

Population structure and Food preference of Lion-tailed Macaques (*Macaca silenus*) in Annamalai Hills, Western Ghats, Southern India



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Abstract

The Lion-tailed Macaque (*Macaca silenus*), endemic to the evergreen forests of the Western Ghats in Southern India, is endangered. The present study focuses on population and food preference of Lion-tailed Macaque (LTM) in the Anaimalai Hills, Western Ghats. The tropical rainforest of Anaimalai Hills, State of Tamil Nadu was surveyed in April-2018 to May-2018. The surveyed Regions (R) of Anaimalai Hills such as R1-Puthuthotam Estate (PT), R2-Kavarkal Estate (KE), R3-Wayverlay Estate (WE), R4-Water Falls Estate (WF) and R5-Attakatti (AK), these all are the major LTM distributed area. The LTM population was estimated by the Buckland and Thomas line transects method and one zero samplings methods were used by (Altmann) to assess the feeding activity. Population estimation in this study obtained a total of 53 sightings of lion-tailed Macaque (*Macaca silenus*) groups. The estimated number of troops in the region was 34. The estimated minimum population size in the study site was 529 monkeys in 53 sights. R1, R2 and R3 have a significant population compare to others. The total average of the data is 21.16 and SD of the population is 5.48. In the study regions, LTM has consumed the feed-in 18 types of plants. LTM feed upon a wide variety of food, although plants and fruits form the major part of their diet. Suitable foods include leaves, stems, and flowers. This article's result discusses the importance of food, population, and conservation for the Lion-tailed macaque (*Macaca silenus*).

Keywords: Population; Food preference; Lion-tailed Macaque

Introduction

The Western Ghats mountain range lies parallel to the western coast of southern India through six states from 8° to 21°N [1]. Although humans have lived in these hills since prehistoric times, organized state sponsored forestry and non-forestry activities only began c. 200 years ago [2]. Commercial crop plantations, Horticultural crop cultivation, construction of hydroelectric dams and power generation brought millions of people to the area and, as a result, wildlife habitats, especially the rainforests, have undergone drastic changes, including extensive fragmentation. However, the Western Ghats still harbors a high diversity of flora and fauna and is one of eight 'hottest hotspots' of global biodiversity [3]; it also has the highest human population density of all these eight hotspots [4].

About 12% of the mammal species present in the Western Ghats is endemic. This diversity includes several species of primates, notably the endemic lion-tailed macaque (*Macaca silenus*). The lion-tailed macaque ranges across three southern Indian states: Karnataka, Tamil Nadu and Kerala. The Lion-tailed macaque (*Macaca silenus*) or "LTM" is a species of primate which

is endemic to the rain forests of the Western Ghats. Presently it is estimated that 3000 to 4000 Lion-tailed Macaques survive in the wild in the 3 southern Indian states of Kerala, Karnataka and Tamil Nadu. The Tamil Nadu LTM groups are virtually isolated as they are unable to use their surroundings for movement between fragments (e.g. Valparai plateau of the Anaimalai Hills and Indira Gandhi Wildlife Sanctuary [5]). Because of its highly selective feeding habits, limited range of occupancy, delayed sexual maturity, long interbirth interval, low turnover and small wild population, it is categorized as Endangered on the IUCN Red List [6]. Habitat loss and fragmentation have severely affected the species [7,8]. It is endemic to the narrow ranges of the southern and central Western Ghats. [9]. The lion-tailed macaque (*Macaca silenus*) inhabits the rain forests of Western Ghats in southern India. Since these rain forests have been severely disturbed and decimated during the past 200 years; the species has now become highly endangered. The current population estimates project the number of wild life group as between 160-170, and the number of individuals between 2,975-3,252 a number of studies have reported on the distribution and status [10-15] and ecology and behavior [16-19] of lion tailed

macaques in different regions of Western Ghats. Since the lion tailed macaque is a habitat specialist' [15] it may be assumed that it would be behaviorally very sensitive to habitat vulnerability. It is, therefore, essential to monitor any such behavioral sensitivity in this endangered species for its long-term conservation and management. The present study focuses on the observation of the population structure and food preference of Lion Tailed Macaque

(*Macaca silenus*) in Annamalai Hills, Western Ghats. Most of the rain forest animals depend on plants so this study very essential for animals in Annamalai Hills, Western Ghats [20].

2. Study area This study conduct in the rain forest fragments in and around Annamalai Tiger Reserve (formerly Indira Gandhi Wildlife Sanctuary and National Park), Annamalai Hills, Western Ghats, India (Figure 1).

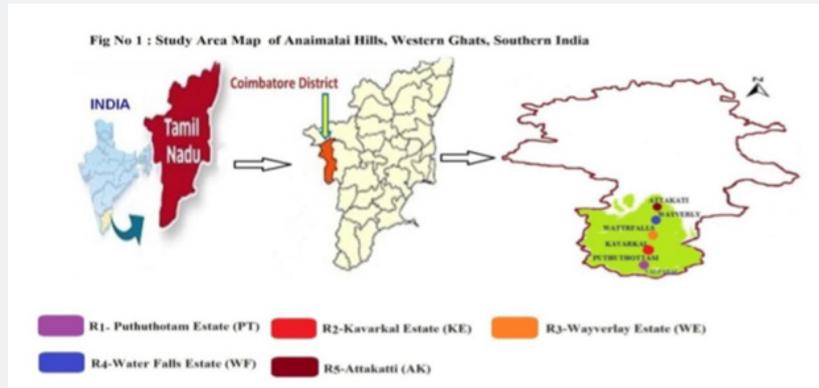


Figure: 1 study Area Map of Animalia Hills, western Ghats, southern India.

Study area is located at 10.37°N 76.97°E. It is a mid-elevation hill station and has an average elevation of 3,914 feet (1,193 m). Briefly stated, the Annamalai Hills was once a continuous rain forest, but between 1860 and 1930, it was clear-felled for tea, coffee, Teak and eucalyptus plantations, resulting in many forest fragments varying in size from a few hectares to >2000 ha [21]. The Annamalai Tiger Reserve (10°11'08"N to 10°33'27"N and 76°49'02"E to 77°21'09"E) isolated in the state of Tamil Nadu is one of the largest sanctuaries in south India (Figure 2) with an area of 987sq km. Rainfall varies from 800 mm to 1000 mm. The day temperature varies from 23°C to 40°C at the foothills, and from 20°C to 30°C at higher elevations (above 1800m). Extensive clear-felling has reduced the tropical rain forest in the sanctuary and adjoining areas to 30 fragments ranging in the area from less than 10 hectare to about 2500 hectares [22]. The subjects for this study included five different regions of Annamalai Hills, R₁. Puthuthotam Estate (PT), R₂. Kavarkal Estate (KE), R₃. Wayverlay Estate (WE), R₄. Water Falls Estate (WF) and R₅. Attakatti (AK) respectively. These all are the major LTM distributed area, because of major feeding source available in the floral and plantations. The LTM overlap their territory with other primates and squirrels Figure.

Materials and methods

Lion-tailed macaques occur in low numbers and are restricted to narrow strips of rainforest 20 km wide, in the Western Ghats Mountains. Given their preference for the rainforest canopy, the Population estimation of macaque density by line transects [23,24] and one zero sampling [25] for feeding activity requires

considerable effort, and it is often impossible to use transects because of the rough terrain. For population estimation of the animal sex identification make major role, but it's difficult to understand in field. Since the dominance hierarchy and lineage of the monkeys were not clearly known, the criteria used in determining an individual's age/sex class are also given below. We thus employed two different but complementary methods, in during the summer period April-2018 to May-2018. Firstly, to evaluate the population and feeding preferences of macaques over the entire study area we selected trails (mean length 2.43 km, range 1.50–4.50 km), evenly distributed across all the study sites and including the entire representative forest types, and then walked them repeatedly. The walks were conducted over 06.30–10.30 and 16.00–18.30, when the species is active [26]. With two to three trained field assistants, walked in parallel, 100 m from each other, at least twice, along chosen trails within each study site. Upon sighting a group its location was noted with a global positioning system and we counted the individuals and determined ages and sex. Additionally, we collected secondary information on macaque sightings from local people, hunters and Forest Department personnel. All sighting of the species was mapped and compared with the group localities and the species' potential habitat at these sites as described by [27]. This allowed us to enumerate the likely distribution range of the species within the Valparai Estates (Annamalai Hills) and around areas. The study was done where the Forest Department allows visiting the public without disturbance of Wild Animals.

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. Results Population estimation in this study obtained a total of 53 sightings of lion-tailed macaque (*Macaca silenus*) groups and, on many occasions in Annamalai Hills, Western Ghats (Valparai Estate). The estimated number of Troops in the region was 34 (Table 1).

Groups in R₁, R₂, R₃, R₄, R₅ ranges respectively. Complete group counts were obtained for 15 groups, providing a mean group size of 23 individuals/ group (Table 1). The group size varied from 12 to 35. About 60% of the groups had sizes of between 16 and

25. The estimated minimum population size in the study site was 529 monkeys in 53 sights, excluding the four lone males. R1, R2 and R3 have significant population compare than others. The current study in R1(PE) sited Macaques is 138 consists 34 Adult Male, 32 Adult Females, 28 Subadults, 31 Juveniles, 13 Infants and Average and SD is (27.6, 8.44) respectively. R2 (KE) sited totally consist 126, 32 Adult Male, 29 Adult Females, 31 Subadults, 23 Juveniles, 11 Infants and Average and SD is (25.2, 8.67) respectively. R3 (WE) sited Macaques is 102 consists 27 Adult Male, 23 Adult Females, 25 Subadults, 18 Juveniles, 9 Infants and Average and SD is (20.4, 7.19) respectively. The total of Adult Male Macaques in all the Estates is 141, Adult Female 121, Subadults 127, Juveniles 95 and Infants of the total troops is 45. Total average of the data is 21.16 and SD of the population is 5.48 (Table 1).

Table 1: Population structure of lion-tailed macaque in Study area in Annamalai Hills, Western Ghats (Valparai Estates).

S. No	Study Range	Adult Male	Adult Female	Sub adult	Juvenile	Infant	Total in Ranges wise	Average	S. D
1	R1	34	32	28	31	13	138	27.6	8.4439
2	R2	32	29	31	23	11	126	25.2	8.6718
3	R3	27	23	25	18	9	102	20.4	7.1972
4	R4	29	21	23	14	8	95	19	8.1548
5	R5	19	16	20	9	4	68	13.6	6.8775
Total		141	121	127	95	45	529	21.16	5.48161

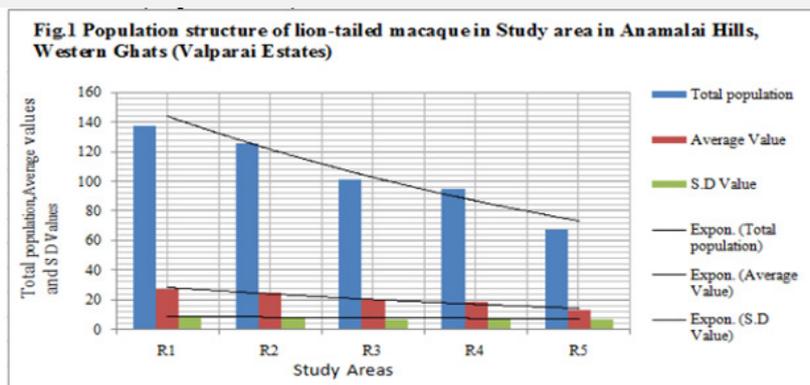


Figure 2: Population structure of lion-tailed macaque in Study area in Annamalai Hills, Western Ghats (Valparai Estates).

(Figure 1) clearly shows the population data fluctuation the study area. Hunting and Road kills levels in these Estates are however lower than those prior to 1990. Our interviews with local respondents also revealed a widespread belief in the medicinal value of this species because they forage on vegetative materials in the high forest canopy. Feeding activity as omnivore animals, Lion-tailed macaques feed upon a wide variety of food, although

fruits form the major part of their diet. Suitable foods include leaves, stems, flowers, buds, fungi as well as meat such as insects, lizards, tree frogs and various small mammals. It acquires both faunal and floral diets. In this study focus only the floral diets of LTM. 18 types of plants were identified in this study: macaques frequently using these plant and parts of the plants for feeding in the study period (Table 2).

Table 2: Feeding Activity of lion-tailed macaque in various Areas in Annamalai Hills, Western Ghats (Valparai Estates).

S. No	Plant species	Flower	Fruit	Leaves	Others
1	Ficus sp	√	√	√	√
2	Cullenia exarillata	√	√	√	0
3	Bischofia javanica	√	√	0	0
4	Palaquium ellipticum	√	√	0	0
5	Artocarpus heterophyllus	√	√	0	√
6	Mangifera indica	√	√	0	0
7	Coffea Arabica	0	√	√	√
8	Pandanus tectorius	0	√	√	0
9	Eucalyptus sp.	0	0	√	√
10	Eleaocarpus tuberculatus	√	√	√	0
11	Ficus bengalensis	√	0	0	0
12	Maccaranga peltata	0	√	0	0
13	Maccaranga roxburghii	0	√	0	0
14	Measua ferrea	√	0	√	0
15	Mimusops elengii	√	√	0	0
16	Palaquium ellipticum	0	√	0	√
17	Sheleichera oleosa	0	0	√	√
18	Syzygium cumini	√	√	√	0

Ficus species, Cullenia and Syzygium cumini are the most sought after by the lion-tailed macaques and are important food resources throughout the year. Two main attributes determine Ficus species as an important food resource for primates during periods of fruit scarcity. Firstly, fruiting patterns of Ficus species exhibit spatiotemporal patchiness [28-30] ensuring that some individual Ficus species are in fruit throughout the year within the same habitat. Secondly, Ficus species are usually present at low densities, when compared to other trees in forest ecosystems, and individual trees are usually clumped [31].

Owing to these characteristics, it appears that Ficus species can be exploited as a major fruit resource only by an animal with a relatively large home range [32]. The lion-tailed macaques feed on Cullenia flowers and seeds for most of the year. Flowering in Cullenia occurs during periods of fruit scarcity (February–April) and also when most of the other plant species do not flower [33]. During this time the lion-tailed macaque feeds heavily on the flowers of Cullenia. Although the macaques do depend on nectar, because of its low volume, the fleshy and sweet sepals are readily consumed. The height of these plants and the presence of primary and secondary branches favored roosting. And the canopy provides an opportunity to hide to themselves to the predators. Discussion The population of the lion-tailed macaque (*Macaca silenus*) s over its entire range in the Western Ghats or specifically in Tamil Nadu state, as estimated by various studies, no estimates are available separately for Tamil Nadu state. In two theoretical population assessments the lion tailed macaque population across the entire Western Ghats was estimated at 3,500-4,000 and 3,500 individuals. The difference in the group size between the study pe-

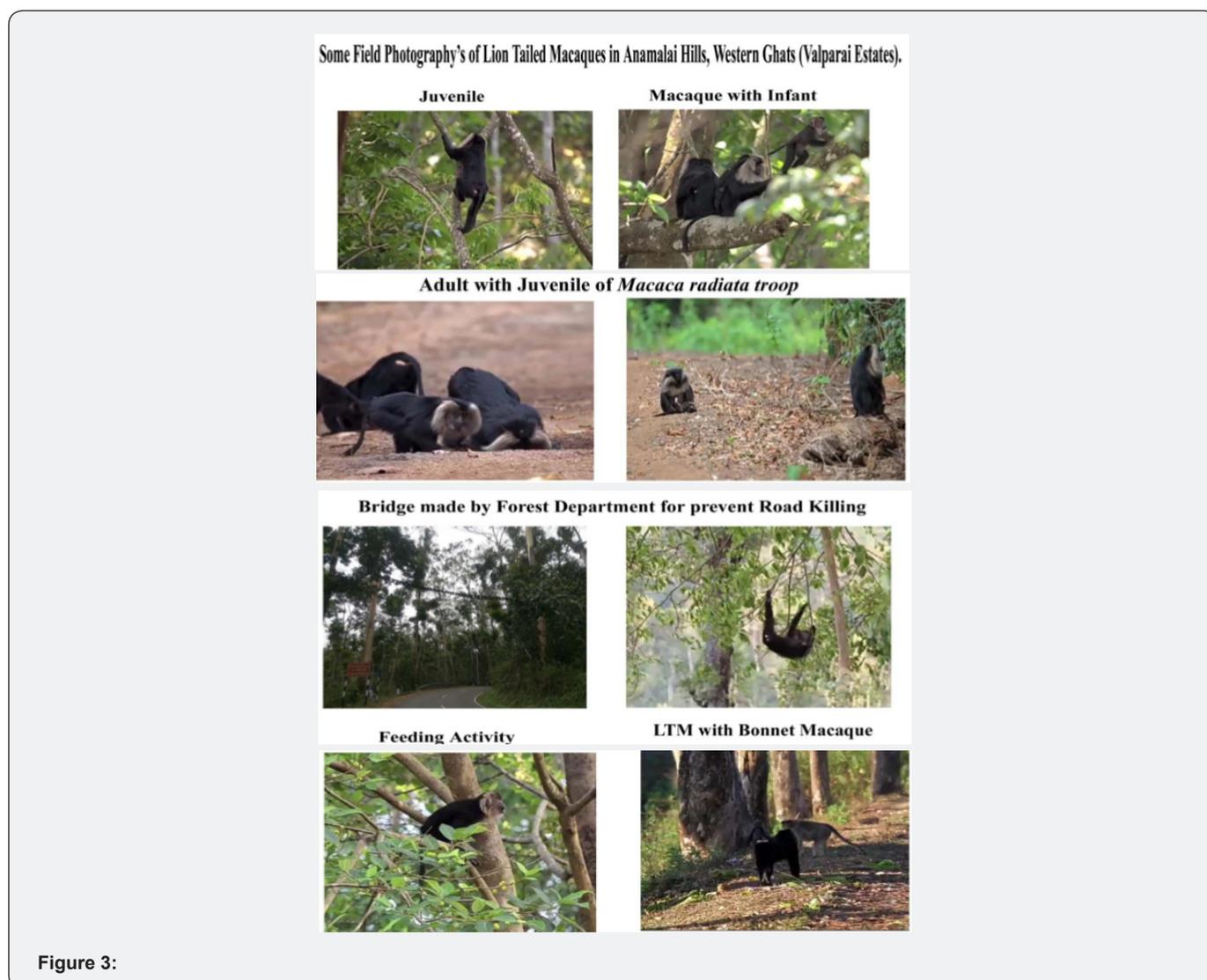
riods can be attributed to observer bias or to increased hunting, or mortality due to such as electrocution or snares set for other animals. There is little direct hunting; >90% of the inhabitants are Hindus who believe in the monkey god Hanuman, and killing monkeys is taboo. During our survey, however, we were told by many villagers that people from Kerala who have settled in neighboring Taluks of the Valparai area and people from coastal areas venture into the region using local hunters, to hunt primates. We deduce that this is increasingly damaging to the entire of the area, causing local extinctions of many of the large mammals.

Such local extinctions and sharp declines in the lion-tailed macaque population have been reported in different parts of Tamil Nadu (Kumara and Sinha 2009). Hunting should now be considered as one of the major threats prevalent in the area. The high human density has led local people to expand their commercial plantation (Tea and Teak) and increase the area of settlements and villages. Forests are shrinking, especially evergreen forest, at a rapid rate 1.9% yearly leading to the loss of 11.5% just in the last decade [34]. Until the conservation management plan is prepared, we suggest a few immediate interventions, such as avoiding cutting monoculture plantations within the habitat, since they act as a link between most forest stretches and also avoid development activities (building roads or laying electricity lines), Reduce the Horticultural crop cultivation and prevent further fragmentation of the habitat. Extension of the existing farmlands and further honeycombing of valleys for agriculture, uncontrolled timber extraction, and leaf-litter and green-manure collection [34,35] are some of the activities that are detrimental to the forests.

Management interventions against such threats should be taken seriously as an attempt to conserve the population of LTM and its contiguous habitat. The forest fragments inhabited by Lion Tailed Macaques continue to shrink in size and the habitat quality deteriorate in terms of food resources especially since many of these fragments are on private lands and the forest departments have no jurisdiction in such properties. The species appears to be a worse situation than it was some 30 years ago. Primates generally give birth when the food resources are abundant [36], whereas the lion tailed macaques give birth during December to February, and their favored food trees are not in fruit during February to April. During this time the macaques depend on the flowers of *Cullenia* and a seasonal and nonsynchronous fruits of *Ficus*. The high survival rates of the neonates in these macaques prove that the macaques may not face problems associated with no availability of food resources during the time when they are born. *Ficus* species form a major portion of lion-tailed macaque's diet.

Ficus species contain high amounts of amino acids, such as leucine, lysine, valine, and arginine and minerals, such as potassium, calcium, magnesium, sodium, and phosphorous [37]. Although no

single species of *Ficus* may be sufficient to sustain frugivores; a mix of *Ficus* species can provide a complete set of nutrients. In the southern region of the Western Ghats, *Ficus* trees are at low densities, and hence *Cullenia* is the major keystone species [38]. Hence the lion-tailed macaques do not suffer during periods of fruit scarcity even in the absence of *Cullenia*. The high survival rates of the infant lion-tailed macaques prove that the macaques may not face problems associated with non-availability of food resources during the time when they are born; however, it is difficult for them to proliferate since the lean season seems to be a bottleneck. Vegetation around small fragments plays a major role in the survival of lion tailed macaques [39], and thus it is essential to conserve this vegetation. More than one fourth of the trees in the small fragments were food trees of lion-tailed macaques and need to be protected. Degradation of habitat as a result of fuel wood collection and illegal timber extraction would severely affect the survival of the lion-tailed macaques, and these activities should be stopped immediately. Finally, in Puthuthottam forest fragment, monkeys use aerial bridges set up by the Forest Department to cross a road figure 3.



Conclusion

Through this study we conclude the Macaque population is Diverse from Rainforest to the Human plantation area for the reason of mostly preferred feeding plants are available. This diverse macaque population gets various anthropogenic pressures like Hunting for medicinal purpose, Road kills and some others. Some of the conservation managements also made by the Forest Department side but that is not enough for that macaque. Because of this Lion Tailed Macaque species population going to be endangered more and more in future, Now onwards get started practice to conserve the species [40-42].

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