



POPULATION STRUCTURE, DISTRIBUTION AND FEEDING HABITAT OF BONNET MACAQUE (*MACACA RADIATA*) IN KANYAKUMARI WILDLIFE SANCTUARY, WESTERN GHATS, TAMIL NADU, INDIA

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ABSTRACT: Cercopithecine or Old World monkey societies are typically characterized by social relationships established between individuals belonging to different age cohorts, dominance ranks, and kinship groups. Given the unique nature of every relationship that individuals need to develop and support. The study indicates that bonnet macaques are found in various locations in Kanyakumari Wildlife Sanctuary such as Palali Pvt Estate, Rubber Estate I, Pechiparai Dam, Horticulture Farm, (HF) Horticulture Research Station (HRS) and Rubber Estate II. The population structure, distribution, and feeding habits of bonnet macaques study observed on top of areas. The direct count method was used for this study in addition to data collection. The observed sited data of bonnet macaque population structure and distribution maximum results observed in HRS and HF in the meantime least macaque troop size observed in Pechiparai Dam and Palali Pvt Estate. The similar results observed in Rubber estate I and II regions. The feeding habitat of bonnet macaque consumed 17 different plant species. The consumed leaf, flower, fruit and stem of the four food item fruit constituted most frequent food item in this observation. The favorable food plant species are frequently available in HRS and HF in the meantime lowly available food in Pechiparai Dam and Palali Pvt Estate. The no available chance to feed its go to had Rubber estate I and II plant leaves and fruit for day-to-day survival. In spite of it's a not natural food of Bonnet Macaque. By improving the conflict management and vegetation involvement is one of the management techniques for conserving the bonnet macaque (*Macaca radiata*).

Key words: Population Structure, Distribution, Feeding Habitat and *Macaca radiata*

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INTRODUCTION

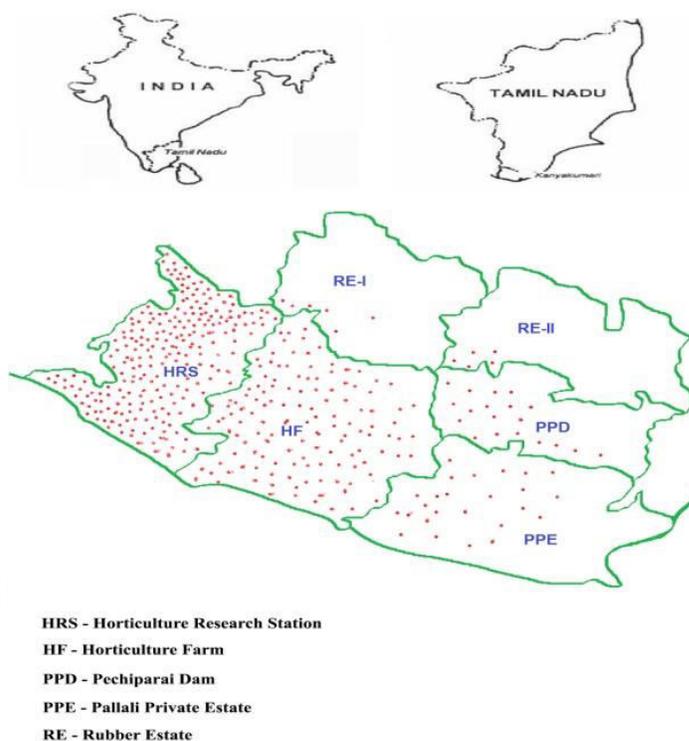
The bonnet macaque (*Macaca radiata*) is the most common extensively distributed from the wet montane rainforest of the Western Ghats through the dry scrublands of central southern India to most of the hot, dusty temple towns and bustling cities of the peninsular [1]. Referred to as “The common performing monkey of southern India” [2]. Bonnet Macaque are remarkable for primarily two reasons-first, their inordinate ability to successfully adapt to almost any kind of environment and second, the intense love-hate relationship that they enjoy with the people of southern India [3,4]. Ubiquitously distributed throughout peninsular India the bonnet macaque was traditionally believed to occur only up to the rivers Godavari and Tapti in the east and west, respectively [5, 6]. The bonnet macaque usually lives in multi-male and multi female troops; these troops size varies from 15 to 74 individuals in the study area. According to Kurup [7] the troop size varies from 5 to 75 individuals in the wild. Although troop size highly variable in a particular ecological area, it tends much smaller in natural forest and significantly larger in near human habitation [8]. Going by Prater [9] we may consider the benchmark troop size as between 20-30 individuals. Each troop typically consists of one to several adult males and females and variable several sub adults, juveniles, and infants of both sexes. Similarly, the ratio of different age-sex classes within troops shows some variation across ecological habitats [10,11].

Bonnet macaques are known to feed on vegetative, floral and fruit buds, leaves, petioles, stems, pith, tendrils, roots, flowers, fruits, seeds and even leaf galls of different herbs, climbers, shrubs, trees and grasses [12,13, 14, 15,16, 17, 3]. Bonnet monkeys are omnivores and have also been observed feeding on insects (about 13 % of their diet, [17] including crickets, cicadas, grasshoppers, termites and insect pupae, and on spiders and bird eggs [13, 15]. Thus, only ten species constituted about 72 % of the diet of a troop in the dry evergreen forest [18]. In the present study assess the population structure, distribution and feeding habitat of Bonnet Macaques in Kanyakumari Wildlife Sanctuary.

Study area

Kanyakumari Wildlife Sanctuary is a 402.4 km² (155.4 sq mi) protected area in Kanyakumari district, Tamil Nadu South India declared in February 2008. The area is a tiger habitat. The virgin forests of Kanyakumari District got transferred from Kerala to Tamil Nadu on the 1st November 1956 as a result of the state reorganization. Government Reserved Forests occupy an area of 50486 ha, i.e., 30.2% of the total geographic area of the Kanyakumari District. Kanyakumari Forest Division is located between 77°10' - 77°35' east longitude and 8°5' - 8°35' north latitude. The highest point is 1829.4 m at the tri junction of Mahendragiri, Kalakad and Veerapuli Reserved Forests. Kanyakumari Forests though small in area has as many as 14 forest types as far classification Champion and Seth [19].

Study Area's in Kanyakumari Wildlife Sanctuary



MATERIALS AND METHODS

Study Material used for Bonnet Macaque observation

Various types of forests from luxuriant tropical wet evergreen forests to Southern Thorn Scrub forests occur in this division because of diverse locality factors (edaphic and biotic) varying rainfall from 50 to 310 cm and elevations from Sea level up to 1829 M. A 10×50 binocular was used for observation. The camera (20MP) was used for capture the picture in this study evidence. The range finder for used finds out the distance of animal present in the field for the finding animals location we used the GPS (Global Positioning System). Other field materials also used in the study period such as Field note, Measurement tape, Data sheets, etc.

Method of Bonnet Macaque observation

Direct observation method was used during the study period the observation data followed two methods like aerial and ground level [20].

Table: 1 Bonnet Macaque distribution, observation, date and time period of various sites in Kanyakumari Wildlife Sanctuary. Range: Kalial and Kulasekaram.

S.No	Places	Date	Time Periods
1	Palali Pvt estate	01.02.17 to 25.02.17	8AM to 10AM and 4PM to 6PM.
2	Rubber estate –I	01.03.17 to 25.03.17	8AM to 10AM and 4PM to 6PM.
3	Pechiparai Dam area	01.04.17 to 25.04.17	8AM to 10AM and 4PM to 6PM.
4	Horticultural farm	01.05.17 to 25.05.17	8AM to 10AM and 4PM to 6PM.
5	Rubber estate – II	01.06.17 to 25.06.17	8AM to 10AM and 4PM to 6PM.
6	Horticultural Research Station	01.07.17 to 25.07.17	8AM to 10AM and 4PM to 6PM.

Identification, Feeding, Habitat of Bonnet Macaque

Bonnet Macaque an old world monkey is also known by the scientific name of *Macaque radiata*. Found in India, it has been named so because of its physical appearance our Indian bonnet macaque have a cap like whorl of hair on their head, which radiates outward from the center. Since the coil of hair resembles a hat, they have been named as Bonnet Macaque. The fur on their body is dusky brown to golden yellow in color. The ears as well as the lower lip are black. The face of a female bonnet macaque is red in color. Bonnet macaques are found only in India, occupying wet lowland to dry deciduous forest, at a height up to 2100m.

Adult Male: Any male that was morphologically bigger than an adult female by at least one third. Adult Female: Any female that was carrying a neonate, pregnant or swollen. Sub adult: Any male that was morphologically similar to an adult female or any female that was bigger than a juvenile but smaller than an adult female. Juvenile: Any member that was independent of its mother, fed alone and indulged in playing. Young once: Always dependent mothers.

Bonnet macaques of India are quite sociable and are seen mostly in groups, which comprise of both males as well as females. There can be up to 12 males in a group and the number of females can go up to 15. They live in their own marked territory and defend it very fiercely, Diurnal in nature, Bonnet macaque frequently sleep in fig trees near human settlements or tall trees with dense foliage. The gestation period of female is approximately 165 days (5months). The number of offspring born is only one. There was a large population of bonnet macaque in India. Thus they are not listed as an endangered species [8,18].

Feeding Habitat

Macaque radiata was Omnivorous the diet Indian bonnet macaques consist of fruits, nuts, seeds, flowers, invertebrates and cereals. Bonnet macaque feeding habitats were observed in same places. Bonnet macaque feeding plants species in different physiognomic categories. The details of food plant part eaten (based on one zero sampling) in Kanyakumari Wildlife Sanctuary. Basic statistics viz. mean, standard deviation and standard error were calculated for all the replicative variables and are given as $X \pm SD$ or $X \pm SE$. Statistical analysis were performed by using windows based statistical package viz. Microsoft Excel, and SPSS.

RESULTS AND DISCUSSION

The results show that bonnet macaques are found in many more locations and in diverse habitat types in Kanyakumari Wildlife Sanctuary. This is more likely due to a bias in our choice of the survey locations than a reflection of the true status of bonnet macaques totally 239 Macaques are sited and their size varied from 15 to 74 individuals.

Bonnet macaque and their troop size

The data of bonnet macaque troop size most results observed in HRS and HF in the meantime least Number of macaque troop size noted in Pechiparai Dam and Palali Pvt Estate. The similar results have renowned in Rubber estate I and II regions. Table: 2. It was generally believed that the bonnet macaque ubiquitously present throughout its geographic range in India [21]. Ubiquitously distributed throughout peninsular India the bonnet macaque was traditionally believed to occur only up to the rivers Godavari and Tapti in the east and west, respectively [5,6]. Extensive surveys now show distribution more specifically; the distribution limit of the species seems too marked by the in Kanyakumari Wildlife Sanctuary.

In reality, however, little is actually known about the population distribution of the species in some parts of its range, particularly the southern. It has estimated that the total population of bonnet macaques in the four south Indian states would be of the order of 1, 70,000, with about 81,000 monkeys in Karnataka, 64,000 in Andhra Pradesh, 16,000 in Tamil Nadu and 11,000 in Kerala [7]. Existing literature lists only in Kanyakumari Wildlife Sanctuary is in the Southern part of the Western Ghats Mountain Range, towards the South-West of the range of the bonnet macaque.

Table: 2 Number of troops of the Bonnet macaque and their distribution in the study area.

Observation of Macaque Troops	Location of Sights	Troop Size
MT 1	Palali pvt Estate	30
MT 2	Rubber Estate-I	15
MT 3	Pechiparai Dam	37
MT 4	Horticulture Farm	65
MT 5	Horticulture Research Station	74
MT 6	Rubber Estate-II	18

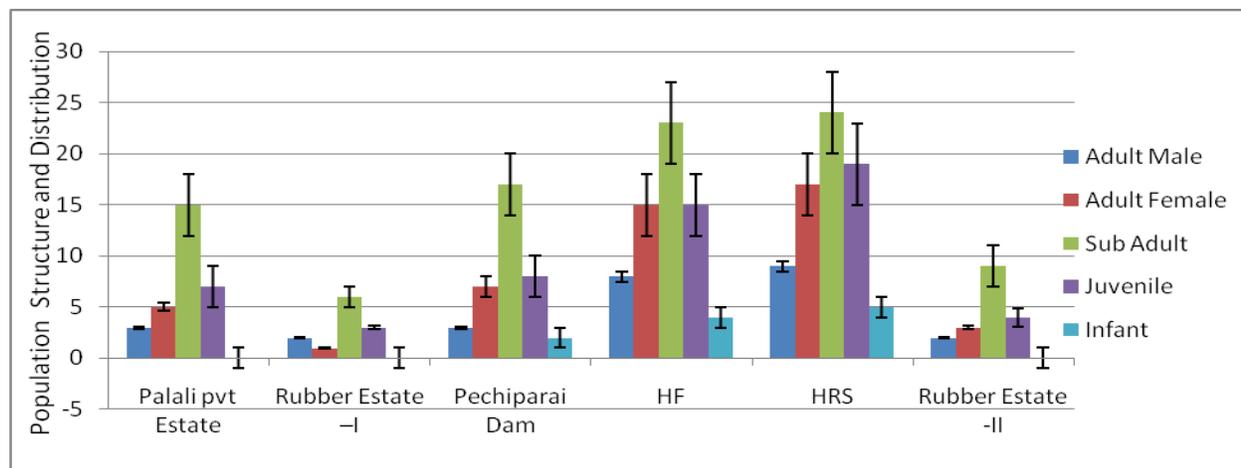
Population structure, distribution, mean and standard error value of Bonnet Macaque

The population status of the vein of an adult male, adult female, sub adult, juvenile and young once, The sub adult and adults population structure was more than juvenile and then young ones. The minimum level of population structure results showed in juvenile stages and very squat point of population structure observed in young ones.

The higher assessment of Bonnet Macaque in HRS region 9 ± 0.5 in Adult male, 17 ± 3 in Adult female, 24 ± 4 in Sub adult, 19 ± 4 in Juvenile and 5 ± 0.3 in Infant. Lower assessment of bonnet macaque in Rubber Estate I 2 ± 0.1 in adult male, 1 ± 0.1 in adult female, 6 ± 0.1 in sub adult, 3 ± 2 in juvenile and no Infants recorded. Similar results assessed other places. (Table: 3). For that reason for more population status occurring in HF and HRS, where most of the favorable food plant species are frequently available. The adult and sub-adult increasing strategy of the study found that male influxes associated with strict breeding seasonality, and presence of few adult males (usually unimale groups) and many estrous females [22,23,24]. Macaques form large multimale and female groups. The sex ratio among adult macaques in these groups biased in favor of females. Males migrate when reaching sexual maturity, and they may transfer between groups several times in their lives. Since sub adult and subordinate adult males may often copulate at higher frequencies than do the more dominant individuals including the alpha male, both in the wild and in captivity, it has suggested that reproductive success for bonnet males may depend on individual mating strategies than dominance rank.

Table: 3 Population structure, Distribution, Mean and \pm Standard Error values of Bonnet Macaque (*Macaca radiata*)

Population Structure of Bonanet Macaque	Palali pvt Estate	Rubber Estate -I	Pechiparai Dam	HF	HRS	Rubber Estate -II	Total
Adult Male	3 ± 0.1	2 ± 0.1	3 ± 0.1	8 ± 0.5	9 ± 0.5	2 ± 0.1	27
Adult Female	5 ± 0.4	1 ± 0.1	7 ± 1	15 ± 3	17 ± 3	3 ± 0.2	48
Sub Adult	15 ± 3	6 ± 1	17 ± 3	23 ± 4	24 ± 4	9 ± 2	94
Juvenile	7 ± 2	3 ± 0.2	8 ± 2	15 ± 3	19 ± 4	4 ± 0.9	56
Infant	0 ± 0	0 ± 0	2 ± 0.1	4 ± 0.3	5 ± 0.3	0 ± 0	11

**Fig: 1** Population Structure, Distribution, Mean and Standard Error Values of Bonnet Macaque

Population Structure, Distribution and Feeding habit of Bonnet Macaque (*Macaca radiata*) in Kanyakumari Wildlife Sanctuary



Adult Male



Adult Female



Adult Female with Infant



Sub Adult



Juvenile



Macaque Troop

Feeding Habitat of Bonnet macaque

Bonnet macaque consumed different plant species from different various physiognomic categories. The details of food plants, parts eaten (based One zero sampling) of bonnet macaque in Kanyakumari Wildlife Sanctuary. During the study period bonnet macaque was consumed 17 different plant species (Table: 4). The consumed leaf, flower, fruit and stem of the four food item fruit constituted most frequent food item in this observation. These observations clearly reveal the population structure with respect to feeding habitat in Kanyakumari Wildlife Sanctuary.

Bonnet macaque consumed different plant species from different various physiognomic categories. The study shown two behavioral feature of feeding bonnet macaques are particularly interesting. When feeding on the ground, typically on foods of human origin, bonnets tend to stuff their cheek pouches hurriedly [1]. They later move to a quieter area or climb to some height and leisurely feed on their cheek pouch contents, sometimes even pushing out the food with their palms and fingers. Cheek pouches are, however, filled up much more methodically, or sometimes not at all, when individuals forage on vegetation on trees or in bamboo clumps [1]. Second, when feeding on solid foods picked up from the ground, all bonnet macaques rub the food between the palms [21] or sometimes on the ground (Sinha pers. obs.) before ingestion. Although this may have originally evolved to serve a cleaning function, it may not always serve the purpose especially when the food is rubbed on the ground. It is also interesting to speculate why and how this behavioral feature has evolved to become an inherent feature of all individuals across ecological habitats.

The monitoring of certain bonnet macaque populations structure in Kanyakumari Wildlife Sanctuary, in fact, revealed that during the very last two decades several groups of monkeys have been completely eliminated and that some areas that had abundant populations earlier are now completely devoid of them. It is entirely possible that in such a scenario the common bonnet macaque of today may well become an endangered species of tomorrow.

Table: 4 Plants used by *Macaca radiata* and their food item

S.No	Plant species	Flower	Fruit	Leaves	Others
1	<i>Syzygium cumin</i>	0	√	√	0
2	<i>Manikara zapota</i>	0	√	√	0
3	<i>Mangifera indica</i>	√	√	√	0
4	<i>Ficus hispita</i>	0	√	0	0
5	<i>Terminalia arjuna</i>	0	√	√	0
6	<i>Ficus religiosa</i>	0	0	√	√
7	<i>Strychnos nux vomica</i>	0	√	0	0
8	<i>Adenathera pavonia</i>	0	√	0	0
9	<i>Cuoutchou(Rubber)</i>	√	√	√	0
10	<i>Cocos nucifer</i>	0	√	0	0
11	<i>Pongamia pinnata</i>	√	0	√	0
12	<i>Grass species</i>	0	0	√	0
13	<i>Areca catchu</i>	√	√	√	0
14	<i>Ananas comosus</i>	0	√	0	0
15	<i>Atrocarpus heterophyllus</i>	√	√	√	0
16	<i>Bambusa</i>	0	0	√	√
17	<i>Eugenia microphylla</i>	0	√	√	0

CONCLUSION

The study articulate that population structure, distribution and feeding habitat of bonnet macaques in Kanyakumari Wildlife Sanctuary. The observation sited data of bonnet macaque troops in various places such as Palali pvt Estate, Rubber Estate I, Pechiparai Dam, HF, HRS and Rubber Estate II. The greatest macaque troop size results observed in HRS and Horticulture Farm in the meantime minimum macaque troop size observed in Pechiparai Dam and Palali pvt Estate. The similar results observed in Rubber estate I and II regions. In the feeding activity it doesn't have much more plant species for feeding. The no available chance to feed its go to had rubber plant leaves and fruit for day-to-day survival. In spite of it's a not natural food of Bonnet Macaque. The human-macaque conflict also one of the reasons for population structure variation. By improving the conflict management and vegetation involvement is one of the management techniques for conserving the bonnet macaque (*Macaca radiata*). Through concluded this study the bonnet macaque population structure and distribution varied according to the ecological demand and variations, particularly it's based on the food availability. It's one of the common species in world, in the same time this also struggle to survive in wild because of climatic changes and insufficient feeding.

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