STUDIES ON

RESOURCE UTILIZATION BY ARBOREAL MAMMALS WITH SPECIAL REFERENCE TO THE NILGIRI LANGUR, *Presbytis Johnii* IN THE HIGH RANGES OF KERALA

THESIS SUBMITTED TO
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IN
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CERTIFICATE

This is to certify that this thesis is a record of the bonafide research work carried out by **Smt. Petrisia Joseph** under my supervision and guidance and that neither this thesis nor any part of it has previously formed the basis for the award of any degree or diploma.

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DECLARATION

I hereby declare that the thesis entitled **"Resource utilization by Arboreal Mammals with Special reference to the Nilgiri Langur, *Presbytis johnii* in the High Ranges of Kerala"**, submitted to the **University of Calicut** for the award of the Degree of **Doctor of Philosophy in Zoology** is a bonafide work done by me and that it has not been submitted earlier in part or in full to any other University for the award of any degree or diploma.

Petrisia Joseph

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CONTENTS

Chapter — 1

INTRODUCTION

Primates and squirrels form the major groups of arboreal mammals in South Indian forests. Primates include the Lion tailed Macaque, *Macaca silenus*, the Bonnet Macaque *Macaca radiata*, the Common Langur, *Presbytis entelles* and the Nilgiri Langur, *Presbytis johnii*, while squirrels comprise the Malabar Giant Squirrel, *Ratufa indica*, the Grizzled Giant Squirrel, *Ratufa macrura* and the Large Flying Squirrel, *Petaurista petaurista*. Of these the Bonnet Macaque, the Nilgiri Langur and the Malabar Giant Squirrel occur together in different parts of the hills of South India.

Nilgiri Langur (*Presbytis johnii*) is an endemic species to the Western Ghats in South India. The species once enjoyed a wide distribution in its range, but has declined considerably in number today due to hunting and habitat destruction [Daniel and Kannan 1967, Kurup 1975]. It is the most threatened and highly endangered than any other species of Indian monkeys. [Cristata 1961, Wolf and Fleagle 1970, Brotoiworo 1979]. The beauty of its fur and the supposed medicinal value of its flesh, blood and organs have caused them to be hunted more than any other species of Indian monkeys. Consequently this species has become severely threatened. Due to habitat destruction and deforestation

in the low elevation areas they have withdrawn to the high ranges of South India where also they survive only in protected areas.

Preliminary observations on the Nilgiri Langur were conducted by Grigg (1880), Leigh (1926 a,b); Lindsay (1926); McCann (1933); Pocock (1928); Prater (1965); Ryley (1913); and Sterndale (1884). Studies have been conducted on the ecology and social behaviour of the species by Poirier (1964; 1966, 1968a, 1968b, 1968c,1969, 1970a, 1970b) at the Annamalais, where the habitat is moist deciduous. Daniel and Kannan (1967) and Kurup (1975) have described the status of the species in south India including Annamalai Hills, Cardomom Hills and Nilgiri Hills. Female emigration in Nilgiri Langur has been documented by Ali *et. al* (1981) while the breeding seasons of the species have been described by Leigh, (1926).

Primates and Squirrels consume buds, leaves flowers and fruits of a variety of plants. Resource utilization by frugivorous birds attending figs in the forests of Kerala has been studied by Vijayakumar (1994). But no similar studies have been carried out on the arboreal mammals in Kerala which consume a large quantity of figs and other fruits. Some studies on the food habits of the Nilgiri Langur have been conducted by Poirier (1964, 1967, 1970) Horwich (1972, 1972a, 1976), while that of the Bonnet Macaque was carried out by Nolte (1955), Simonds (1965), Kuruvilla

(1976) and Ali (1986). Social life of the Bonnet Macaque was studied by Sugiyama (1971). But no studies have been conducted on its sharing of different food plant resources with other arboreal mammals like Bonnet Macaque and Giant Squirrel. Borges (1989, 1992) has studied the foraging ecology of the Malabar Giant Squirrel while a preliminary account on the food habits of the Flying Squirrel was prepared by Zacharias and Bhardwaj (1998). The studies on the Nilgiri Langur, carried out were mostly in the Anamalais, while that of the Bonnet Macaque were carried out in Mundanthurai both in the Tamil Nadu. Studies on the Giant Squirrel were conducted in Karnataka and Maharashtra (Borges 1989). All the above studies however do not adequately cover the evergreen habitats of Southern Western Ghats which is an ecologically important area. The sharing of resources by the Nilgiri Langur and the Malabar Giant Squirrel which use similar food plants has not been well known since the studies on the Giant Squirrel were conducted in an area where the Nilgiri Langur does not occur.

In Periyar, Kerala some short term studies were conducted on the social structure of Nilgiri Langur by Tanaka (1965), behavioural rhythms, whooping display food habits, and home range by Horwich (1972, 1972a, 1976, 1980) and food habits and behaviour by Srivastava *et. al* (1996). However the above studies were of short-term duration and did not

provide detailed information on the seasonal variation in the food habits of the Nilgiri Langur in the wet evergreen forests, the favourite habitat of the species. Also, there is no information on the changes in the troopsize of the Nilgiri Langur, and the quality of the food used in different months by the species in Periyar. Information on the food and feeding behaviour of a species is essential for its conservation and management. It is also important to know the relationship between ecology and social problems (eg. troopsize, intra-troop relations and social changes). The emigration and immigration of members in social group is likely to be related to the quality of the habitat. Knowledge of the natural diet of Nilgiri Langur in different seasons would be necessary for formulating management strategies for the species and useful in the captive breeding, if taken up.

New leaves and fruits are prominent components in the diets of vertebrate primary consumers. To investigate the annual production patterns of new leaves and fruits a study was carried out in Periyar, to determine annual leaf fall, new leaf production patterns, fruit production and flower production of plant species. Knowledge of the phenology of the fruiting plants, especially the ripening time of the fruits and the selection of different food plants by various mammals in different seasons would also be useful for formulating management strategies of the reserve. There are several explanation for the evolution of the timing of life cycle

events in trees. Success of wild life management depends on the sustainable supply of the required food materials in sufficient quantity and quality. Qualitative information on the food helps the establishment of nutritional guidelines and thereby better management.

There exists a mutualistic relation between plants and frugivorous mammals. Plants provide food for these animals on the one hand and get dispersed by animals on the other hand. The role of frugivorous mammals in the dispersal of plants has been well established. Since tropical rainforests have been disappearing or undergoing conversion fast, the importance of frugivorous animals in the regeneration of forests cannot be underestimated. Dispersers play in integral role in the natural dynamics of tropical forests. (Snow 1966, Howe & van de Kerckhove 1979, Lieberman *et. al* 1979, Gentry 1982, Howe & Small wood 1982, Stiles 1985, Estrada & Fleming 1986, Terborgh 1986, Whitemore 1991). Therefore it is essential to retain dispersers in the forest ecosystem for effective tree generation (Bawa *et. al* 1989).

A study on the food habits of the Nilgiri Langur, the Bonnet Macaque and the Malabar Giant Squirrel has been carried out in the high ranges of Kerala from 1993 – 1996. The studies were centred at Periyar Tiger Reserve, though random observations were carried out outside the reserve. Detailed studies were conducted on the Nilgiri Langur; its

troopsize changes, seasonal variation in the food habits, and its preference different food plants, with a view to identifying the ecological requirements of the species in Periyar. Observations on the food habits of the Malabar Giant Squirrel and the Bonnet Macaque were also carried out for studying the interaction and competition for utilising the food resources if any. Casual observations were also conducted on the Flying Squirrels in the reserve and the nearby plantations.

Intensive studies were centred around the Thekkady area of Periyar Tiger Reserve which resemble a Peninsula pushing into the Periyar lake. The Peninsula is about 1.5km in length and 0.2 to 0.4km in width. A road runs through the peninsula from the 'boat landing' to Kumily, the nearby village. Vegetation from the border (check post) of the reserve to the middle of the Peninsula comprises deciduous trees with the teak forming the major portion. From the middle to the end of the Peninsula the vegetation is of evergreen type.

Chapter — 2

STUDY AREA

Periyar Tiger Reserve, situated on the Western Ghats in the Iduki district of Kerala lies between 09°16' and 9°40' North and between 76°55' and 077°26' East and has an area of 777 km^2. It is bordered on the West and North by Peermedu Taluk of the Iduki district, on the South by the Pathanamthitta District and on the North East, East and South East by Madurai and Thirunelveli districts of Tamil Nadu (Fig 1). The reserve and its adjoining areas in the North and West together could be described as Periyar plateau. The height of the reserve ranges from 400-2019m and several peaks rise above 2000 M and the terrain is undulating.

Climate

Periyar has a humid climate with temperature varying from 15 to 31°C and an average rainfall of 2500mm. July has the heaviest rainfall (Table 1 and 2). There is however, variation in the amount of rainfall in different parts of the reserve (Table 3). November to January are cooler months and March to April are hotter months.

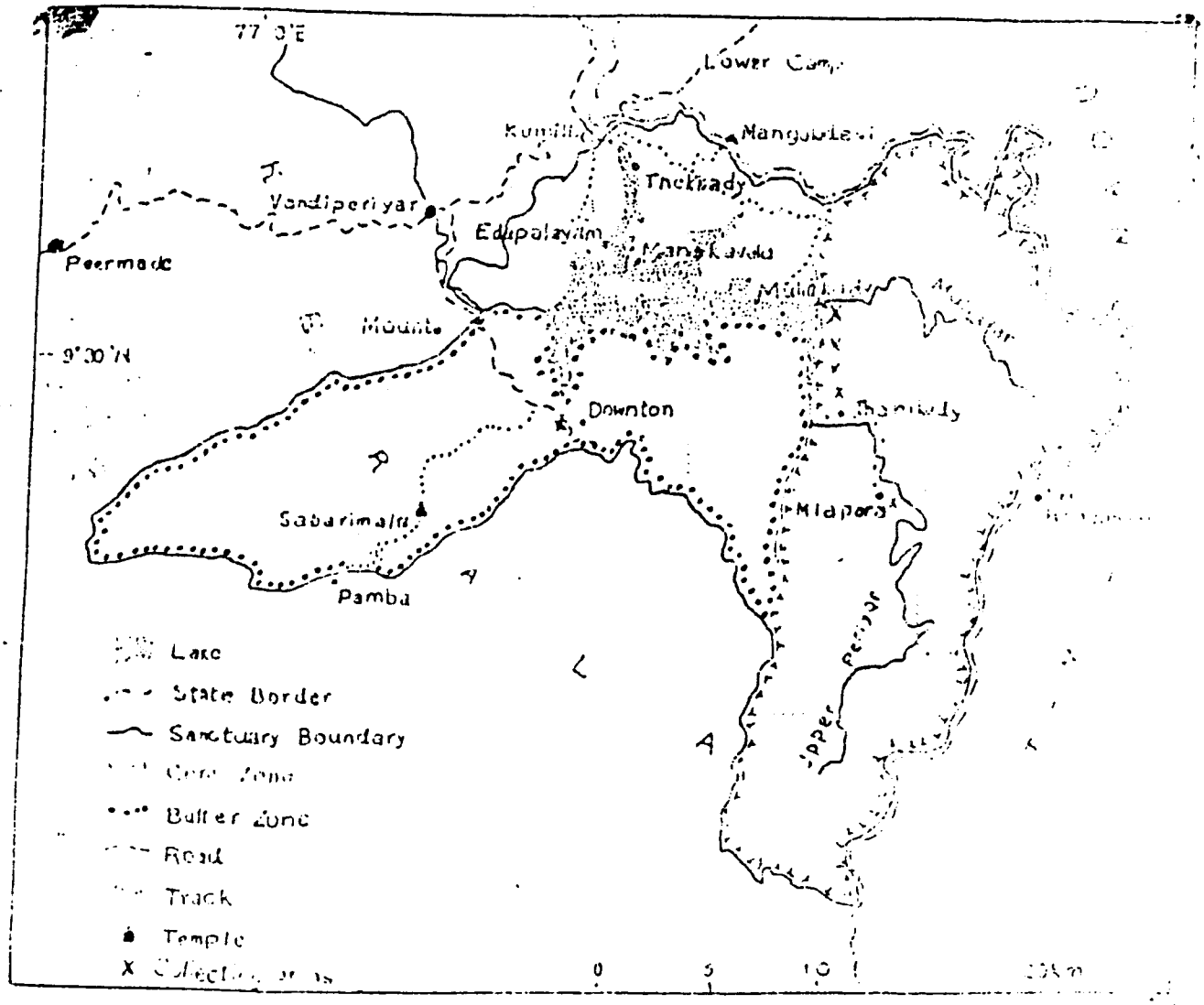


Fig. 1 MAP OF PERIYAR TIGER RESERVE.

Table – 1

Temperature in Periyar (1994 – 95)

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Average Minimum Value	18.37	19.47	20.02	22.1	21.69	20.7	20.59	20.39	20.58	20.73	19.91	18.98
Average Maximum Value	25.5	27.88	30.3	30.59	29.36	25.36	25.58	26.03	26.47	26.61	24.35	25.68

Table – 2

Rainfall in Periyar (1992-95)

Year	Periyar Dam in mm.	Thekkady in mm.	Mullakudy in mm.	Manakavala in mm.
1992	3275.00	3104.00	1530.00	1078.00
1993	1898.63	1200.00	1175.00	1124.00
1994	2413.00	1925.00	1085.00	1117.00
1995	2410.00	1805.00	973.00	1240.00
Total	9996.63	8034.00	4763.00	4559.50

Table - 3

Rainfall of four stations by Months in the study area

Month	Thekkady in mm.	Manakavala in mm.	Mullaperiyar in mm.	Mullakudy in mm.
Jan.	7	Nil	Nil	Nil
Feb.	Nil	1	36	3.5
Mar.	Nil	Nil	Nil	Nil
Apr.	132	77.5	46	70
May	224	141.5	206	82
June	522	239	812	341
July	585	301	716	305.5
Aug.	222	26	331	143.5
Sep.	72	15.5	119	58.5
Oct.	198	50	208	144
Nov.	210	10	113	104.5
Dec.	22	1.5	5	4

Hydrology

The sanctuary has two river basins, Mullayar and Periyar with numerous perennial and seasonal tributaries. River Periyar orginates from Chokkampetti – Kallimala at Sivagirimettu and Mullayar from Kottamalai. These two rivers join together to form Mullaperiyar river, which was impounded by the construction of the Mullaperiyar dam in

1895, resulting in the formation of a lake of about 26km^2. Around the lake the elevation is about 950M.

Vegetation

The following types of vegetation have been identified in the reserve, [Chandrasekharan 1973] viz, the tropical evergreen forests (305 km^2) tropical semi evergreen forests (275Km^2) moist deciduous forests (98km^2) grasslands (12km^2) eucalyptus plantations (55km^2) and reeds of approximately about 5km^2 (Table 4).

Grasslands in the core area are of Savannah type, probably because of the annual fire. The high hills are covered with grasses. Bourdillon (1983) has described the grasslands of Periyar being grazed by cattle coming in large numbers from the Eastern side of Tamil Nadu and forest fire made by the graziers. He has described the submerged areas of the lake having marshy vegetation, sandy river bed and patches of forests in between hillocks.

The evergreen forests, major portions of which is in the core area have tall trees with almost closed canopy. Trees which are common to this biotype are *Vateria indica, Mesua ferrea, Artocarpus hirsuta, Elaeocarpus tuberculatus, Elaeocarpus serratus, Myristica doctyloides, Cullenia exarillata, Evodia lunu ankenda and Hopea parviflora.* Climbers such as

canes (*Calamus* spp) and bamboo reeds (*Ochlandra* spp) also occur here, the latter mostly in swampy areas.

Table – 4

Classification of the habitat types in the study area

Area Km	Vegetation Type		Tree	Shrub	Herb	Grass/Reeds
35	West Coast Evergreen		Mesuaferrea Canarium strictum Cullenia exarillata Evodia lunu ankenda	Strobilanthes spp. Apama siliquosa Curcuma spp.	Elatostemma sessile E. lineolatum	Ochlandrascriptoroia O. travancorica Bambusa arundinacea
275	West Coast Semi evergreen		Dysoxylum malabaricum Persea macrantha Holigama grahemii	Strobilanthes spp. Solanum verbascifolium	Knoxiamollis Bidens pilosa Tridax procumbens	Cyrtococcum oxyphyllum Oplismenus compositus
98	Southern moist mixed deciduous forest		Tectona grandis Dalbergia latifolia Terminalia paniculata Pterocarpus marsupium	Helicteres isora Lantana aculeata	Hackeria subpeltata Mimosa pudica Peristrophe montana	Cyrtococcum oxyphyllum Oplismenus compositus, Digitaria spp.
	South Indian Trophical Hill Savannah		Terminalia paniculata T.chebula Pterocarpus marsupium Phyllanthu embilica	Vernonia Indica Desmodium pulchellum	Crotalaria spp. Desmodium spp.	Themada cymbaria T.triandra Cymbopogon flexuosus
12	Grass Land	1. Hill top 2. Hill slop 3. Lake share				Chrysopogon orientalis Evagrostiella bifaria Themeda cymbaria T.triandra Panicum repens Cynodon dactylon
55	Plantation		Eucalyptus grandis	Lantana aculeata	Curculigo orchioides	Cymbopogon flexuosus Themeda cymbaria T.triandra

Major tree species in the deciduous forests are *Dalbergia latifiolia, Lagerstromia lanceolata, Pterocarpus marsupium, Terminalia bellarica, Terminalia paniculata, Terminalia chebula, Emblica officinalis, Grewia tiliaefolia and Bombax malabaricum. Lantana aculeata and*

Eupatorium odoratum grow as dense understory at several places in the deciduous biotope.

Fauna

Arboreal animals of Periyar comprise the Nilgiri Langur *Presbytis johnii,* the Liontailed Macaque, *Macaca silenus,* the Bonnet Macaque, *Macaca radiata* the Malabar Giant Squirrel, *Ratufa indica*, the Large Flying Squirrel, *Petaurista petaurista*, the Small Flying Squirrel, *Petinomys fuscocapillus* and the Threestriped Palm squirrel, *Funambulus palmarum.* Tanaka (1965) has listed the Hanuman Langur, *Presbytis entelles* also in Periyar which was not met with during this study. A large number of bats and frugivorous birds such as Hornbills, Pigeons and Parakeets shared the fruits and seeds of the plants eaten by the arboreal mammals in the reserve.

The tourist zone of the reserve where the study area was centred, harboured the Nilgiri Langur, the Bonnet Macacque, the Malabar Giant Squirrel, the Large Flying Squirrel, the Threestriped Palm squirrel, and frugivorous birds such as Hornbills, Pigeons, Barbets and Parakeets.

Chapter — 3

MATERIALS AND METHODS

The Nilgiri Langur (Presbytis johnii) in Periyar Tiger Reserve was studied over a three year period from April 1993 to May 1996 in the Thekkady area. The Langur troops in the study area were accustomed to people because of the large number of tourists visiting the reserve. Even then they were wary, moving away when the observations started. It took 2-3 months for the Langur troops to get habituated with the observer. This habituation enabled to identify individuals in the troop and observe them closely.

Two troops of the Nilgiri Langur were selected for intensive study. These troops had identifiable individuals in them; one right leg paralised female in troop I and stump tailed female in troop II. Aspects such as troop size, composition of various age groups, and sex of individuals in these groups were recorded. Two individuals (one adult male and an adult female) in each of these two groups were observed for time budget study and their food habits and behavioural patterns were recorded at one hour interval. Observations were carried out with binocular on 6 days every month, from dawn to dusk. Random observations were carried out on three other groups. All observations were assisted by a botanist and a field watcher.

In the beginning it was difficult to distinguish males from females in the Nilgiri Langur troops or individual males from other males by observing only their coat colours or appearance. Depending on the crotch of an individual whether white in a triangular from or not, females were distinguished from males.

The total number of the members of each troop was counted during their movement from one place to another. Nilgiri Langur troops in the study area always followed a specific path, the path followed by the first monkey. Their number, approximate age, size and sex were confirmed when they jump from one branch to another, or move across the road.

Food and feeding habits of the Nilgiri Langur were studied mostly by direct observations in the field. The stages of fruit (ripe/unripe), methods of fruit handling and rate of consumption during different months were also noted. The following typology was used for the various parts of food plants. 1. Fruits: juicy and dry fruits 2. Leaf: Tender and mature leaves 3. Stem: stems and wings 4. Other plant parts: flowers, bark and petioles.

Fecal samples were collected, twice in a month. Samples were strained in a sieve with water and dried on filter paper. Dry samples were

examined under a microscope. Only intact seeds were included in the analysis.

Resource utilization of other arboreal mammals such as Bonnet Macaque and the Malabar Giant Squirrel, was also recorded using the same methodology, along with that of the Nilgiri Langur though not as intensively. Casual observations on the food habits of the Large Flying Squirrel and the Threestriped Palm Squirrel were also carried out. Observations on the food habits of the Giant Squirrels and Bonnet Macaques in the study area were carried out once in every week. The Giant Squirrels are shy, where as the Bonnet Macaque are accustomed to the large number of tourists visiting the reserve. In cases where they share same plant species, the type of the resource (eg. leaf, bark) and time spend by each species are recorded. In the case of Large Flying Squirrel and the Palm Squirrel there were no systematic observations.

Altogether about 3000 hrs were spent in the field. Feeding records were analysed by summing up the total number of observations for each food species or plant part and expressing these as percentages of the total number of feeding records collected. These proportions were regarded as estimates of the proportion of time which the animals spent feeding on each food species or part. Feeding observations were pooled for every month.

Almost all species of food plants in the study area were collected and their phenology was recorded every month. Most of the plant species and parts eaten could be identified in the field. In certain cases, leaves, fragments of leaves, flowers and fruits which had fallen to the ground were collected, brought to the laboratory and identified with the help of flora of British India volumes.

Forest was stratified according to the height of plants. Strata of the forest were recorded as : level i,a understory 0.5 – 1m, level i,b low shrub 1-2m height, level ii tall shrubs 2 – 4m height, level iii short trees 4 –10m height, level iv tall trees10 – 30m height.

Biochemical Analysis

Leaves, fruits and flowers of some of the preferred food plants were collected, dried, powdered and stored in a desicater for analysis.

Collection and Preparation of Plant Samples

All samples were dried as rapidly as possible after collection, so as to reduce chemical and biological changes to a minimum. Considerable loss in dry weight may occur, due to respiration, while proteins are also broken down to simpler nitrogeneous compounds if drying is unduly delayed. Drying is most conveniently carried out at a temperature of 60°C to 70°C. Original sample was ground by hand or porcelain mortar and

sieved. After grinding, samples were mixed thoroughly, transferred to suitable bottles, labelled clearly and tightly corked. Along with fruits, flowers and leaves were also collected in different seasons and their carbohydrate, protein and lipid were estimated. Total soluble carbohydrates were obtained using the anthrone method. Proteins were analysed using modified biuret method and lipids by sulpho-phospho vanilin method.

Chapter — 4

TROOPSIZE, COMPOSITION AND POPULATION DYNAMICS

Troopsize of the Nilgiri Langur, *Presbytis johnii* in Periyar during the present study varied from 8-27. Composition of each of the five troops observed from January 1993 to December 1996 and the babies born from 1993 to 1996 is given in table 5 & 6. Of these troops, 2 are unimale hetero sexual troops, 2 are multimale hetero sexual troops and one, an all male troop. The following proportion of various age classes are observed in these troops; adult male 9.8%, adult female 38%, sub adult male 18.6%, sub adult female 14%, Juveniles 14%, and infants 5.6%.

Sex ratio was in favour of females. Adult females formed about a third of the total number of the troop members. The homerange of the Nilgiri Langur in the Thekkady area is small in size, when compared to that in the other areas of the reserve. Troopsize seems to be varying with areas; troops with large number of individuals were seen in the tourism zone and in the well protected inner areas of the core zone, while small number of individuals were seen in the boarder areas of the reserve, where human activity is intense and habitat degraded. It seems in the troopsize and size of the homerange, the Nilgiri Langur is influenced by the quality of the habitat in Periyar.

Table – 5a

Troop I – Right Leg Paralysed Female Troop (RLPF) size and composition from 9/93 to 3/96

Month & Year	Adults		Sub adults		Juveniles	Infants	Troop
	Male	Female	Male	Female			
9/93	3	6	8	-	-	6	23
3/94	5	6	9	-	3	-	23
9/94	2	6	8	-	3	-	19
3/95	2	4	-	-	-	-	6
9/95	2	4	-	-	-	3	9
3/96	1	4	-	-	3	-	8

Table – 5b

Troop II – Stumb Tailed Female Troop (STF) size and composition from 9/93 to 3/96

Month & Year	Adults		Sub adults		Juveniles	Infants	Troop
	Male	Female	Male	Female			
9/93	2	7	4	2	4	1	20
3/94	2	7	5	3	4	-	21
9/94	2	7	5	3	4	2	23
3/95	2	7	5	3	4	3	24
9/95	3	8	6	3	5	1	26
3/96	3	8	7	3	5	1	27

Table – 5c

Troop III – size and composition from 9/93 to 3/96

Month & Year	Adults		Sub adults		Juveniles	Infants	Troop
	Male	Female	Male	Female			
9/93	2	8	-	-	2	2	14
3/94	2	8	-	-	3	2	15
9/94	2	8	-	-	5	1	16
3/95	2	8	2	2	4	1	19
9/95	2	8	3	5	1	-	19
3/96	2	8	3	5	1	2	21

Table – 5d

Troop IV – size and composition from 9/93 to 3/96

Month & Year	Adults		Sub adults		Juveniles	Infants	Troop
	Male	Female	Male	Female			
9/93	1	5	-	2	-	-	8
3/94	1	5	-	2	-	-	8
9/94	1	6	-	1	3	1	12
3/95	1	6	-	1	4	2	14
9/95	1	7	-	-	6	-	14
3/96	1	7	3	2	1	1	15

Table – 5e

Troop V – all male Troop size and composition from 9/94 to 3/96

Month & Year	Adults		Sub adults		Juveniles	Infants	Troop
	Male	Female	Male	Female			
9/93							
3/94	Troop not formed						
9/94	4	-	-	-	-	-	4
3/95	6	-	6	-	3	-	15
9/95	7	-	8	-	-	-	15
3/96	8	-	8	-	-	-	16

Formation of New Troop

An all male troop formed in 1994 (Table 5e) is a split away part of the RLPF troop. The formation of this can be better understood with the help of table (5a & e). The troopsize of the parent troop was 23 at the beginning of the split. In 1994 June, 4 adult males left the troop. In july 1994, two subadult males followed. By the end of October 1994, the size of the new troop increased to 15 with the subadults and the juveniles from the parental troop. By this time, the strength of the parental troop was reduced to 8; 2 adult males and 6 adult females. In January 1995, 2 adult females joined the all male troop and stayed for a short period of 2 weeks with the troop. Then they left the troop and joined another all male troop (9 adult) of the adjacent territory. In July 1995, one of the adult males

from the parent troop also joined the first all male troop increasing its size to 16.

Several curious behaviour patterns were seen within the all male troop. The troop didn't have a well defined home range. The troop members roam about in a wide area for foraging and frequent conflicts with adjacent troops due to trespassing are usual. Their movements were faster when compared to that of other troops. While crossing the road, they preferred walking or running along the road. They were found tolerating human presence to a great extent when compared to the other troops of the area. Playing and mounting activities were maximum in this troop.

Table – 6

Nilgiri Langur infants born in different months

Month	Year			
	1993	1994	1995	1996
January			1	1
February			2	1
March			1	1
April		2		
May		1		
June		2		
July	1		1	
August		1	2	
September		2	1	
October				
November				
December		1		

According to Ali *et. al* (1985) the presence of all male bands in the Nilgiri Langur indicate that the habitat is suboptimal in Periyar and the reason for the formation of all male troop is not known.

Mating and Birth

Mounting is usually observed in Nilgiri Langur among sub adults and juveniles regardless of sex (male-male, male-female). Mating of adult individuals was observed only once during day time; on 23.6.1994. The day was cloudy and with sporadic rain. The STF troop was near the forest Range Office around 10.05 AM. All members of the troop were active with playing feeding and moving around. At 10.35, the dominant adult male was found mounting an adult female. This activity lasted for about 15 seconds. Unlike play mounting, here the erected penis of the male was clearly visible. The mating pair was little away from the feeding site of the other members. They were sitting on a teak tree about 8m height. The male made a strange call before starting the mounting and continued it throughout mounting. This type of call is commonly heard in usual play mounting of sub adults and juveniles. But the pitch of the mating male was little high. After mating, both of them rested for about 10 minutes, then they started moving and the male resumed feeding followed by the female.

New births were noticed in almost all months of the year (Table 6) except in October and November. The infants were reddish brown and their colour changes to jet black within three months. There is a considerable degree of infant transfer among females of a troop, but suckling by the foster mother was not observed. Infant transferring occurred only among adult females. Sub adults and juvenile females never tried to take infant from its mother, nor were they ever recipients in infant transferring sequences as described by Poirier (1968a). The reproductive success of the observed troops, expressed by the ratio of births to adult females (KOFORD, 1965) was fairly high. Twentyone out of thirty adult females which were counted, were associated with infants under one year, a reproductive success of 70% according to Poirier (1968).

It may also be noted that there was no emigration or immigration in troop II, III and IV. The troopsize increased from 20 to 27 (Troop II), 14 to 21 (Troop III), 8 to 15 (Troop IV), ie. the average number of infants born in these troops during 1993-1996 was constant (Table 5). The ratio of infants to adult females were same ie. 27:19; during 1994 and 1995 (Table 5). Nineteen out of the twentyseven adult females were associated with infants/juveniles under one year, a reproductive success of 70%. The interval between 2 gestation period in two identifiable individual females, is calculated to be about 2 years.

Mortality

One of the major reasons for mortality seems to be predation. Though 90% of the Leopard scats contained hair of Nilgiri Langur, no predation was observed in the field. On one occasion a juvenile Langur was observed being eaten by an Eagle, *Owl Bubo zeylonensis* and on another occasion an infant Langur was observed falling from the talon of a Black Eagle. Predation attempts by the Black Eagle were observed on two occasions during the period of study. Two Nilgiri Langurs were electrocuted while a third one fell to the road and succumbed to injuries while jumping from one tree to another on the opposite side of the road.

In addition to the above, a number of Nilgiri Langurs have been killed by Ganja cultivators camping inside the forest. The forest staff on a couple of times have come across skin of Nilgiri Langur during "Ganja Operations".

Chapter – 5

PHENOLOGY

Phenology patterns of 132 tree species in the study area were recorded. Of these fiftyseven percent were deciduous, while the rest evergreen (43%). Phenological traits like leaf fall and leaf flush were pronounced in the drier half of the year. (Table 8 and Fig 2). The deciduous plants shed their leaves during December, January, February, March and April months. But in evergreen plants, there was no pronounced leaf shed and leaf flush. However fruit production and flowering continue throughout the year for both deciduous and evergreen plants (Table 7). Patterns of plant phenology in tropical forest invariably indicate that the availability of plant reproductive parts seasonal (Medway 1972, Foster 1982 a, Peres 1994). There is no definite fruiting season in Periyar and fruits will be available here throughout the year. In other words, there would be some trees with fruits in the study area all the time. Ripe, nearly ripe and unripe fruits were available simultaneously throughout the year (Table 7).

Analysis of the data has indicated that although the number of species in fruit were maximum in July, the Nilgiri Langur selected only seven plants from the seventyone fruit plants during this period. Hence

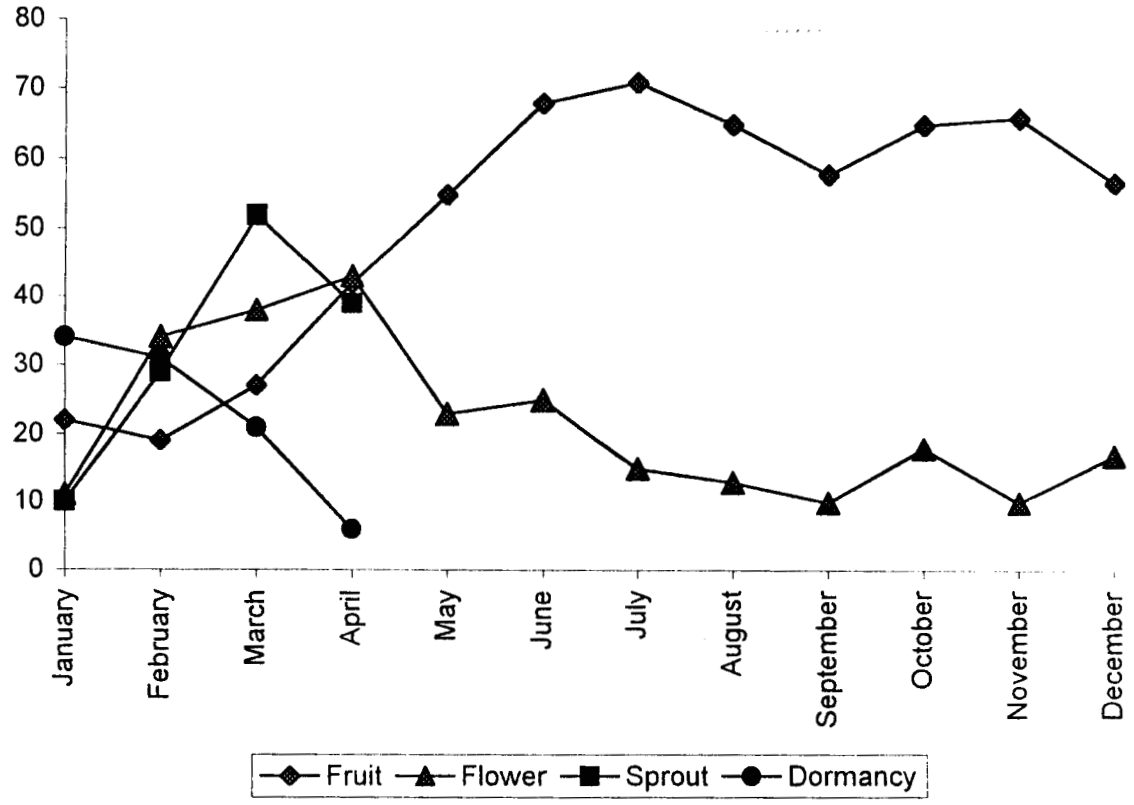
there is no relation between the number of fruiting trees and consumption of fruits.

Table – 8

Number of plants in different phenological stages and selected plants at different months in an year

Sl. No	Month	Number of Plants having				Number of selected fruits plant
		Fruit	Flower	Sprout	Dormancy	
1.	January	22	11	10	34	4
2.	February	19	34	29	31	5
3.	March	27	38	52	21	11
4.	April	42	43	39	6	6
5.	May	55	23			12
6.	June	68	25			11
7.	July	71	15			7
8.	August	65	13			18
9.	September	58	10			16
10.	October	65	18			22
11.	November	66	10			11
12.	December	57	17			18

Fig.2 Graphical Representation of Table 8



The duration of fruiting also varied in different plant species. Certain plants have a fruiting period of six months; (June/July to December), while certain others have more than six months duration ie. *Hydonocarpus laurifolia* have a fruiting period of ten months duration and rest of the trees have a fruiting period of less than six months (3 to 5 months).

Phenological traits of certain figs have some specificity. Of the twelve fig species observed in the study area, three have two fruiting periods. They are *Ficus amplissima* (May to June and October to December), *Ficus exaspirata* (May to June and October to December and *Ficus mysorensis* (April to June and January to March). This character makes their fruits available to tropical frugivorous animals throughout the year. Various Ficus species show intraspecific asynchrony in fruit production (Newton & Lomo 1979; Janzen 1979; Milton *et.al* 1982). Intervals between fruit crops may also be short. Fig trees bearing more than one crop per annum have been reported by various authors; (Hill 1967; Newton & Lomo 1979). Several fig plant species have one fruit crop per year. Most of the tropical fig trees which show intraspecific synchrony and a consistent season of annual fruit production, produce, at best one fruit crop per year (Koelmeyer 1961; Fankie; Baker & Opler 1974; Foster 1982).

Table – 7

Phenology of trees in the study area

Sl. No.	Botanical Name	Family	Season of			
			Dormancy	Vegetative growth	Flowering	Fruiting
1.	*Dillenia pentagyna*	Dilleniaceae	Jan-Feb	May	Mar-Apr	May-July
2.	*Meiogyne pannosa*	Annonaceae	Evergreen	Dec-Jan	Jan-April	April-Sep
3.	*Polyalthia longifolia*	Annonaceae	Evergreen	Feb-Mar	Apr-May	June-Dec
4.	*Bixa orellana*	Bixaceae	Evergreen	-	Apr-July	June-Sep
5.	*Flacourtia montana*	Bixaceae	Evergreen	Nov-Dec	Nov-Feb	Mar-May
6.	*Hydnocarpus laurifolia*	Bixaceae	Evergreen	Feb-June	Feb-June	Mar-Jan
7.	*Xanthophyllum flavescens*	Polygalaceae	Evergreen	Dec-Feb	Feb-May	Mar-Sep
8.	*Calophyllum polyanthum*	Clusiaceae	Evergreen	-	Jan-Mar	June-Dec
9.	*Bombax ceiba*	Bombacaceae	Dec-Feb	Mar-May	Nov –Feb	Feb-Apr
10.	*B.insigne*	Bombacaceae	Dec-Feb	Feb-Mar	Nov-Feb	Feb-Apr
11.	*Sterculia guttata*	Sterculiaceae	Jan-Feb	Feb-Apr	Aug-Sep	Sep-Jan
12.	*S.villosa*	Sterculiaceae	Dec-Jan	Feb-Mar	Feb-Mar	May-Dec
13.	*Eriolaena quinguelocularis*	Sterculiaceae	-	-	May-Aug	July-Dec
14.	*Grewia tiliaefolia*	Tiliaceae	Dec-Feb	Mar-Apr	Apr-June	June-Aug
15.	*G.disperma*	Tiliaceae	-	-	July-Sep	Sep-Jan
16.	*Elacocarpus oblongus*	Elaeocarpaceae	Evergreen	-	May-July	July-Dec
17.	*E. tuberculatus*	Elaeocarpaceae	Evergreen	-	Dec-Mar	Apr-Sep
18.	*Alcronychia laurifolia*	Rutaceae	Evergreen	-	May-July	July-Dec
19.	*Clausena indica*	Rutaceae	Dec-Feb	Feb-Mar	Mar-Apr	May-July
20.	*Evodia lunu-ankenda*	Rutaceae	Evergreen	-	June-Aug	Aug-Jan
21.	*Canarium strictum*	Burseraceae	Dec-Jan	Jan-Feb	Mar-May	June-Dec
22.	*Amoora rohituka*	Meliaceae	Evergreen	-	June-Aug	Sep-May
23.	*Dysoxylum malabarium*	Meliaceae	Evergreen	-	Jan-Mar	Apr-Sep
24.	*Heynea trijuga*	Meliaceae	Dec-Jan	Jan-Mar	Mar-July	June-Dec
25.	*Mappia foetida*	Icacinaceae	Apr-May	June-July	July-Aug	Aug-Dec
26.	*Zizyhus rugosa*	Rhamnaceae	Dec-Jan	Feb-Mar	Mar-Apr	Apr-May

Sl. No.	Botanical Name	Family	Season of			
			Dormancy	Vegetative growth	Flowering	Fruiting
27.	*Turpinia malabarica*	Staplyleaceae	Evergreen	-	Dec-Feb	Apr-Aug
28.	*Allophylus rheedii*	Sapindaceae	Jan-Mar	Apr-May	Apr-May	June-Sep
29.	*Democarpus longana*	Sapindaceae	Evergreen	Jan-Feb	Feb-Mar	Apr-July
30.	*Filicium decipiens*	Sapindaceae	Evergreen	Jan-Feb	Oct-Dec	Jan-Mar
31.	*Harpullia unbricata*	Sapindaceae	Dec-Jan	Jan-Feb	Jan-Mar	Mar-July
32.	*Schleichera trijuga*	Sapindaceae	Dec-Jan	Jan-Feb	Feb-Mar	Apr-June
33.	*Meliosma pinnata*	Sabiaceae	Jan-Feb	Mar-Apr	Apr-June	June-Sep
34.	*M. simplicifolia*	Sabiaceae	Evergreen	-	May-July	Aug-Dec
35.	*Buchanania lanzan*	Anacardiaceae	Nov-Jan	Feb-Mar	Feb-Mar	Apr-Nov
36.	*Holigarna grahamii*	Anacardiaceae	Jan-Mar	Apr-May	Oct-Dec	Nov-Feb
37.	*Lannea coromandelica*	Anacardiaceae	Dec-Jan	Mar-Apr	Feb-Mar	May-July
38.	*Mangifera indica*	Anacardiaceae	December	Jan-Feb	Jan-Feb	Mar-July
39.	*Spondias pinnata*	Anacardiaceae	Jan-Feb	Feb-Mar	Feb-Apr	May-Sep
40.	*Dalbergia latifolia*	Fabaceae	Dec-Jan	Feb-Mar	Apr-May	June-Dec
41.	*Erythrina variegata*	Fabaceae	Dec-Jan	April	Feb-Mar	Mar-Apr
42.	*Pterocarpus marsupium*	Fabaceae	Jan-Feb	Mar-Apr	May-July	July-Dec
43.	*Acrocarpus fraxinifolius*	Cassalpiniaceae	Nov-Dec	Jan-Feb	Dec-Jan	Mar-May
44.	*Cassia fistula*	Cassalpiniaceae	Dec-Feb	Mar-Apr	Apr-May	June-Dec
45.	*Delonix regia*	Cassalpiniaceae	Jan-Feb	Mar-Apr	Apr-June	July-Dec
46.	*Tamarindus indiens*	Cassalpiniaceae	Jan-Mar	Apr-May	May-June	July-Mar
47.	*Albizzia odoratissima*	Mimosae	Dec-Feb	Mar-Apr	Apr-June	July-Dec
48.	*Prunus ceyylanica*	Rosaceae	Evergreen	-	Oct-Dec	Jan-Mar
49.	*Anogeissus latifolia*	Combretaceae	Jan-Feb	Mar-Apr	July-Aug	Aug-Dec
50.	*Terminalia chebula*	Combretaceae	Jan-Feb	Mar-Apr	Aug-Sep	Oct-Jan
51.	*T. paniculata*	Combretaceae	Jan-Feb	Mar-Apr	Aug-Oct	Oct-Mar
52.	*Eucalyptus globulus*	Mystaceae	Evergreen	-	Apr-June	July-Dec
53.	*E. grandis*	Mystaceae	Evergreen	-	May-June	July-Dec
54.	*Psidium guajava*	Mystaceae	Evergreen	-	Feb-June	Apr-Sep

Sl. No.	Botanical Name	Family	Season of			
			Dormancy	Vegetative growth	Flowering	Fruiting
55.	*Syzygium cumini*	Mystaceae	Dec-Jan	Jan-Feb	Feb-Mar	Mar-May
56.	*S. gardneri*	Mystaceae	Dec-Jan	Jan-Feb	Jan-Mar	Mar-May
57.	*Careya arborea*	Lecythidaceae	Dec-Jan	Mar-Apr	Feb-Mar	Apr-July
58.	*Memycelon malabaricum*	Melastomaceae	Evergreen	-	May-June	June-Aug
59.	*LagerstroemiaFlos-Reginae*	Lythraceae	Jan-Mar	Mar-Apr	Apr-July	July-Mar
60.	*L. lanceolata*	Lythraceae	Jan-Mar	Mar-Apr	Apr-June	July-Mar
61.	*Casearia esculenta*	Samydaceae	Evergreen	-	Mar-May	June-Sep
62.	*Schefflera sp.*	Araliaceae	Evergreen	-	Apr-June	June-Aug
63.	*Viburnum punctuatum*	Caprifoliaceae	Evergreen	-	Dec-Mar	Mar-July
64.	*Mitragyna parvifolia*	Rubiaceae	Dec-Feb	Feb-Apr	July-Aug	Sep-Dec
65.	*Pavetta indica*	Rubiaceae	Jan-Feb	Mar-Apr	Apr-May	May-July
66.	*Plectronia parviflora*	Rubiaceae	Dec-Jan	Feb-Mar	Apr-May	May-July
67.	*P.didyma var.neilgherrensis*	Rubiaceae	Evergreen	-	Mar-May	June-Aug
68.	*Randia dumatorum*	Rubiaceae	Jan-Feb	Mar-Apr	Apr-June	July-Jan
69.	*Vernonia monosis*	Olsteraceae	Evergreen	-	Dec-Feb	Mar-June
70.	*Maesa indica*	Myrsinae	Evergreen	-	Jan-June	June-Jan
71.	*Chrysophyllum lancealatum*	Sapotaceae	Evergreen	-	Feb-Apr	June-Dec
72.	*Mimusops elengi*	Sapotaceae	Evergreen	-	Mar-June	July-Feb
73.	*Diospyros Montana*	Ehenaceae	Jan-Mar	Mar-Apr	Apr-June	June-Feb
74.	*D. ovalifolia*	Ehenaceae	Jan-Mar	Mar-Apr	Apr-June	June-Feb
75.	*Linociera malabarica*	Oleaceae	Evergreen	-	Feb-Mar	Apr-June
76.	*Olea dioica*	Cleaceae	Dec-Feb	Feb-Mar	Feb-Mar	Mar-May
77.	*Alstonia scholaris*	Apocyanaceae	Jan-Feb	Mar-Apr	Oct-Dec	Jan-June
78.	*Rejoua dichotoma*	Apocyanaceae	Jan-Feb	Mar-Apr	Mar-July	Aug-Dec
79.	*Cordia obliqua*	Boraginaceae	Jan-Feb	Mar-Apr	Apr-May	May-Aug
80.	*Ehretia canarensis*	Boraginaceae	Dec-Jan	Feb-Mar	July-Aug	Aug-Sep
81.	*Spathodea campanulata*	Bignoniaceae	Mar-May	Apr-June	Sep-Dec	Nov-Mar

Sl. No.	Botanical Name	Family	Season of			
			Dormancy	Vegetative growth	Flowering	Fruiting
82.	*Radermachera xylocarpa*	Bignoniaceae	Dec-Feb	Mar-Apr	Feb-Apr	Apr-Nov
83.	*Stereospermum suaveolens*	Bignoniaceae	Jan-Feb	Mar-Apr	May-June	July-Dec
84.	*Callicarpa lanata*	Verbenaceae	-	-	Apr-June	July-Dec
85.	*Gmelina arborea*	Verbenaceae	Dec-Jan	Mar-Apr	Feb-Mar	Apr-June
86.	*Tectona grandis*	Verbenaceae	Dec-Mar	Mar-Apr	May-July	July-Feb
87.	*Vitex altissima*	Verbenaceae	-	-	June-July	Aug-Dec
88.	*Myristica dactyloides*	Myristicaceae	Evergreen	-	Oct-Dec	Jan-Aug
89.	*Cinnamomum malabatrum*	Lauraceae	-	-	Jan-Mar	Apr-Oct
90.	*C. Sulphuratum*	Lauraceae	-	-	Jan-Mar	Apr-Aug
91.	*Actinodaphne hirsuta*	Lauraceae	-	-	Aug-Oct	Nov-June
92.	*Litsea bourdilonii*	Lauraceae	-	-	June-July	Aug-Dec
93.	*L. laevigata*	Lauraceae	-	-	Oct-Dec	Jan-July
94.	*L. deccanensis*	Lauraceae	Jan-Feb	Mar-Apr	June-July	Aug-Nov
95.	*L. oleoides*	Lauraceae	-	-	July-Sep	Oct-May
96.	*L. stocksii*	Lauraceae	-	-	Oct-Dec	Dec-June
97.	*Persea macrantha*	Lauraceae	-	Feb-Mar	Dec-Feb	Mar-May
98.	*Phoebe lanceolata*	Lauraceae	-	-	Apr-June	June-Dec
99.	*Santalum album*	Santalaceae	Jan-Feb	Feb-Apr	May-July	Aug-Mar
100.	*Scleropyrum wallichianum*	Santalaceae	-	-	Sep-Oct	Nov-Jan
101.	*Antedesma menasu*	Euphorbiaceae	-	-	Apr-May	June-Aug
102.	*Aporosa spp.*	Euphorbiaceae	Dec-Jan	Feb-Mar	Feb-Mar	May-July
103.	*Bischoffia javanica*	Euphorbiaceae	Dec-Jan	Feb-Mar	Feb-Apr	May-Dec
104.	*Briditia roxhurghiana*	Euphorbiaceae	Jan-Feb	Mar-Apr	May-June	June-Nov
105.	*Croton malabaricus*	Euphorbiaceae	Mar-Apr	Apr-May	May-July	July-Dec
106.	*Emblica officinalis*	Euphorbiaceae	Dec-Jan	Feb-Mar	Feb-May	July-Feb
107.	*Glochidion tomentosum*	Euphorbiaceae	-	-	Apr-June	June-Jan
108.	*Kirganelia reticulata*	Euphorbiaceae	-	-	Sep-Oct	Dec-May
109.	*Mallotus philippinensis*	Euphorbiaceae	Mar-Apr	Apr-May	Aug-Oct	Nov-Mar

Sl. No.	Botanical Name	Family	Season of			
			Dormancy	Vegetative growth	Flowering	Fruiting
110.	*M. tetracoccus*	Euphorbiaceae	-	-	July-Sep	Oct-Feb
111.	*Macaranga peltata*	Euphorbiaceae	-	-	Sep-Nov	Nov-Mar
112.	*Trema orientalis*	Ulmaceae	Jan-Mar	Mar-Apr	Apr-June	June-Sep
113.	*Celtis tetrandra*	Ulmaceae	Dec-Jan	Feb-Mar	May-June	July-Dec12
114.	*Villegrunia integrifolia*	Urticaceae	Evergreen	-	June-July	Aug-Nov
115.	*Artocarpus gomezianus*	Moraceae	Jan-Feb	March	Mar-Apr	May-Aug
116.	*A. hirsutus*	Moraceae	-	-	Dec-Feb	Feb-Aug
117.	*A. integrifolia*	Moraceae	-	-	Oct-Dec	Jan-June
118.	*Ficus amplissima*	Moraceae	Jan-Mar	Mar-Apr	Mar-Apr Sep-Oct	May-June Oct-Dec
119.	*F. beddomei*	Moraceae	Jan-Mar	Mar-Apr	Apr-June	June-Jan
120.	*F. benghalensis*	Moraceae	Evergreen	-	Nov-Jan	Jan-Apr
121.	*F. callosa*	Moraceae	Jan-Mar	Mar-Apr	Mar-May	June-Dec
122.	*F. exasperata*	Moraceae	Feb-Apr	Apr-May	Mar-Apr Sep-Oct	May-June Oct-Dec
123.	*F. hispida*	Moraceae	Feb-Mar	Apr-May	Apr-May Sep-Oct	May-July Oct-Dec
124.	*F. mysorensis*	Moraceae	Feb-Mar	Mar-Apr Sep-Oct	Mar-Apr Oct-Dec	Apr-June
125.	*Ficus nervosa*	Moraceae	Feb-Mar	Mar-Apr	Apr-June	June-Sep
126.	*F. talbotii*	Moraceae	Jan-Mar	Mar-Apr	Jan-Feb	Mar-May
127.	*F. tintoria*	Moraceae	Evergreen	- - - -	May-June	July-Oct
128.	*F. tjakela*	Moraceae	Jan-Feb	Feb-Mar	Dec-Jan	Feb-Apr
129.	*F. virens*	Moraceae	Jan-Feb	Feb-Mar	Nov-Jan	Jan-Mar
130.	*Salix tetrasperma*	Salicaceae	Dec-Jan	Jan-Feb	Dec-Jan	Feb-May
131.	*Rejoua dichotoma*	Apocynaceae	Dec-Jan	Feb-Mar	May-June	Aug-Oct
132.	*Erythrina subumbrans*	Fabaceae	Nov-Dec	Dec-Jan	Jan-Feb	Apr-May

The fruiting patterns of figs exhibit spatiotemporal patchiness (Janzen 1979; Milton *et. al* 1982). Ensuring that some individual figs are in fruit throughout the year within the habitat. Also figs are usually present at low densities in forest ecosystems and individual trees are usually clumped, (Heithaus & Fleming 1978, Gautier-Hion & Michaloud 1989). Owing to these characteristics, it appears that figs can be exploited as a major fruit source by a mobile species with a large homerange and with the ability to track fruiting figs in the habitat.

Thus all the trees in the study area, exhibited phenological traits, that would tend to make their new leaves, flowers and fruits available to primary consumers, especially arboreal mammals almost throughout the year.

Chapter — 6

FEEDING PATTERN AND TECHNIQUES

The Nilgiri Langur in Periyar always moved in compact groups for feeding. Major food plants, like *Terminalia paniculata, Tectona grandis, Dalbergia latifolia, and Pterocarpus marsupium* have a sparse distribution in their homerange. When these plants have good crop, almost all the members of the troop sit scattered on their branches and eat the fruits in one feeding bout, (Table 9) especially during rainy season. In certain cases members of the troop consumed food from different plants at a time; especially during winter and summer months (Table 9).

On arriving at a feeding tree, there was a good deal of commotion for a few minutes until the individuals adjusted distances between them, so as to feed comfortably. They emitted many 'whoo' 'whoo' sounds and contact calls and moved up and down before starting feeding.

The male langur actively defended the territory of the feeding site. Only the adult male of each troop directly involved in the defense. Clashes occurred when a troop trespassed into the territory of a neighbouring troop. The leader male sitting on a tall branch of the tree, opened his mouth, exposed his lower incisors and emitted a continued low pitched sound. Sometimes sounds are produced by biting the teeth.

Table – 9

Variation in the selection of plant resources by different members of Nilgiri Langur in various seasons

Rainy season – June, July

Name of certain Food Plants species	♂ A	♀ A	♂ ♀ SA	Juveniles
Grewia tiliaefolia	x	x	x	x
Tectona grandis	x	x	x	x
Terminalia paniculata	x	x	x	x
Clausena indica	x	x	x	x
Winter season – November, December				
Name of certain Food Plant species	♂ A	♀ A	♂ ♀ SA	Juveniles
Persea macrantha	x	x	x	x
Mallotus philippinensis	x	x	-	-
Doliches falcatus	-	x	-	x
Evodia lunu-ankenda	-	x	x	-
Bambusa vulgaris	x	-	-	-
Summer – March, April				
Name of certain Food Plant species	♂ A	♀ A	♂ ♀ SA	Juveniles
Ficus mysorensis	x	x	x	x
Santalum album	-	x	x	x
Loranthus tomentosus	-	-	x	-
Flacocurtia montana	-	x	x	-

This is often responded by the male of the neighbouring troop. The males quickly raise the head upwards keeping their mouth opened and

closed slightly as if biting the air. The leader male then ran towards the other, often giving 'whoops' grunts and 'hoho' calls.

The male chased the other male into the latters territory only to be chased immediately back to its own territory. After the confrontation, the troops moved in opposite directions to their respective territories and resumed feeding calmly.

The members of a Nilgiri Langur troop modified their pattern of feeding according to the types of food plants eaten. Some items were stripped with the incisors directly from the plant, while others were hand picked and conveyed to the mouth.

Feeding Pattern of Leaves

The method of handling of larger leaves like that of figs and Tectona were different from smaller ones. These leaves were pulled manually off the branch one at a time and then treated individually. But the twig of small leaves were stripped with the incisors and consumed as a whole.

Only rarely the Langur consumed complete leaves. In most cases only parts of the leaves were preferred; others discarded. For example, in the case of Pterocarpus they took flowers and leaves together and discarded after taking a bite. When they took older leaves of Pterocarpus, they consumed petiole of the leaf and dropped out the remaining parts. In

the same way, they consumed the leaves of Santalum, Terminalia, Dalbergia, Acacia and Evodia. At least one third of all food materials were found dropped and wasted by the Langur troops. This was also observed by Poirier (1967).

While eating the whole leaf (eg. Teak leaf), the Langur held the leaf in one hand, rolled the leaf together, then took a bite from the rolled leaf, until it is finished completely or fell down.

Feeding Pattern on Fruits

While smaller individuals fed on terminal fruiting branches, larger ones fed by bending or snapping the fruit twigs, (Fig 3). Feeding pattern on fruits by the Nilgiri Langur depended upon the type of fruits. They consumed simple, aggregate and multiple fruits. In most cases bunch of multiple fruits were stripped with the incisors, dropped down after three or four bites. (eg; *Actinodaphne hirsuta, Cinnamomum malabatrum*). Some other fruits were hand picked and conveyed directly to the mouth. (eg; *Tabernae*).

The Nilgiri Langur consumed only the fleshy part of certain fully ripe fruits and ripe seeds were left. (eg; *Gnetum ula*). The unripe and nearly ripe fruits were crushed and only the seeds were consumed (eg; *Sterculia guttata, Artocarpus hirsuta*). Very rarely they consumed full

Plate I (Fig-3) - Nilgiri Langur

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seed. The Nilgiri Langur couldn't open certain fruits with its incisors. In such cases, the Langur consumed the inner part of the fruits which were opened by the Giant Squirrel. The thorny pericarp of *Artocarpus hirsuta* and *Artocarpus integrifolia* were eaten after they were opened by Malabar Giant Squirrel (*Ratufa indica*).

Daily Activity Pattern of Nilgiri Langur

The Nilgiri Langur travelled an average of 1.5km (range 0.4 to 3 km) from dawn to sunset and spent about 36% of its total activity time for feeding (Srivasthava *et. al.* 1996). The daily activities of the Nilgiri Langur could be classified into three categories; movement, feeding and resting. During day, time spent for feeding alternates with rest and movements to changing feeding locations. Defecation and urination by almost all the members of the troop indicate the stopping of rest and initiation of the next activity – feeding or movement whatever it may be.

Activity patterns are changed with season. In the rainy season the Nilgiri Langur spent more time for feeding, (40.7%) and least time for movements (12.8%), (Table 10). But during summer months (February, March and April) the time spent for resting (40.1%) was higher than that for feeding (31.6%) and movement 12.6% (Table 10). Their rate of movement was higher during August, September, October, November and

December than other months of the year (range, 16.8 – 22.7%), (average, 23.04%) but little time was spent for resting during this period

Table – 10

Percentage of time spent for feeding, resting, movement and other activities by RLPF (Troop I) and STF (Troop II) of Nilgiri Langur at different months in an year during the study

Activity	Jan	Feb	Mar	Ap	May	Ju	July	Aug	Sep	Oct	Nov	Dec	Average time
Feeding	31	27.5	33.1	34.4	40.9	47.2	44	38.5	32.9	33.6	34	30.5	36
Resting	37.2	40.6	42.7	37.2	35.1	40.6	38.6	30.5	26.2	22.2	27.7	28.4	33
Movement	18	13.8	10.4	13.1	14.4	4.1	7.2	16.8	21.7	30.6	23.4	22.7	16.35
Other activities	13.8	18	13.8	15.2	9.7	8.3	10.4	14.5	19.4	19.4	15.2	18.75	14.7

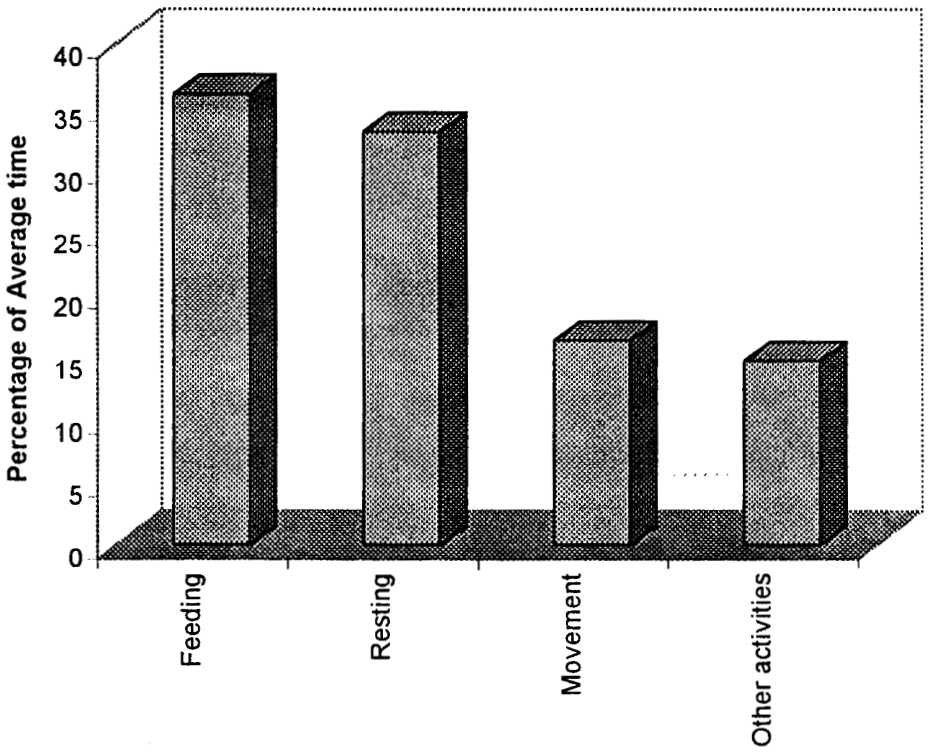
Table – 11

The approximate distance between Troop I and Troop II during the study

Rainy season	Winter season	Summer season
50 – 70m	1000m – 2000m	4000 – 5000
100m – 150	2500– 4000m	100m – 800m
75m – 170	1500 – 2100	200m – 400
60m – 300m	1060m – 1110m	100 – 800
90m – 120m	1100m – 2000m	1000 – 1900

(25.9%), compared to other months (36.5%), (Table 10). In an year, the average time spent for feeding (36%) was higher than for other activities. (Fig 4).

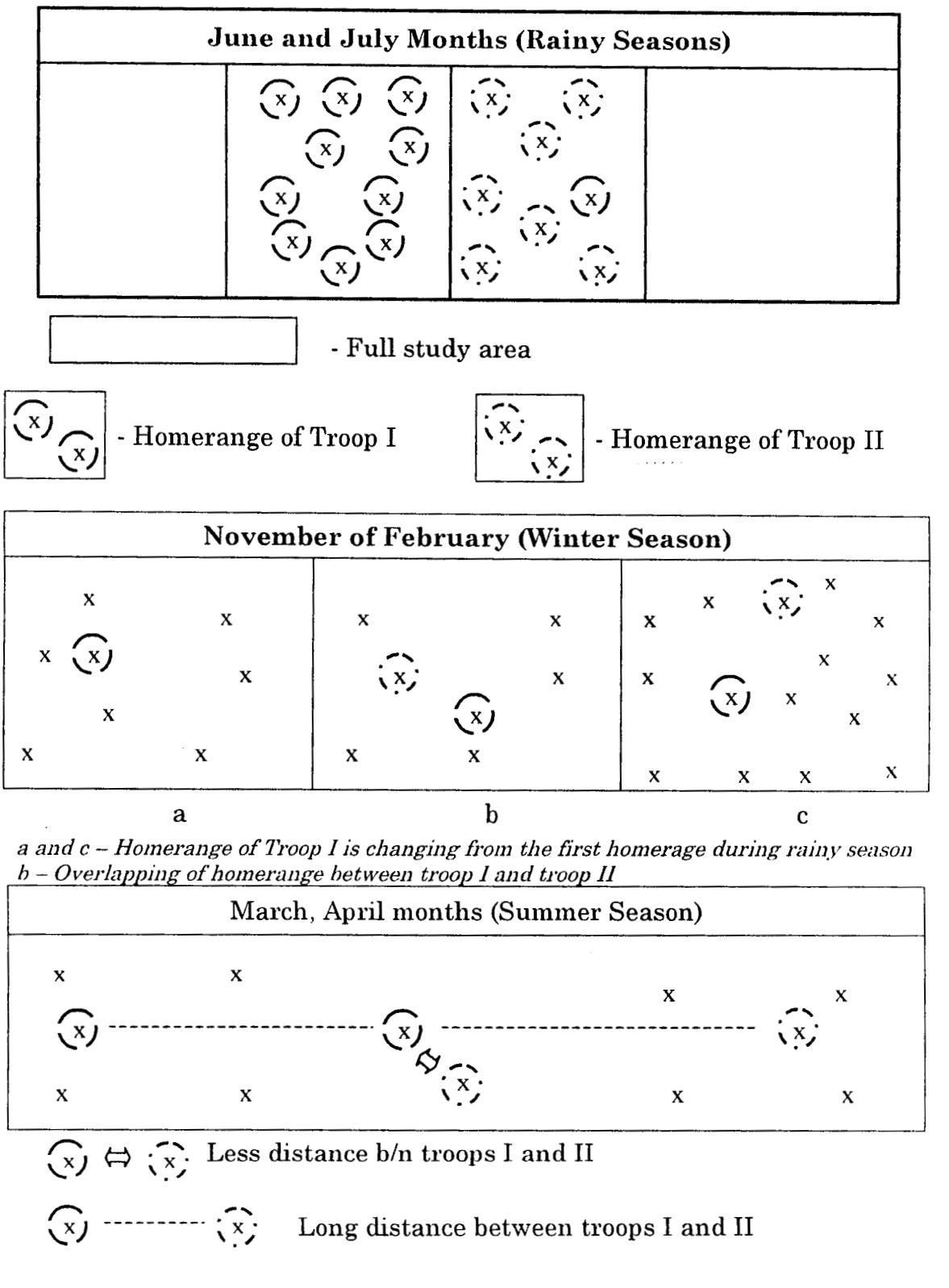
Fig.4 Graphical Representation of Table 10



Utilization of Feeding area by Troop I and Troop II at Different Months

The mean daily distance maintained between Troop I and Troop II varied in different seasons. Difference in the movement pattern of the troops in the feeding area appear to be related to the abundance of preferred food plants in the area. During winter season, the average distance between the feeding sites of two troops were greater than that of other seasons, (Table 11). During this season, they roamed over and utilised almost the entire study area without confining to any definite homerange. There is also frequent overlapping of the homerange of adjacent groups. During summer months on the other hand, they used some areas continuously and avoided certain areas completely during movements, (Fig 5). So, in March and April months they were found at nearby places and at distant places (Fig 5). So inter troop distance, varied with seasons, (Table11). For example, during the fruiting season of *Persea macrantha* and *Ficus mysorensis*, troop I (RLPF) and II (STF) were found in nearby places in order to exploit these food sources. Thus during January, February (Winter) March (Summer) their home range was everchanging (Fig 5,a,c). Home range of troop I was permanently overlapped by troop II (Fig 5,b).

Fig. 5. **Diagramatic representation of utilization of feeding area at different months**



During the rainy season, distance between two troops was less (Table 11). The homerange of troop I and Troop II were restricted to the middle of the study area (Fig 5). Size of their homerange was smaller and constant for a period of time during rainy season. This area is highly dense with leaves, flowers and fruits of *Tectona grandis, Grewia tiliaefolia, Pterocarpus marsupium and Terminalia paniculata.* The flowers, fruits and leaves provided abundant food sources which minimized the need for extensive movement for procuring food. Climatic factor also seems to be limiting movements during monsoon.

The cyclic fruiting and flowering of many food plants noticeably influenced troop movements. Occurrence of various food plants and their concentration in the homerange played a major role in determining its size according to Poirier, (1967a, 1968b, 1977). The homerange is constant for a given period of time and does not include areas crossed on occasional long forays of possibly exploratory nature as observed by Poirier (1965a, 1967a,b).

Like homerange, 'core areas', areas frequently used by Langur which contained sleeping trees, resting sites and preferred food sources also changed with season according to Poirier (1966a, 1967a,b). But there was not much change noted in the present study. In fact unlike the rainy

season there were instances of permanent overlapping of core areas in the winter and part of summer.

Utilization of Different Forest Strata

Nilgiri Langur performed their main activities on trees. But often they moved to different strata of the forest and occasionally came to the ground. Regarding the utilization of the forest strata, four levels could be identified. The strata in which more than 50% of the total individuals present was considered as the strata of utilization.

Level (1) ground level

Level (2) low shrubs 1-2m height
tall shrubs 2-4m height

Level (3) Short trees 4-10m height

Level (4) More than 10m height from the ground. (Table 12)

Generally they spent maximum time in stratum 2 (34.09%), which is followed by stratum 3 (33.63%) (Fig 6). They spent lowest time, on the ground level 1.03%, (Fig 6). Again utilization of plants at different strata varied with seasons. During monsoon season, (end of May to August) activities were mostly confined to stratum level 4. From December to April activities of the Nilgiri Langur were mostly restricted to stratum 3 and 2, (Table 12). Very rarely they were found at level 1.

Table – 12

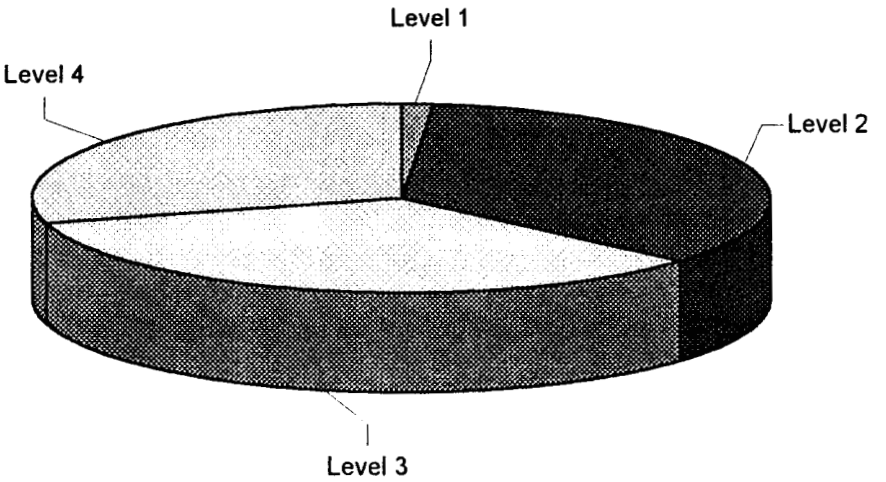
Percentage of time spent for the utilization of different forest strata by troop I

Troop at	J	F	M	A	M	J	J	A	S	O	N	D	Average time
Level (1)	4.5	-	0.7	1.3	-	0.1	-	0.1	-	1.4	4.0	0.2	1.03
Level (2)	28.5	32.4	38.3	33.3	31.4	38.4	36.3	31	30	36.1	32.4	41	34.09
Level (3)	42	41.4	39.7	43.2	26.5	14.8	16.4	29.9	38.1	41.2	33.3	37	33.63
Level (4)	25	26.2	21.3	22.2	42.1	46.7	47.3	39	31.9	21.3	30.3	21.8	31.26

Though the Nilgiri Langur is considered as vegetarian in diet, on several instances, they were found feeding on termites, soil from the ground and dead tree stumps. During March 1995, three adult members of troop of Nilgiri Langur were observed eating mud from the lake-shore. Members of a troop were once observed digging out something from the ground. But it was not clear what they were taking out.

Poirier also has observed Nilgiri Langur males coming to the ground to eat red coloured earth. The earth was scrapped off with the incisors, rolled into a ball and started eating the same, after climbing on a tree (1967, 1969a, 1977a).

Fig.6 Graphical Representation of Table 12



Chapter — 7

FOOD SELECTION BY NILGIRI LANGUR

Seasonal Variation in the Selection of Plant Resources

One hundred species of plants are eaten by the Nilgiri Langur (*Presbytis johnii*). This include eighty species of trees, eleven species of climbers, four species of shrubs and five species of climber herbs, (appendix 1). The average number of food plants used by the Langur in a month was in the range of 16-37 from January to December (appendix 1). About 40 species of plants in the study area are avoided by the Langur (appendix 2) though some of them were taken by other arboreal animals.

Major, Common and Rare Food Plants

As described by Maruhashi(1976) in his studies on the food habits of Japanese Monkey, the food of Nilgiri Langur in Periyar could be divided into three categories; major, common and rare. Major food species comprise the most preferred five species in each month, (Table 13). These species constitute approximately one half of the diet every month, (Fig 7). But there are seasonal variations. During May, June, July months percentage of time spent on these major plants were higher, (65.5-78), (Table 15). But during October, November and December their utilization is less than forty percent (range 29-34). From January to April, August and September use of major plants is around 50% (range 41-49), (Table 15). The individuals of a troop fed on them synchronously in a

Table – 13

Major food plants of winter season (Mid October to February)

October

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Rejoua dichotoma*	Fruit	3-4
2.	*Spathodium companulata*	Leaf + flower	4-5
3.	*Ficus tjakela*	Fruit	15-20
4.	*Evodia lunu ankenda*	Fruit + Leaf	7-8
5.	*Terminalia paniculata*	Fruit	10-11

November

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Hydnocarpus laurifolia*	Fruit + Leaf	11-25
2.	*Terminalia paniculata*	Fruit	13-14
3.	*Vitex altissima*	Fruit	7-8
4.	*Ehretia canarensis*	Leaf	5-7
5.	*Rejoua dichotoma*	Fruit	6-8

December

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Bombax ceiba*	Flower	5-6
2.	*Terminalia paniculata*	Fruit	9-10
3.	*Pygeum acuminatum*	Fruit	10-11
4.	*Rejoua dichotoma*	Leaf	4-5
5.	*Vitex altissima*	Fruit	3-4

January

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Rejoua dichotoma*	Leaf	10-15
2.	*Ficus beddomei*	Fruit	10-25
3.	*Persea macrantha*	Flower	7-10
4.	*Santalum album*	Leaf	6-7
5.	*Evodia lunu ankenda*	Leaf	8-9

February

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Evodia lunu ankenda*	Leaf	12-14
2.	*Myristica dactyloides*	Fruit	8-95
3.	*Persea macrantha*	Flower	10-11
4.	*Dalbergia latifolia*	Leaf	7-8
5.	*Acacia concina*	Leaf+ Flower	6-7

Major Food Plants of Summer Season (March and April)

March

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Ficus mysorensis*	Fruit	10-12
2.	*Evodia lunu ankenda*	Leaf	9-12
3.	*Persea macrantha*	Leaf	10-11
4.	*Sterculia guttata*	Fruit	6-7
5.	*Dalbergia latifolia*	Leaf+ Flower	8-10

April

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Dalbergia latifolia*	Leaf + Flower	14-15
2.	*Persea macrantha*	Fruit	10-11
3.	*Ficus mysorensis*	Fruit	5-6
4.	*Grewia tiliaefolia*	Leaf + Flower	11-13
5.	*Pterocarpus marsupium*	Leaf	8-9

Major Food Plants of Rainy Season (Mid May to September)

May

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Grewia tiliaefolia*	T. Leaf + Flower	11-15
2.	*Tectona grandis*	Tender Leaf	8-14
3.	*Pterocarpus marsupium*	Tender Leaf	12-18
4.	*Ficus amplissima*	Fruit	12-16
5.	*Litsea laevigata*	Fruit	14-15

June

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Grewia tiliaefolia*	Fruit	14-15
2.	*Evodia lunu ankenda*	Flower	11-12
3.	*Actinodaphne hirsuta*	Fruit	16-18
4.	*Meliosma pinnata*	Fruit	10-14
5.	*Terminalia paniculata*	Tender Leaf	15-16

July

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Grewia tiliaefolia*	Fruit	20-21
2.	*Schefflera (Spp)*	Fruit	15-13
3.	*Santalum album*	Leaf	10-11
4.	*Pterocarpus marsupium*	Flower	12-15
5.	*Clausena indica*	Fruit	18-19

August

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Litsea deccanensis*	Fruit	10-12
2.	*Maesa indica*	Fruit	8-11
3.	*Terminalia paniculata*	Flower	11-12
4.	*Cinnamomum malabatrum*	Fruit	10-11
5.	*Gmelina arborea*	Leaf	12-13

September

Sl. No.	Name of the Plants	Plant parts	% of time (Range)
1.	*Rejoua dichotoma*	Fruit	8-10
2.	*Psidium guajava*	Fruit	11-12
3.	*Ficus nervosa*	Fruit	10-12
4.	*Pterocarpus marsupium*	Fruitwing + Leaf	11-12
5.	*Terminalia paniculata*	Flower Leaf	9-10

feeding bout of daily activity. The troop movements seems to be related strongly to the availability of these species in the area. They took these

species frequently. All members of a troop invariably consumed all the major plant species.

Common food species comprise the next five species in the order of preference of plants. These plants constitute approximately thirty percent (30%) of the diet, (Fig 7). During October, November, December months the percentage of time spent on common plants was less (20-25) (Table 15). But during May, June, July months percentage of time spent on common plants were still lesser, (11.2-24.1%). An average time of 27.16% was spent on these plants in an year.

All other plant food species which constitute the rare food species fall below the tenth rank in the order of preference. Members of the Langur troop eat these species opportunistically. Rare plant species would be different or same for different troops. They form approximately 1/5 of the diet, (Fig 7). During November, December and January months 45% of time was used on rare plants (Table 15). Time spent on rare plants during this period was higher than that on other months. During rainy season (May, June, July months), the average time spent on rare plants was less than in any other months, (Table 15).

Preference to different plants by the Nilgiri Langur varied seasonally. The major common and rare plants also changed with season, (Table 14). Partial consumption characterized periods of low and high

abundance of food; specialization or deletion of less selected foods did not occur as a consequence of elevated resource abundance; and rank order of selection for each food did not remain constant as observed by Willig *et. al* (1991).

Seasonal progression of food preference was noticed for certain plants (Table 14). In such cases leaf buds and tender leaves of a single species were taken when they first developed. When the leaves were grown and the flowers appeared, they turned exclusively to the flowers. The interest on flowers slowly decreased as fruits ripen. Thus tender leaves, buds, flowers and fruits of these plants were taken by the Langur at different seasons. They consumed leaves, flowers and fruits of twelve plant species. Of these, *Meliosma pinnata* is a rare plant during the period of consumption while *Persea macrantha* is a major one during its consumption period of 4 months. *Terminalia, Evodia, Pterocarpus, Grewia* and *Dalbergia* were utilized almost throughout the year. *Grewia tiliaefolia, Pterocarpus marsupium, Dalbergia latifolia, Evodia lunu-ankenda* and *Terminalia paniculata* have great significance than other food plants. All the three parts (leaf, fruit and flower) of these plants were highly preferred (+) and these are the only five species of (Fig 8) food plants selected in this way. The leaves of *Tectona grandis*

Quantitative structure of feeding behaviour of Nilgiri Langur

Table – 15

Percentage of time spent on feeding different plants and plant parts

(a)

No:	Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nove	Dec	Average
1.	Major Food plants	32	30	45.1	48.5	65.5	71.4	78	48.52	43.9	41.7	31	29	47.05
2.	Common Food plants	27	31	32.7	38.8	24.1	20.1	11.2	32.7	30	33.3	20	25	27.16
3.	Rare Food Plants	41	39	22.2	12.7	10.4	8.5	10.8	18.78	26.1	25	49	46	25.79

(b)

1.	Fruits	15	20	32.18	23.3	44	50	56.25	51.05	41.95	49.98	28.57	40.91	37.76
2.	Leaves	60.84	63.09	49.99	49.68	40	31.86	21.96	28.2	33.43	42.52	60.7	46.8	44.89
3.	Flowers	20.59	16.9	12.5	27	16	18.14	21.7	20.12	11.11	4.06	7.14	9.44	15.39
4.	Petiole + Bark	3.57	0	5.33	0	0	0	0	0	13.51	3.44	3.59	2.85	2.69
5.	Other items	0	0.01	0.02	0	0	0	0.09	0.63	0	0	0	0	0.06

Fig.7 Graphical Representation of table-15(a)

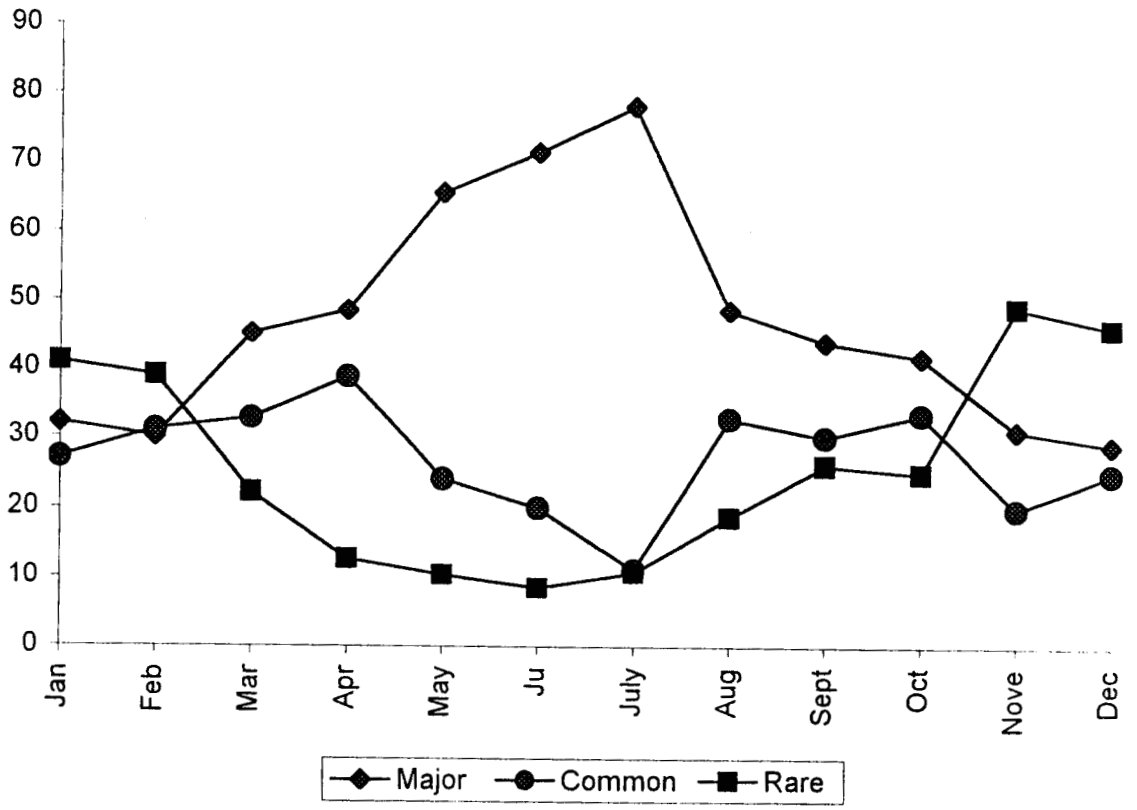
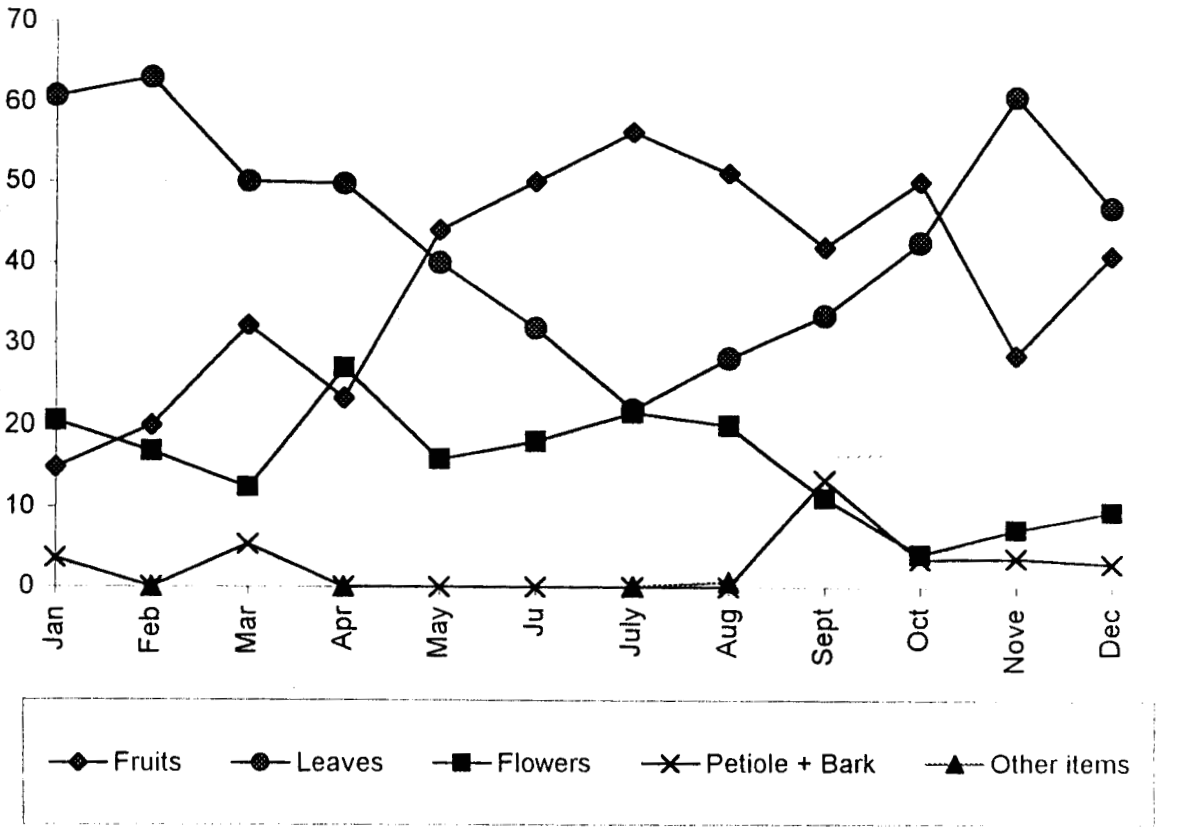


Fig.9 Graphical Representation of table 15(b)



were highly preferred (+) while its fruits and flowers were less preferred ('0','–').

Thus major plants of certain months would be common or rare during other months, (Fig 8 & Table 14).

Nilgiri Langur often consumed only one particular part of a plant, (Fig 8). They consumed fruits of twenty four plants, leaves of twenty nine plants and flowers of three plants. No other part of these plants were consumed, (Table 14).

Again, the leaves of *Santalum album* were highly preferred (+) during January, February and March months. It is a major plant during these months, (Fig 8). Langur consumed leaves of twenty eight plant species (-) very rarely, only in one month, (Table 14).

Of the twenty four varieties of fruits consumed, seven are of completely rare plants (Table 14). Other plant species of this group were differentially preferred at different seasons. They would be major, common and rare plant species at different months, (Fig 8). The Nilgiri Lnagur preferred nearly ripe (F(NR)+ fruits than fully riped (F(R) and unripe (F(UR-) fruits, (Fig 8). The Nilgiri Langur consumed leaves and flowers of ten plants, fruits and leaves of fourteen species and fruits and flowers of eight species (Table 14).

Table – 14

Preference for different plant parts by the Nilgiri Langur (Troop I & Troop II)

All plant parts

No.	Name of the Plant Species	Jan.	Feb.	Mar.	Apr.	May.	Ju.	July	Aug.	Sept.	Oct.	Nove.	Dec.
1.	*Grewia tiliaefolia*		T.L^{+}	L+Fl^{0}	L+Fl^{+}	L+ Fl^{+}	F(UR)	F(NR)$^{+}$	F(NR)	F(R)			
2.	*Tectona grandis*			T.L.	T.L.$^{+}$	T.L.$^{+}$	T.L.	T.L+Fl	-	F(R)	F(R)	F(R)	F(R)
3.	*Pterocarpus marsupium*		T.L.	T.L.	T.L.$^{+}$	T.L+Fl^{+}	T.L+Fl^{+}	T.L+Fl^{+}	F(UR)$^{+}$	F(UR)$^{+}$	F(NR)$^{+}$	N(R)	F(R)
4.	*Terminalia paniculata*	F(R)	F(R)	F(R)	T.L.$^{+}$	T.L.$^{+}$	L^{+}	L	Fl^{+}	Fl^{+}	Fl^{+}	F^{0}	F^{0}
5.	*Evodia lunu-ankenda*	T.L.	L^{+}	L^{0}	L^{+}	L^{+}	Fl^{+}	Fl^{+}	Fl^{0}	L+F^{0}	L+F^{+}	L+F	L+F(R)^{0}
6.	*Dalbergia latifolia*	F(R)+L	F(R)+L	L^{+}	L+Fl^{+}	Fl^{+}	-	-	-	F(UR)$^{+}$	F(R)$^{+}$	F(R)	L^{+}
7.	*Diospyros Montana*	F(R)+TL^{+}	F(R)+TL^{0}	L	L+Fl	-	-	-	-	F(UR)	F(R)$^{+}$	F(R)	F(R)^{0}
8.	*Spondias pinnata*		T.L	T.L+Fl	Fl	-	-	-	F(R)	F(NR)$^{+}$	F(R)	-	-
9.	*Delonix regia*			T.L	T.L+Fl	Fl	-	-	-	-	F(R)	-	-
10.	*Persea macrantha*	Fl^{+}	Fl+L^{+}	F(UR)$^{+}$	F(R)$^{+}$	-	-	-	-	-	-	-	-
11.	*Meliosma pinnata*				T.L	Fl	F(UR)	F(UR)	-	-	-	-	-
12.	*Toddalia asiatica*	Fl_T.L								F^{+}			

Legend : F - Fruit, L – Leaf, Fl – Flower, T.L – Tender leaf, R – Ripe, UR – Unripe
(+) – Major plant part, (0) – Common plant Part, (-) – Rare plant part

Fruit only

No.	Name of the Plant Species	Jan.	Feb.	Mar.	Ap.	May.	Ju.	July	Aug.	Sept.	Oct.	Nove.	Dec.
1.	*Myristica dactyloides*		$F(UR)^{-}$	$F(NR)^{+}$	$F(NR)^{+}$	$F(R)^{0}$	$F(R)^{-}$						
2.	*Litsea oleoides*			$F(R)^{0}$									
3.	*Mallotus tertracoccs*								$F(UR)^{-}$				$F(R)^{0}$
4.	*Litsea laevigata*			$F(UR)^{-}$	$F(NR)^{+}$	$F(R)^{0}$							
5.	*Memecylon malabaricum*								$F(NR)^{+}$	$F(R)^{0}$			
6.	*Cordia oblique*						$F(NR)^{+}$						
7.	*Uvaria hookerii*									F^{-}			
8.	*Cinnamomum malabaricum*							F(NR)	$F(NR)^{+}$	$F(R)^{+}$			
9.	*Ficus nervosa*									$F(NR)^{0}$			
10.	*Artocarpus gomezianus*					$F(NR)^{+}$	$F(NR)^{+}$	$F(R)^{0}$					
11.	*Disoxylum malabatrum*								$F(R)^{-}$	$F(R)^{-}$			
12.	*Psidium guajava*						$F(UR)^{-}$	$F(UR)^{-}$	$F(UR)^{0}$	$F(NR)^{+}$	$F(NR)^{+}$	$F(R)^{0}$	$F(R)^{-}$
13.	*Litsea deccanensis*							$F(UR)^{-}$	$F(NR)^{+}$	$F(R)^{0}$			

No.	Name of the Plant Species	Jan.	Feb.	Mar.	Ap.	May.	Ju.	July	Aug.	Sept.	Oct.	Nove.	Dec.
14.	*Syzygium cumini*					F^{-}							
15.	*Rhynchosia cyanosperma*		F^{-}										
16.	*Gnetum ula*								$F(NR)^{+}$				
17.	*Ficus beddomei*	$F(NR)^{+}$	$F(NR)^{+}$										
18.	*Elaeocarpus oblongus*										F^{-}		
19.	*Schefflera (sp)*							F^{+}	F^{o}				
20.	*Allophylus rheedi*								F^{-}				
21.	*Casearia esculenta*								F^{o}				
22.	*Artocarpus integrifolia*					F^{o}	F^{o}	F^{o}					
23.	*Flacourtia montana*			$F(UR)^{-}$									
24.	*Artocarpus hirsuta*					F	F^{o}	F^{+}					

Leaf only

No.	Name of the Plant Species	Jan.	Feb.	Mar.	Ap.	May.	Ju.	July	Aug.	Sept.	Oct.	Nove.	Dec.
1.	*Santalum album*	$T.L^{+}$	$T.L^{+}$	L^{+}	L^{0}	L^{0}	L^{0}	L^{0}	L^{0}	L^{-}	L^{-}	L^{0}	L^{0}
2.	*Spathodea companulata*										L^{-}		
3.	*Toona ciliate*										L^{-}		
4.	*Bombusa vulgaris*											L^{0}	L^{0}
5.	*Wagatia spicata*										L^{-}		
6.	*Mikania scandens*								L^{-}				
7.	*Anogeissus latifolia*											L^{0}	L^{0}
8.	*Cinnamomum sulphuratum*			L^{0}	L^{0}								
9.	*Elytranthe lonicerodes*	L^{0}											
10.	*Celastrus paniculata*				L^{-}								
11.	*Clausena indica*	L^{-}											
12.	*Turpinia malabarica*	L^{-}											
13.	*Olea dioica*	L^{-}										Petiole^{-}	
14.	*Pomoea obscura*					L^{-}							
15.	*Meliosma simplicifolia*				$T.L^{-}$								

No.	Name of the Plant Species	Jan.	Feb.	Mar.	Ap.	May.	Ju.	July	Aug.	Sept.	Oct.	Nove.	Dec.
16.	*Dolichos falcatus*										L^{-}		
17.	*Premna coriacea*			$T.L^{-}$									
18.	*Entada rheedei*										$T.L^{+}$		
19.	*Clematis gouriana*											L^{o}	
20.	*Syzygium gardnerii*	$T.L^{-}$											
21.	*Dimocarpus longan*				$T.L^{-}$								
22.	*Ficus talbotii*	$T.L^{o}$		$T.L^{-}$									
23.	*Xanthophyllum flavescens*	L^{-}											
24.	*Terminalia chebula*	$Petoile^{-}$								L^{o}	Petiole		
25.	*Aganosma cymosa*												L^{-}
26.	*Eucalyptus globulus*											L^{-}	$Bark^{o}$
27.	*Stereospermum suaveolens*		$T.S^{-}$										
28.	*Diospyros ovalifolia*												L^{-}
29.	*Lagerstromia lanceolata*										L^{-}		

Flower only

No.	Name of the Plant Species	Jan.	Feb.	Mar.	Ap.	May.	Ju.	July	Aug.	Sept.	Oct.	Nove.	Dec.
1.	*Ficus hispida*								Fl				
2.	*Loranthus tomentosus*	Fl		Fl						Fl	Fl	Fl	Fl
3.	*Erythrina variegata*	Fl		Fl									Fl

Fruit and Flower

No.	Name of the Plant Species	Jan.	Feb.	Mar.	Ap.	May.	Ju.	July	Aug.	Sept.	Oct.	Nove.	Dec.
1.	*Mollotus philippinensis*		$F(NR)^-$	$F(R)^+$					T.S		Fl^-	Fl^-	
2.	*Zyziphus rugosa*				Fl^0+F^0	F^0							
3.	*Canarium strictum*				Fl^-	T.L.+Fl							
4.	*Dillenia pentagyna*		Fl^-		Fl	F							
5.	*Sterculia guttata*			F^+									
6.	*Vitex altissima*									Fl			
7.	*Viburnum accuminatum*							Fl	F^+	F^+	F^0	L^0	
8.	*Pygeum accuminatum*									Fl		F^-	F^+

Fruit and Leaf

No.	Name of the Plant Species	Jan.	Feb.	Mar.	Ap.	May.	Ju.	July	Aug.	Sept.	Oct.	Nove.	Dec.
1.	*Albizzia odoratissima*		T.S					$F(UR)^{0}$	$F(UR)^{0}$				
2.	*Randia dumatorum*									L^{0}	$\underline{L}$	$\overset{+}{L}+\bar{F}$	$\bar{L}+\overset{U}{F}$
3.	*Lannea coromandelica*			$\bar{T}.\bar{L}+\bar{F}$									
4.	*Linociera malabarica*		$T.L^{-}$	T.L						$T.S^{-}$	$\underline{L}+F^{-}$		
5.	*Maesa perrottetiana*	$T.L^{0}$	$T.L^{0}$	$T.L^{0}$					$F(UR)^{-}$	$F(NR)^{-}$	$F(NR)^{+}$	$F(R)^{-}$	
6.	*Hydnocarpus laurifolia*	$F(R)^{+}$	$F(R)^{+}$						$F(UR)^{-}$	$F(NR)^{+}$	$F(NR)^{-}$	F(NR)	$\overset{U}{F(R)}+\bar{L}$
7.	*Rejoua dichotoma*	$T.L^{+}$	$T.L^{+}$	$T.L^{+}$					F(UR)	$F(NR)^{0}$	$F(NR)^{+}$	$L^{+}+F(NR)^{U}$	
8.	*Ficus mysorensis*			$F(NR)^{+}$	L^{0}								
9.	*Fiscus tjakela*			$T.L^{0}$	$F(NR)^{+}$	$F(NR)^{+}$							L^{0}
10.	*Emblica officinalis*			$T.S^{-}$					$F(NR)^{0}$	$F(NR)^{0}$			
11.	*Celtis tetrandra*											$F^{-}+L^{-}$	
12.	*Actinodaphne hirsuta*	T.S				$F(UR)^{+}$	$F(NR)^{+}$	$F(NR)^{+}$	$F(R)^{-}$	T.S			
13.	*Mangifera indica*			T.L+F									
14.	*Ficus amplissima*				L^{-}	F^{0}							

Leaf and Flower

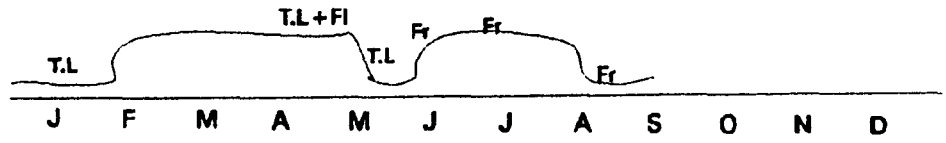
No.	Name of the Plant Species	Jan.	Feb.	Mar.	Ap.	May.	Ju.	July	Aug.	Sept.	Oct.	Nove.	Dec.
1.	*Bischoffla javanica*			$T.L^{+}+Fl^{+}$									
2.	*Radermachera xylocarpa*				Fl				L				
3.	*Acronychia laurifolia*					L+Fl	L+Fl						
4.	*Bombax ceiba*	Fl								Petiole	Petiole		Fl^{0}
5.	*Ehretia canarensis*	L^{+}							Fl	L^{-}	L^{-}	L^{+}	L^{+}
6.	*Acrocarpus fraxinifolius*	$Fl^{-}+TL^{-}$											
7.	*Erythrina subumbrans*	Fl+T.L											
8.	*Buchanania lanzan*	$Fl^{-}+L^{-}$											
9.	*Lantana aculeata*		$L^{+}+Fl^{+}$	L^{+}	L							L^{0}	
10.	*Acacia concinna*		$L^{+}+Fl^{+}$	$L^{+}+Fl^{-}$									

Fig 8. Schema of seasonal variation, in utilization of Fruit, Flower and Leaf of twelve food plant species of Langur

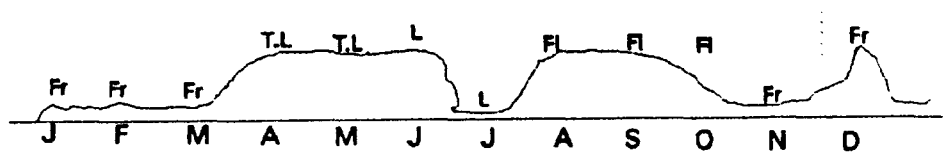
Fruit, Leaf, Flower

Evodia lunu-ankenda

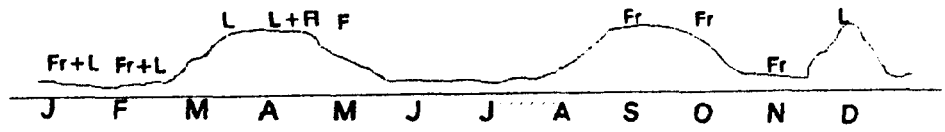
Grewia tiliaefolia



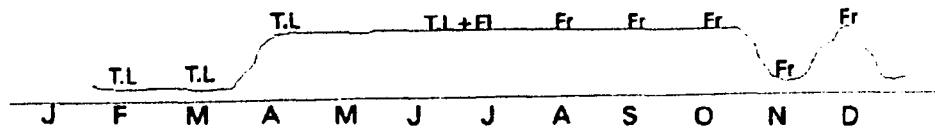
Terminalia paniculata



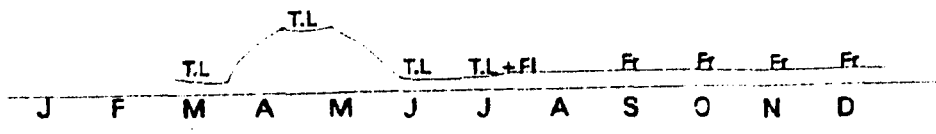
Dalbergia latifolia



Pterocarpus marsupium

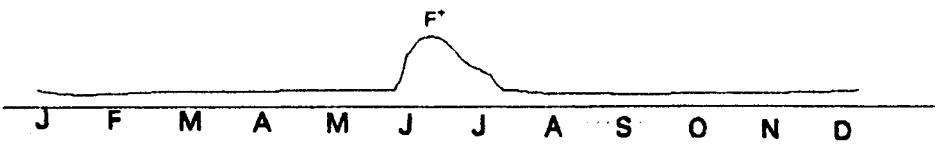


Tectona grandis

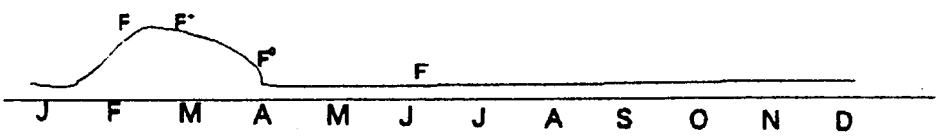


Fruit only

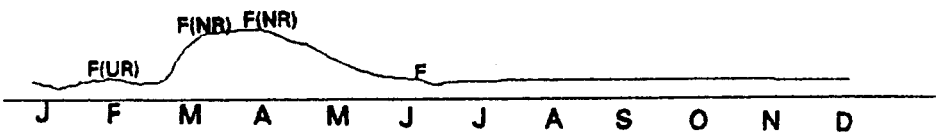
Cordia obliqua



Ficus beddomei

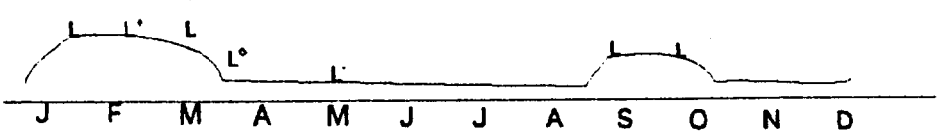


Myristica dactyloides

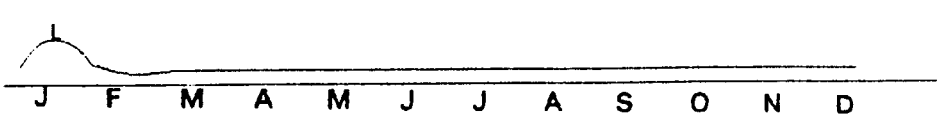


Leaf only

Santalum album

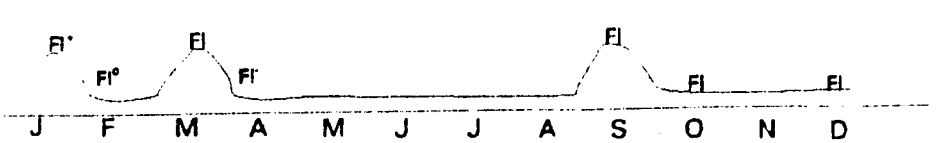


Clausena indica



Flower only

Loranthus tomentosus



Seasonal Variation in the Consumption of Different Plant Parts

As already mentioned, Nilgiri Langur's preference for different plant parts viz fruits, flowers, leaves, petiole and tender shoot varied in different months (Table 15 & Fig 9). The percentage of time spent on each plant parts varied with season (Fig 10) and it seems to be related to the change in food availability and change in the physiological requirements of the Langur during different seasons.

Diet During Rainy Season

The consumption of fruits by the Nilgiri Langur was higher during this season. The Langur troops consumed more fruits (49.81%) than leaves (28.8%) and flowers (17.7%), (Table 16). They utilized most of their time on feeding fruits of major plants, (more than 60%) but consumed parts of common and rare plants only rarely.

There were monthly differences in the intake of food even during rainy season. During June, they consumed fruits of eleven plant species, leaves of eight plant species and flowers of six species, (Table 16). All the troop members consumed parts of same plant species during this season (Table 9). During July, the percentage of time spent on feeding fruits was higher than that of other months of rainy season, (Table 16). They consumed nine types of fruits, four types of leaves and four types of

flowers. The average time spent on one plant species was higher than that in August and September months.

During August and September months, they consumed nineteen types of fruits, ten types of leaves and five types of flowers.

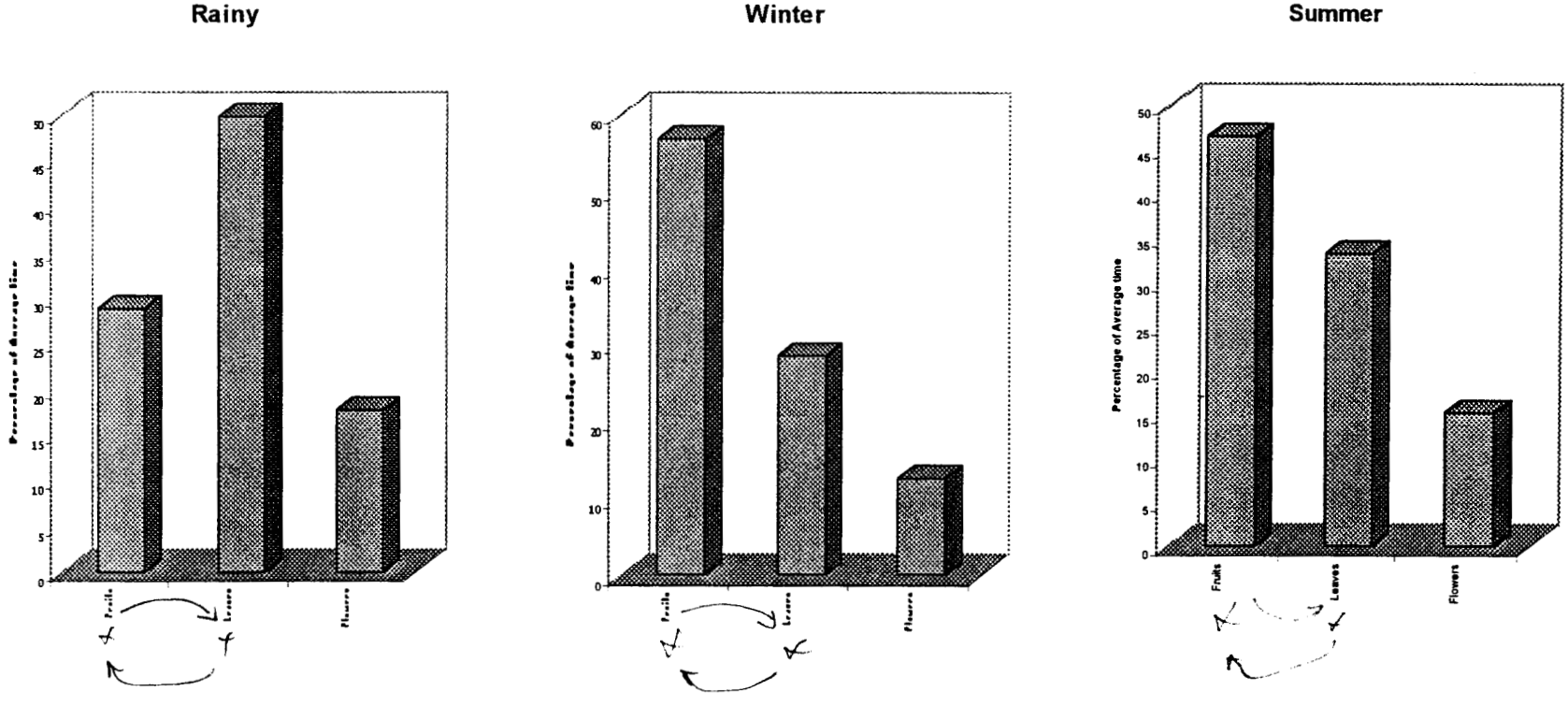
Table – 16

The average time spent for feeding fruits, leaves and flowers and the total time spent on feeding fruits and leaves (Fr+L), and fruits and flowers (Fr+Fl)

Rainy Months	L	Fr	Fl	Fr+Fl	Fr+L
June	31.86	50	18.14	68.14	81.86
July	21.96	56.25	21.7	77.95	78.21
August	28.2	51.05	20.12	71.17	71.25
September	33.43	41.95	11.11	53.06	75.38
Average	28.8	49.81	17.7	67.58	**78.61**
Winter Months	**L**	**Fr**	**Fl**	**Fr+Fl**	**Fr+L**
October	42.52	49.98	4.06	54.04	92.5
November	60.7	28.5	7.14	35.71	89.2
December	46.8	40.91	9.44	50.35	87.71
January	64.41	15	20.59	35.59	79.41
February	63.09	20	16.9	36.9	88.09
Average	56.87	28.66	12.7	41.36	**85.53**
Summer Months	**L**	**Fr**	**Fl**	**Fr+Fl**	**Fr+L**
March	49.99	32.18	12.5	44.68	82.17
April	49.68	23.3	27	50.3	72.98
May	40	44	16	60	84
Average	46.5	33.16	15.16	48.32	**79.66**

Legend *L-Leaf, Fr-Fruit, Fl-Flower, NP-Number of plants*

Fig.10 Graphical Representation of table 16



The sum of two parts (leaves & fruits) comprised 81.35% (50% fruits and 30% leaves) during this season. The average consumption of flowers was highest during this season (17.07%). The average consumption of fruit and flower together was 67.51%.

Winter Diet

The percentage of time spent on feeding on leaves was higher during winter season (Table 16). The average consumption of leaves was 56.87% and fruits 28.66%, (Table 16). But during this period in October and December, they consumed almost equal proportion of leaves and fruits (40% to 49%). During November, January and February months range of consumption was highly varied, leaves 60% to 64% and fruits 15% to 28%. However, the average time spent by Nilgiri Langar for feeding on fruits and leaves was around 80%(85.53) as in rainy and summer months (Table 16). When consumption of leaves increased fruit consumption decreased. Similarly when fruit consumption increased consumption of leaves decreased.

The average consumption of flowers was 12.7%. During January and February months, the number of fruit bearing plant species was less (3-4) compared to other months. The Nilgiri Langur depended completely on these plant species for its fruit requirements. These plant species

hardly occupied most of the feeding sites of the Langur so as to limit their utilization.

Summer Diet

As in winter, the average time spent on feeding on leaves (46.5%) was higher than the time spent on feeding on fruits (33.16%) and flowers (15.16%) during summer months, especially in March and April. From the middle of May they started to eat more fruits (44%) than leaves (40%). Total consumption of fruits and leaves was around 80% (79.66%) as in winter and rainy seasons (Table 16).

It is believed that, like the humans, food preference of Langur is notably influenced by their odour, colour and flavour but their evaluation is extremely difficult. However during the study an attempt was made to detect colour and flavour of certain important plants consumed by Langur.

Flavour

Selection of fruits seemed to be related to their flavour. Most of the fruits consumed by the Nilgiri Langur have an acidic (45%) or sweet-bitter taste (44%) (Table 17). There are three basic flavours; sweet, sour and bitter. Salt flavour is not detected in any food of Langur. Some fruits have complex flavours. Most food plants have some sweetness in their flavour. The food frequently consumed was basically sweet, but slightly

acidic and bitter in taste. Approximately 90% of the fruit plants studied were sweet and among them 45% were slightly acidic (sweet-sour) and 40% slightly bitter (sweet bitter), 5% sweet and 10% bitter in taste, (Table 17). Sweet sourness taste seemed to be the mostly enjoyed flavour in the food of Nilgiri Langur. Most of the leaves consumed by them are bitter in taste though some of them have a mixed complexion of bitter and sour tastes, eg. *Tectona grandis.*

Table – 17

Colour and flavour of food plants selected by Nilgiri Langur

Colour of fruits consumed by Langur	
Colour	**Number**
Green	17
Brown	4
Purple	10
Greenish purple	5
Orange	8
Crimson	4
Yellow	3
Blue	2
Red	1
Flavour	**Taste preference**
Sweet-sour (acidic)	45%
Sweet-bitter	40%
Sweet	5%
Bitter	10%

Colour

The colouration of the fruits consumed by the Nilgiri Langur varied from green through greenish purple to pale yellow (80%). Another 20% of fruits had colours, ranging from intense red to orange, crimson and yellow, (Table 17).

Chapter — 8

QUALITATIVE STRUCTURE OF THE DIET

Biochemical analysis of some of the 'major' leaves, flowers and fruits consumed by the Nilgiri Langur has shown that carbohydrates, proteins and lipids were present in all the plant parts. (leaves, fruits and flowers). (Table 18 & Fig 11). The proportion of lipid in flowers was higher than that in the leaves. But, the proportion of protein was higher for leaves than flowers. But, fruits were the main source of carbohydrate, protein and lipid (Table 18).

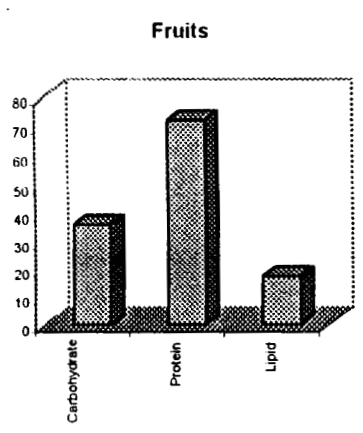
Since fruits were the main source of carbohydrates, proteins and lipids, eight major fruits each from three seasons (Table 13) were analysed mainly for evaluating proportion of these three nutrients in the diet of the Nilgiri Langur (Table 19).

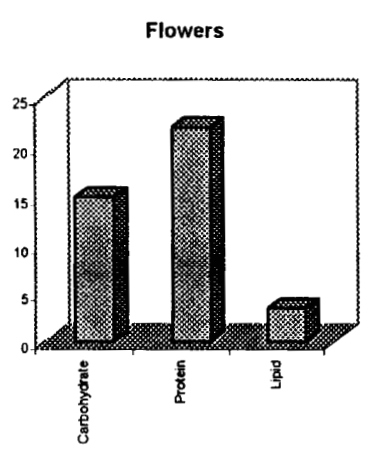
Seasonwise observation of eight major fruit plant samples of the three seasons showed that the Nilgiri Langur consumed fruits containing more proteins than carbohydrates and lipids.

Table - 18
Average proportion of carbohydrates, proteins and lipids in fruits, leaves and flowers of major food plants.

	Nutrients			
Name of the Plant parts	Carbohydrate mg/g	Protein mg/g	Lipid mg/g	Number of samples taken
Fruits	36.2	72	17.2	6
Flowers	15	22	3.4	6
Leaves	12	32	0.08	6

Fig.11 Graphical Representation of table 18





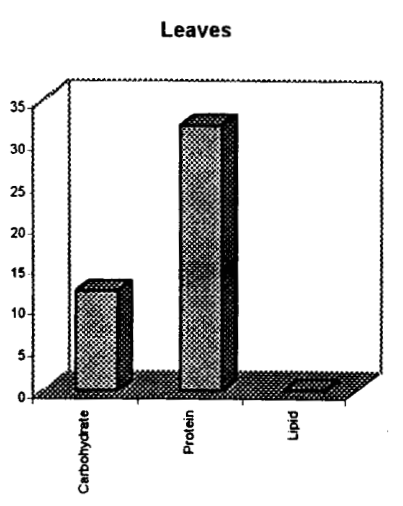


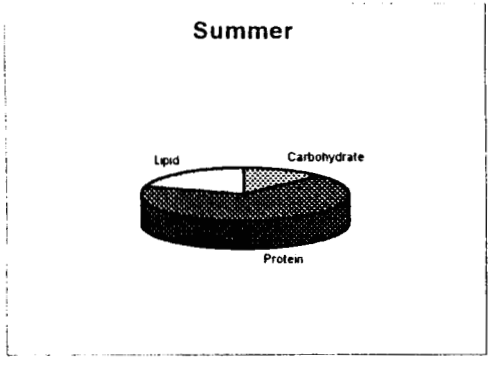
Table - 19

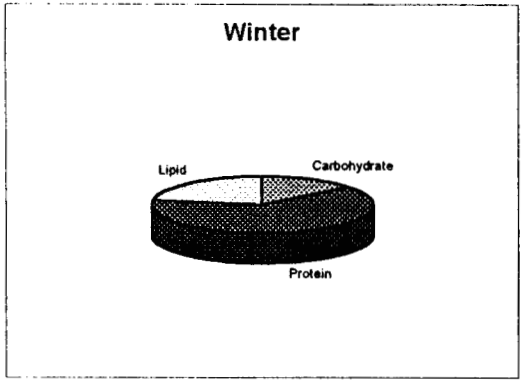
The amount of Carbohydrates, Proteins and Lipids in the fruits of eight major food plants of Nilgiri Langur at each of the three seasons

Seasons											
Rainy				Winter				Summer			
	Carbohydrate (mg/gm)	Protein (mg/gm)	Lipid (mg/gm)		Carbohydrate (mg/gm)	Protein (mg/gm)	Lipid (mg/gm)		Carbohydrate (mg/gm)	Protein (mg/gm)	Lipid (mg/gm)
1.	5.3	194.1	34.8	1.	4.5	28.9	1.2	1.	48.2	1.9	2.9
2.	6.9	12.9	0.06	2.	25.9	29	10.2	2.	105	18	14.8
3.	31.9	198	6.4	3.	9.2	88.4	1.8	3.	14.3	64	4.5
4.	36.2	4.37	1.8	4.	2.3	65	0.02	4.	9.9	32	2.3
5.	6.2	98.9	22.4	5.	9.8	72	94	5.	8.2	44	2.9
6.	19.1	88.3	72	6.	3.1	22.1	6.8	6.	218	8.2	12.1
7.	41.5	8.9	114	7.	2.7	32.9	5.1	7.	11.3	50.2	8.2
8.	12.8	140.9	0.08	8.	19	1.4	2.1	8.	5.2	59.3	0.04

** There was an overlap of major food plants in the three seasons.*

Fig.12 Graphical Representation of table 20





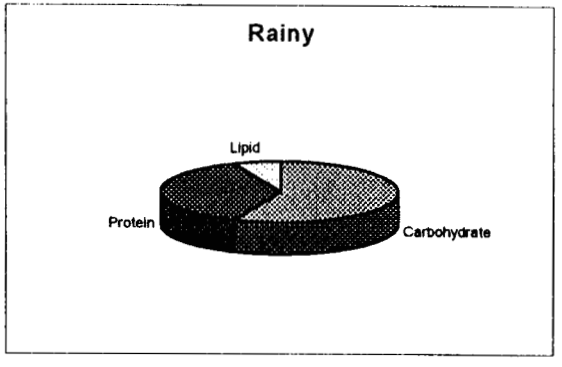


Table – 20

The average amount of carbohydrate, protein and lipid present in the major twentyfour fruit plants at three seasons

Seasons	Carbohydrate mg/g	Protein mg/g	Lipid mg/g	No.of samples
Rainy	19.9	105.2	31.4	8
Winter	9.5	42.46	15.15	8
Summer	52.5	34.7	5.9	8
Total	81.9	182.36	52	24

Total quantity of protein in twentyfour samples of the three seasons was protein 182.36mg/gm, carbohydrate 81.9mg/gm, lipid 52mg/gm. (Table 20). During summer months the Nilgiri Langur consumed food containing more carbohydrate than in rainy and winter months, (Table 20 & Fig 12). The ratio of intake of protein and lipid was higher during rainy and winter months (Fig 12).

Chapter — 9

FOOD HABITS OF OTHER ARBOREAL MAMMALS IN THE STUDY AREA

The Malabar Giant Squirrel (*Ratufa indica*)

The Malabar Giant Squirrel enjoyed a wide distribution in Periyar and different parts of the High ranges of Kerala. The Giant Squirrel co-exist with the Nilgiri Langur, (*Presbytis johnii*) in the same habitat and share different kinds of plant species. The Giant Squirrel consumed different kinds of plant parts ie. fruits, flowers, leaves and bark of sixty one plant species in the study area. (Appendix 3). Of these, 45 plant species were selected for their fruits only. One plant species was selected for its flower and another one for leaf only. No other parts of these plant species were utilised by them. Other plant species were selected for different parts; fruits and flowers of two plant species, leaf and flower of plant species, fruit and leaf of four plant species, bark and fruit of two plant species, bark and bean of one plant species, wood and bark of one plant species and fruit, leaf and bark of two plant species were used by the Giant Squirrel, (Table 21).

Field observations have shown that fruits were the main plant part consumed, (90.8%) by the Giant Squirrel than leaves (5.1%), flowers (1.8%)

and bark and wood (2.3%), (Fig 13). Like flower and leaf, bark is an important item of plant part consumed by Giant Squirrel, (Table 21).

Table – 21

Proportion of consumption of various plant items by the Malabar Giant Squirrel

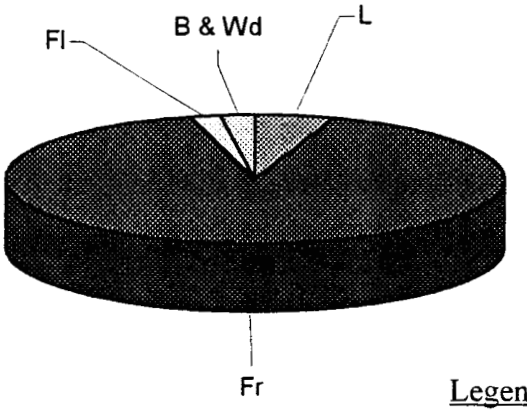
Percentage of consumption	Fr		L		Fl			B & Wd			
	90.8%		5.1%		1.8%			2.3%			
Parts	Fr+Fl	Fl+L	L+Fr	B+Fr	B+Be	Wd+B	Fr+Fl	Fr+L+B	Fr	L+B	Fl
NP	2	1	4	2	1	1	1	2	45	1	1

Legend : Fr – Fruit, Fl – Flower, L – Leaf, B – Bark, Wd – Wood, Be – Bean, NP – Number of plant species

* *Based on field observation*

The Malabar Giant Squirrel shared the habitat and food of the Nilgiri Langur in a high degree. Their sharing of plant species is given in Table 22. When the Giant Squirrel and the Nilgiri Langur used the same plant, their preference to the plant parts varied, (Table 22 & 23). The Giant Squirrel usually preferred fruits having hard epicarps, (eg, fruits of Tectona grandis) and unripe and ripe fruits, while the Nilgiri Langur preferred nearly ripe fruits (Table 22).

Fig.13 Graphical Representation of table 21



Legend

Fl	:	Floweres
B	:	Bark
Wd	:	Wood
L	:	Leaves
Fr	:	Fruits

Plate II - Giant Squirrel

Table – 22

Selection of common food plants and their parts by Arboreal mammals in different months in any year

No	Name of food plants	Months											
		Jan	Feb	Mar	Apr	May	Ju	July	Aug	Sept	Oct	Nove	Dec
1.	*Grewia tiliaefolia*		$T L^{+}+Fl^{(1)}$	$L+Fl^{(1)}$	$L+Fl^{*(1)}$	L+Fl	$F(UR)^{-(1)}$ $F(UR)^{-(2)}$ $F(UR)^{-(3)}$	$F(NR)^{*(1)}$ $F(NR)^{*(2)}$ $F(NR)^{-(3)}$	$F(R)^{-(1)}$	$F(R)^{-(1)}$ $F(R)^{-(2)}$			
2.	*Toddalia asiatica*	$Fl+T.L^{(1)}$						$F(NR)^{-(2)}$	$F(NR)^{-(1)}$ $F(NR)^{-(2)}$	$F(R)^{*(1)}$ $F(R)^{*(2)}$ $F(R)^{*(3)}$			
3.	*Evdoia lunu-ankenda*	$T.L^{-(1)}$	$L^{*(1)}$	$L^{0(1)}$ $L^{*(3)}$	$L^{0(1)}$ $L^{*(3)}$	$L^{*(1)}$	Fl	Fl	Fl	Fl+L $F(UR)^{0}$	$L^{-}+F(NR)$ $F(NR)^{0(2)}$ $F(NR)^{-(3)}$	$^{*(1)}L^{0}+F^{-(1)}$ $F(R)^{*(2)}$	$L^{-}+F^{(1)}$ $F(R)^{*(2)}$
4.	*Sterculia guttata*	$Seed^{*2}(UR)$	$Seed^{0(2)}(UR)$	$F^{*}(1)(NR)$						$Fl^{*(1)}$			$Seed^{*(2)}$
5.	*Bombax ceiba*	$Fl^{*(1)}$ $Fl\ bud^{-(2)}$	$Seed^{*(2)}$ $Seed^{*(3)}$ $Seed^{*(4)}$	$Seed^{*(2)}$	$Seed^{-(2)}$					Petiole$^{-(1)}$	Petiole$^{-(1)}$		
6.	*Actinodaphne hirsuta*	$T.S.^{-(1)}$	$L^{(1)}$	$F(UR)^{-(2)}$	$F(UR)^{0(2)}$	$F(UR)^{0(2)}$ $F(UR)^{-(2)}$	$F(NR)^{*(1)}$ $F(NR)^{-(2)}$	$F(NR)^{*(1)}$ $F(NR)^{-(2)}$	$F(R)^{0(3)}$	F(R)			
7.	*Rejoua dichotoma*	$T.L.^{*(1)}$	$T.L.^{*(1)}$	$T.L.^{0(1)}$				$F(UR)^{-(1)}$	$F(NR)^{*(1)}$ F	F(R) $F(NR)^{*(1)}$ $F(NR)^{-(2)}$	$L^{*(1)}F(R)$ $F(R)^{0(2)}$	$F(R)^{-(2)}$	$F(R)^{-(3)}$
8.	*Ficus mysorensis*			$F(NR)^{*(1)}$	L^{0} $F(R)^{(4)}$								
9.	*Gnetum ula*								$F(NR)^{0(1)}$ $F(NR)^{-(2)}$ $F(NR)^{(3)}$	- $F(R)^{0(2)}$ $F(R)^{-(3)}$			

No	Name of food plants	Months											
		Jan	Feb	Mar	Apr	May	Ju	July	Aug	Sept	Oct	Nove	Dec
10.	*Memecylon malabaricum*			T.L.$^{-(2)}$				F(NR)$^{-(2)}$	F(NR)$^{-(1)}$ F(NR)$^{0(2)}$	F(R)$^{-(1)}$ F(R)$^{+(2)}$ F(R)$^{-(3)}$	F(R)$^{+(2)}$		
11.	*Ehretia canarensis*	L$^{+(1)}$ L$^{(2)}$							Fl$^{+(1)}$ Fl$^{0(3)}$	L$^{-(1)}$ Fl$^{+(2)}$ Bark$^{-(2)}$	L$^{-(1)}$ F(R)$^{+(2)}$	L$^{0(1)}$	L$^{+(1)}$
12.	*Dalbergia latifolia*			T.L$^{+(1)}$ T.L$^{0(2)}$									
13.	*Pterocarpus marsupium*	F(R) Bean$^{0(2)}$	T. L$^{-(1)}$	T. L$^{+(1)}$	L+Fl$^{+(1)}$	L+Fl$^{+(1)}$	L+Fl$^{+(1)}$	F(UR)$^{+}$	F(NR)$^{+(1)}$	F(NR)$^{+(1)}$ Bark$^{-(2)}$	F(NR)$^{+(1)}$	F(R)$^{-(1)}$	F(R)$^{-(1)}$
14.	*Terminalia chebula*	P$^{-(1)}$ F$^{0(2)}$										F$^{-(2)}$	F$^{+(2)}$
15.	*Cinnamomum sulphuratum*			L$^{-(1)}$	L$^{-(1)}$				F(IP)$^{-(2)}$ F(OP)$^{+(3)}$ F$^{-(1)}$				
16.	*Litsea laevigata*			F(UR)$^{-(1)}$ F(UR)$^{0(3)}$	F(NR)$^{0(1)}$	F(R)$^{-(1)}$	F(R)$^{+(2)}$	F(R)$^{+(2)}$					
17.	*Meliosma pinnata*				T.L.$^{-(1)}$	Fl$^{(1)}$	F(UR)	F(NR) F(NR)$^{0(2)}$	F(R)$^{+(2)}$	F(R)$^{+(2)}$			
18.	*Dillenia pentagyna*		Fl$^{-(1)}$		Fl$^{-(1)}$ Fl$^{-(2)}$	Fl$^{0(2)}$ Calyx	Fl$^{0(2)}$ Calyx						
19.	*Uvaria hookerii*									F$^{-(1)}$ F$^{-(2)}$	F$^{0(2)}$	F$^{0(2)}$	

No	Name of food plants	Months											
		Jan	Feb	Mar	Apr	May	Ju	July	Aug	Sept	Oct	Nove	Dec
20.	*Hydnocarpus laurifolia*	FR $^{+(1)}$ FR $^{-(2)}$	FR $^{-(1)}$ FR $^{0(2)}$	FR $^{+(2)+}$T F(UR)$^{(1)}$ F(UR)$^{-(2)}$	L-F(R)$^{+2}$ F(R)$^{0(2)}$	Fl+F(R)$^{+2}$			F(UR)$^{-(1)}$	F(NR)$^{-(1)}$	F(NR)$^{+(1)}$	F(NR)$^{+(3)}$	F(R)$^{0(1)}$ F(R)$^{-(3)}$
21.	*Flacourtia montana*												
22.	*Elaeocarpus oblongus*	F$^{-(2)}$									F$^{-(1)}$	F(R)$^{0(2)}$	F(R)$^{+(2)}$ F(R)$^{(4)}$
23.	*Acronychia laurifolia*					L+Fl$^{-(1)}$	L+Fl$^{-(1)}$			F$^{(2)}$	F$^{(2)}$		
24.	*Canarium strictum*				Fl	T.L$^{-(1)}$+Fl^{-}		Seed$^{0(2)}$	Seed$^{+(2)}$ Fruitwall^{-} $^{(1)}$	Seed$^{+(2)}$			
25.	*Dysoxylum malabaricum*					Seed$^{-(2)}$	Seed$^{0(2)}$	Seed$^{+(2)}$	FR$^{-(1)}$ Seed$^{+(2)}$	FR$^{+(1)}$			
26.	*Mangifera indica*						F$^{+(2)}$ F$^{+(3)}$ F$^{+(4)}$						
27.	*Spondios pinnata*		T.L$^{-(1)}$	TL+Fl$^{-(1)}$	Fl		F(UR)$^{-(2)}$	F$^{0(2)}$	F(NR)$^{-(1)}$ F$^{0(2)}$	F(R)$^{+(1)}$	F(R)$^{-(1)}$	F(R)$^{-(1)}$	
28.	*Entada rheedei*								Bean$^{0(2)}$	Bean$^{0(3)}$	T.L$^{-(1)}$		
29.	*Tectona grandis*	(endosperm of the)											
30.	*Maesa perrotettiana*	Seed$^{+(2)}$	Seed$^{+(2)}$	T.L$^{-(1)}$ Seed$^{-(2)}$ T.L$^{-(3)}$	T.L$^{0(1)}$	T.L$^{+(1)}$	T.L+Fl$^{+(1)}$	F(OP)$^{-(1)}$	F(OP)$^{-(1)}$	F(OP)$^{-(1)}$ Seed$^{+(2)}$	Seed$^{0(2)}$	Seed$^{0(2)}$	F(OP)$^{-(1)}$ Seed$^{0(2)}$
31.	*Psidium guajava*							F(UR)$^{-(1)}$ F(UR)$^{-(2)}$	F(UR)$^{0(2)}$	F(NR)$^{-(1)}$ F(NR)$^{0(2)}$			

No	Name of food plants	Months											
		Jan	Feb	Mar	Apr	May	Ju	July	Aug	Sept	Oct	Nove	Dec
32.	*Casearia esculenta*							$F(UR)^{0(3)}$ $F(UR)^{0(2)}$ $F^{+(1)}$ $F^{0(2)}$	$F^{0(1)}$ $F^{-(2)}$ $F^{+(1)}$ $F^{-(2)}$	$F(R)^{0(1)}$			
33.	*Schefflera (sp)*												
34.	*Persea macrantha*	$FI^{+(1)}$	$FI^{+} + TL^{+(1)}$ $F(UR)^{+(2)}$	$F(NR)^{+(1)}$ $F(UR)^{-(2)}$	$F(R)^{0(1)}$ $F(R)^{+(2)}$		Leafmidrib $^{+(2)}$						
35.	*Diospyros montana*	$F(R) + TL^{-(1)}$	$F(R) + TL^{-(1)}$	$L^{-(1)}$	$L+ FI^{-(1)}$					$F(UR)^{-(1)}$	$F(NR)^{+(1)}$ $F(NR)^{+(2)}$	$F(R)^{-(1)}$ $F(R)^{+(2)}$ $F^{0(2)}$	$F(R)^{+(2)}$ $L^{-(1)}$
36.	*Diospyros ovalifolia*	$F^{+(2)}$											
37.	*Cordia obliqua*					$Seed^{+(2)}$	$F(R)^{+(1)}$ $Seed^{-(2)}$						
38.	*Myristica dactyloides*		$L^{0(2)}$	$F(NR)^{+(1)}$ $F(NR)^{-(2)}$	$F(NR)^{-(1)}$ $F(NR)^{-(2)}$	$F(R)^{-(1)}$ $F(R)^{+(2)}$	$F(R)^{-(1)}$ $F(R)^{+(2)}$	$F(R)^{0(2)}$ $Bark^{-(2)}$	$Bark^{-(2)}$				
39.	*Litsea deccanensis*							$F(UR)^{-(1)}$	$F(UR)^{-(1)}$	$F(NR)^{+(1)}$ $F^{-(2)}$	$F(R)^{-(1)}$ $F(R)^{+(2)}$		
40.	*Litsea oleoides*				$F(R)^{0(1)}$ $F(R)^{+(2)}$	$F(R)^{+(2)}$							
41.	*Croton malabaricus*									$F(NR)^{+(2)}$	$F(NR)^{0(2)}$	$F(R)^{+(1)}$ $F(R)^{-(2)}$	
42.	*Ficus amplissima*				$L^{-(1)}$	$F^{0(1)}$ $F^{-(2)}$					$F^{+(2)}$	$F^{-(2)}$	

No	Name of food plants	Months											
		Jan	Feb	Mar	Apr	May	Ju	July	Aug	Sept	Oct	Nove	Dec
43.	*Ficus beddomei*	$F(NR)^{+(1)}$	$F(NR)^{+(1)}$									$F(UR)^{+(2)}$	$F(UR)^{-(1)}$ $F(UR)^{+(2)}$
44.	*Ficus callosa*									$F(R)^{+(2)}$ $F(R)^{+(3)}$			
45.	*Ficus nervosa*									$F(NR)^{0(1)}$			Bark+wood$^{-}_{(2)}$
46.	*Ficus exasperata*	$L^{-(1)}$ $L^{-(3)}$						$F^{0(2)}$ $F^{0(3)}$					
47.	*Ficus talbotii*								$F^{-(1)}$	$F^{-(2)}$			
48.	*Ficus tjakela*		$F(UR)^{0(2)}$	$TL^{0(1)}$	$F(NR)^{+(1)}$	$F(NR)^{+(1)}$				$F^{-(2)}$			
49.	*Artocarpus integrifolia*					$F(UR)^{+(1)}$	$F(NR)^{+(1)}$ $F(NR)^{+(2)}$ $F^{0(4)}$	$F(R)^{0(1)}$ $F(R)^{+(2)}$ $F^{0(4)}$					
50.	*Artocarpus hirsuta*					$F(UR)^{+(2)}$	$F(R)^{0(1)}$ $F(R)^{0(2)}$ $F^{-(4)}$						
51.	*Artocarpus gomezianus*				$F(NR)^{+(2)}$	$F(NR)^{+(1)}$ $F(NR)^{-(2)}$	$F(R)^{-(1)}$ $F(R)^{+(2)}$	$F(R)^{+(2)}$					
52.	*Lantana aculeata*	$L^{-(3)}$	$L^{+}+Fl^{+(1)}$ $L^{+}+Fl^{+(3)}$	$L^{+}+Fl^{+(1)}$ $L^{+}+Fl^{0(3)}$									
53.	*Clausina indica*	$L^{-(1)}$				$F(UR)^{-(3)}$	$F(R)^{+(3)}$ (Pulp)						
54.	*Radermachra xylocarpa*				$Fl^{-(1)}$ $Fl^{0(3)}$		$F^{-(3)}$		$L^{-(1)}$				
55.	*Vitex altissima*							$Fl^{-(1)}$	$F^{+(1)}$	$F^{+(1)}$	$F^{0(1)}$ $F^{+(3)}$	$F^{0(3)}$	
56.	*Delonix regia*			$TL^{-(1)}$ $TL^{+}+Fl^{0(3)}$	$TL^{-}+Fl^{-(1)}$ $TL^{+(3)}$	$Fl^{-(1)}$ $Fl^{+(3)}$					$F(R)^{-(1)}$		

No	Name of food plants	Months											
		Jan	Feb	Mar	Apr	May	Ju	July	Aug	Sept	Oct	Nove	Dec
57.	*Cinnamomum malabatrum*						F(NR) $^{+(1)}$	F(NR) $^{+(1)}$	F(R) $^{0(1)}$	F(R) $^{+(3)}$			
58.	*Ficus hispida*						F(NR) $^{-(1)}$	F(R) $^{+(3)}$					
59.	*Emblica officinalis*			TS $^{-(1)}$					F(NR) $^{0(1)}$	F(NR) $^{0(1)}$	F(R) $^{-(1)}$ F(R) $^{0(4)}$		
60.	*Terminalia paniculata*	F(R) $^{-(1)}$	F(R) $^{-(1)}$	F(R) $^{-(1)}$	TL $^{+(1)}$	TL $^{+(1)}$	L $^{+(1)}$	L $^{-(1)}$	F $^{+(1)}$ Bark $^{0(3)}$	Fl $^{+(1)}$	Fl $^{+(1)}$	F $^{0(1)}$	F $^{0(1)}$
61.	*Mallotus philippinensis*		F(NR) $^{0(1)}$	F(R) $^{0(1)}$					TS $^{0(1)}$		Fl $^{-(1)}$	Fl $^{(1)}$ Fl $^{(3)}$	
62.	*Bischoffia javanica*												

Nilgiri Langur (1) Giant Squirrel (2) Bonnet Macaque (3) Flying Squirrel (4)
NR – Nearly ripe, R - Ripe

Table – 23

Difference in the sharing of same food plant species by Langur and Giant Squirrel

Name of the plant species	Fr	Fl	L	Bak	Pet
1. Bombax ceiba	x^1	x^1			
2. Pterocarpus marsupium	x^1	x^1	x^1	x^2	
3. Ehretia canarensis		x^1	x^1	x^2	
4. Terminalia chebula	x^2				x^1
5. Dillenia pentagyna	x^2	x^1			
6. Acronychia laurifolia	x^2	x^1	x^1		
7. Canarium strictum	x^2	x^1	x^1		
8. Entada (sp)	x^2		x^1		
9. Ficus nervosa	x^1			x^2	
10. Grewia tiliaefolia	x^1 (NR) x^2 (R)	x^1	x^1		
11. Tectona grandis	x^1 Cal x^2 (sd) x^1	x^1			

Legend : x^1 – Nilgiri Langur, x^2 – Giant Squirrel, Fr – Fruit, Fl – Flower, L – Leaves, Bak – Bark, Pet – Petiole, sd – seed, Cal – Calyx, NR – Nearly Ripe, R - Ripe

Degree of preference of food plants by the Nilgiri Langur and the Giant Squirrel also varied. For example, in the case of *Litsea oleoides* the ripe fruit of the plant species is common / rare (0 / -) for Langur but it is a "major" item (+) for the Giant Squirrel. (Table 22). Different parts of the eleven plant species were shared by them, (Table 23). The Nilgiri Langur and the Giant Squirrel shared two different parts of a plant species at a time. ie. during October – December period leaves of *Ehretia canarensis* was highly preferred by the Langur, whereas the ripe fruits of plant species were highly consumed by Giant Squirrel (Table 23).

Food Habits of Bonnet Macaque (*Macaca radiata*)

It was noted that twentynine plant species in the study area were consumed by Bonnet Macaque, (Appendix 4). The Macaque also shared the food plants of the Nilgiri Langur as the Giant Squirrel. Twentysix food plant species of Nilgiri Langur were shared by Bonnet Macaque. But their preference to different plant parts varied, (Table 22). The Nilgiri Langur and the Bonnet Macaque shared many fruits, leaves and flowers, (Table 22). Fruits were the most preferred plant part by Bonnet Macaque. Sixtyeight percent of their food plant species were selected only for fruits. They consumed flowers of five plant species (17.2%) leaves of 6 plant species (20.6%) bark of one plant species (3.4%) and one species of grass (3.4%), (appendix 4).

Bonnet Macaque also consumed pieces of bread, fruits and other wastes thrown around by the tourists. From December to March their dependence on plant species was less when compared to June, July, August, September months.

Large Flying Squirrel (*Petaurista petaurista*)

Random observations on the food habits of the Large Flying squirrel in and around the study area have shown that the species also took a variety of fruits and flowers, some of which are shared by the Nilgiri Langur and the Giant Squirrel. The Flying Squirrel was found to

Plate III - Bonnet Macaque

consume fruits of *Elaeocarpus oblongus, E.tuberculatus, Bischoffia javanica, Artocarpus hirsuta, A.integrifolia, Mangifera indica* and *Ficus mysorensis* and flowers of *Vernonia monosis*, (Table 22). Two Flying Squirrels run over by motor vehicles inside the reserve had mainly figs and flowers of *Terminalia* in their stomach.

Threestriped Palm Squirrel (*Funambulus palmarum*)

Palm Squirrel, another species of arboreal mammal in Periyar very rarely shared the food of the Langur. They mostly preferred barks of trees. They also consumed ants, termites and small insects etc.

Chapter — 10

DISCUSSION

The Nilgiri Langur, *Presbytis johnii* the Bonnet Macaque, *Macaca radiata* and the Malabar Giant Squirrel, *Ratufa indica* co-exist in different parts of the High Ranges of Kerala. The Nilgiri Langur (*Presbytis johnii*) studied in Periyar Tiger Reserve, were found in troops of 8 – 27 which seemed to be the optimum number for the habitat studied. They exploited a large number of plant resources in their environment for food, with fruits, leaves, and flowers being the main components of their diet. One hundred species of plants were eaten by the Nilgiri Langur. They exploited different plant species during different months for fruits, flowers, leaves, fruits and leaves, leaves and flowers, tender shoot, petiole, bark and calyx. Their dependency on different plant species varied in different months.

Seven plant species were highly preferred by the Langur for their fruits, seeds, leaves and flowers. Species such as *Terminalia paniculata* and *Evodia lunu-ankenda* were exploited throughout the year; while, *Pterocarpus marsupium* and *Tectona grandis* were consumed at all months except in January. *Grewia tiliaefolia, Dalbergia latifolia* and *Persea macrantha* were the other highly preferred plant resources.

Forest guenons are selective feeders and a few plant species make up the staple diet of each species according to Gautier Hion (1988). Several studies, both of New World and Old World monkeys have shown that although fruit–eating monkeys consumed many different items, they rely on a small subset in any given period, (Rudran 1978, Cords 1986, Sourd & Gautier – Hion 1986, Beeson 1989, etc.) Only a small number of items composed the bulk of their diet in any given month. However this is not the case with the Nilgiri Langur. All parts of the seven food plant species they preferred, didn't form a staple food throughout the year. Preferences to these plants varied with season (Table 24). But when these plant species had preferred parts, the percentage of average time spent on these parts were higher than that on any other food plant resources. From May to Mid August their dependency on six plant species was higher than in other months. During this period movements of the Langur were restricted to certain parts of the study area and hence these plant species seem to have some influence in the movement patterns. These plant species were however not the major, resources for the Langur in all months of the year. There were certain major common, and rare food plant resources in each month. They never relied completely on a small subset in any given period.

As already discussed, along with the highly preferred plant species the Nilgiri Langur also utilised rare plants. But the percentage of time spent on rare plants were low, during May to August.

Table – 24

The most preferred seven plant resources and their preference by Nilgiri Langur

Name of Plant species		Jan	Feb	Mar	Apr	May	Ju	July	Aug	Sept	Oct	Nov	Dec.
Tem	Part	$F(R)^{0}$	$F(R)^{+}$	$P(R)^{+}$	$T.L^{0}$	$T.L^{+}$	L^{+}	L^{0}	Fl^{+}	Fl^{0}	Fl^{0}	$F(R)^{-}$	$F(R)^{+}$
	% time	3.9	0.6	0.8	4.2	8.2	7.8	5.2	9.2	5.4	6.1	8.2	8.4
Evd	Part	$T.L+F^{0}$	L^{+}	L^{+}	L^{0}	L^{0}	Fl^{0}	Fl^{+}	Fl^{0}	Fl^{-}	F^{0}	$F(R)^{+}$	$F(R)^{+}$
	% time	2.9	6.2	5.9	4.1	4.4	6.2	7.1	4.4	2.1	1.9	9.9	7.6
Grw	Part	-	TL^{-}	$L+Fl^{0}$	$L^{+}+Fl^{+}$	$L^{+}+Fl^{+}$	$Fl^{+}+F(UR)^{-}$	$F(R)^{+}$	$F(R)^{+}$	$F(R)^{-}$			
	% time		0.1	4.8	8.2	13.8	7.9	8.9	6.5	1.4			
Ptr	Part		TL^{-}	TL^{0}	TL^{+}	$TL^{-}+Fl^{+}$	$TL^{0}+Fl^{+}$	F^{+}	$F(UR)^{+}$	$F(UR)^{0}$	$F(R)^{0}$	$F(R)^{-}$	$F(R)^{-}$
	% time		1.2	4.2	8.1	6.8	8.4	4.4	4.8	3.9	3.4	2.4	1.2
Tct	Part		TL^{-}	TL^{-}	TL^{0}	TL^{0}	TL^{+}	$TL^{+}+Fl^{-}$	TL^{-}	TL^{-}	$F(UR)^{-}$	$F(R)^{0}$	$F(R)^{-}$
	% time		1.5	1.2	4.8	9.4	10.8	3.2	0.9	0.1	1.2	0.8	0.2
Dal	Part	$F(R)+L^{-}$	L^{+}	$L+Fl^{0}$	Fl^{0}	Fl^{0}	-	-	-	-	$F(R)^{-}$	$F(R)^{-}$	L^{-}
	% time	5.9	7.4	6.8	5.2	4.4					2.2	1.3	0.4
Per	Part	Fl^{-}	$Fl^{+}+L^{+}$	F^{+}	$F^{+}(R)$								
	% time	7.2	6.8	8	8.2								

Legend : Tem – Terminalia paniculata, Evd – Evodia lunu ankenda, Grw- Grewia tiliaefolia, Ptr – Pterocarpus marsupium Tct – Tectona grandis, Dal – Dalbergia latifolia, Per- persea macrantha (-) – rare, (0) – Common, (+) - major

From August to mid April the percentage of time spent on common and rare plants has been increasing and consequently there was an increase in the diversity of diet. Their preference to major plants seemed to be less

during this period as they spent less time on them. Thus major (+) and common (0) food plant of this season (ten food plants; November to March) were not highly preferred.

The proportion of time spent on preferred plant parts viz. fruit, leaf and flower was almost constant with slight variations throughout the year (Table 25). During the study, it was found out that the Nilgiri Langur consumed more quantity of leaves than fruits during this study, though their general tendency was to exploit more fruits than leaves when preferred fruits were available (Table 25). For instance, the percentage of time spent on feeding leaves was highest during January and February but, at the individual level the percentage of time spent on feeding the fruits of *Ficus beddomei* was higher (50.8%) than the preferred leaves of *Rejoua dichotoma* (20%) (Table 25). However during rainy season, when major fruits were adundant in the area, they spent an average 30% of the time for leaves and 20% for flowers.

Studies of Cercopithecus monkeys have shown differing results in the animal's reactions to variability in fruits abundance. Rudran has (1978) found that the diet of blue monkey in Kibale Forest Uganda was more diverse during periods of low fruit availability.

Table - 25

Variations in the percentage of time spent for feeding fruit, flower and leaf at three periods

Rainy Season June – July			Summer Season March – April			Winter Season January – February		
Plant species	Part	Time	Plant species	Part	Time	Plant species	Part	Time
1. *Grewia tiliaefolia*	F	55%	1. *Ficus mysorensis*	F	60.2%	1. *Ficus beddomei*	F	64.4%
2. *Tectona grandis*	L	31%	2. *Dalbergia latifolia*	L	29.6%	2. *Rejoua dichotoma*	L	28%
3. *Terminalia paniculata*	Fl	14%	3. *Dalbergia latifolia*	Fl	10.2%	3. *Persea macrantha*	Fl	7.6%

In the present study, leaf and flower consumption of the Nilgiri Langur have increased during the period of low fruit abundance. On such occasions they hardly maintained fruits in their diet. Whenever fruits were available in the feeding site, they spent more time feeding on fruits. For example, during summer and winter seasons (fruit scarcity season) percentage of time spent on a fruit plant was higher than that in the rainy season, (Table 25) thus maintaining a good proportion of fruits also in their diet.

Fig fruits seem to be an important resource at certain times of fruits scarcity. Different species of figs which provide fruits almost throughout the year, provide a sustainable supply of fruits, thereby preventing fruit scarcity in any period. But, figs could not sustain most populations of frugivorous animals during lean fruiting periods and were probably important only to widely ranging species. (Gautier-Hiion &

Michaloud 1989). Though Nilgiri Langur consumed fig fruits throughout the year their dependency on fig fruit resources were higher during periods of fruit scarcity. For example, if *Ficus beddomei* were available in the site, the average time spent on *Ficus beddomei* was higher than on any other preferred fruit resource during scarcity period. If it (Ficus species) is not available, the average intake of leaves increased, to overcome fruit scarcity. Owing to these characteristics, it appears that figs can be exploited as a major fruit source at certain times of fruit scarcity. The Primate species studied by Peres (1994) in Amazone forests fed largely on ripe fruit pulp and shifted to alternative plant resources during the dry season when density of fruiting trees and abundance of ripe fruits reached their lowest level.

Quality of the habitat which changed with seasons seems to be a main factor influencing the movements of the Nilgiri Langur in the study area. During rainy season (June, July, August) troop I and troop II concentrated their activities in the middle part of the study area. Their feeding and resting were higher during this season. This seems to be related to the abundance of fruits, leaves and flowers during this period. The most preferred plant species (Table 24) were highly exploited by the Langur during this period. Thus it was found out that if the Nilgiri Langur gets sufficient quantity of preferred food plants in an area its

movements would be less and there is very little overlapping of homerange and no competition for food, even though they consumed lesser variety of plant resources. During winter season (November to February) the average time spent on major plants was least (29% to 32%), while time spent on rare plants was higher, (39% to 49%). This may be because the highly preferred five species may not have its preferred food items. In such situations they roamed over and utilized a wider area without confining to their homerange. Time spent on movement during this period was higher than that in the rainy season. Certain preferred plant species like *Presea macrantha, Ficus mysorensis, Sterculia guttata* were available only in certain localities of the study area, (March to April) so the Langur mainly visited that part, in search of food. According to Newton (1967) and Foster (1977) sedentary species when exposed to an annual lean period spend more time on searching and must look in for a wide variety of food items. They increase the time spent for foraging and the range of habitats and microhabitats in which they forage. Movements however also seemed to be related to the breeding season. When they have infants, they seem to restrict their activities within the homerange.

The use of different feeding techniques by the Nilgiri Langur seem to depend on the morphological features of the food plants. Feeding activities lasted throughout the day. Nevertheless factors such as

weather, time of the day, temperature, rainfall, wind and features of the food plant affected the intensity of feeding. Though the Langur continued feeding in light moderate rain, they were not active in heavy rain.

Phenological studies have shown that abundance of plant resources is not an important factor in the selection of different plants. For instance during rainy season there were seventy fruit plants, but they exploited only ten species. As already discussed, selection of different plants varied with seasons. From August to December the average number of plants having fruits were sixtyone but they selected fruits of twenty species which was higher than that of June, July months.

Although the different removal rates of fruits suggest that arboreal mammals select some species of fruit over others, the exact factors influencing these preferences are unknown. The ripening sequence of fruit must place an initial constraint upon the selection of fruits (Foster 1977). Further more, variations in the feeding techniques of arboreal mammals would result in some species of fruits being more accessible than others.

The Nilgiri Langur consumed plant parts containing proteins, carbohydrates and lipids throughout the year. The quantity of these nutrients varied in different plant parts. The Langur consumed food

containing more protein than carbohydrate and lipid. This would be a preventive measure to avoid bloat in sacculated sotmach; a peculiar physiological condition in Langurs. langurs have sacculated stomachs in which cellulysis and fermentation occur, and the consumption of carbohydrate can lead to a condition comparable to that of bloat in cattle, in which the stomach becomes actually distended (Hungate *et. al*; 1959, Bauchop, 1978). Bloat and hyper-acidity have caused fatalities among captive colobines (Collins & Roberts, 1976; Davies *et. al*, 1983). Nilgiri Langur consumed more carbohydrate containing food during summer months than rainy and winter months. The rate of intake of protein and lipid was higher during rainy and winter months than summer. This may be related to its breeding period.

Bennett (1983) suggested that Banded Leaf Monkeys avoided consuming fleshy fruits in order to avoid bloat, similarly the Nilgiri Langur preferred nearly ripe and unripe fruits than fully ripe juicy fruits. The quantitative analysis of sugar content of seven samples of nearly ripe and fully ripe fruits showed that, ripe fruits had more sugar than nearly ripe and unripe fruits. This may be the reason for their preference to bitter taste (sweet taste with little acidic) than sweetly fruits (fully ripe fruits). Previous studies have highlighted various factors that affect feeding in primates. Among these are the need to increase the diversity of

the food items eaten (Marsh 1978), and the need to avoid compounds in plant material that are potentially poisonous to the monkey, such as the various alkaloids and tannin normally present in leaf material (McKey 1978). As mentioned by Sorensen (1981) in the case of birds, palatability or content of other nutrients may be also important in determining the feeding preferences of the Nilgiri Langur.

The Malabar Giant Squirrel and the Bonnet Macaque, the other common arboreal mammals occurring in the study area, also utilized leaves, flowers and fruits of a number of plants. Observations have shown that the Malabar Giant Squirrel shared its habitat and food with Nilgiri Langur in high degree than any other arboreal mammals in the study area (80.32%). The Giant Squirrel exploited different parts of sixty one plant species in the study area, with fruits being the main component of their diet (90.8%). Out of the one hundred food plant species of the Langur, fortynine were shared by the Giant Squirrel, (Table 27). In other words, the Giant Squirrel shared 80.32% of their plant with Langur. The sharing of plants varied in both animals. Different parts of the same plant species were shared by them. There was no competition for these plant resources between the Langur and the Giant Squirrel. For instance, the Giant Squirrel preferred ripe fruits of *Grewia tilaefolia* but, the nearly ripe and unripe fruits of the species was utilized by the Langur.

In January, it was observed that fruits of *Elaeocarpus oblongus, Prunus ceylanicam* and *Teminalia chebula,* were taken by the Giant Squirrel (Table 26). Of the total fifty observations in January, 23% were on these three plant species. Besides, they consumed seeds of *Pterocarpus marsupium, Tectona grandis and Sterculia guttata.* The Giant Squirrel consumed dry seeds (endosperm of the seed) also, full fruits. During the rest of January, Giant Squirrel shared fruit plants of Langur (*Hydnocarpus laurifolia, Ficus beddomei*) may be to overcome scarcity of fruits.

Terborgh (1983, 1986a, 1986b) has suggested that figs are important key resources for both Neortropical and Paleotropical frugivorous vertebrates during the periods of fruits scarcity. This suggestion stemmed from the findings that figs were important in the lean season diets of several arboreal primates, procyonids, and birds in a Peruvian rain forest (Terborgh 1983) as well as from observations of a frugivorous community in a tropical lowland rain forest in East Kalimantan, Indonesia (Leighton & Leighton 1983). They have also observed that foliage and bark were principal resources for several primates and squirrels during fruit shortages. According to Borges (1989), the Giant Squirrel restricted to a diet of leaves, flowers and bark during periods of fruit scarcity. During the periods, when fruits were scarce, the

Giant Squirrel employed different strategies like the Nilgiri Langur. They maintained fruits in their diet by consuming new plant species and consumed endosperm of the dry seeds. Also they took leaves, bark and wood of different plant species to overcome fruit scarcity. According to Borges (1989) the Giant Squirrel restricted to a diet of leaves, flowers and bark during periods of fruit scarcity. Supporting the statement of Terborgh (1983, 1986a, b), the Giant Squirrel consumed different fig plant species also to overcome fruit scarcity.

Table – 26

Food plants of the Giant Squirrel during fruit scarcity(ie. January)

Name of the plant species	F	% of time	Total
Elaeocarpus oblongus	Fruit	8	
Prunus ceylanica	Fruit	9	23%
Terminalia chebula	Fruit	6	
Pterocarpus marsupium	Bean (seed)	5	
Tectona grandis	Seed	10	37%
Sterculia guttata	Seed	15	
Bombax ceiba	Seed	7	
Ficus beddomei	Fruit	30	40%
Hydnocarpus laurifolia	Fruit	10	

Table – 27

Sharing of food plants of the Nilgiri Langur by other Arboreal Mammals

	No.of plants consumed by			
Nilgiri Langur	G.squirrel	Bonnet Macaque	Flying Squirrel	Palm Squirrel
100	49	26	5	2

While feeding, the Giant Squirrel associated with the Langur during 45% of the total observations. The feeding association seem to be advantages for the Giant Squirrel, as it gets protection from enemies, as Langur always gave alarm signals on the approach of enemies / predators. The Giant Squirrel, on the other hand, helped the Langur, in locating food plants. On several occasions it was observed that the Langur utilised certain plants, which were already located by the Giant Squirrel. Also certain fruits having hard epicarps (eg. *Artocarpus hirsuta, and Artocarpus integrifolia*) which could not be opened by the Nilgiri Langur were opened by the Giant Squirrel. It was noticed on many occasions that, as soon as these fruits are opened by the Giant Squirrel, the Langur arrived at the spot. The Giant Squirrel after eating a portion, always let the fruits to be taken over by the Langur without any conflict.

Home ranges of the Nilgiri Langur in the study area were overlapped with that of the Bonnet Macaque. The Langur used the interior of the forest more extensively than the Bonnet Macaques, where

as the latter does much of their foraging on the sides of the road. The Bonnet Macaque troops frequently came in contact with the Langur troops during their daily movements. Occasionally both the species mingled and moved together without any conflict, however clashes occurred between them at times and the Langur troops were to leave the area always. The Nilgiri Langur, usually avoided the Bonnet Macaque, although it occasionally exhibited a slight defensive expression (Sugiyama, *et. al 1971*). The daily movements of one species was however, never disturbed by troops of the other species. The Bonnet Macaque shared twentysix food plants of Nilgiri Langur, (Table 27) while fifteen plant species in the study area were shared by the Nilgiri Langur, the Giant Squirrel and the Bonnet Macaque. Little competition was observed between the two species while feeding. The Bonnet Macaque is a highly adaptive animal and known to take a variety of food items including fruits, leaves and barks of a number of trees, grasses, herbs and insects (Ali 1986). They spent a considerable time in the areas where there are tourists and also around human habitations and take kitchen scrapes, and pieces of human food, including bread, nuts, fruits, etc. This may also prevent a closer interaction between the two species in the study area.

The Large Flying Squirrel though share a variety of fruits with the Nilgiri Langur does not seem to enter into any conflict with the other

arboreal mammals in the study area. The limited data however is not sufficient to make any conclusion in this regard. In any case their nocturnal habits would prevent them from having any conflict or competition with other arboreal mammals.

Vertebrate frugivores especially birds, primates and squirrels are the principal seed dispersers of a high proportion of tree and shrub species in moist tropical forests. (Gentry 1982, Stiles 1985). Nilgiri Langur preferred nearly ripe fruits than fleshy juicy fruits. They wasted fully fruits after partial consumption; thus they cause a high level of seed waste by dropping seeds to the ground. On certain occasions they consumed outer parts of the nearly ripe fruits; and seeds are thrown away. According to Howe (1980) fruit eating monkeys cause a high level of seed waste by depositing seeds in concentration, that cause seed and seedling mortality or by destroying seeds during ingestion.

In the present study it was found out that the Nilgiri Langurs are poor seed dispersers. Observations on fecal samples have shown that seeds of the fruit eaten were not defecated, probably because most of the nearly ripe and unripe fruits eaten by Langur were crushed by its teeth. Again, in the case of ripe fruits they took, the seeds are excluded, utilizing only the outer parts. They rarely acted as seed dispersers by transferring fruits, away from the parent plants to the distant places.

Chapter — 11

SUMMARY AND CONCLUSION

Detailed studies were carried out on the resource utilization by the Nilgiri Langur, *Presbytis johnii* in Periyar Tiger Reserve while data on the food habits of the Malabar Giant Squirrel, *Ratufa indica* and the Bonnet Macaque, *Macaca radiata* which co-existed with the Nilgiri Langur in the area was also collected. Oberservations were conducted in Thekkady area of the reserve.

The phenology of 132 tree in the study area was studied and its relation with the food habits of the Nilgiri langur was examined. Trees include both evergreen and deciduous types. There is no definite flowering or fruiting season as fruits are available throughout the year.

The study was aimed at getting a detailed account on the food habits and food preference of the Nilgiri Langur during different months of the year. Since a positive relationship between groupsize and habitat quality in terms of food have been demonstrated in group living (social) animals the relationship between Niligri Langur troops and its habitat have also been studied.

The troop size of the Nilgiri langur in the study area varied from 8-27 during the four year study period. This figure was almost constant

during the study period. This seems to be optimum for the Nilgiri Langur in the evergreen habitat of Periyar. Annual recruitment to the population remained more or less the same. Hence this also shows the optimal condition of the habitat of the Langur in Periyar.

The Nilgiri Langur in Periyar took leaves, fruits and flowers throughout the year. There were certain major, common and rare food plants every month. There seemed to be some patterns in the selection of food plants by the species. Though they consumed a good quality of leaves, their general tendency was to consume more fruits. Phenological characters didn't seem to have any relation with food selection of the Nilgiri Langur. In other words, if there was an abundant supply of its major food, it may not take that food item in enormous quantity. There were variations in the type of food taken by the Langur every month. In some cases they consumed fruits, leaves, and flowers of the same plants. Seasonal progression was also observed in the utilization of the parts of the food plants, along with the proportion of time spent on different plant parts. They preferred ripe and unripe fruits of different plants.

The determinants of food selection by the Nilgiri Langur are complex and likely to maintain a constant ratio of fruits (50%) leaves (30 %) and flowers (20%) in their diet, eventhough, there were seasonwise variations, in the proportion of these plant parts. Nilgiri Langur

consumes mostly unripe fruits and crush the seeds of the ripe fruits, the animal seems to have little role in the transportation of seeds.

Though the Nilgiri Langur is a sedentary species, restricting its feeding activity mainly within its homerange, it wandered over a wider area during certain months in winter and summer. The movements of the Langur however is restricted to its homerange during rains, which may be due to the presence of new borns with them.

Biochemical analysis of certain food plants of Nilgiri Langur has shown that on the whole the Langur consumed more protein containing food. The species consumed more carbohydrate containing food during summer months and the rate of protein and lipid consumption was higher during rainy and winter seasons.

The Malabar Giant Squirrel and the Bonnet Macaque shared the habitat and food plants of the Nilgiri Langur in Periyar. The Giant Squirrel utilized flowers, fruits and barks of sixtyone plants in the study area. Its shared the food plants in a higher degree with the Nilgiri Langur. Out of the one hundred food plants of the Nilgiri Langur, fortynine were shared by the Giant Squirrel and both the species were seen feeding together on same plant. However, no competition was observed for food between the two species. In fact they utilized different

parts of the same tree and while feeding on the same fruits, they consumed different parts of the same fruit. (eg. pericarp and seed) or different stages of the fruits, (eg. unripe and ripe).

Bonnet Macaque also shared the food plants of the Nilgiri Langur to a great extend. Though competition for food was rarely observed, they never fed together. The Langur often left the area as soon as the Bonnet Macaque came closer. Twentysix food plants of Langur were taken by Bonnet Macaque.

Preliminary studies have shown that the Large Flying Squirrel also shared the habitats and food plants of the Nilgiri Langur. Though detailed studies have not conducted on the Flying Squirrel, the temporal variations in the feeding is certainly a factor preventing any sort of competition between the two species.

In the rain forest habitat of Periyar, there are some plants with tender leaves, flowers and fruits during all months of the year. This condition provides a steady supply of fruits to the arboreal mammals in the area throughout the year. Figs which are known as keystone species and provides fruits for a number of arboreal mammals and birds are represented by several species in the study area. Most species of figs have different flowering seasons, while some of them have two flowering

seasons. Again, most of the figs have prolonged flowering and fruiting seasons. These factors indicate the importance of figs as a major source of food for frugivorous mammals and birds in Periyar and neaby areas.

Conclusion

The troopsize of the Nilgiri Langur in the study area is almost constant during a four year study, from 1992 – 1996. The proportion of young ones borne in these years is also constant. This indicates that there may not be much changes in the availability of food for the Nilgiri Langur in the study area, though there was scarcity of fruits, to certain extent during certain periods. The importance of food as a limiting factor has been emphasised by Lack (1954). The Langur could adjust to the changes in the habitat, by feeding one more leaves, figs, etc. on such occassions. In other words, food doesnot seem to be a limiting factor for the Langur in Periyar. Further study is needed on this aspect. Positive relations between habitat quality in terms of food and carrying capacity have been demonstrated by Tabor and Dasman (1957). Though there is little change in the troopsize and population density of the Nilgiri Langur in the study area, the situation is different in the boarder areas of the reserve, where biotic pressure is very high. Knowledge of the phenology of plants, especially food plants of Nilgiri Langur and other arboreal mammals is helpful for formulating management strategies for these animals.

Recommendations

1. Troopsize and population density of the Nilgiri Langur in Periyar should be systematically monitored.
2. Important food plants of the Nilgiri Langur in the study area should be identified and protected and their regeneration should be monitored.
3. It is advisable to allow Nilgiri Langur to live in multiculture habitat considering the fact that they consume different plants and plant parts in different seasons, instead of introducing them into monoculture plantations.
4. Nutrient elements of different food plants should be analysed for getting more details about its food preference and quality of the food consumed.

Chapter — 12

REFERENCES

Ali, R, J.M. Johnson and Jim Moore 1985. Female Emigration in *Presbytis johnii.* A life history strategy. *J.Bombay Nat. Hist. Soc.* 82(2) : 1-4.

Ali, R. 1986. Feeding Ecology of the Bonnet Macaque at the Mundanthurai sanctuary, TamilNadu, *J.Bombay Nat. Hist. Soc.* 83 : 98-10

Bawa, K.S, P.S. Ashton, R.B. Primack; J. Terborgh, Salleh Mohd Nor, F.S. P.NG, and M.Hardley 1989. Reproductive ecology of tropical forest plants. *Biology International,* Special issue 21. Biology International, Paris, France.

Bauchop, T; 1978. Digestion of leaves in vertebrate arboreal folivores. In : *The Ecology of Arboreal Folivores*, Smithsonian Institution, Washington D.C; 192-204.

Beeson, M; 1989. Seasonal dietary stress in a forest monkey. (C. mitis) *Oecologia* 78 : 565-570.

Bennett. E; 1983. The banded Langur; ecology of a colobine in West Malaysian rain forest. Unpubl. Ph.D thesis, Cambridge University.

Borges R.M. 1989. Resources heterogeneity and the foraging ecology of the Malabar Giant Squirrel, *Ratufa indica.* Doctorial dissertation University of Meami, Florida.

_____ 1992. A nutritional analysis of foraging in the Malabar Giant Squirrel *Ratufa India. Biol. Linn. Soc.* 47 : 1-21.

_____ 1993. Figs, Malabar Giant Squirrel and fruit shortages within two tropical Indian Forests. *Biotrop.* 25(2) 183-190.

Chapman C A; 1989. Primate Seed Dispersal: The Fate of Dispersed Seeds. *Biotrop* 21(2) 148-154.

Collins, L; & M. Roberts, 1978. Arboreal folivores in captivity – maintenance of a delicate minority. *The Ecology of Arboreal Folivores* Smithsonian Institution, Washington; 5-11.

Cords, M. 1986. Interspecific and Intraspecific variation in diet of two forest guenons. *Cercopithecus ascanius* and *Cercopithecus mitis. J. Anim.* Ecol. 55 : 811-827.

Daniel J.C. and Kannan P. 1967. The status of the Nilgiri Langur (*Presbytis johnii,* Fisher) and Lion tailed Macaque (*Macaca silenus,* Linnaeus) in South India. Bombay National History Society Report 1-9.

Davies, A.G; J.O Caldecott, & D.J. Chivers, 1983. Natural foods as a guide to nutrition of Old World primates. *Standards in Laboratory Animal Management;* 225-241.

Estrada and T.H. Fleming (Eds) 1986. Frugivorous and seed dispersal. Dr. W.Junk Publishers, Dordrecht, Netherlands.

Foster M.S. 1977. Ecological and Nutritional effect of food scarcity on a tropical frugivorous bird and its fruit source. *Ecology* 58 : 73-85.

Foster R.B. 1982 a. The seasonal rhythm of fruit fall on Barro Colorado island. In EG. Leigh jr, A.S Rand & D.W. Windsor (*Eds*). *The Ecology of a Tropical Forest* pp 151-172. Smithsorian Institution Press.

Frankie, G.W; Baker, H.G; & Opler, P.A; 1974. Comparative phenological studies of trees on tropical wet and dry forests in the low lands of Costa-Rica. *Journal of Ecology;* 62 : 881-919.

Gautier-Hion, 1988. The diet and dietary habits of forest guenons. In A.Gautier-Hion, F.Bourliere, Gautier, J.P; and J.Kingdon (Eds). A primate radiation *evolutionary biology of the African guenons,* 257-283. Cambridge University Press Cambridge, England.

Gautier-Hion, A; & G. Michaloud, 1989. Are figs always keystone resource for tropical frugivorous vertebrates? *A test in Gabon Ecology;* 70: 1826-1833.

Gentry, A.H. 1982. Patterns of Neotrophical plant species diversity. *Evol. Biol.* 15 : 1-84.

Grewal B.S, 1980. Social Relationships Between Adult Central Males and Kinship Groups of Japanese Monkeys at Arashiyama with Some Aspects of Troop Organization. *Primates, 21(2) :* 161-180.

Grigg, B; 1880. *A manual of the Nilgiri District* Government Press, Madras.

Heithaus, E.R; & T.H. Fleming, 1978. Foraging movement of a frugivorous bat, *Carollia perspicillata; Ecol, Monogr;* 48: 127-143.

Horwich R.H; 1972. Homerange and food habits of Nilgiri Langur, *Presbytis johnii. J. Bombay Nat. His. Soc.* 69 : 255-267.

_____ 1976. The Whooping Display in Nilgiri Langurs : An Example of Daily Fluctuations Superimposed on a General Trend. *Primates,* 17(4) : 419-431.

_____ 1980. Behavioural Rhythms in the Nilgiri Langur, *Presbytis johnii. Primates,* 21(2) : 220-229.

Howe, H.F; and G.A. Van de Kerckhove 1979. Seed dispersal by birds and the fecundity of a Tropical forest. *Ecology* 60 : 180-189.

Howe, H.F; and J. Smallwood 1982. Ecology of seed dispersal. *Ann. Rev. Ecol. Syst,* 13 : 201-228.

Janzen, D.H.; 1979. How to be a fig; *Annu. Rev. Ecol. Syst.* 10 : 13-51.

Kaplin B.A, Munyaligoga V, T.C Moermond, 1998. The influence of Temporal Changes in Fruit Availability on Diet Composition and Seed Handling in Blue Monkeys (*Cercopithecus mitisdoggetti) Biotrop.* 30(1) : 56-71.

Koelmeyer,K.O; 1961. The periodicity of leaf change and flowering in the principal forest communities of Ceylon. *Ceylon Forester;* 4 : 157-189; 308-364.

Kurup, G.U; 1975. Status of the Nilgiri Langur *Presbytis johnii* (Fisher) in the Anamalai, cardomom and the Nilgiri Hills of the Western Ghats. *J. Bombay Nat. Hist. Soc.* 72(1) : 21-29.

_____ 1984. Census Survey and Population Ecology of Hanuman Langur, *Presbytis entellus* (Dufresne) in South India. *Proc. Indan Natn. Sct. Acad. B50 : 245-256.*

Kuruvilla, G. 1976. Ecology of Bonnet Macaque (*Macaca radiata,* Geoffroy) with special habits M.Sc., Thesis, University of Bombay.

Lack, D; 1954. Natural regulation of Animal Numbers. Oxford University Press, London.

Lambert, F; 1989 b. Fig-eating and seed dispersal by pigeons in a Malaysian Low land forest. *Ibis,* 131.

Lambert F, 1990. Some notes on Fig-eating by Arborial Mammals in Malaysia. *Primates,* 31(3): 453-458.

Leigh C; 1926 (a) Weights and measurements of the Nilgiri Langur (*Presbytis johnii) J. Bom. Nat. Hist. Soc.* 30 : 223.

_____ 1926 (b). Breeding seasons of the Nilgiri Langurs. *J. Bombay Nat. Hist. Soc.* 24(3) : 93.

Leighton, M; & Leighton, D.R; 1983. Vertebrate responses to fruiting seasonality within a Bornean rain forest. In S.L. Sutton, T.C. Whitmore, and A.C. Chadwick (Eds). Tropical rain forest : *ecology and management;* 181-196. Blackwell Scientific Publications, Ltd; London.

Lieberman, D; J.B. Hall, M.D. Swaine, and M. Lieberman, 1979. Seed dispersal by baboons in the Shai Hills, Ghana. *Ecology;* 60 : 65-75.

Lindsay, H.M; 1926. Bombay natural history society mammal survey of India, Burma and Ceylon, *J. Bom. Nat. Hist. Soc.* 30 : 591-656.

Marsh, C.W; 1978. Ph.D. Thesis, University of Bristol.

Maruhashi, T; 1980. Feeding Behavior and Diet of the Japanese Monkey (*Macaca fuscata yakuit)* on Yakushima Island, Japan. *Primates,* 21(2) : 141-160.

McCann, C; 1993. Observations on some Indian Langurs. *J. Bombay. Nat. Hist. Soc.* 36 : 618-628.

McKey, D; 1978. Soils vegetations and seed eating by the black colobus monkey. In '*The Ecology of Arboreal Folivores*'. (G.G. Montgomery, ed.3).

Medway L. 1972. Phenology of a Tropical Rainforest in Malaysia *Biol. J. Linn. Soc.* 4 : 117-146.

Milton, K; 1980. The Foraging Stragegy of Howler Monkeys. *A study in Primate Economics;* Columbia University Press, New York.

_____ D.M. Windsor, D.W. Morrison, and M.A. Estribi; 1982. Fruiting phonologies of two neotropical Ficus species. *Ecology*, 63 : 752-762.

_____ 1991. Leaf change and Fruit production in six Neotrophical moraceae species. J. Ecology 79 : 1-26.

Newton I, 1967. The adaptive radiation and feeding ecology of some British Finches *Ibis* 109 : 33-98.

Newton, L.E; & Lomo, A; 1979. The pollination of Ficus vogelii in Ghana. *Botanical Journal of the Linnean Society.* 78 : 21-30.

Nolte, A; 1955. Field observation on daily routine and social behaviours of common South Indian Monkeys, with special reference to the bonnet monkey *J. Bombay Nat. Hist. Soc.* 53 : 177-184.

_____ Oates, J.F.; 1978. The Gruereza and its food. In Primate Ecology (T.H. Cutton – Brock, ed) Academic Press, London.

Peres Carlos, A 1994. Primate responses to phenological changes in an Amazonian Terra Forme Forest *Biotrop.* 26(1) 98-112.

Prater, S.H.; 1965. Book of Indian Animals. Bombay Natural History Society, Bombay.

Poirier, E.E; 1968. The Nilgiri Langur (*Presbytis johnii*) Mother – Infant Dyad. *Primates,* 9 : 45-68.

_____ 1968. The Ecology and Social behaviour of the Nilgiri Langur, *Presbytis johnii*, in S. India. University micro films Ann Arbor, Michigan pp. 322.

_____ 1968(a) Analysis of Nilgiri Langur, *(Presbytis Johnii)* Homerange change, *Primates* 9 : 29-44.

_____ 1968. Nilgiri Langur (*Presbytis johnii*) Territorial Behaviour, *Primates,* 9 : 351-364.

_____ 1969(a). Behavioural flexibility and inter troop variability among Nilgiri Langurs of S. India. *Folia Primat* 11 : 119-133.

_____ 1969. The Nilgiri Langur, *Presbytis johnii*, troop, its composition structure, function and change. *Folia primat.* 10 : 20-47.

_____ 1970(a). The Nilgiri Langur, *Presbytis johnii* of S. India in primate behaviour, development in field and laboratory research Vol. 1 (Ed. L.A. Rosenblum) Academic Press New York pp. 254-283.

_____ 1970 (b). Dominance structure of the Nilgiri Langur, *Presbytis johnii*, of S. India. *Folia Primat.* 12 : 161-186.

Pocock, R.I; 1928. The langurs or Leaf Monkeys of British India. *J. Bombay Nat. Hist. Soc.* 32 (1-2) : 472-565.

Post, W, and Baulu Jean; 1978. Time Budgets of Macaca mulatta. *Primates.* 19(1) : 125-140.

Rudran, R. 1978. Socioecology of the Blue monkeys of the Kibale Forest, Uganda. Smithsonian Contribution to Zoology, No. 249, Smithsonian Institution Press Washington. D.C.

Ryley. K.V; 1913. The Bombay natural history society mammal survey of India. *J. Bom. Nat. His. Soc.* 22 : 13-76.

Simonds, P; 1965. The Bonnet Macaque in South India. In *Primate Behaviour* (I. Davore, ed), Holt, Rinehart and Winston. N.Y.

Snow. D.W; 1966. A possible selective factor in the evolution of fruiting seasons in a tropical forest. *Oikos*; 15 : 274-281.

Sorensen, A.E; 1981. Interaction between birds and fruits in a temperate woodland *Oecologia* (Berl) 50 : 242-249.

Sourd, C; & A. Gautier – Hion; 1986. Fruit selection by a forest guenon. *J. Anim. Ecol;* 55 : 235-244.

Srivastava, K.K; V.J. Zacharias, A.K. Bhardwaj, Petrisia Joseph and Sherly Joseph 1996. Some observations on troop structure, activity budget and food habits of the Nilgiri Langur, *Presbytis johnii* in Periyar, during Monsoon (June to August), *Indian Forester* 122, 10 : 946-950.

Sterndale, R.A; 1884. *Natural History of the Mammals of India and Ceylon.* Thacker, Spink and Company, Calcutta.

Stiles, F.G; 1985. On the role of birds in the dynamics of Neotropical forests. In A.W. Diamond and T.E. Lovejoy (Eds) *Conservation of tropical forest birds.* 49-59. ICBP Technical Publication, No.4, Cambridge, England.

Sugiyama, Y; 1971. Characteristics of the Social Life of Bonnet Macaques (*Macaca radiata*) *Primates*, 12(3-4) : 247-266.

Taber R.E. ad R.f. Dasmann 1957. The dynamics of three natural population of deer. Odocoileus hemionus columbianus *Ecology* 38 : 233-246.

Tanaka, J; 1965 Social Structure of Nilgiri Langurs. *Primates,* 6, 1 : 107-122.

Terborgh, J; 1983 Five New World Primates. *Comparative Ecology* Princeton University Press, Princeton, N.J.

_____ 1986 Keystone plant resources in the tropical forest. *Conservation Biology*; 330 – 344.

Vijakumar, T.N.; 1994 Resource Utilization by birds attending Figs in South India. PhD thesis, Calicut University.

Whitemore, T.C. 1991 Tropical rain forest dynamics and its implications for management. In A. Gomez-Pompa, T.C. Whitemore and M. Hadley (Eds) *Rainforest regeneration and management*, 67 – 89.

Willig, M.R; and Thomas E. Lacher Jr, 1991. Food Selection of a Tropical Mammalian Folivore in Relation to Leaf-Nutrient content. *J. Mamm*; 72(2); 314 – 321.

Zacharias, V.J; and A.K. Bharwaj 1997. Observations on the flying Squirrels, *Petaurista petaurista* (Elliot) and *Petinomys fuscocapillus* (Jerdon) in Periyar Tiger Reserve and its neighbourhood. *Indian Forester*. 123 : 973 – 974.

Appendix

Appendix - 1

Food Plants of Nilgiri Langur in Periyar

Name	Family	Type	Part
January			
1. *Hydnocarpus laurifolia*	Bixaceae	Tree	Fruits
2. *Bombax ceiba*	Bombacaceae	Tree	Flower
3. *Evodia lunu-ankenda*	Rutaceae	Woody climber	Leaf
4. *Toddalia asiatica*	Rutaceae	Small tree	Flower, Leaf
5. *Clausena indica*	Rutaceae	Tree	Leaf
6. *Turpinia malabarica*	Staphyleaceae	Tree	Tender leaf
7. *Buchanania lanzan*	Anacardiaceae	Tree	Flower, L-Midrib
8. *Erythrina subumbrans*	Fabaceae	Tree	Flower, Leaf
9. *Erythrina variegata*	Fabaceae	Tree	Flower
10. *Dalbergia latifolia*	Fabaceae	Tree	Fruits
11. *Acrocarpus fraxinifolius*	Caesalpiniaceae	Tree	Flo, Tender leaf
12. *Entada rheedei*	Mimosae	Climber	Leaf
13. *Terminalia chebula*	Combretaceae	Tree	Petiole
14. *Terminalia paniculata*	Combretaceae	Tree	Fruits, Petiole
15. *Syzygium gardneri*	Myrtaceae	Tree	Tender leaf
16. *Maesa indica*	Myrsinae	Small tree	Leaf
17. *Diospyros montana*	Ebenaceae	Tree	Leaf
18. *Olea dioica*	Oleaceae	Tree	Leaf
19. *Rejoua dichotoma*	Apocyanaceae	Tree	Leaf
20. *Ehretia canarensis*	Boraginaceae	Tree	Leaf
21. *Lantana aculeata*	Verbenaceae	Shrub	Leaf
22. *Persea macrantha*	Lauraceae	Tree	Flower
23. *Actinodaphne hirsute*	Lauraceae	Tree	Tender stem
24. *Loranthus tomentosus*	Loranthaceae	Parasitic shrub	Flower
25. *Elytranthe loniceroides*	Loranthaceae	Parasitic shrub	Leaf

26. *Santalum album*	Santalaceae	Tree	Leaf
27. *Ficus talbotii*	Moraceae	Tree	Tender – Leaf
28. *Ficus beddomei*	Moraceae	Tree	Fruit
29. *Elytranthe loniceroides*	Loranthaceae	Parasitic shrub	Leaf

February

1. *Dillenia pentagyna*	Dilleniaceae	Tree	Flower bud, flowers
2. *Hydnocarpus laurifolia*	Bixaceae	Tree	Fruit
3. *Xanthophyllum flavescens*	Polygalaceae	Small tree	Leaf
4. *Sterculia guttata*	Sterculiceae	Tree	Tender – Leaf
5. *Grewia tiliaefolia*	Tiliaceae	Tree	Tender – shoot
6. *Evodia lunu-ankenda*	Rutaceae	Tree	Leaf
7. *Canarim strictum*	Burseraceae	Tree Tender, leaf	Flower
8. *Turpinia malabarica*	Staphyleaceae	Tree	Tender leaf
9. *Erythrina subumbrans*	Fabaceae	Tree	Leaf, flower
10. *Erythrina variegata*	Fabaceae	Tree	Flower
11. *Dalbergia latifolia*	Fabaceae	Tree	Fruits, Tender shoot
12. *Rhynchosia cyanosperma*	Fabaceae	Climber	Seed
13. *Pterocarpus marsupium*	Fabaceae	Tree	Pulvinus, Leaf
14. *Acacia concinna*	Mimosae	Climber	Leaf, Flower
15. *Albizzia odoratissima*	Mimosae	Tree	Tender-shoot
16. *Entada rheedei*	Mimosae	Climber	Tender-leaf
17. *Terminalia paniculata*	Combretaceae	Tree	Fruits
18. *Randia dumatorum*	Rubiaceae	Tree	Leaf
19. *Maesa indica*	Myrsinae	Small tree	Leaf
20. *Diospyros montana*	Ebenaceae	Tree	Leaf, Fruit
21. *Linociera malabarica*	Oleaceae	Tree	Tender – leaf
22. *Olea diaica*	Oleaceae	Tree	Tender – leaf
23. *Rejoua dichotoma*	Apocyanaceae	Tree	Leaf
24. *Ehretia canarensis*	Boraginaceae	Tree	Leaf
25. *Stereospermum suaveolens*	Bignoniaceae	Tree	Tender shoot

26. *Lantana aculeate*	Verbenaceae	Large shrub	Leaf, Flower27
27. *Tectona grandis*	Verbenaceae	Tree	Leaf, Midrib
28. *Myristica dactyloides*	Myristicaceae	Tree	Fruits

March

1. *Dillenia pentagyna*	Dilleniaceae	Tree	Flower
2. *Flacourtia Montana*	Flacourtiaceae	Tree	Fruit
3. *Grewia tiliaefolia*	Tiliaceae	Tree	Tender-leaf
4. *Evodia lunu-ankenda*	Rutaceae	Tree	Leaf
5. *Celastrus paniculata*	Celastraceae	Climber	Leaf
6. *Mangifera indica*	Anaeardiaceae	Tree	Tender-leaf, fruit
7. *Spondias pinnata*	Anaeardiaceae	Tree	Tender-leaf, fruit
8. *Lannea coromandelica*	Anaeardiaceae	Tree	Tender-leaf, fruit
9. *Erythrina variegata*	Fabaceae	Tree	Flowers
10. *Dalbergia latifolia*	Fabaceae	Tree	Tender shoot, flower
11. *Pterocarpus marsupium*	Fabaceae	Tree	Tender-leaf
12. *Delonix regia*	Caesalpiniaceae	Tree	Tender-leaf
13. *Acacia concinna*	Mimosae	Climber	Leaf, flowerbud
14. *Terminalia paniculata*	Combretaceae	Tree	Tender-shoot
15. *Rajoua dichotoma*	Apocynanceae	Tree	Tender-leaf
16. *Radermachera xylocarpa*	Bignoniaceae	Tree	Flower bud, flower
17. *Lantan auleata*	Verbenaceae	Shrub	Leaf
18. *Tactona grandis*	Verbenaceae	Tree	Leaf midrib
19. *Premna coriacca*	Verbenaceae	Shrub	Tender-leaf
20. *Myristica dactyloides*	Myristicaceae	Tree	Fruits
21. *Actinodaphne hirsuta*	Lauraceae	Tree	Fruits
22. *Litsea laevigata*	Lauraceae	Tree	Fruits
23. *Santalum album*	Santalaceae	Tree	Leaf
24. *Mallotus philippinensis*	Euphorbiaceae	Tree	Fruits
25. *Ficus mysorensis*	Moraceae	Tree	Fruits
26. *Artocarpus integrifolia*	Moraceae	Tree	Fruits

27. *Artocarpus hirsuta*	Moraceae	Tree	Fruits
28. *Cinnamomum sulphuratum*	Lauraceae	Tree	Leaf
29. *Persea macrantha*	Lauraceae	Tree	Tender-leaf
30. *Loranthus tomentosus*	Loranthaceae	Parasitic shrub	Flower
31. *Emblica officinalis*	Euphorbiaceae	Tree	Tender shoot
32. *Bischoffia javanica*	Euphorbiaceae	Tree	Tender leaf, flower
33. *Ficus tjakela*	Moraceae	Tree	Leaf
34. *Ficus talbotii*	Moraceae	Tree	Tender leaf

April

1. *Dillenia pentagyna*	Dilleniaceae	Tree	Flower
2. *Grewia tiliaefolia*	Tiliaceae	Tree	Leaf, flower
3. *Evodia lunu-ankenda*	Rutaceae	Tree	Leaf
4. *Canarium strictum*	Burseraceae	Tree	Flower
5. *Ziziphus rugosa*	Rhamnaceae	Weak shrub	Flower, fruit
6. *Dimocarpus longan*	Sapindaceae	Tree	Tender-leaf
7. *Meliosma pinnata*	Sabiaceae	Tree	Flower
8. *Meliosma simplicifolia*	Sabiaceae	Tree	Tender-leaf
9. *Spondias pinnata*	Anacardiaceae	Tree	Leaf, flower
10. *Dalbergia latifolia*	Fabaceae	Tree	Flower
11. *Pterocarpus marsupium*	Fabaceae	Tree	Leaf
12. *Delonix regia*	Caesalpiniaceae	Tree	Leaf, flower
13. *Acacia concinna*	Mimosae	Climber	Leaf
14. *Terminalia chebula*	Combretaceae	Tree	Leaf
15. *Terminalia paniculata*	Combretaceae	Tree	Leaf
16. *Lagerstroemia lanceolata*	Lythraceae	Tree	Leaf, flower
17. *Diospyros montana*	Ebenaceae	Tree	Leaf, flower
18. *Radermachera xylocarpa*	Bignoniaceae	Tree	Flower
19. *Lantana aculeata*	Verbenaceae	Tree	Leaf
20. *Tectona grandis*	Verbenaceae	Tree	Leaf-midrid
21. *Actinodaphne hirsuta*	Lauraceae	Tree	Fruit

22. *Litsea laevigata*	Lauraceae	Tree	Fruit
23. *Litsea oleoides*	Lauraceae	Tree	Fruit
24. *Ficus amplisstma*	Moraceae	Tree	Leaf-midrid
25. *Fiscus mysorensis*	Moraceae	Tree	Fruit
26. *Artocarpus hirsuta*	Moraceae	Tree	Fruit
27. *Artocarpus intergrifolia*	Moraceae	Tree	Fruit
May			
1. *Dillenia pentagyna*	Dilleniaceae	Tree	Fruit
2. *Grewia tiliaefolia*	Tiliaceae	Tree	Flower, leaf
3. *Evodia lunu-ankenda*	Rutaceae	Tree	Leaf
4. *Acronychia laurifolia*	Rutaceae	Tree	Leaf
5. *Canarium strictum*	Burseraceae	Tree	Tender-leaf, flower
6. *Zyziphus rugosa*	Rhamnaceae	Weak shrub	Fruit
7. *Dolichos falcatus*	Fabaceae	Climber	Leaf
8. *Pterocarpus marsupium*	Fabaceae	Tree	Leaf
9. *Delonix regia*	Caesalpiniaceae	Tree	Flower
10. *Terminalia paniculata*	Combretaceae	Tree	Leaf
11. *Syzygium cumini*	Myrtaceae	Tree	Fruit
12. *Schefflera sp.*	Araliaceae	Small tree	Leaf, flower
13. *Stereospermum suaveolens*	Bignoniaceae	Tree	Leaf, flower
14. *Ipomoea obscura*	Convolculaceae	Climber	Leaf
15. *Lantana aculeata*	Verbenaceae	Shurb	Leaf,
16. *Tectona grandis*	Verbenaceae	Tree	Leaf, Midrib, Flower
17. *Myristica dactyloides*	Myristicaceae	Tree	Fruit
18. *Actinodaphne birsuta*	Lauraceae	Tree	Fruit
19. *Litsa laevigata*	Lauraceae	Tree	Fruit
20. *Santalum album*	Santalaceae	Tree	Fruit
21. *Artocarpus gomezianus*	Moraceae	Tree	Fruit
22. *Artocarpus hirsuta*	Moraceae	Tree	Fruit
23. *Artocarpus integrifolia*	Moraceae	Tree	Fruit

24. *Ficus amplissima*	Moraceae	Tree	Fruit
25. *Ficus mysorensis*	Moraceae	Tree	Fruit

June

1. *Grewia tiliaefolia*	Tiliaceae	Tree	Fruit
2. *Evodia lunu-ankenda*	Rutaceae	Tree	Flower
3. *Acronychia laurifolia*	Rutaceae	Tree	Leaf, Flower
4. *Clausena indica*	Rutaceae	Tree	Fruit
5. *Canarium strictum*	Burseraceae	Tree	Tender stem
6. *Meliosma pinnata*	Sabiaceae	Tree	Fruit
7. *Pterocarpus marsupium*	Fabaceae	Tree	Leaf, Flower
8. *Terminalia paniculata*	Combretaceae	Tree	Leaf
9. *Psidum guajava*	Myrtaceae	Tree	Fruit
10. *Schefflera sp.*	Araliaceae	Small tree	Flower
11. *Cordia oblique*	Boraginae	Tree	Fruit
12. *Stereospermum suaveolens*	Bignoniaceae	Tree	Leaf
13. *Lantana aculeata*	Verbenaceae	Shrub	Leaf
14. *Tectona grandis*	Verbenaceae	Tree	Leaf, Midrib
15. *Vitex altissima*	Verbenaceae	Tree	Leaf, Flower
16. *Actinodaphne hirsuta*	Lauraceae	Tree	Fruit
17. *Myristica dactyloides*	Myristicaceae	Tree	Fruit
18. *Santalum album*	Santalaceae	Tree	Leaf
19. *Fiscus amplissima*	Moraceae	Tree	Fruit
20. *Artocarpus gomezianus*	Moraceae	Tree	Fruit
21. *Artocarpus hirsute*	Moraceae	Tree	Fruit
22. *Artocarpus integrifolia*	Moraceae	Tree	Fruit

July

1. *Grewia tiliaefolia*	Tiliaceae	Tree	Fruit
2. *Evodia lunu-ankenda*	Rutaceae	Tree	Flower
3. *Clausena indica*	Rutaceae	Tree	Flower
4. *Meliosma pinnata*	Sabiaceae	Tree	Fruit

5.	*Pterocarpus marsupium*	Fabaceae	Tree	Flower
6.	*Psidium guajava*	Myrtaceae	Small tree	Fruit
7.	*Delonix regia*	Caesalpiniaceae	Tree	Leaf
8.	*Albizza odoratissima*	Mimosae	Tree	Fruit
9.	*Schefflera spp.*	Araliaceae	Small tree	Leaf
10.	*Lantana aculeata*	Verbenaceae	Shrub	Leaf
11.	*Tectona grandis*	Verbenaceae	Tree	Leaf, Midrib, Flower
12.	*Vitex altissima*	Verbenaceae	Tree	Flower
13.	*Santalum album*	Santalaceae	Tree	Leaf
14.	*Artocarpus gomezianus*	Moraceae	Tree	Fruit
15.	*Arocarpus hirsuta*	Moraceae	Tree	Fruit
16.	*Artocarpus integrifolia*	Moraceae	Tree	Fruit

August

1.	*Hydnocarpus laurifolia*	Bixaceae	Tree	Fruit
2.	*Sterculia guttata*	Sterculiaceae	Tree	Flower
3.	*Grewia tiliaefolia*	Tiliaceae	Tree	Fruit
4.	*Evodia lunu-ankenda*	Rutaceae	Tree	Flower
5.	*Dysoxylum malabaricum*	Meliaceae	Tree	Fruit
6.	*Allophylus rheedei*	Sapindaceae	Shrub	Fruit
7.	*Spondias pinnata*	Sapindaceae	Tree	Fruit
8.	*Pterocarpus marsupium*	Fabaceae	Tree	Fruiting, Flower
9.	*Acacia concinna*	Mimosae	Climber	Leaf
10.	*Albizza odoratissima*	Mimosae	Tree	Fruit
11.	*Terminalia paniculata*	Combretaceae	Tree	Flower
12.	*Anogeissus latifolia*	Combretaceae	Tree	Leaf
13.	*Psidium guajava*	Myrtaceae	Small Tree	Fruit
14.	*Memecylon malabaricum*	Melastomaceae	Tree	Fruit
15.	*Casearia esculenta*	Samydaceae	Tree	Fruit
16.	*Schefflera spp.*	Araliaceae	Small Tree	Fruit
17.	*Viburnum acuminatum*	Caprifoliaceae	Tree	Flower

18. *Randia dumatorum*	Rubiaceae	Tree	Leaf
19. *Mesa indica*	Myrsinae	Small Tree	Fruit
20. *Diospyros montaana*	Ebenceae	Tree	Fruit
21. *Olea dioica*	Oleaceae	Tree	Leaf
22. *Rejaoua dichotoma*	Apocyanaceae	Tree	Fruit
23. *Ehretia canarensis*	Boraginae	Tree	Flower
24. *Radermachera xylocarpa*	Bignoniaceae	Tree	Leaf
25. *Lantana aculeata*	Verbenaceae	Shrub	Leaf
26. *Gmelina arborea*	Verbenaceae	Tree	Leaf
27. *Tectona grandis*	Verbenaceae	Tree	Accrescent Calys
28. *Cinnamomum malabatrum*	Lauraceae	Tree	Fruit
29. *C. sulphuratum*	Lauraceae	Tree	Leaf
30. *Litsea deccanensis*	Lauraceae	Tree	Fruit, Leaf
31. *Actinodaphne hirsute*	Lauraceae	Tree	Tender stem
32. *Loranthus tomentosus*	Loranthaceae	Plastic shrub	Flower
33. *Santalum album*	Santalaceae	Tree	Flower bud
34. *Emblica officinalis*	Euphorbiaceae	Tree	Fruit
35. *Mallotus philippinensis*	Euphorbiaceae	Tree	Tender shoot
36. *M. tetracoccus*	Euphorbiaceae	Tree	Fruit
37. *Gnetum ula*	Gnetaceae	Large climber	Seed

September

1. *Uvaria hookerii*	Annonaceae	Climber	Fruit
2. *Sterculia guttata*	Sterculiaceae	Tree	Flower
3. *Bombax ceiba*	Bombacaceae	Tree	Petiole
4. *Evodia lunu-ankenda*	Rutaceae	Tree	Fruit, Leaf
5. *Toddalia asiatica*	Rutaceae	Climber	Fruit
6. *Dysoxylum malabaricum*	Meliaceae	Tree	Fruit
7. *Spondias pinnata*	Anacardiaceae	Tree	Fruit
8. *Pterocarpus marsupium*	Fabaceae	Tree	Fruitwing, Leaf
9. *Delonix regia*	Caesalpiniaceae	Tree	Leaf

10. *Acacia cocinna*	Mimisae	Climber	Leaf
11. *Pygeun accuminatum*	Rosaseae	Tree	Flower
12. *Terminalia paniculata*	Combretaceae	Tree	Petiole
13. *Terminalia chebula*	Combretaceae	Tree	Flower
14. *Anogeissus latifolia*	Combretaceae	Tree	Petiole
15. *Psidium guajava*	Myrtaceae	Small tree	Fruit
16. *Memecylon malabaricum*	Melastomaceae	Tree	Fruit
17. *Viburnum auminatum*	Caprifoliaceae	Tree	Fruit
18. *Randia dumatorum*	Rubiaceae	Tree	Leaf
19. *Mikania scandens*	Asteraceae	Climber	Leaf
20. *Maesaindica*	Myrsinae	Tree	Fruit
21. *Diosphyros montana*	Ebenaceae	Tree	Fruit
22. *Linociera malabarica*	Oleaceae	Tree	Tender shoot
23. *Olea dioica*	Oleaceae	Tree	Petiole
24. *Aganosma cymosa*	Apocyanaceae	Climber	Petiole
25. *Rejoua dichotoma*	Apocyanaceae	Tree	Fruits
26. *Ehretia canarensis*	Boraginae	Tree	Leaf
27. *Stereospermum suaveolens*	Bignoniaceae	Tree	Leaf
28. *Pyrostegia venusta*	Bignoniaceae	Climber	Leaf, Flower
29. *Lantana aculeate*	Verbenaceae	Shrub	Leaf, Flower
30. *Tectona grandis*	Verbenaceae	Tree	Calyx of fruit
31. *Vitex altissima*	Verbenaceae	Tree	Fruits
32. *Persea macranta*	Lauraceae	Tree	Leaf
33. *Litsea deccanensis*	Lauraceae	Tree	Leaf
34. *Santalum album*	Santalaceae	Tree	Leaf
35. *Ficus amplissima*	Moraceae	Tree	Fruit
36. *F. nervosa*	Moraceae	Tree	Fruit
37. *F. tjakela*	Moraceae	Tree	Fruit

October

1.	*Bombax ceiba*	Bombacaceae	Tree	Petoile of leaf
2.	*Elaeocarpus oblongus*	Elaeocarpaceae	Tree	Fruit
3.	*Evodia lunu-ankenda*	Rutaceae	Tree	Fruit, Leaf
4.	*Toona ciliata*	Heliaceae	Tree	Tender leaf
5.	*Spondias pinnata*	Anacardiaceae	Tree	Fruit
6.	*Dolichos falcatus*	Fabaceae	Climber	Leaf
7.	*Dalbergia latifolia*	Fabaceae	Tree	Fruit
8.	*Pterocarpus marsupium*	Fabaceae	Tree	Fruitwing, petiole
9.	*Wagatia spicata*	Caesalpiniaceae	Climber	Tender shoot
10.	*Delonix regia*	Caesalpiniaceae	Tree	Fruit
11.	*Entada rheedei*	Himosae	Climber	Leaf
12.	*Terminalia chebula*	Combretaceae	Tree	Fruit
13.	*Terminalia paniculata*	Combretaceae	Tree	Fruit
14.	*Anogeissus latifolia*	Combretaceae	Tree	Leaf
15.	*Psidium guajava*	Myrtaceae	Tree	Fruit, Leaf
16.	*Randia dumotorum*	Rubiaceae	Tree	Fruit
17.	*Maesa indica*	Myrsinae	Tree	Fruit, Leaf
18.	*Diospyros montana*	Ebenaceae	Tree	Fruit
19.	*Diospyros ovalifolia*	Ebenaceae	Tree	Fruit
20.	*Rejoua dichotoma*	Apocyanaceae	Tree	Fruit
21.	*Ehretia canarensis*	Boraginae	Tree	Leaf
22.	*Linociera malabarica*	Oleaceae	Tree	Leaf
23.	*Stereospermum suaveolens*	Bignoniaceae	Tree	Leaf
24.	*Spathodea campanulata*	Bignoniaceae	Tree	Tender leaf
25.	*Lantana aculeate*	Verbenaceae	Shrub	Flower leaf
26.	*Vitex altissima*	Verbenaceae	Tree	Fruit
27.	*Tectona grandis*	Verbenaceae	Tree	Fruit, calyx
28.	*Cinnamomum malabatrum*	Lauraceae	Tree	Fruit
29.	*Litsea deccanensis*	Lauraceae	Tree	Fruit

30. *Santalum album*	Santalaceae	Tree	Leaf
31. *Emblica officinalis*	Euphorbiaceae	Tree	Fruit, Leaf
32. *Celtis spp.*	Ulmceae	Tree	Fruit, Leaf
33. *Ficus amplissima*	Moraceae	Tree	Fruit
34. *Ficus hispida*	Moraceae	Tree	Flower
35. *Ficus tjakela*	Moraceae	Tree	Fruit

November

1. *Clematis gouriana*	Ranaculaceae	Climber	Leaf
2. *Hydnocarpus laurifolia*	Bixaceae	Tree	Fruit, Leaf
3. *Evodia lunu-ankenda*	Rutacae	Tree	Fruit, Leaf
4. *Pterocarpus marsupium*	Fabaceae	Tree	Leaf
5. *Entada rheedei*	Mimoceae	Climber	Leaf
6. *Albizzia odoratissima*	Mimoceae	Tree	Fruit
7. *Pygeum acuminatum*	Rosaceae	Tree	Fruit
8. *Terminalia paniculata*	Combretaceae	Tree	Fruit
9. *Anogeissus latifolia*	Combretaceae	Tree	Leaf
10. *Viburnum acuminatum*	Combretaceae	Tree	Leaf
11. *Randia dumatoum*	Rubiaceae	Tree	Leaf
12. *Maesa indica*	Myrsinae	Tree	Fruit, Leaf
13. *Diospyros Montana*	Ebeneceae	Tree	Fruit, Leaf
14. *Diospyros ovalifolia*	Ebeneceae	Tree	Fruit, Leaf
15. *Olea dioica*	Oleaceae	Tree	Petiole
16. *Rejova dichotoma*	Apocyanaceae	Tree	Fruit, Leaf
17. *Ehretia cnarensis*	Boraginaceae	Tree	Leaf
18. *Stereosermum suaveolens*	Boraginaceae	Tree	Leaf
19. *Lantana aculeata*	Verbenaceae	Shrub	Leaf
20. *Pyrostegia venusta*	Bignoniaceae	Climber	Leaf
21. *Tectona grandis*	Verbenaceae	Tree	Fruit calyx
22. *Vitex altissima*	Verbenaceae	Tree	Fruit
23. *Loranthus tomentosus*	Loranthaceae	Parasiticshrub	Flower

24. *Santalum album*	Santalaceae	Tree	Leaf
25. *Mallotus philippinensis*	Euphorbiaceae	Tree	Flower
26. *Ficus amplissima*	Moraceae	Tree	Leaf
27. *Ficus tjakela*	Moraceae	Tree	Leaf
28. *Bambusa vulgaris*	Gramineae	Tree	Leaf

December

1. *Hydnocarpus laurifolia*	Bixaceae	Tree	Fruit
2. *Bombax ceiba*	Bombacaceae	Tree	Flower bud
3. *Grewia tiliaefolia*	Tiliaceae	Tree	Leaf
4. *Evodia lunu-ankenda*	Rutaceae	Tree	Leaf, Fruit
5. *Dolichos falcatus*	Fabaceae	Tree	Leaf, Fruit
6. *Dalbergia latifolia*	Fabaceae	Tree	Leaf
7. *Pterocarpus marsupium*	Fabaceae	Tree	Leaf
8. *Delonix regia*	Caesalpiniaceae	Tree	Leaf
9. *Acacia concinna*	Mimosae	Tree	Leaf
10. *Pygium acuminatum*	Rosaceae	Tree	Fruit
11. *Albizzia odoratissima*	Mimosae	Tree	Leaf, Fruit
12. *Anogeissus latifolia*	Combretaceae	Tree	Leaf
13. *Terminalia chebula*	Combretaceae	Tree	Fruit
14. *Terminalia paniculata*	Combretaceae	Tree	Fruit
15. *Eucalyptus globulus*	Myrtaceae	Tree	Bark
16. *Randia dumatorum*	Rubiaceae	Tree	Leaf, Fruit
17. *Maesa indica*	Myrsinae	Tree	Fruit
18. *Diospyros montana*	Ebenaceae	Tree	Frui
19. *Diospyros ovalifolia*	Ebenaceae	Tree	Leaf
20. *Rejoua dichotoma*	Apocyanaceae	Tree	Leaf
21. *Ehretia canarensis*	Boraginae	Tree	Leaf
22. *Lantana aculeata*	Verbenaceae	Tree	Fruit, Leaf
23. *Tectona grandis*	Verbenaceae	Tree	Fruit
24. *Vitex altissima*	Verbenaceae	Tree	Fruit

25. *Persea macrantha*	Lauraceae	Tree	Flower
26. *Actinodaphne hirsuta*	Lauraceae	Tree	Leaf
27. *Loranthus tomentosus*	Lauraceae	Tree	Flower, Leaf
28. *Santalum album*	Santalaceae	Tree	Fruit
29. *Mallotus philippinensis*	Euphorbiaceae	Tree	Flower
30. *Mallotus tetracoccus*	Euphorbiaceae	Tree	Fruit
31. *Emblica officinalis*	Euphorbiaceae	Tree	Fruit, Leaf
32. *Ficus beddomei*	Moraceae	Tree	Fruit
33. *Ficus mysorensis*	Moraceae	Tree	Leaf
34. *Ficus nervosa*	Moraceae	Tree	Fruit
35. *Bambusa vulgaris*	Gramineae	Tree	Leaf

Appendix - 2

Plants not consumed by the Nilgiri Langur but by other Arboreal mammals and birds in the Study Area

Name of the plants	Langur	Other arboreal mammals and birds		
		Bonnet Macaque	Malabar Giant Squirrel	Birds
1. *Polyalthia longifolia* (E)				
2. *Calophyllum polyanthum* (E)				
3. *Bombax insigne* (D)				
4. *Sterculia villosa* (D)				
5. *Eriolaena quinquilocularis* (D)				
6. *Grewia disperma* (D)				
7. *Elaeocarpus tuberculatus* (B)			x	
8. *Amoora rohituka* (E)				
9. *Heynea trijuga*				
10. *Mappia foetida* (D)				
11. *Filicium decipiens* (E)			x	
12. *Harpullia unbricata* (D)				
13. *Schleichera trijuga* (D)				
14. *Holygama grahami* (D)				
15. *Cassia fistula* (D)				
16. *Tamarindus indicus* (D)				
17. *Eucalyptus grandis* (E)				
18. *Lagerstroemia Flos-Reginae* (D)				
19. *Mitragyna parvifolia* (D)				
20. *Pavetta indica* (D)				

Name of the plants	Langur	Other arboreal mammals and birds		
		Bonnet Macaque	Malabar Giant Squirrel	Birds
21. *Plectronia parviflora* (D)				
22. *C. didyma vanneilgherrensis* (B)				
23. *Vernonia monosis* (B)				
24. *Mimusops elengi* (B)			x	
25. *Callicarpa lanata*		x		
26. *Litsea stocksii* (D)				
27. *Phoebe lanceolata* (B)				
28. *Seleropyrum wallichianum* (D)				
29. *Antidesma mensasu* (D)				
30. *Aporosa lindleyana* (D)			x	
31. *Bridelia roxhurghiana* (D)				
32. *Glochidion tomentosum* (D)			x	x
33. *Kirjanelia reticulata* (D)			x	x
34. *Macranga peltala* (D)				
35. *Trema orientalis* (D)				
36. *Villegrunia integrifolia* (B)				
37. *Ficus benghalensis*			x	x
38. *Ficus callosa* (D)			x	x
39. *F. exaspirata*				x
40. *F. tintoria*				
41. *F. virens*				x
42. *Salix tetrasperma*				x
43. *Ficus gibbosa*				x

Legend : *D – Deciduous,* *B – Evergreen*

Appendix – 3

Food Plants of the Malabar Giant Squirrel (*Ratufa indica)*

Sl. No	Name of the food plants	Part consumed	Month of consumption											
			J	F	M	A	M	J	J	A	S	O	N	D
1.	*Dillenia pentagyna*	Flower[1], Fleshy accrescent calyx of fruit[2]				x[1]	x[2]	x[2]						
2.	*Uvaria hookerii*	Fruit										x	x	x
3.	*Hydnocarpus laurifolia*	Fruit, (outerpart), inner (L), tender leaf, Flower	x	x	x	x	x							
4.	*Flacourtia montana*	Fruit			x	x								
5.	*Bombax ceiba*	Flowerbud[1], seed[2]	x[1]	x[2]	x[2]	x[2]							x[1]	x[1]
6.	*Sterculia guttata*	Seed	x	x	x	x								x
7.	*Grewia tiliaefolia*	Fruit (UR) Fullpart							x	x	x			
8.	*Elaeocarpus oblongus*	Fruit	x										x	x
9.	*Evodia lunu-ankenda*	Fruit (inner part)									x	x	x	x
10.	*Toddalia asiatica*	Fruit							x	x				
11.	*Acronychia laurifolia*	Fruit									x	x		
12.	*Canarium strictum*	Endospermof seed							x	x	x			
13.	*Dysoxylum malabaricum*	Seed					x	x	x	x				
14.	*Mappia foetida*	Tenderleaf flower[2]							x[2]			x[1]		
15.	*Democarpus longan*	Fruit						x	x					
16.	*Meliosma pinnata*	Fruit(UR), Leaves							x	x	x			
17.	*Mangifera indica*	Fruit						x						
18	*Spondias pinnata*	Fruit						x	x	x				

Sl. No	Name of the food plants	Part consumed	Month of consumption											
			J	F	M	A	M	J	J	A	S	O	N	D
19.	*Pterocarpus marsupium*	Bean[1], Bark[2]	x[1]					x[2]						x[1]
20.	*Entada rheedei*	Bean							x	x				
21.	*Prunus ceylanica*	Fruit	x	x										x
22.	*Terminalia chebula*	Fruit											x	x
23.	*Psidium guajava*	Fruit							x	x	x			
24.	*Memecylon malabaricum*	Fruit, leaves							x	x	x	x		
25.	*Casearia esculenta*	Fruit							x	x				
26.	*Schefflera sp.*	Fruit[1], Bark[2]					x[2]		x[1]	x				
27.	*Maesa perrottetiana*	Fruit rip											x	x
28.	*Chrysophyllum lansolatum*	Fruit												x
29.	*Diospyros montana*	Fruit										x	x	x
30.	*D. ovalifolia*	Fruit	x										x	x
31.	*Rejoua dichotoma*	Fruit									x	x	x	
32.	*Cordia obliqua*	Seed					x	x						
33.	*Ehretia canarensis*	Flower[1], Bark[2], leaf[5], Fruit[4]	x[3]							x	x[4]			x[2]
34.	*Tectona grandis*	Endosperm ofseed	x	x	x						x	x	x	x
35.	*Myristica dactyloides*	Fruit[1], leafmidrib[2] Bark[3]			x[1]	x[1]	x[1]	x[1]	x[3]	x[2]				
36.	*Persea macrantha*	Fruit[1], leafmidrib[2]		x[1]	x[1]			x[2]	x[2]					
37.	*Actinodaphne hirsuta*	Fruit (R)				x	x	x						
38.	*Litsea deccanensis*	Fruit									x	x		
39.	*Litsea laevigata*	Fruit						x	x					

Appendix – 4

Food Plants of Bonnet Macaque (*Macaca radiata)*

Sl. No	Name of the food plants	Part consumed	Month of consumption											
			J	F	M	A	M	J	J	A	S	O	N	D
1.	*Grewta tiliaefolia*	F						x	x					
2.	*Evodia lunu-ankenda*	L^1, F^2			x	x						x^2		
3.	*Actinodaphne hirsuta*	F								x				
4.	*Gnetum ula*	F									x			
5.	*Memycelon malabaricum*	F									x			
6.	*Ehretia canarensis*	Fl								x				
7.	*Cinnamomum sulphuratum*	F								x				
8.	*Litsea laevigata*	F			x									
9.	*Mangifera indica*	F					x							
10.	*Maesa perrotettiana*	F							x				x	x
11.	*Psidium guajava*	F					x							
12.	*Emblica officinalis*	F							x					
13.	*Terminalia paniculata*	B							x					
14.	*Cinnamomum malabatrum*	F								x				
15.	*Ficus hispida*	F						x						
16.	*Delonix regia*	$T.L^1$ + Fl^2				x^1	x^2							
17.	*Vitex altissima*	F										x		
18.	*Radermachra xylocarpa*	Fl^1, F^2				x^1		x^2						
19.	*Clausina indica*	F					x	x						
20.	*Lantana aculeata*	L^1 + Fl^2	x^1	x^1	x^1									
21.	*Ficus exasperata*	L^1 + F^2							x^2					
22.	*Tectona grandis*	L				x								
23.	*Mallotus philippinensis*	Fl											X	
24.	*F. callosa*	F									x			
25.	*Rejoua dicholoma*	F					•							x
26.	*Hydonocarpus laurifola*	F											x	x
27.	*Largerstromia lanceolata*	L									x	x		
28.	*Solanum torvum*	F										x		
29.	*Digitaria sanguilanica*	(Grass)												

Legend : F – Fruit, Fl – Flower, L – Leaf, T.L. – Tender Leaf

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