The Lion-tailed Macaque (*Macaca silenus*): Life History, Ecology, Distribution and Conservation

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Abstract

The Lion-tailed macaque, endemic to the rainforest of the Western Ghats, is the ancestor of all Asian macaques. It occurs from slightly north of the Sharavati River in Karnataka to the southernmost tip of the Western Ghats, with a current population of ca. 4,000 animals, that are highly fragmented. The mean group size is 18–19 animals, usually with one adult male and 5–6 adult females. The macaque is adapted to the stability of rainforests, with a low capability to recover from drastic population reductions. Plant species richness in its habitat is critical in providing year round fruit and seeds, as well as foliage invertebrates. The home range varies from 125 to 500 ha, reflecting the difference in habitat quality. Pregnancy lasts about 170 days, and births peak in December–February. Although the vocal repertoire is similar to that of other macaques, the whoop and copulatory calls are unique.

The populations in forest fragments carry a high risk of extinction, a major determinant of which is the quality of the fragment and surrounding vegetation, rather than the

Introduction

The Lion-tailed macaque (Family: Cercopithecidae) is endemic to the tropical rainforest of the Western Ghats. It is considered the ancestor of all Asian macaques, since it is probably the direct descendent of the first macaque to reach Asia (***Macaca paleoindica***), nearly 5 million years ago, more or less the time when man evolved. This ancestor, the fossils of which have been obtained from Shiwalik Hills, is thought to have reached Southeast Asia through southern India. Geo-climatic changes during the Pleistocene, especially glaciation and the monsoonal climate, isolated the ancestral stock to the Western Ghats, whereas the stock which had reached Southeast Asia underwent repeated speciation to give rise to most of the extant macaques. The Lion-tailed macaque is a descendant of that stock which was isolated in the Western Ghats. Having been isolated in the tropical rainforests for all its life, the species shows striking adaptations to this habitat.

Practically unknown until the 1960s, there have

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fragment area. Management of these populations and their habitat is critically important. Some of the most important measures needed are discussed in the present communication. The rainforest fragments, which harbour a rich fauna, are of immense conservation value and can also be a major source of income from eco-tourism, if properly supported, encouraged, and managed.

been several studies on the species following Sugiyama's 3-month pilot study in the Cardamom Hills. There are several reports on its distribution and population status (Sugiyama, 1968; Green & Minkowski, 1977; Kurup, 1978; Ali, 1985; Karanth, 1985; Bhat, 1994; Kurup, 1994; Ramachandran, 1994; Kumar ***et al.,*** 1995); long term studies on its ecology, demography and behaviour in Ashambu Hills (Green & Minkowski, 1977), Anamalai Hills (Kumar, 1987; Kumar & Kurup, 1985; Kurup & Kumar, 1994; Menon, 1993), and Silent Valley (Joseph, 1998); vocalization; impacts of habitat fragmentation (Umapathy, 1998; Umapathy & Kumar, 2000); and recently, on social development and reproductive behaviour. Thus, we have a better understanding of the life history, ecology, behaviour, distribution and conservation problems of the Lion-tailed macaque, than of most other species in India.

Life History

The Lion-tailed macaque lives in groups with an average of about 18 animals (mean 18.8 and the median 17.4). In undisturbed habitats the group size ranges from 7 to about 40. However, in forest fragments in the Anamalai Hills group size may be as high as 65 animals. Most of the groups in undisturbed forests have only one adult male (mean 1.5, median 1), with 6 or 7 adult females and one sub-adult male, the remaining being immature. However, groups with as many as 4 adult males occur in forest fragments. The mean group size of the Lion-tailed macaque is slightly smaller than that reported for other macaques, in the range of 20–30 animals. Moreover, the adult sex ratio in a group is more biased towards the females, with about 5–6 females per male compared to 2–3 females per male reported for most other macaques. There is no indication of geographical variation in group size and composition. For example, the populations south and north of the Palghat Gap have similar group sizes (18.4 and 19.1 respectively). Their age/sex compositions are also not significantly different.

Information on other life history parameters comes almost entirely from the Anamalai Hills, where the species has been studied for over a decade. The Lion-tailed macaque has a very low birth rate (the proportion of females giving birth in a year) compared to most other macaques. Data from 8 groups gave a birth rate of only 0.30 (SD = 0.07). Consequently the inter-birth interval is very long; data from 3 females gave a mean of 30 months or two and a half years. The age at which females give birth for the first time is also unusually high (6.6 years, n = 3) compared to other macaques. The only redeeming feature of its life history seems to be the very low mortality rate, only about 0.05/year for all age/sex classes together. Adult males probably have a greater mortality or emigration rate (0.08/year), compared to adult females (0.03/year) and immatures (0.05/year).

Most of the mating in the Lion-tailed macaque occurs when the female is in estrus, which is indicated by a swelling in the perineal area, especially at the base of the tail. The duration of the sexual cycle is on an average 30 days,

with a swelling phase of 14 days and a flat phase of 16 days. Mating reaches a peak about 11–13 days after the swelling appears.

The life history parameters of the Lion-tailed macaque are exceptional compared to other macaques. The high age at first birth, low birth rate, and low mortality rates at all stages of life are noteworthy features, and highly adapted to its relatively stable habitat. The inevitable consequence of the above set of parameters is that the Lion-tailed macaque would have very low capability to track rapid changes in resources and to recover from population perturbations caused, for example, by diseases or hunting.

Feeding Ecology

The Lion-tailed macaque feeds exclusively on food items which are rich in simple carbohydrates or lipids (ripe fruit, seeds, nectar, gums and resins), and proteins (chiefly invertebrates, but could also include bird eggs and nestlings, and giant squirrels). The annual diet consists of 57.5% of fruit and seeds, 37.3% of animal matter, and 5% of other plant parts such as nectar, resins and flowers. Nearly 220 plant species are used for food in 3 sites together (Kalakad, Silent Valley and Anamalai Hills). Over a 3–year period, one group in the Anamalai Hills used 93 plant species belonging to 39 families, with the number of species used each month varying from 8 to 25. Most species (56.0% in the Anamalai Hills) are exploited only for the ripe fruit flesh (***e.g., Mangifera indica*** and ***Semicarpus travancorica***) but many species (16.5%) are also used for their seeds. Few species (***e.g., Artocarpus hirsuta*** and ***A. integrifolia***) are used for both the seed and the mesocarp, and few others for nectar (***e.g***., ***Bombax malabarica***). Gums or resins of few species are also used (***e.g., Gnetum ulae*** and ***Vepris bilocularis***). The only species exploited for its flowers is ***Xanthophyllum flavescens***. Other plant food items include mushrooms, lichens, and mosses. Feeding on leaves is negligible and confined to infrequent and short bouts of feeding on some grass species.

Most of its protein requirements are met primarily from invertebrates, but it also feeds opportunistically on snails, birds eggs, nestlings, and giant squirrel nestlings. It spends considerable time looking for invertebrates (mean = 27.4% of daytime) and feeding on them (mean = 18%). Green leaves are, by far, the major source of invertebrates (77.2%).

Thus, the diet is dominated by plant parts (fruit flesh and seeds) rich in simple carbohydrates, and foliage insects rich in protein. The availability of fruit and seeds, and green foliage throughout the year, therefore, is critical to the survival of the Lion-tailed macaque. Only the very high diversity of plant species in the rainforests can ensure the availability of fruit and seeds, and invertebrates throughout the year. The same high plant species diversity also buffers against variations between years in the availability of fruit, seeds and invertebrates.

Distribution

Even within historical times, the Lion-tailed macaque was distributed as a contiguous population from the southern end of the Western Ghats to well into the state of Maharashtra. Over the past many centuries, however, its distribution range in the north has shrunk to just north of the Sharavati River in Karnataka, as most of the rainforests in the states of Maharashtra and Goa were wiped out. Similarly, the lowland rainforests in Kerala and Karnataka were also wiped out, confining the

Lion-tailed macaque to higher elevations. Moreover, the remaining forests have been fragmented into numerous small isolated patches. Presently, therefore, the Lion-tailed macaque occurs as numerous small populations (Figure 1).

Karnataka

In Karnataka, it occurs from slightly north of the Sharavati River up to the southernmost part, Srimangala Forest Range, adjoining Kotiyur forests in Kerala. The narrow band of rainforest on the western face of the Western Ghats in Karnataka is largely contiguous through most of its length. Four populations can be identified in Karnataka.

1. North of the Sharavati River and south of the Aghanashini River is a remnant population mostly in the Siddapur Forest Range. A small population might also occur in the Kumta Range. The habitat is highly fragmented, and has been surveyed by Bhat (1994).
2. South of the Sharavati River, the habitat is largely contiguous up to Belthangadi Range. The Wildlife Sanctuaries and Forest Ranges included in this area are: Sharavati, Mookambika and Someshwara Wildlife Sanctuaries, Kudremukh National Park, and Forest Ranges of Shankaranarayana, Hosanagara, Agumbe, Karkala, Mudbidri, Kudremukh, Sringeri, and Kalasa. This stretch is however cut by at least 3 state highways, making it discontinuous. Large stretches of rainforests occur at low elevations in Mookambika, Someshwara and Shankaranarayana ranges.
3. The above population is separated from the large stretches of contiguous forest in Kodagu district, by a large discontinuous section in the Belthangadi and Mudigere ranges. There is, however, a small remnant population in the Charmadi Hills of the Belthangadi range.
4. South of the Mangalore–Sakleshpur road, the habitat is again contiguous and mostly at a low elevation, extending up to Kotiyur forests in Kerala. Most of these forests fall in Kodagu district. This area covers forest ranges of Subramanya, Sampaji, Bhagamandla, Makut, Mundrote, and Srimangala. Three state highways, however, cut across this area, creating discontinuous stretches. In terms of habitat quality, this is undoubtedly the best in Karnataka, being the southernmost, at a low elevation and not logged intensively. However, the population has been severely suppressed by poaching from Kerala and Kodagu sides. The population density is therefore, very low.

A rough estimate of the area of the Lion-tailed macaque's habitat in Karnataka is possible from Pascal ***et al***., (1982). The area under each vegetation type and the estimated population are given in Table 1. Working groups estimated the population in each area during the 4th International Symposium on the Lion-tailed Macaque held in Chennai in 1993 (Kumar ***et al***., 1995).

Kerala and Tamil Nadu

Compared to Karnataka, the rainforests in Tamil Nadu and Kerala occur at a higher elevation, mostly above 700 m. The best quality low elevation habitats have all been cleared. An assessment is severely handicapped because of the absence of a vegetation map comparable to the one available for Karnataka. Although Kerala accounts for nearly 50% of the population and Tamil Nadu for 25%, in both these

Table 1. The distribution of lion-tailed macaques in the different vegetation associations in rainforests in Karnataka. The vegetation association follows Pascal (1988) and the area was estimated from the vegetation map (Pascal 1982). Population estimates are from Kumar (1995). (Altitude: low = 0–850 m, med = 600–1400 m).

Population	Vegetation type	Altitude	Area (Km^2)	Est. LTM groups
North of Sharavati River	***Persea macarantha-Diosphros-Holigarna*** spp;	Low	80	
	Dipterocarpus indicus-Diospyros candolleana-Diospyros occarpa;	Low	30	
Total			110	10
Mookambika–Someshwara area	***Dipterocarpus indicus-Diospyros candolleana-Diospyros oocarpa;***	Low	235	
	Poeclioneuron indicum facies of above ***Dipterocarpus indicus-Humboldtia brunonsis-Poeciloneuron indicum;***	Low Low	187 138	
	Palaquium ellipticum-Poeciloneuron indicum-Hopea ponga;	Med	70	
	Dipterocarpus indicus-Kingiodendron pinnatum-Humboldtia brunonsis-Poeciloneuron indicum;	Low	75	
Total area			705	26
Charmadi Hills	***Dipterocarpus indicus-Kingiodendron pinnatum-Humboldtia brunonsis;***	Low	24	2
Kodagu area	***Dipterocarpus indicus-Kingidoendron pinnatum-Humboldtia brunonsis;***	Low	697	
	Mesua ferrea-Palaquium ellipticum;	Med	324	
	Cullenia exarillata-Mesua ferrea-Palaquium ellipticum	Med	30	
Total area			1051	10

states the habitat and populations have been severely fragmented. The only exceptions are Silent Valley–New Amarambalam area, Ashambu Hills, and to some extent, the Cardamom Hills. There are about 7 populations in these 2 states together, but except in the 3 areas just mentioned the population is further fragmented into smaller populations (Table 2).

1. North of Nilambur: This population is confined to Kerala. The northernmost is the Kotiyur forest in Kannoth Range, which is contiguous with the Kodagu population in Karnataka. The extent of forest in Kerala is however very small (> 20 km^2). There are 3 other isolated populations, with 1–4 groups each, in Periyar, Manjeri Kovilakam and Nadukani. Some of these habitats have been underplanted with cardamom, and all populations are under poaching pressure.
2. Silent Valley–New Amarambalam: This is also entirely confined to Kerala, and is the largest population in the state, and the best

Table 2. The distribution and approximate population of Lion-tailed macaqe (from Kumar *et al.* 1995) in Kerala and Tamil Nadu.

Population	Kerala	Tamil Nadu	No. of groups groups	Remarks
North of Nilambur	Kotiyur, Periya, Manjeri-Kovilakam, Nadukani	–	4–8	Fragmented
Silent Valley New amarambalam	Silent Valley & New Amarambalam	–	> 30	Contiguous population
Siruvani-Attapadi	Siruvani & Attapadi area	Boluvampatti	4–5	Contiguous population
Anamalai Hills	Nelliampathi RF Parambiculam WLS Sholayar RF	Indira Gandhi WLS, private forests	43–58	Highly fragmented 1–5 groups each
Munnar	Pappathi, Vattavada	–	1–2	One small fragment
Cardamom Hills	Periyar Tiger Reserve, Ranni & Konni forest Divisions	Megani Valley, Srivilliputhur	21	Fragmented into 3–4 populations
South of Achankoil	Thenmala, Chenduruny & Peppara WLs, Neyyar WLS, Kulathpuzha	Kalakkad-Mundanthurai Tiger Reserve	50–55	Contiguous in Tamil Nadu, Fragmented in Kerala, but contiguous with Tamil Nadu

habitat in terms of quality and contiguity. The population is estimated to be about 600 animals (30 groups). Although relatively free from major habitat loss, poaching has been reported recently.

3. Siruvani–Attapadi: Although contiguous with the Silent Valley population till recently, this is now an isolated population. At an elevation of above 900 m, the Colleen dominated forest has a population of about 3–5 groups.
4. Anamalai Hills: This area probably had the largest extent of rainforests in Western Ghats, until about 200 years back. Large areas were cleared for reservoirs, plantations, and tea and coffee estates. Presently the Lion-tailed macaque habitat is highly fragmented and surrounded by tea estates. Many of the patches are at a low elevation (600–700 m), compared to other parts in these two states, and therefore the density is relatively higher than in most other areas, including the higher elevation forests in the much southern Ashambu Hills. The total population in the Anamalai Hills is probably about 23–32 groups in Kerala and 20–27 groups in Tamil Nadu, with nearly 800 animals in total. Except for the Karimala Gopuram–Sholayar forests, with about 12–16 groups, the remaining populations are all small, mostly with 1–2 groups, isolated in forest fragments ranging an area from 15 ha to 2000 ha. Some of these fragments are also under private ownership and highly degraded (Puthuthottam and Korangumudi estates). While most of the areas in Tamil Nadu fall within the Indira Gandhi Wildlife Sanctuary, large areas in Kerala are out-

side the Parambiculam Wildlife Sanctuary.

5. Munnar: Most of the forests in Munnar have been cleared for tea estates and those that remain are at high elevations and not suitable for Lion-tailed macaques. Perhaps the only remnant population (of 1–2 groups) is in the Pappathi Shola.
6. Cardamom Hills: Most of the rainforests in Cardamom Hills are in Kerala, in the Periyar Tiger Reserve, and Ranni and Konni Forest Divisions. Although the estimated population is about 17 groups, and the habitat area about 250 km^2 a considerable extent of these forests is either semi-evergreen or at high elevations, which may not be optimal Lion-tailed macaque habitat. There is also a small, and probably isolated, population (of about 4 groups) on the eastern side in Tamil Nadu (Sirivilliputhur).
7. South of Achankoil and Ashambu Hills: The forests in Kerala, south of Achankoil, are perhaps contiguous with extensive forests in Ashambu hills, which largely fall in Tamil Nadu. The total population is estimated to be about 50–55 groups—nearly 25% of the entire Lion-tailed macaque population. The forests in Tamil Nadu have retained their contiguity in the Ashambu Hills and isolated small populations are not likely. In Kerala, there has been extensive forest loss, and small isolated populations are likely, although the southern part of this range is contiguous with Tamil Nadu.

Conservation Problems

The major problems in the conservation of the Lion-tailed Macaque are:

1. Habitat and Population Fragmentation: Most of the rainforests in the Western Ghats have been lost and the remaining habitat occurs mostly as small patches with 1–4 groups each. During the 4th International Symposium (Kumar ***et al.*** 1995) the Working Group on Census and Distribution identified at least 40 isolated populations, of which 26 had less than 2 groups each, 9 had between 3 and 10 groups, and only 5 had more than 10 groups. The areas with substantial, but fragmented, populations are Anamalai Hills and Cardamom Hills. Charmadi Hills in Karnataka and north of Nilambur in Kerala, also have a few small populations confined to small patches of habitat. In Kodagu area, a small population is confined to a large stretch of habitat, a consequence of many years of hunting pressure. South of Achankoil also there might be isolated small populations in Kerala.

A recent study in the Anamalai Hills has shown that Lion-tailed macaques often become extinct from small habitat fragments (Umapathy & Kumar, 2000). Moreover, isolated populations have a low birth rate and a lower proportion of immatures.

2. Hunting: Poaching is a serious problem in certain places. It had been prevalent in Kodagu forests for many years. As a result, the population in this ideal habitat has been reduced drastically. Hunting is also a problem in north of Nilambur, and in Cardamom Hills. Recently, hunting has also been reported from the Silent Valley Area. Given the low birth rate and high age at first birth, the Lion-tailed macaque does not have the ability to recover from even low levels of hunting.

3. Habitat Degradation: Almost all the small patches of rainforests have been degraded due to logging, cardamom planting, and fuel and timber wood collection. Logging has already reduced the population in some patches in recent years (Puthutottam and Korangumudi

estates), and continues to be the major and immediate threat to many small populations in Anamalai, Manjeri Kovilakam forests in Nilambur, and Srivilliputhur.

2. Private Ownership: Many of the small patches are under private ownership, especially in the Anamalai, Cardamom, and Ashambu Hills. This offers the Lion-tailed macaque and its habitat very low protection from logging, poaching, fuel wood collection. Logging in such privately owned patches has become a serious threat to resident populations in recent years.

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