio was 1:1.5. Highest density of spotted deer in a season was observed at Chambakkad followed by Kootar and Churulippetty. Similarly highest density was observed in the summer season (49.85 animals/km^2) in the Chambakkad area (Table

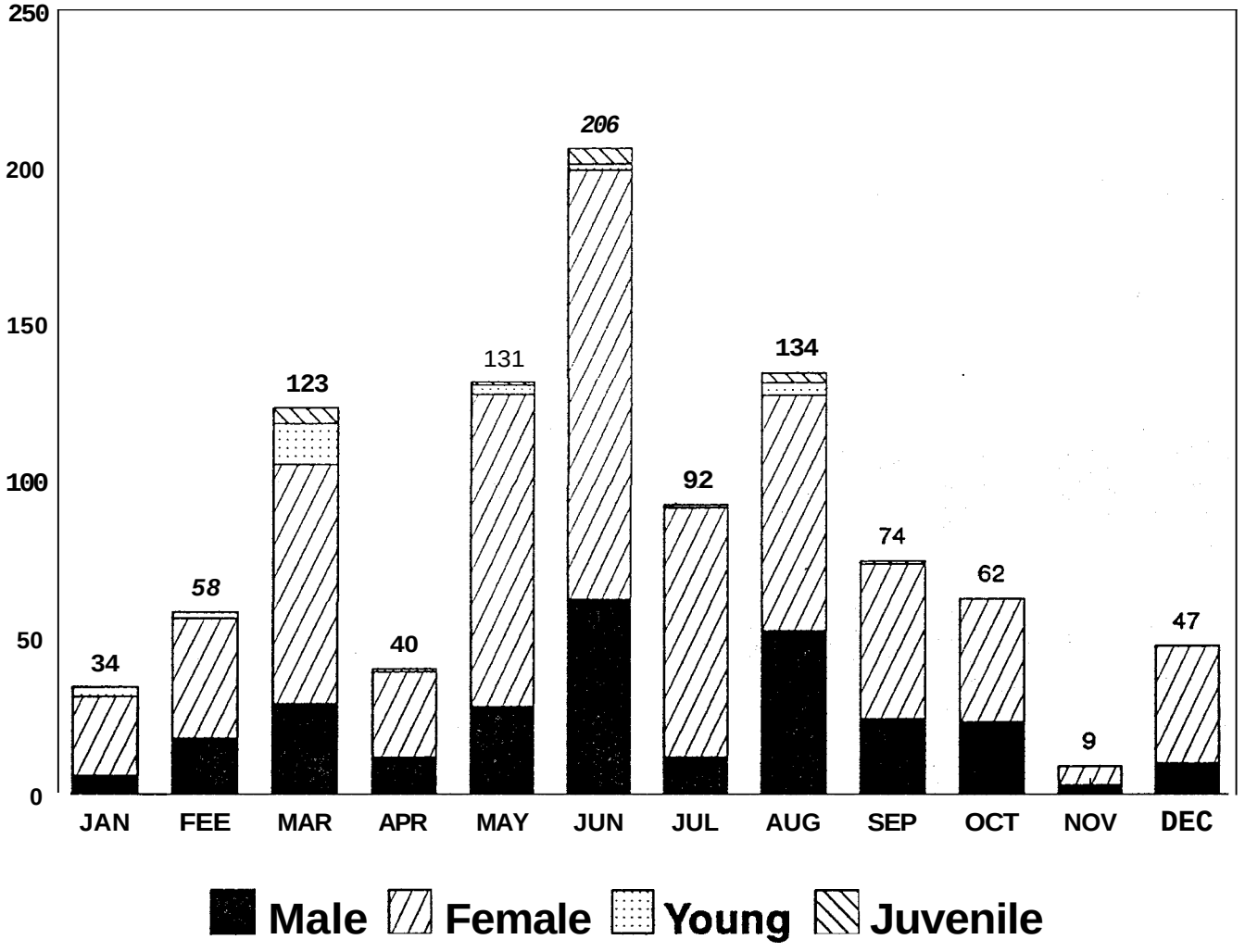


Fig. 4. Population structure of sambar in different months

Table 7. Density of spotted deer in the study sites (Animals/km^2)

Seasons	Churulippetty Density(%CV)	Kootar Density(%CV)	Chambakkad Density(%CV)
Summer (Jan. - Aug.)	17.20(41.17)	7.37(40.46)	49.85(21.50)
North-East Monsoon (Sep. - Dec.)	5.83(45.68)	22.47(46.59)	28.83(25.72)

Maximum population of spotted deer was seen in dry deciduous scrub forest followed by dry deciduous forest (Table 8). Population structure of spotted deer during different months is given in the Fig. 5.

Table 8 Number of spotted deer in different habitats

Months	Dry deciduous scrub	Dry deciduous forest
January	51	137
February	28	75
March	43	64
April	26	44
May	71	142
June	--	223
July	155	29
August	142	--
September	110	--
October	27	--
November	52	--
December	151	--
Mean	71.33	59.5

(--) = nil

Barking deer *Muntiacus muntjak* (Zimmermann)

Altogether 14 barking deer were sighted. Nine sightings were from Churulippetty and another sighting was from Alampetty. This deer is very rare in the sanctuary (Table 9).

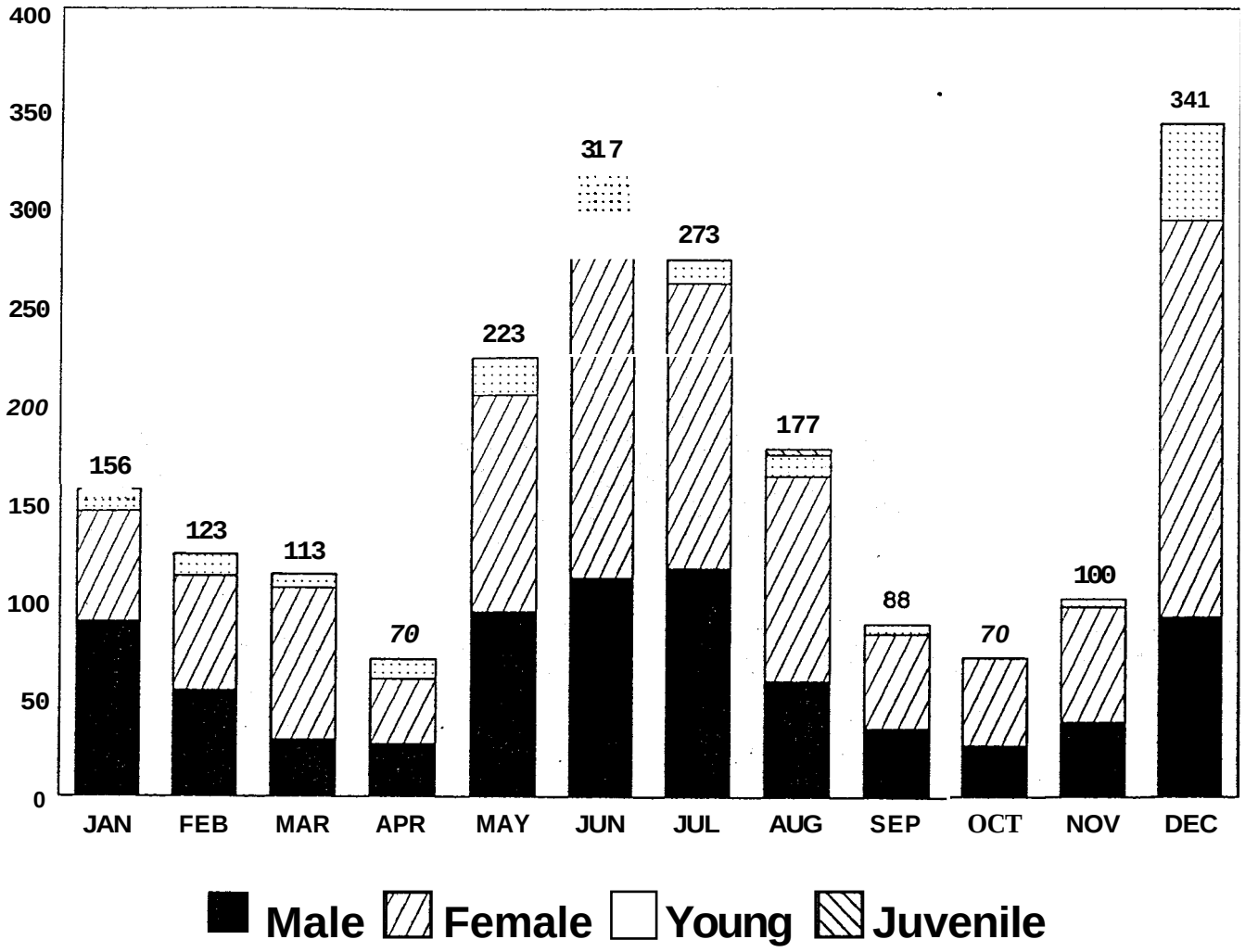


Fig. 5. Population structure of spotted deer in different months

Table 9 Number of barking deer in two habitats.

Months	Dry deciduous scrub	Dry deciduous forest
January	--	--
February	--	--
March	--	--
April	1	--
May	--	--
June	2	1
July	2	--
August	1	--
September	1	--
October	1	--
November	1	--
December	--	--
Total	9	1

(--) = nil

Wild boar *Sus scrofa* Linnaeus

Wild boar was not common in the study area. Only 291 individuals were seen during the study. Among the animals sighted, seventeen were adult males and 118 were young ones. Highest number of wild boar was recorded from the dry deciduous scrub (x=12.83) followed by dry deciduous forest (Table 10). They mainly feed on species like *Tribulus terrestris, Asparagus racemosus* and *Boerhaavia diffusa.*

Table 10 Number of wild boar sighted in different habitats.

Months	Dry deciduous scrub	Dry deciduous forest	Riverine
January	--	41	--
February	--	3	--
March	--	9	--
April	5	1	--
May	7	20	17
June	3	40	1
July	10	_	--
August	1	5	--

September	26	--	--
October	9	--	--
November	13	--	--
December	80		--
Mean	12.83	9.92	1.5

(--) = nil

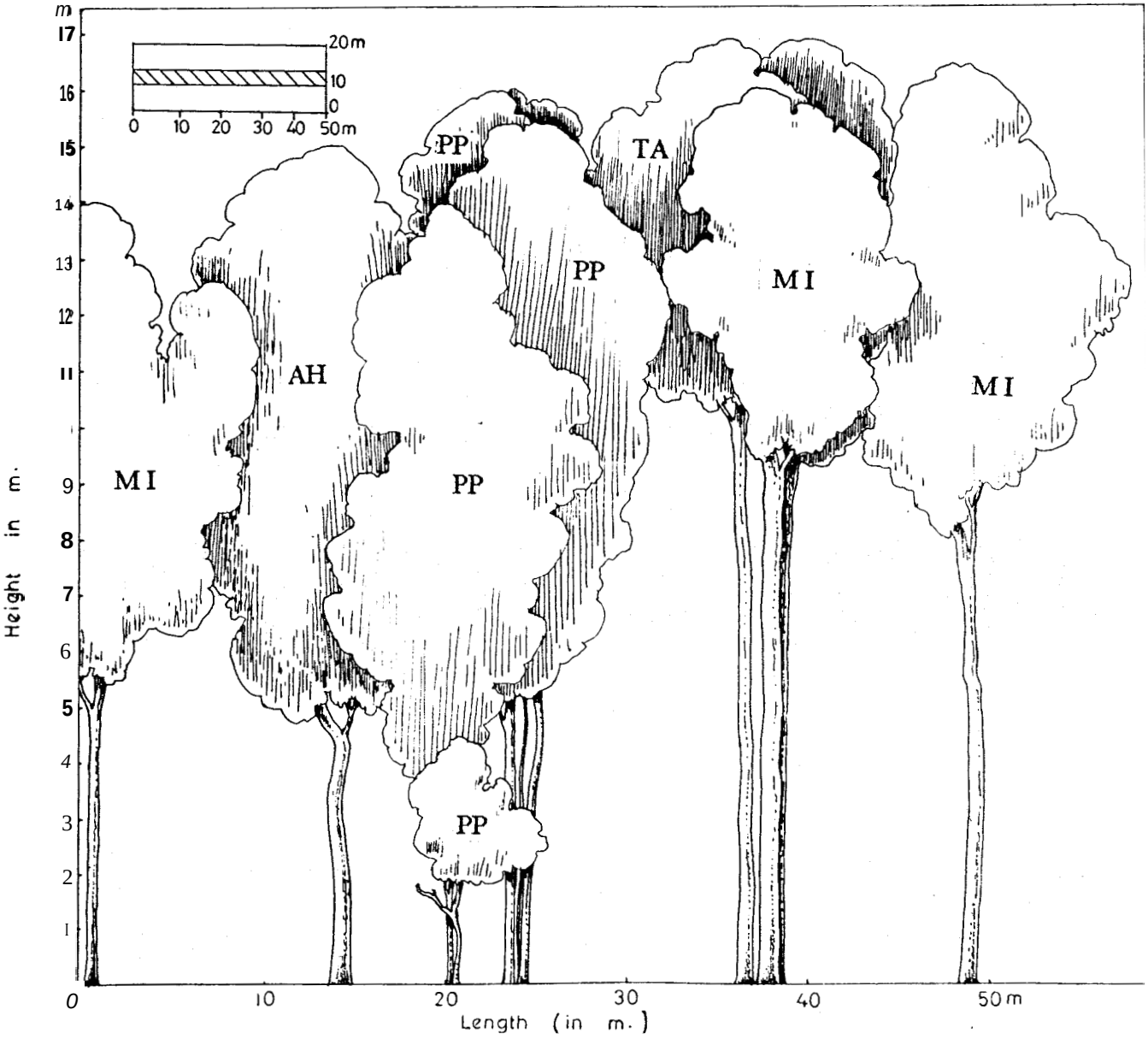
3.2. Habitat structure

Vegetation profile

Profile diagram of riverine vegetation at Kootar (Fig. 6) showed tall trees with two canopy layers. Presence of few trees in the lower canopy indicated very low regeneration of trees at this area. Profile diagram of dry deciduous scrub vegetation at Kootar plains revealed trees of shorter height reaching a maximum of 6m to 7m and the canopy is not closed. Due to this feature no arboreal mammals like grizzled giant squirrel or primates were seen in this type of vegetation (Fig. 7). Profile diagram of dry deciduous forest vegetation at Alampetty indicates canopy in two layers (Fig. 8) and the trees have a maximum height of 11 metres. In this vegetation type also canopy was not closed and the population of grizzled giant squirrel was scanty.

Girth class distribution of trees

Girth class distribution of trees in the three areas namely Kootar, Churulippetty and Alampetty is given in the Table 11. At Kootar, most of the trees were in the range of 21cm to 40cm class. Similar distribution of trees was found at Churulippetty also. One difference observed at Churulippetty and Alampatty was the high occurrence of trees of higher GBH classes than at Kootar.



M I - ***Mangifera indica***

AH- ***Artocaarpus hirsutus***

PP - ***Pongamia pinnata***

TA - ***Terminalia arjuna***

Fig. 6 Profile diagram of riverine vegetation.

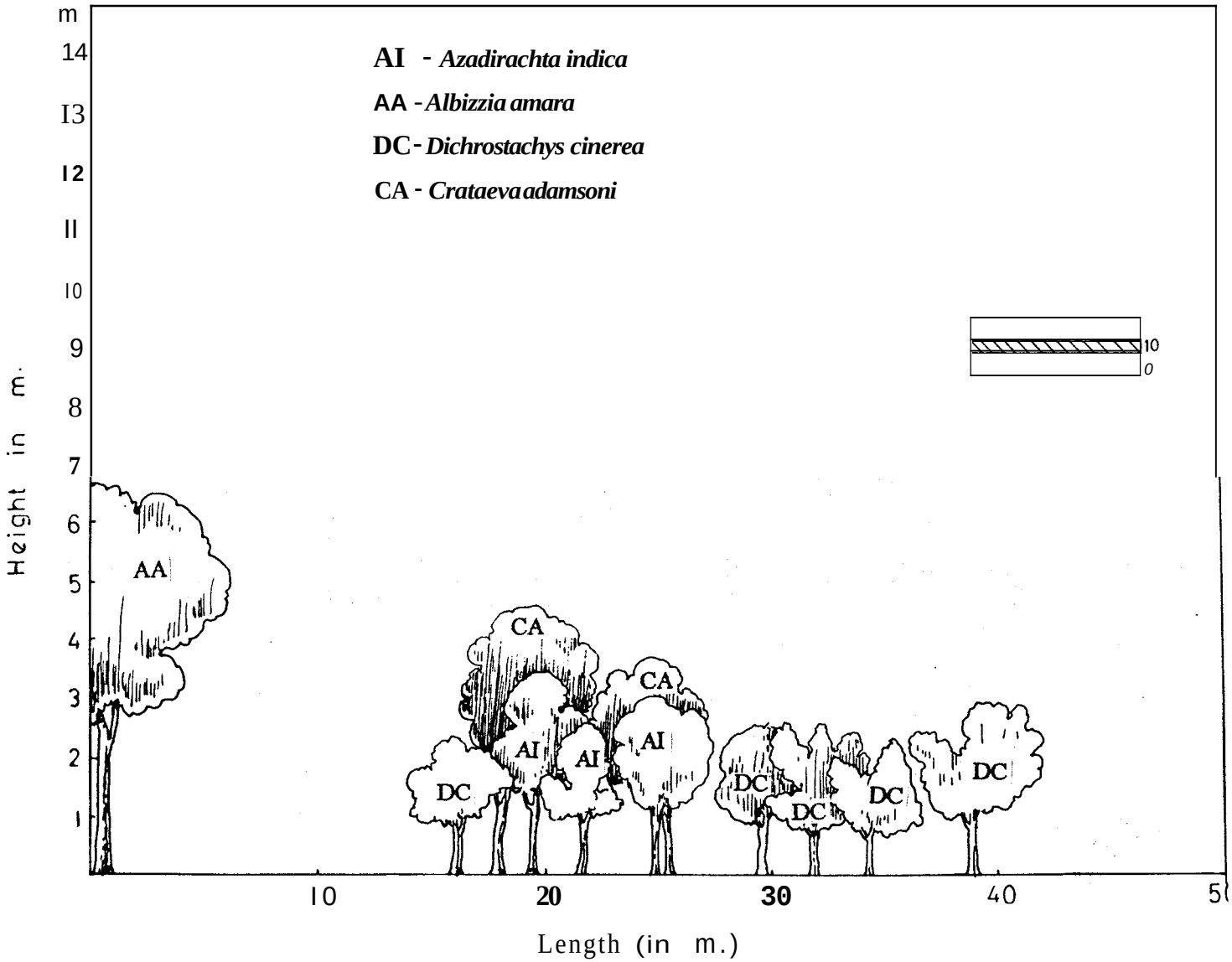


Fig. 7. Profile diagram of *dry* deciduous scrub vegetation.

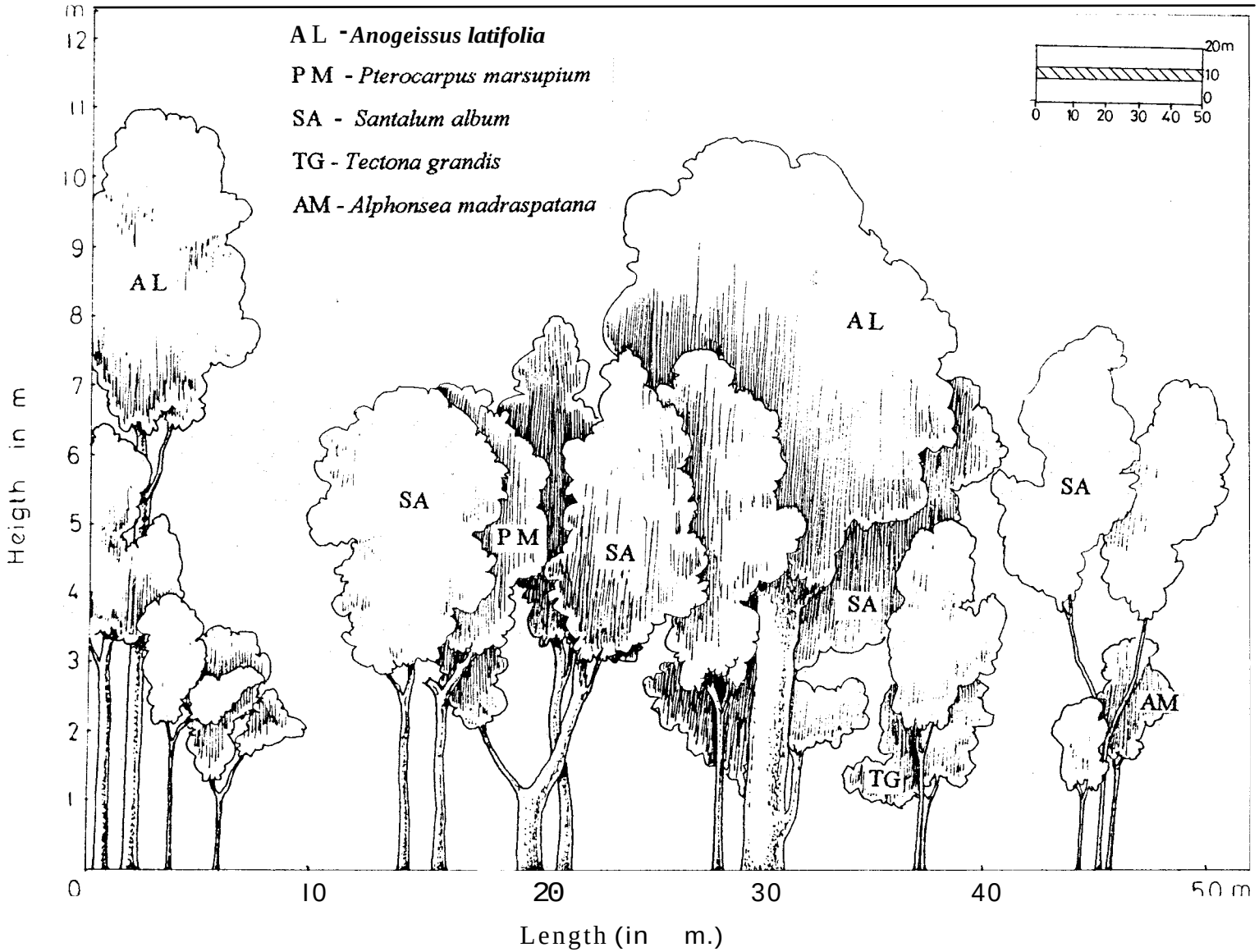


Fig. 8. Profile diagram of dry deciduous vegetation.

Table 11. Frequency distribution of GBH of trees at Kootar, Churulippetty and Alampetty.

GBH classes (cms)	Kootar % (n=218)	Churulippetty % (n=218)	Alampetty % (n=307)
1 - 20	25.69	21.17	12.41
21 - 40	42.20	37.79	24.84
41 - 60	21.10	19.54	23.79
61 - 80	7.34	10.10	14.14
81 - 100	1.83	4.89	12.07
101 - 120	0.92	2.93	6.21
121 - 140	0.46	1.95	3.45
141 - 160	--	0.97	1.03
161 - 180	-	--	1.38
181 - 200	0.46	0.33	0.34
201 - 220	-	0.33	--
221 - 240	--	--	0.34

(--)= nil

At Alampetty also trees occurring in the second category (21-40) was higher in percentage. In all the areas good regeneration of new seedlings were seen.

Abundance of tree species in different habitats.

Kootar and Churulippetty have dry deciduous scrub vegetation. This has been reflected in the abundance of trees also. At Kootar highest importance value was obtained for *Dichrostuchys cinerea* followed by *Albizia amara* and *Azadirachta indica* (Table 12). Thirty one species of trees or large shrubs were obtained from Churulippetty area. Highest importance value was for *Gyrocarpus americanus* followed by *Atalantia monophylla* and *Euphorbia antiquorum* (Table 13).

Table 12. Abundance of tree species at Kootar.

Species	RD %	RDO %	RF %	RIVI %	R
Dichrostachys cinerea	7.95	18.00	18.11	14.65	1
Albizia amara	13.61	11.30	11.71	12.19	2
Azadirachta indica	8.64	14.30	12.6	11.83	3

Ailanthus excelsa	13.61	12.80	9.02	11.80	4
Dalbergia paniculata	13.11	5.20	6.31	8.21	5
Bauhinia racemosa	8.37	4.43	5.41	6.07	6
Canthium coromendalicum	2.95	7.42	6.31	5.57	7
Anogeissus latifolia	8.47	2.99	3.61	5.00	8
Crataeva adainsonii	4.12	2.99	3.61	3.57	9
Ginelina asiatica	1.89	2.99	3.61	2.83	10
Strychnos potatorum	3.39	2.21	2.71	2.78	I I
Zizyphus sp.	3.19	2.21	2.71	2.75	12
Acacia ferruginea	3.01	1.52	1.81	2.31	13
Acacia planifrons	1.41	2.21	2.70	2.15	14
Randia dumetorum	0.78	2.21	2.70	1.96	15
Mitragyna parvifolia	1.43	1.52	1.71	1.68	I6
Prosopis juliflora	2.48	0.95	0.79	1.36	17
Preinna whightiana	0.64	0.95	0.79	0.77	18
Erythroxylon monogynum	0.34	0.95	0.79	0.66	19
Commiphora berryi	0.31	0.95	0.79	0.65	20
Atalantia monophylla	0.12	0.95	0.79	0.65	21
Carissa carandas	0.08	0.95	0.79	0.56	22

RD=Relative Density; RDO=Relative Dominance; RF=Relative Frequency; RIVI=Relative Importance Value Index; R=Rank

Table 13. Abundance of tree species at Churulippetty.

Species	RD %	RDO %	RF %	R N I %	R
Gyrocarpus americanus	20.69	6.79	8.24	11.97	1
Atalantia monophylla	8.77	14.29	12.4l	11.85	2
Euphorbia antiquorum	16.79	9.97	8.24	11.67	3
Cordia sp.	4.94	15.89	13.61	11.55	4
Randia dumetorum	1.66	10.59	12.41	8.25	5
Albizzia amara	7.59	6.97	6.89	7.13	6
Canthium coromendalicum	1.59	5.83	6.2l	4.53	7
Gmelina asiatica	2.69	4.66	5.52	4.35	8
Crataeva adainsonii	2.09	4.18	4.82	3.75	9
Hardwickia binatu	9.38	1.16	0.53	3.73	10
Sapindus emarginatus	2.51	2.39	2.74	2.53	11
Givotia rottleriformis	4.4l	0.71	0.67	1.87	12
Commiphora caudata	1.67	1.89	1.38	1.62	
Ficus bengalensis	3.49	0.71	0.67	l .57	14
Ficus sp.	3.21	0.71	0.67	l .47	15
Peliospermum alatum	0.52	1.89	2.07	l .42	16
Cordia sp.	0.29	1.89	2.07	1.39	17

Commiphora berryi	1.12	1.16	1.38	1.27	18
Grewia sp.	0.61	1.16	1.38	1.05	19
Bauhinia racemosa	1.75	0.71	0.67	0.99	20
Unidentified	0.31	1.16	1.38	0.95	21
Mitragyna parvifolia	0.82	0.71	0.67	0.68	22
Diospyros cordifolia	0.73	0.71	0.67	0.65	23
Acacia ferruginea	0.60	0.71	0.67	0.62	24
Acacia leucophloea	0.30	0.72	0.67	0.57	25
Memecylon petiolatum	0.30	0.72	0.67	0.57	26
Dalbergia panicdata	0.33	0.71	0.67	0.52	27
Mitrephora heyneana	0.39	0.71	0.67	0.50	28
Erythrina indica	0.39	0.71	0.67	0.50	29
Capparis heyneana	0.06	0.65	0.67	0.48	30

RD=Relative Density; RDO=Relative Dominance; RF=Relative Frequency; RIVI=Relative Importance Value Index; R=Rank

Alampetty being a dry deciduous forest area the composition and abundance of tree species were different. Highest Importance Value was for *Anogeissus latifolia* followed by *Givotia rotteleriformis* and *Strychnos potutorum.* Thirty two plant species were enumerated from the area. Compared with the other species, relative frequency and other values were very high for *Anogeissus latifolia* (Table 14).

Table 14. Abundance of tree species at Alampetty.

Species	RD %	RDO %	RF %	RIVI %	R
Anogeissus latifolia	36.80	33.60	22.72	31.03	1
Givotia rottleriformis	17.50	4.29	4.25	8.67	2
Strychnos potatorum	6.52	6.15	6.38	6.33	3
Chloroxylon swietenia	5.54	4.29	4.96	5.91	4
Grewia sp.	1.69	7.23	6.38	5.10	5
Dalbergia paniculata	4.55	3.56	3.55	3.60	6
Acacia ferruginea	3.30	3.56	3.55	3.48	7
Premna tomentosa	0.94	4.29	4.96	3.38	8
Atalantia monophylla	1.58	4.29	4.25	3.37	9
Ficus sp.	2.32	3.56	3.55	3.15	10
Diospyros cordifolia	1.66	3.56	3.55	2.93	11
Azadirachta indica	2.47	3.16	2.84	2.69	12
Albizzia amara	4.39	1.76	2.14	2.66	13
Mimusops hexandra	3.78	1.17	1.42	2.17	14
Dolichandrone arcuata	2.29	1.76	2.13	2.05	15
Commiphora caudata	2.00	1.76	2.13	1.96	16
Sapindus emarginatus	0.50	2.46	2.84	1.53	17
Peliospermum alatum	0.58	1.78	2.13	1.49	18

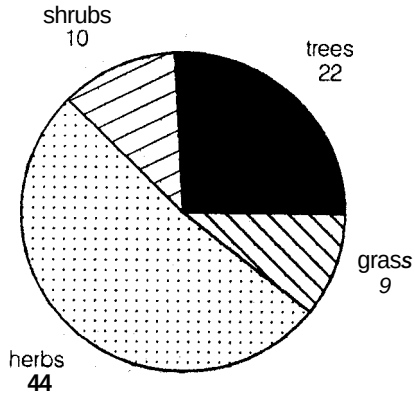
Gardenia lucida	0.00	0.39	1.76	1.40	19
Cordia sp.	0.09	1.78	2.13	1.33	20
Commiphora berryi	0.06	1.17	1.42	0.87	21
Wrightia tinctoria	0.16	1.17	1.42	0.80	22
Ixora arborea	0.30	1.17	1.42	0.66	23
Unidentified	0.26	0.19	0.74	0.38	24
Euphorbia antiquorum	0.21	0.19	0.74	0.34	25
Bauhinia racemosa	0.10	0.19	0.74	0.33	26
Unidentified	0.06	0.19	0.74	0.31	27
Acacia leucophloea	0.05	0.19	0.74	0.31	28
Crataeva adamsonii	0.04	0.19	0.74	0.30	29
Santalum album	0.21	0.19	0.74	0.30	30
Cordia sp.	0.01	0.19	0.74	0.29	31
Cordia obliqua	0.01	0.19	0.74	0.29	32

RD=Relative Density; RDO=Relative Dominance; RF=Relative Frequency; RIV=Relative Importance Value Index; R=Rank

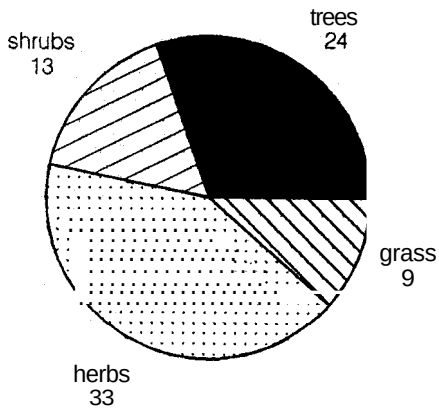
Availability of fodder

Maximum number of herbs were found in Churulippetty followed by Kootar and Chambakkad. Number of shrubs were higher at Chambakkad followed by Kootar and Churulippetty (Fig. 9). Maximum species of trees were found in the Chambakkad followed by Churulippetty.

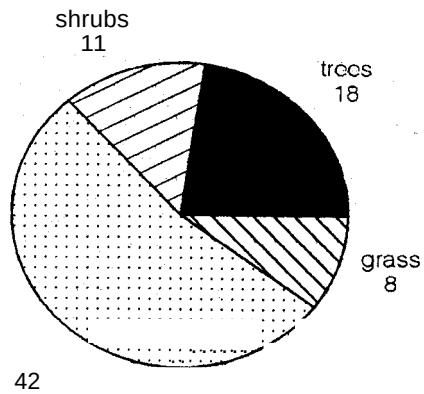
Two samples were collected for assessing the abundance of fodder. First sample was collected in the months of October and November 1993 and the second during September and October 1995. During these months the growth of vegetation was maximum due to the North-east monsoon. Highest weight of plants was obtained from the Alampetty area (Table 15). This was followed by Churulippetty and Kootar.



Churulippetty

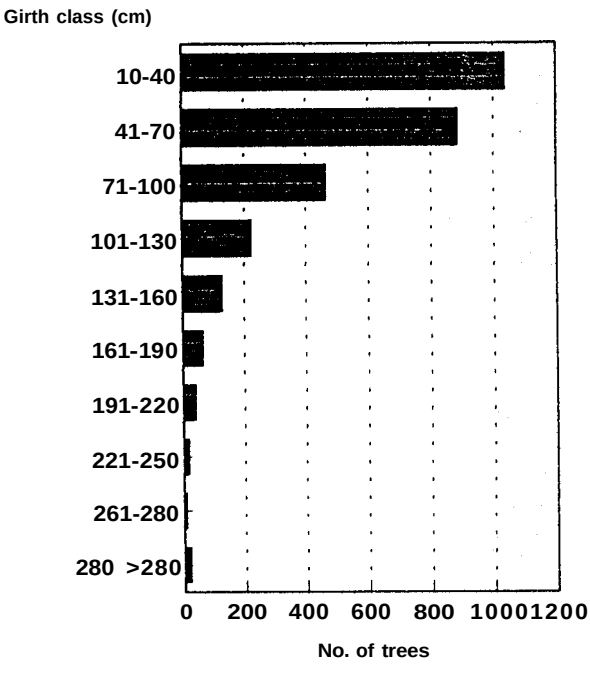


Chambakkad

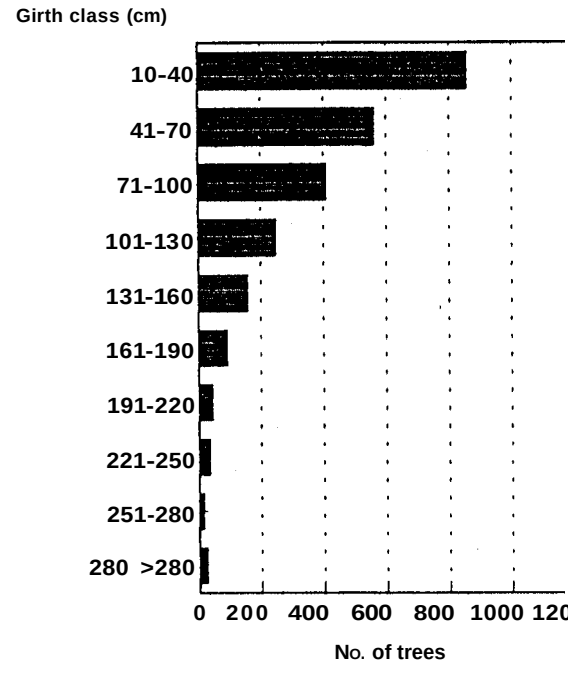


Kootar

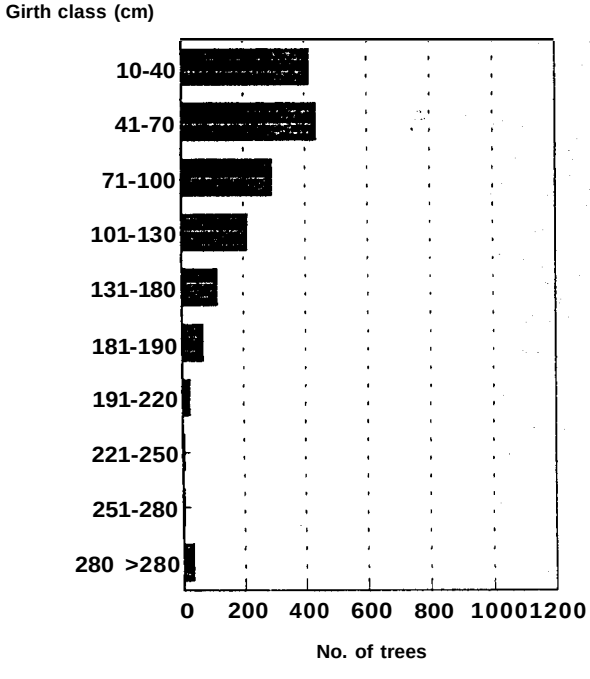
Fig. 9. Number of tree, herb, shrub and grass species at Chinnar Wild life Sanctuary



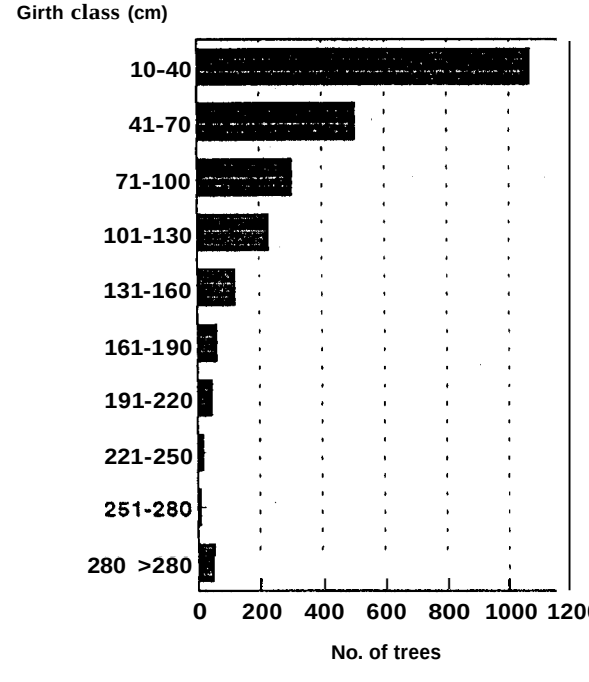
Chinnar-Churulippetty (Kerala side)



Chinnar-Churulippetty (Tamil Nadu side)



Chinnar bridge-Kootar (Kerala side)



Chinnar bridge-Kootar (Tamil Nadu side)

Fig. 10. Distribution of GBH of trees in the stretch starting from Kootar to Churulippetty.

Table 15. Abundance of fodder plants in three study areas.

Areas	No. of plots	Mean weight in first sample (gdm^2)	Mean weight in second sample (gm/m^2)
Alampetty	40	189.62	139.29
Churulippetty	50	83.89	115.01
Kootar	50	67.47	100.72

3.3. Grizzled giant squirrel *Ratufa macroura* (Pennant)

Hundred and nineteen grizzled giant squirrels were sighted in 112 sightings. Most of them were sighted in the Kootar- Churulippetty stretch. Very often they were sighted as single individual. Altogether 150 grizzled giant squirrels were estimated from this area (Ramachandran, 1993). The riverine habitats of grizzled giant squirrel were divided into the following habitat stretches.

1. Chinnar bridge to Kootar through Chinnar river (2 km)
2. Chinnar bridge to Churulippetty through Chinnar river (2 km)
3. Alampettey bridge to settlement (1.5 km)
4. Kootar to Sungam, through Athiodai (4 km)
5. From Chambakkad through Pambar river (2.5 km)

Number of grizzled giant squirrels sighted in the above stretches is given in the Table 16.

Table 16 Number. of grizzled giant squirrels sighted in the riverine habitats.

Date	Habitat stretches				
	1 2km	2 2km	3 1.5km	4 4km	5 2.5km
11-01-94	6	--	--	--	--
12-01-94	--	--	3	--	--

16-01-94	--	--	--	--	3
19-01-94	--	--	--	3	--
20-01-94	--	--	--	--	4
14-03-94	3	--	--	--	--
15-03-94	3	--	--	--	--
16-03-94	5	--	--	--	--
23-03-94	3	--	--	--	--
19-05-94	3	--	--	--	--
20-05-94	--	6	--	--	--
21-05-94	2	--	--	--	--
23-05-94	--	--	--	--	6
23-05-94	4	--	--	--	--
24-05-94	--	--	--	4	--
25-05-94	--	--	--	--	3
27-05-94	--	4	--	--	--
14-06-94	4	--	--	--	--
18-06-94	3	--	--	--	--
23-06-94	4	--	--	--	--
08-09-94	--	3	--	--	--
09-09-94	3	--	--	--	--
20-10-94	2	--	--	--	--

(--) = nil

In stretches 1, 2 and 5 a maximum of 6 squirrels were sighted. In the stretches 3 and 4 (Alampetty bridge to settlement and Kootar to Sungam) the maximum was only 4. This indicates the low density of population in this area.

Table 17. Species of trees and the number of grizzled giant squirrels sighted on each species.

Species of tree	No. of squirrels
Terminalia arjuna	15
Marigifera indica	11
Ficus sp.	8
Calophyllum sp.	6
Tamarindus indica	5
Pongamia pinnata	4
Accacia leucophloea	3
Artocarpus hirsuta	3
Mimusops elengi	3

Syzygium cumini	2
Garcinia gummi-gutta	2
Sapindus emarginatus	1
Eucalyptus	1
Terminalia bellerica	1
Albizzia lebbeck	1
Vitex leucoxylon	1
Walsura trifoliata	1
Putranjiva roxburghii	1
Albizzia amara	1
Prosopis juliflora	1
Commiphora caudata	1

Eventhough more than 100 species of trees are found in the riverine habitats, grizzled giant squirrels were seen only on 21 species of trees (Table 17). This indicates the importance these tree species to the long term conservation of grizzled giant squirrels.

Analysis of grizzled giant squirrel habitat

Abundance of trees:

Riverine habitat, where the endangered grizzled giant squirrel inhabit, was studied in detail. Analysis of GBH of trees showed that regeneration is very low in Kerala side starting from Chinnar to Kootar compared to other three stretches. Otherwise the pattern was similar in all other stretches (Fig. 10). Hundred and one species of trees were identified from the both sides of Chinnar river (Appendix - II Among this prominent species was *Pongamia pinnata* followed by *Terminalia arjuna, Mangifera indica, Atlantia monophylla, Diospyros* sp., *Lepisanthes tetraphylla, Tamarindus indica, Syzygium cuminii* and *Gyrocarpus americanus*.

Another habitat of grizzled giant squirrel is the riverine vegetation on the two sides of the Pambar river (Plate 1). Fifty seven species of trees were recorded from this area from 50 plots using point-centered quadrat method. The species of trees were ranked according to the importance value. First position was for *Mangifera indica* followed by *Terminalia arjuna, Pongamia pinnata, Schleichera oleosa, Tamarindus*

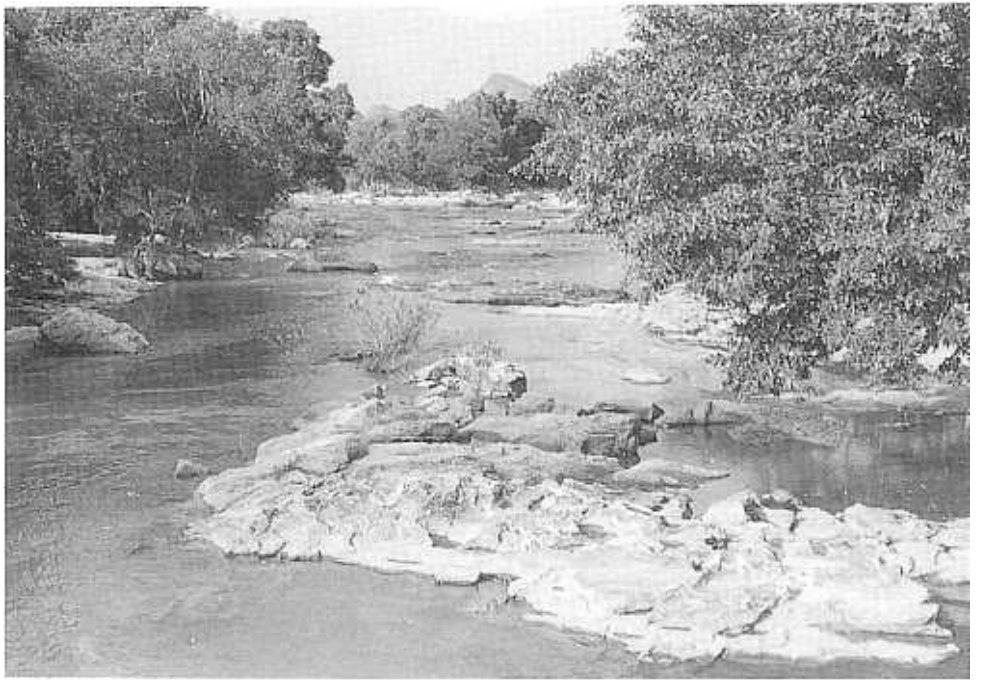


Plate 1. Riverine vegetation along the sides of Pambar river

indica, Acacia leucophloea, Syzygium cumini, Pterocarpus marsupium, Celtis cinnamomea and *Mitrephora heyneana.*

Continuity of riverine vegetation

The narrow strips of riverine vegetation in the sanctuary is crucial to the existence of grizzled giant squirrel. This type of vegetation was found only in a few stretches. One main stretch of riverine vegetation along Chinnar river is starting from Churulippetty to Kootar passing through the Chinnar check post area. Schematic diagrams showing the width of riverine vegetation on both sides of the Chinnar river from Churulippetty to Kootar are prepared and given in the Fig. 11.

Average width of the riverine vegetation is 17 metres in the Kerala side and 19 metres in Tamil Nadu side. But at some critical points identified(I to IV), the width is even less than this. In the Kerala side, the 15th block situated in the stretch from Chinnar to Kootar, the width of vegetation is only 10 metres. At this point the riverine vegetation on the Tamil Nadu portion is almost nil. Similarly the tract from Chinnar to Churulippetty also has some vulnerable areas where the canopy continuity could be severed. The need for maintaining the compactness of riverine vegetation and its importance in the conservation of grizzled giant squirrel is dealt in the discussion.

Phenology of important tree species

Phenological data of 14 common tree species found in the riverine habitat is given in Fig. 12. No specific pattern of flowering and fruiting was observed. All through the year some species were in flowers or fruits.

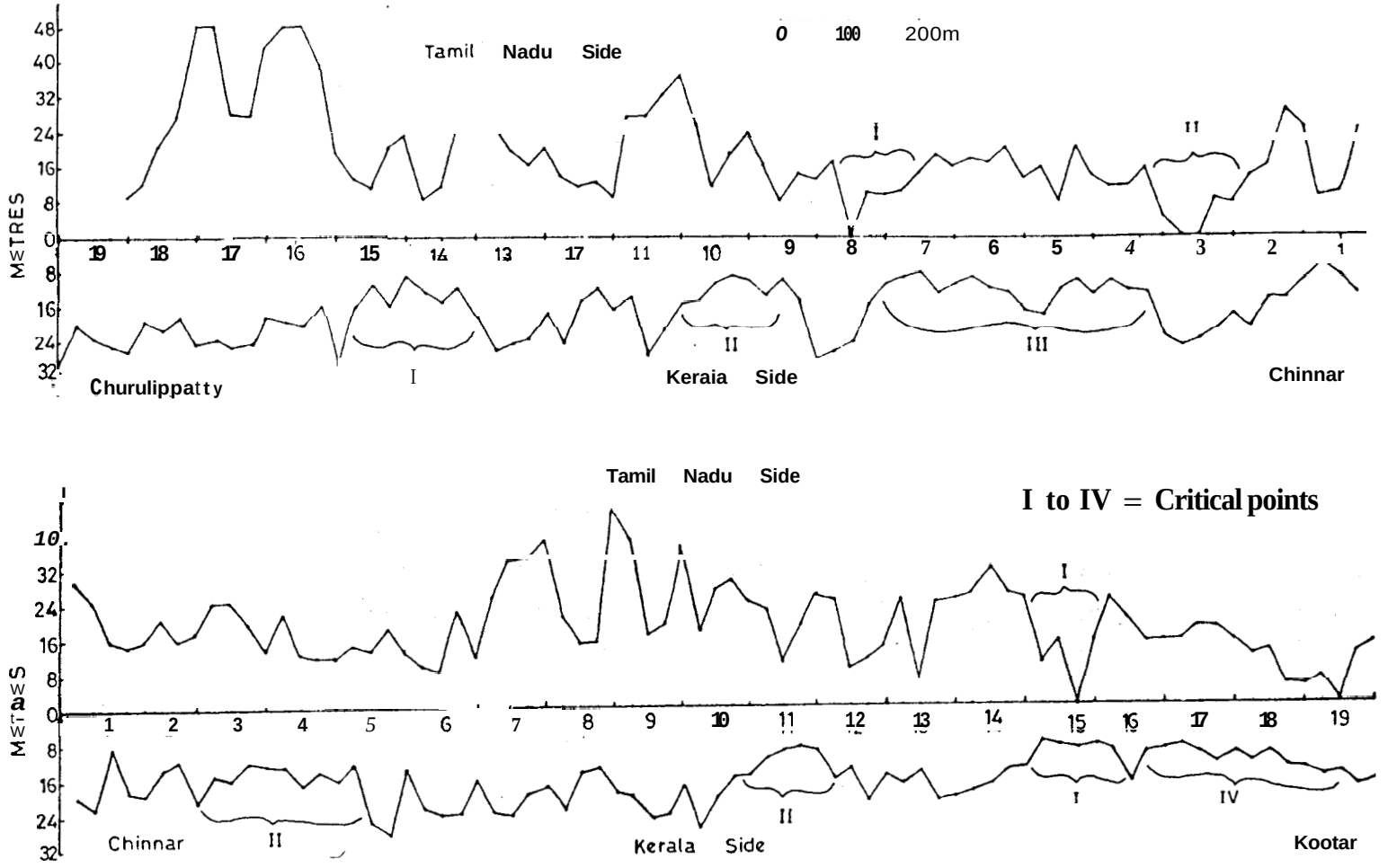


Fig. 1 1. Schematic diagram showing the width of riverine vegetation from Churulippetty to Kootar.

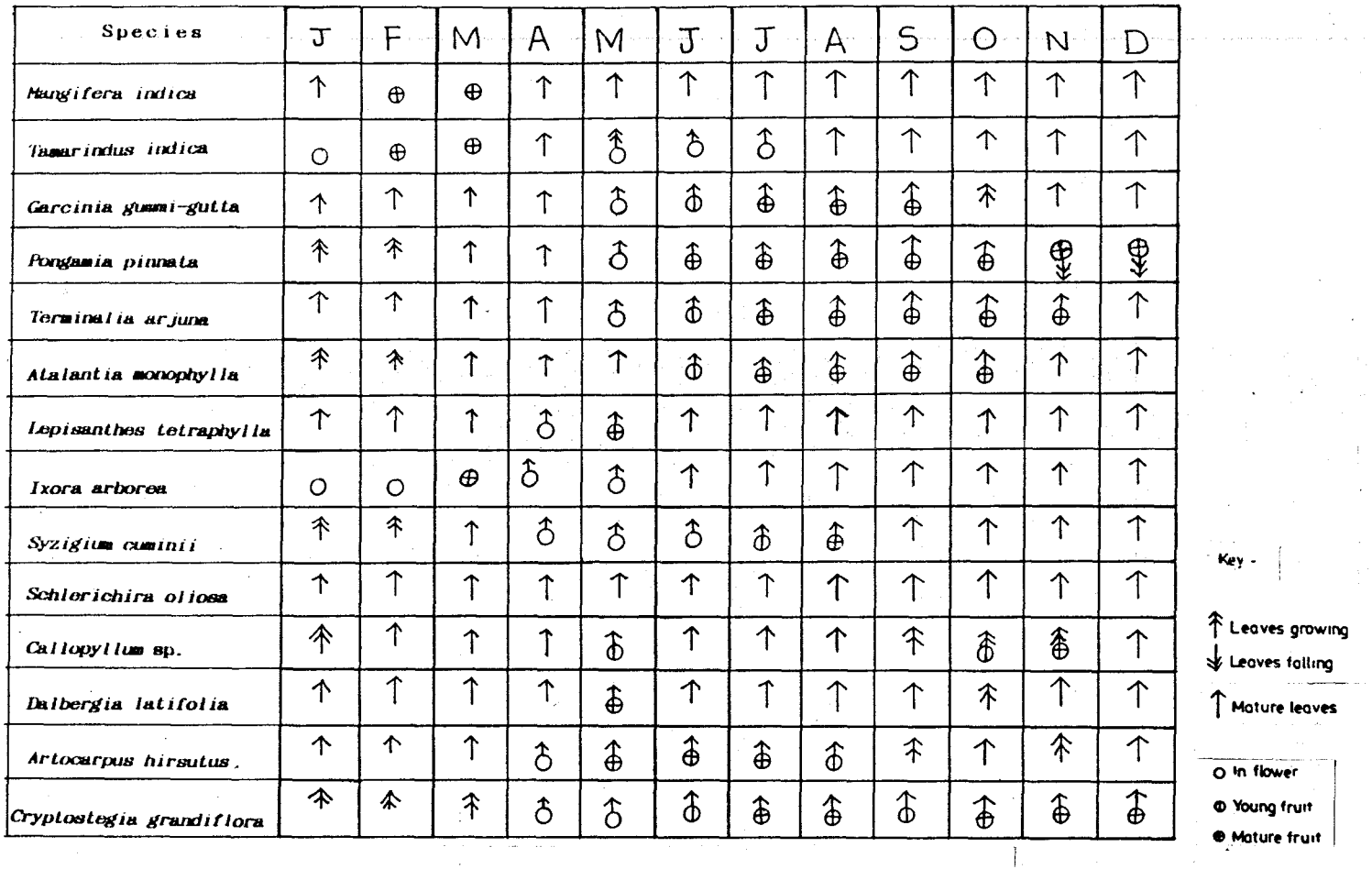


Fig. 12. Schematic diagram of phenology of trees.

4. DISCUSSION

Habitat use of larger mammals

Twenty seven species of larger mammals were recorded from the sanctuary. Highest density of elephant was observed during the summer months at Kootar and Churulippetty. This can be attributed to the rainfall pattern prevalent in the area. As the North-east monsoon is vigorous in the area, growth of vegetation is at its peak during the months of December, January and February. Increased availability of fodder during these months may be the reason for the higher density of elephants in summer season starting just after the North-east monsoon. No similar increase in the density was found in the case of other herbivores during these months. Highest number of elephants were recorded from the dry deciduous scrub compared to other vegetation types. No particular reason can be attributed for the preference in habitat use. In a study conducted at Parambikulam Wildlife Sanctuary (Nair and Jayson, 1988) elephants preferred younger teak plantations which provided more open space and fodder.

Density of gaur was highest in Churulippetty area, which can be attributed to the occurrence of more grassland area combined with the high water availability. Density of sambar is very high in the Kootar plains and lowest in the Chambakkad. In the case of spotted deer high density is found in the Chambakkadd and low densities are found in the Kootar and Churulippetty. Dry deciduous forest and dry deciduous scrub showed almost equal density of herbivores. Kootar and Chambakkad areas are important for spotted deer. All the habitat improvement works contemplated by the managers in these areas should be beneficial to the spotted deer and sambar.

Habitat structure

Alampetty area supported a good vegetation with multilayered canopy. Similarly riverine vegetation also has two layers of canopy which harboured grizzled giant squirrel, Malabar giant squirrel and common langur because multilayer forests are conducive for the arboreal animals. Girth class distribution of trees showed that all the areas are with trees of lesser GBH (< 80cm) and only at Alampetty trees with higher GBH was observed. This may be due to the felling of mature trees from the Kootar and Churulippetty area, before the declaration of the sanctuary.

Tree species coming in the first and second rank (Table 12) at Kootar namely *Dichrostachys cinerea* and *Albizzia amara* have been extensively fed by elephants, sambar and spotted deer. No substantial difference in the availability of fodder was observed among the 3 intensive study areas. Since the Alampetty area is having tropical dry deciduous forest, it is natural to have the highest biomass among the three areas.

Grizzled giant squirrel

Analysis of grizzled giant squirrel habitat revealed some important findings. Average width of the riverine vegetation is thin on the Kerala side and it is even less on the stretch from Kootar to Chinnar check post area along the Chinnar river. Higher number of vulnerable areas, where canopy discontinuity can occur in the near future due to the reduced width of the riverine iregetation, are encountered on the Kerala side than on the Tamil Nadu side. Similarly, regeneration of new seedlings were less on the stretch of riverine vegetation from Chinnar check post to Kootar. But in all the other stretches, good regeneration of trees was observed.

Management

Chinnar Wildlife Sanctuary is important for the existence of grizzled giant squirrel. Preservation of riparian forests along the river banks of Chinnar and Pambar river and its tributaries is crucial for this. Due to the high accessibility, the stretch of riverine vegetation from Chinnar check post upto Kootar in Kerala side is highly degraded. Many of the vulnerable areas with the low width of riverine vegetation are found in this portion. If proper protection is not given, the continuity of canopy may break, which is not ideal for the grizzled giant squirrel. Removal of fruits like *Garcinia gummi-gutta* and *Mangifera indica* by local people, by way of cutting the whole branches is highly detrimental to the riverine vegetation. Planting of riverine species like *Tamarindus indica, Terminalia bellirica , Terminalia arjuna, Mangifera indica* and *Artocarpus heterophyllus* may be attempted in the identified gaps where the width of riverine vegetation is very less.

Kootar plains have the highest concentration of herbivores. Due to the intensive fire protection afforded, the growth of vegetation has increased. Extensive growth of vegetation may transform the ideal spotted deer habitat to a sambar habitat. Because spotted deer is an animal of plain, open places and mainly depends on sight to escape from the predators. Considering this, no more planting should be attempted in the

Kootar plains if spotted deer herds has to survive here. Similarly the vegetation of the Chambakkad also should be kept in the present condition for maintaining the high density of spotted deer found in this area.

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7. APPENDICES

Appendix - I List of mammals recorded from the sanctuary during the period of study.

Common name	Scientific name
Mammals	
1. Bonnet Macaque	*Macaca radiata* (Geoffroy)
2. Common Langur	*Presbytis entellus* (Dufresne)
3. Slender Loris	*Loris tardigradus* (Linnaeus)
4. Tiger	*Panthera tigris* (Linnaeus)
5. Leopard or Panther	*Panthera pardus* (Linnaeus)
6. Rustyspotted Cat	*Felis rubiginosa* Geoffroy
7. Jungle Cat	*Felis chaus* Guldenstaedt
8. Common Palm Civet or Toddy Cat	*Paradoxurus herinaphroditus* (Pallas)
9. Common Mongoose	*Herpestes edwardsi* (Geoffroy)
10. Indian Wild Dog	*Cuon alpinus* (Pallas)
11. Sloth Bear	*Melursus ursinus* (Shaw)
12. Common Otter	*Lutra lutra* (Linnaeus)
13. Indian Giant Squirrel	*Ratufa indica* (Erxleben)
14. Grizzled Giant Squirrel	*Ratufa macroura* (Pennant)
15. Common Giant Flying Squirrel	*Petaurista petaurista* (Pallas)
16. Three Striped Palm Squirrel	*Funambulus palmarum* (Linnaeus)
17. Indian Porcupine	*Hystrix indica* Kerr
18. Blacknaped Hare	*Lepus nigricollis* F. cuvier
19. Indian Elephant	*Elephas maximus* (Linnaeus)
20. Gaur or Indian Bison	*Bos gaurus* H. Smith
21. Nilgiri Tahr	*Hemitragus hylocrius* (Ogilby)
22. Sambar	*Cervus unicolor* Kerr
23. Spotted Deer	*Axis axis* (Erxleben)
24. Barking Deer	*Muntiacus muntjak* (Zimmermann)
25. Mouse Deer	*Tragulus memminna* (Erxleben)
26. Indian Wild Boar	*Sus scrofa* Linnaeus
27. Indian Pangolin	*Manis crassicaudata* Gray

Appendix - II Number of tree species recorded from the riverine habitat of Chinnar river.

	Species	No. of trees		
		Total	Kerala side	Tamil Nadu side
1	*Pongamia pinnata*	2606	1469	137
2	*Terminalia arjuna*	923	405	518
3	*Mangifera indica*	691	315	376
4	*Lepisanthes tetraphylla*	608	I46	462
5	*Atalantia monophylla*	311	166	145
6	*Diospyros* sp.	289	186	103
7	*Tamarindus indica*	28I	I30	151
8	*Putranjiva roxburghii*	270	112	I58
9	*Mitrephora heyneana*	234	98	136
10	*Syzygium cuminii*	213	123	90
11	*Ixora arborea*	170	86	84
12	*Citrus aurantifolia*	161	28	133
13	*Sapindus emarginatus*	147	40	107
14	*Aglaia elaegnoidea*	146	28	118
15	*Celtis cinnamomea*	125	71	54
16	*Mimusops elengi*	120	82	38
17	*Ficus* sp.	117	61	56
18	*Acacia leucophloea*	105	65	40
19	*Commiphora caudata*	97	92	5
20	*Zizyphus* sp.	94	45	49
21	*Schleichera oleosa*	94	67	27
22	*Mallotus stenanthus*	85	22	63
23	Unidentified	81	39	42
24	*Mallotus philippinetisis*	79	42	37
25	*Memecylon petiolatum*	71	21	50
26	*Streblus asper*	68	32	36
27	*Gyrocarpus americanus*	65	65	
28	*Artocarpus hirsuta*	56	19	37
29	*Hopea parviflora*	54	26	28
30	Unidentified	52	--	52
31	*Eucalyptus grandis*	52	--	52
32	*Garcinia gummi-gutta*	50	17	33
33	*Grewia* sp.	45	25	20
34	*Cryptostegia grandiflora*	43	15	28
35	*Randia malabarica*	37		36

Appendix - II contd.

	Species	No. of trees		
		Total	Kerala side	Tamil Nadu side
36	*Bauhinia racemosa*	33	22	11
37	*Azadirachta indica*	32	17	15
38	*Dalbergia latifolia*	32	3	29
39	*Casine glauca*	31	21	10
40	*Ficus bengalensis*	28	28	--
41	*Ailanthus excelsa*	27	-_	27
42	Unidentified	27	4	23
43	*Vitex altissima*	25	--	25
44	*Memecylon umbellatum*	21	9	12
45	*Albizzia lebbeck*	21	10	
46	*Bischofia javanica*	20	20	
47	Unidentified	19	19	--
48	*Diospyros cordifolia*	17	12	5
49	*Premna tomentosa*	17	--	17
50	*Capparis heyneana*	17	6	11
51	*Prosopis juliflora*	16	4	12
52	*Acacia leucophloea*	16	8	8
53	*Mesua ferrea*	16	13	3
54	*Homonoia riparia*	15	5	10
55	Unidentified	14		3
56	*Chukrasia tabularis*	12	12	--
57	*Cordia sp.*	12	3	9
58	*Albizzia odoratissima*	12	4	8
59	*Strychnos potatorum*	10	10	--
60	*Salix tetrasperma*	10	7	3
61	Unidentified	9	9	--
62	*Crataeva adamsonii*	8		7
63	*Walsura trifoliata*	8	--	8
64	*Canthium coromendalicum*	8	2	6
65	Unidentified	7	--	7
66	*Glycosmis pentaphylla*	7	--	7
67	*Cassia fistula*	7	3	4
68	*Gyrocarpus gossypium*	6	--	6
69	*Olea dioica*	6	6	--
70	*Gardenia lucida*	6	2	4
71	*Gmelina arborea*	5	4	1
72	*Carrisa carandas*	4	--	4

Appendix - II contd.

	Species	No. of trees		
		Total	Kerala side	Tamil Nadu side
73	*Dalbergia paniculata*	4	3	1
74	*Vitex leucoxylon*	3	--	3
75	*Albizzia amara*	3	--	3
76	*Bridelia retusa*	3	3	--
77	*Combretum ovalifolium*	3	--	3
78	*Pterocarpus marsupium*	3	--	3
79	Unidentified	3	--	3
80	*Capparis* sp.	2	--	2
81	*Unidentified*	2	2	--
82	*Hiptage bengalensis*	2	--	2
83	*Acacia nilotica*	2	--	2
84	*Nothopegia colebrookiana*	2	--	2
85	Unidentified	2	2	
86	Uidentified	2	--	2
87	*Ficus tsjehela*	2	1	1
88	*Chloroxylon swietenia*	1	1	--
89	*Psychotria subintegra*	1	1	--
90	*Phyllanthus emblica*	1	--	1
91	Unidentified	1	1	--
92	Unidentified	1	1	--
93	*Pevetta indica*	1	1	--
94	*Nerium odorum*	1	1	--
95	*Pithecolobium dulce*	1	1	--
96	Unidentified	1	--	1
97	*Terminalia bellerica*	1	1	--
98	*Cordia obliqua*	1	1	--
99	*Diospyros* sp.	1	--	1
100.	Unidentified	1	1	--
101.	Unidentified	1	1	--
	Total	9273	4435	4838

(--) = not present