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Distribution and Relative Abundance of the Slender Loris *Loris lydekkerianus* in Southern Kerala, India

Ramamoorthy Sasi[1] and Honnavalli N. Kumara[2]

[1]*Department of Anthropology, University of Madras, Chennai, India*
[2]*Sálim Ali Centre for Ornithology and Natural History, Coimbatore, India*

Abstract: Two subspecies of slender loris, the Mysore slender loris, *Loris lydekkerianus lydekkerianus*, and the Malabar slender loris, *Loris lydekkerianus malabaricus*, are known from Peninsular India. Their distributions overlap along the southern ridges of the Western Ghats. Although the distribution and abundance of the species is known for part of the state of Kerala, the full extent of the range of the species remains unclear. We surveyed forested areas of southern Kerala for a more comprehensive understanding of their distribution pattern and relative abundance. The range of *L. l. malabaricus* is confined to the western slopes of the Western Ghats. The Ariankavu pass and Palghat gap have created a barrier over a period of time, which has resulted in separate populations of *L. l. malabaricus*. As such, *L. l. malabaricus* is divided into three populations in Kerala—(1) Neyyar Wildlife Sanctuary in the southern tip to the south of the Ariankavu pass, (2) north of Ariankavu pass north to the Palghat Gap, and (3) north of the Palghat gap to the Aralam Wildlife Sanctuary. The relative abundance of *L. l. malabaricus* in most of the forest divisions of Kerala is <0.2 lorises/km, except in the Aralam Wildlife Sanctuary, Konni, Thiruvanthapuram, Nemmara, and Chimmoney.

Key words: Mysore slender loris, *Loris lydekkerianus lydekkerianus*, Malabar slender loris, *Loris lydekkerianus malabaricus*, Eastern Ghats, Western Ghats, Kerala, India

Introduction

The slender loris, *Loris lydekkerianus* Cabrera, 1908, is one of the two nocturnal primate species found in India[1]. The two subspecies currently recognized are the Mysore slender loris, *Loris lydekkerianus lydekkerianus* and the Malabar slender loris, *Loris lydekkerianus malabaricus* Wroughton, 1917, inhabiting the dry forests of the Eastern and Western Ghats, and the wet forests of the Western Ghats, respectively. Although the distribution and abundance of the species is known for the state of Karnataka and some parts of Tamil Nadu, Kerala and Andhra Pradesh (Singh *et al.* 1999, 2000; Kumara *et al.* 2006; Radhakrishna *et al.* 2011), the entire range of the species in southern India remains unknown.

Based on the collection localities of museum specimens, it is evident that historically the River Tapti limited the species' range on the west coast, and the River Godavari on the east coast. The southeastern and southwestern limits of the distribution of lorises are still unclear and an understanding of the distribution pattern is problematic because of the complex geomorphology of southern India. The discontinuous Eastern Ghats, geographical barriers in the Western Ghats such as the Palghat Gap, and other discontinuities that form barriers such as plateaus and escarpments, in addition to historical land-use practices, have led to the fragmented wildernesses in South India (Radhakrishna *et al.* 2011). The dry forest subspecies is thought to be more abundant in the Eastern Ghats and eastern fringes of the Western Ghats, but the full extent of its range and its conservation status along the Western Ghats is not clear. The distributions of both the subspecies are said to overlap, which has never been really explored. As the wet forest subspecies occurs in lower densities in the Western Ghats, understanding its distribution and the quality of the remaining forests will help in prioritizing the forest patches for conservation. Radhakrishna *et al.* (2011) reported on the status and distribution of the slender loris in the northern and central parts of the state of Kerala. Here, I report on the results of surveys in southern Kerala, which complement the findings

[1] The other is the Bengal slow loris, *Nycticebus bengalensis*.

of Radhakrishna *et al.* (2011), providing a picture of the overall pattern of distribution and abundance of the slender loris throughout the state.

Methods

Survey sites

We surveyed forests in southern Kerala from 77°08' to 77°24'E and 08°29' to 09°48'N. They included the Periyar Tiger Reserve, three wildlife sanctuaries (Shendurney, Peppara and Neyyar) and seven reserve forests (Kottayam, Ranni, Konni, Achenkovil, Punalur, Thenmala, and Thiruvananthapuram) (Table 1, Fig. 1). The major vegetation types of southern Kerala are evergreen forests (on the western slopes of Western Ghats), semi-evergreen forests and degraded evergreen or semi-evergreen forests, and deciduous forests in some of the regions that are contiguous with the rain shadow areas of Western Ghats.

Data collection and analysis

All the major forest patches in each forest range of the division were surveyed. Forest Divisions are the administrative units, which include administrative ranges known as Forest Ranges. Forest ranges were considered as the minimum sampling unit for a better understanding of the status of the species; a scheme which is also helpful in informing the local managers. The forest divisions include reserve forests, wildlife sanctuaries and a tiger reserve. Survey sites were selected based on the extent of forest cover in each forest range of the forest division. Night surveys were conducted between 2000 h and 0400 h on pre-determined transects that were already existing trails (as advised by Sterling and Ramaroson 1996, and Walsh and White 1999). Whether we used a vehicle survey or foot transect depended on access and the topography of the terrain (Singh *et al.* 1999, 2000; Nekaris and Jayawardene 2004). Vehicle speed was maintained at an average of 5 km/h (Singh *et al.* 1999). Walking speed averaged 1 km/h (Sterling and Ramaroson 1996). We used flashlights and headlamps; the eyes of slender lorises have a typical orange-red shine that can be seen from a distance of over 100 m (Singh *et al.* 1999, 2000).

The relative abundance index was calculated as the number of animals observed per kilometer (Sterling and Ramaroson 1996), with standard deviation. The number of

Table 1. Sampling effort, number of sightings, and encounter rate of slender loris, *Loris lydekkerianus lydekkerianus* and *L. l. malabaricus*, in different forest divisions of Southern Kerala (SD for sightings per kilometer is provided only if the sample size is more than two for each forest range.)

Forest division	Forest range	Official status	Km walked/ motored	No. of lorises	Sightings/km (±SD)	Subspecies identity
Kottayam	Kumily (1)*	RF	9	3	0.05	?
	Erumeli (2)	RF	8	1	0.12	?
Periyar TR	Thekkady (3)	TR	24	0	-	-
	Vallakadavu (4)	TR	56	1	0.03 (±0.09)	*L. l. malabaricus*
	Periyar (5)	TR	19	0	-	-
	Azhutha (6)	TR	12	0	-	-
	Pampa (7)	TR	10	0	-	-
Ranni	Goodrickal (8)	RF	120	0	-	-
	Vadasserikkara (9)	RF	43	0	-	-
Konni	Naduvathumuzhy (10)	RF	10	5	0.50	*L. l. malabaricus*
	Mannarappara (11)	RF	1	1	0.05	*L. l. malabaricus*
Achenkovil	Kallar (12)	RF	22	4	0.18	*L. l. malabaricus*
	Kanayar (13)	RF	20	1	0.05	*L. l. malabaricus*
	Achenkovil (14)	RF	51	3	0.04 (±0.04)	*L. l. malabaricus*
Punalur	Pathanapuram (15)	RF	25	3	0.07 (±0.11)	*L. l. makabaricus*
Thenmala	Thenmala (16)	RF	8	0	-	-
	Arienkavu (17)	RF	18	1	0.05	*L. l. malabaricus*
Shendurney	Shendurney (18)	WLS	22	2	0.09 (±0.01)	*L. l. malabaricus*
Thiruvananthapuram	Kulathupuzha (19)	RF	40	2	0.05 (±0.07)	*L. l. malabaricus*
	Palode (20)	RF	32	5	0.21 (±0.24)	*L. l. malabaricus*
	Paruthipally (21)	RF	12	6	0.50	*L. l. malabaricus*
Peppara	Peppara (22)	WLS	48	5	0.21 (±0.29)	*L. l. malabaricus*
Neyyar	Neyyar (23)	WLS	36	4	0.12 (±0.14)	*L. l. lydekkerianus*
	Total		**641**	**47**	**0.07 (±0.13)**	

TR: Tiger Reserve; WLS: Wildlife Sanctuary; RF: Reserve Forest
*Numbers in parentheses indicate location in Figure1.

trails or transects walked or motored was the sample size. In each forest range, the standard deviation for encounter rate was computed when the sample size was more than two. A handheld global position system (GPS) was used to record the location of the animals seen and the distance covered during the survey. For each sighting, we recorded the number of individuals, the subspecies, height from the ground, the substratum and tree species, and the habitat type. Body size, coat color, and shape of the circumocular patches were used to distinguish the Mysore from the Malabar slender loris (Kumara *et al.* 2006). The lorises were observed closely in order to distinguish the identity of the subspecies based on coat color and circumocular patches. We took photographs when we were uncertain of the identity of the subspecies. The surveys were carried out between November 2012 and April 2013, and totaled 641 km by foot and vehicle.

We combined our results with those of an earlier study by Radhakrishna *et al.* (2011) to provide an overall picture of distribution and relative abundance of slender lorises in Kerala.

Results

Distribution and abundance in southern Kerala

Forty-seven lorises were seen during the 641 km of transects (Table 1). Slender lorises were found in all of the forest divisions except Ranni (Table 1, Fig. 2). The encounter rate varied considerably between the ranges (Table 1); the highest was in Naduvathumuzhy (0.50 lorises/km) in Konni forest division and Paruthipally range (0.50 lorises/km) in Thiruvananthapuram. They were followed by Palode (0.21 ±0.24 SD lorises/km) in Thiruvananthapuram forest division and Peppara (0.21 ±0.29 SD lorises/km) in the Peppara Wildlife Sanctuary. The overall encounter rate was 0.07 ±0.13 SD lorises/km. We were unable to identify four lorises seen in Kottayam forest divisions. All other lorises seen were *Loris lydekkerianus malabaricus*, except the four in the Neyyar Wildlife Sanctuary, which were *L. l. lydekkerianus*.

The relative abundance of lorises in moist deciduous forest (0.31 ±0.16 SD lorises/km) was significantly higher (Kruskal-Wallis, $\chi^2 = 25.32$, df = 2, $p<0.001$) than in evergreen forest (0.02 ±0.06 SD lorises/km) and plantations (0.04 ±0.05 SD lorises/km) (Fig. 3). Of the 47 lorises seen,

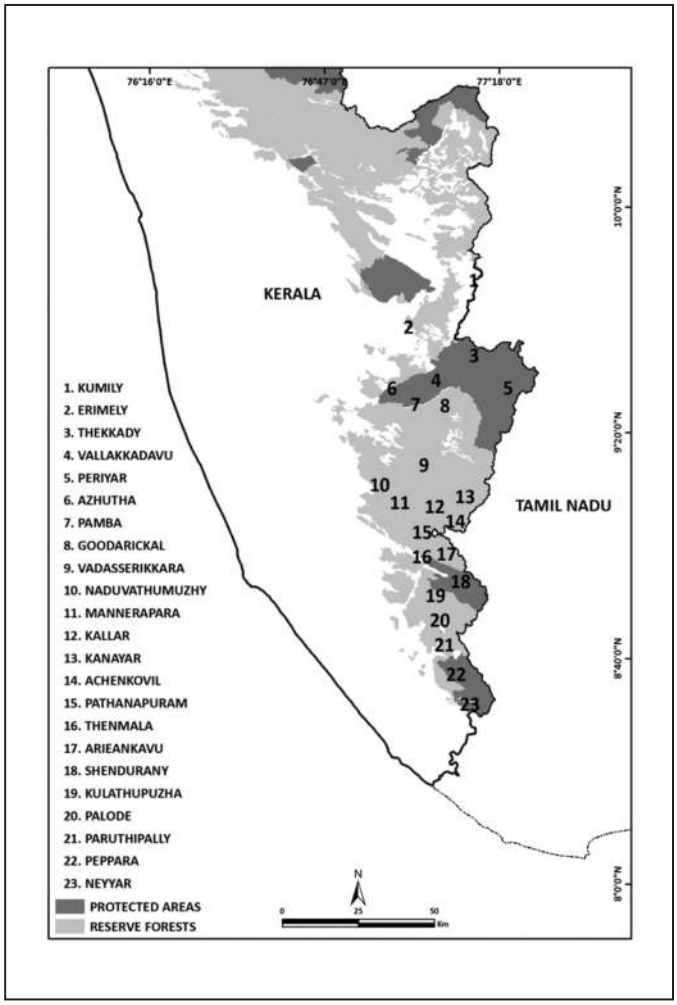

Figure 1. Location of forests surveyed for slender loris in southern Kerala.

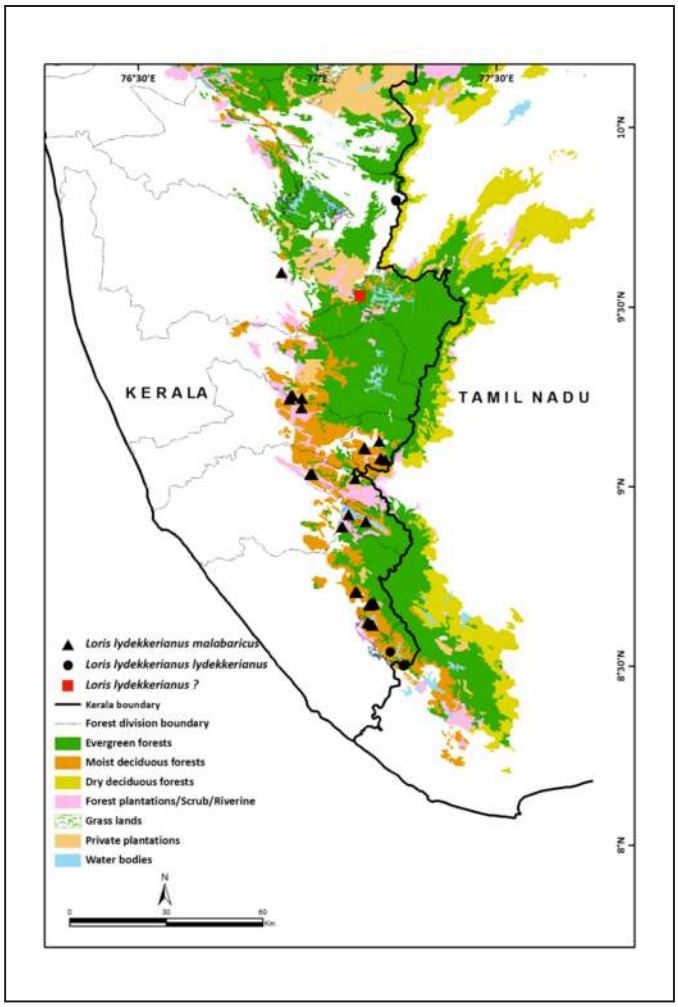

Figure 2. Sightings of subspecies of slender loris in southern Kerala.

36 (77%) were at elevations of <300 m above sea level, and 11 (23%) were between 301 and 1200 m (Fig. 4).

Distribution and abundance in Kerala combining the present survey and that of Radhakrishna et al. 2011

Slender lorises were found in the forests of the Western Ghats from the Neyyar Wildlife Sanctuary in the south to the Aralam Wildlife Sanctuary in the north (Fig. 5). In spite of a large sampling effort, lorises were not seen in stretches of evergreen forest in the Periyar Tiger Reserve (our data) and Parambikulam Tiger Reserve (Radhakrishna *et al.* 2011). Among all the forest divisions and forest ranges, the highest encounter rate was in Aralam Wildlife Sanctuary (1.44 ±1.07 SD lorises/km), followed by the Chimony Wildlife Sanctuary (0.06 ±0.57 SD lorises/km), the Naduvathumuzhy range (0.50 lorises/km) of Konni forest division, and the Paruthipally range (0.50 lorises/km) in Thiruvananthapuram. The overall encounter rate for the state was 0.12 ±0.31 SD lorises/km.

In southern Kerala, lorises were more abundant in moist deciduous forest, whereas in central and northern Kerala they were found predominantly in evergreen forest. Overall, relative abundances were higher in evergreen forest (0.18 ±0.51 SD lorises/km), followed by moist deciduous forest (0.14 ±0.18 SD lorises/km), dry deciduous forest (0.10 ±0.20 SD lorises/km) and plantations (0.07 ±0.13 SD lorises/km) (Fig. 6). The relative abundance of lorises did not differ significantly, however, across these vegetation types (Kruskal-Wallis, $\chi^2 = 4.17$, df = 3, p = 0.244). Lorises were recorded at elevations of 65 to 1871 m above sea level, but 55% of the sightings (N = 81) were at <300 m (Fig. 7). There was no significant difference in the relative abundance of lorises in protected areas (0.14 ±0.40 SD lorises/km) compared to reserve forests (0.11 ±0.18 SD lorises/km) (t = 0.682, df = 181, p =0.496) (Fig. 8).

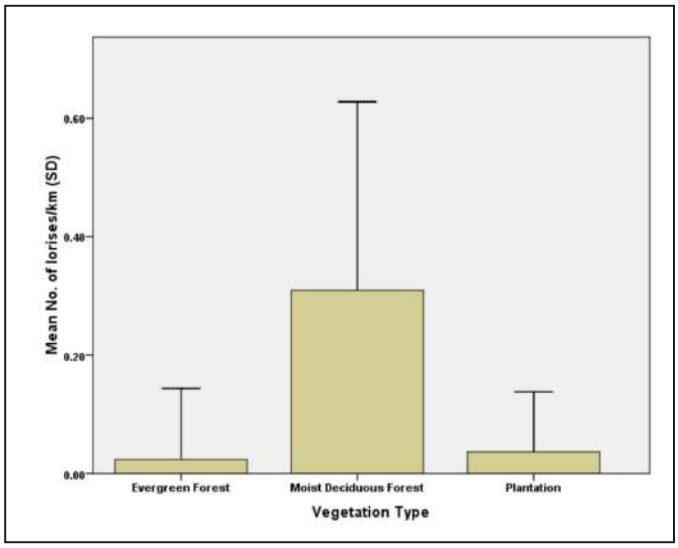

Figure 3. Mean number of lorises sighted in different vegetation types of southern Kerala.

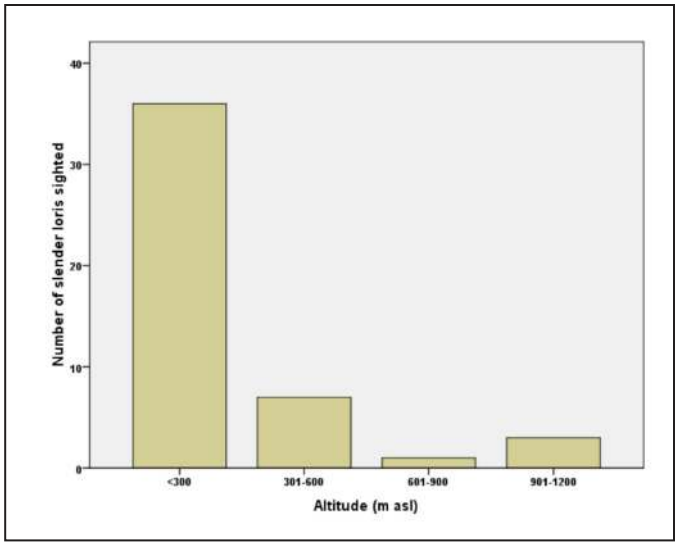

Figure 4. Number of lorises seen at different elevations in southern Kerala.

Discussion

The findings from the present study combined with the data from the surveys of Radhakrishna *et al.* (2011) provide a more complete picture of the distribution and abundance

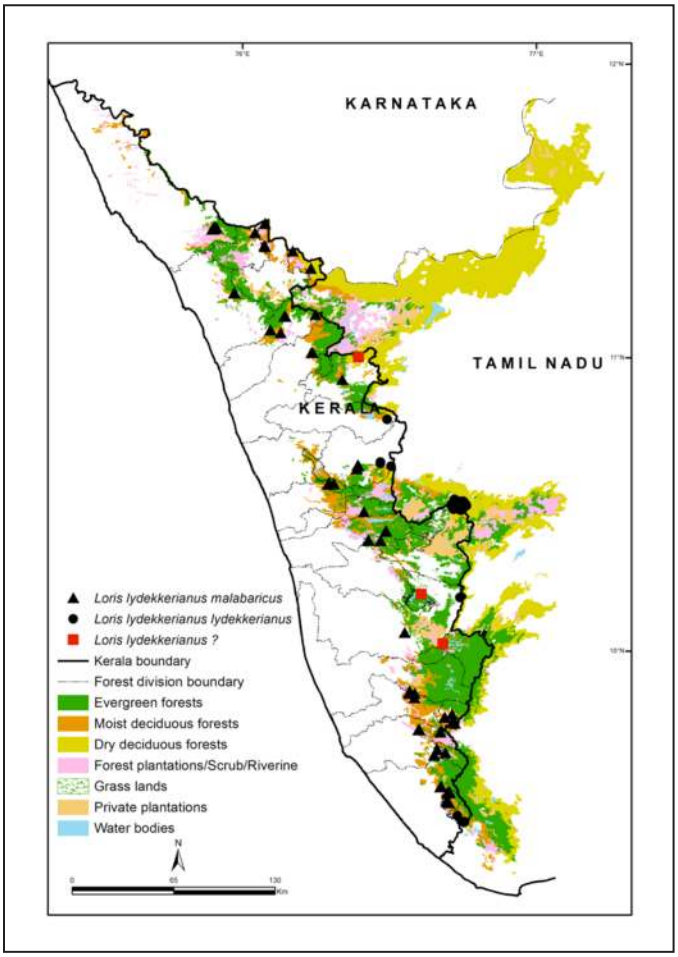

Figure 5. Sightings of different subspecies of slender loris in Kerala (from this study and Radhakrishna *et al*. 2011).

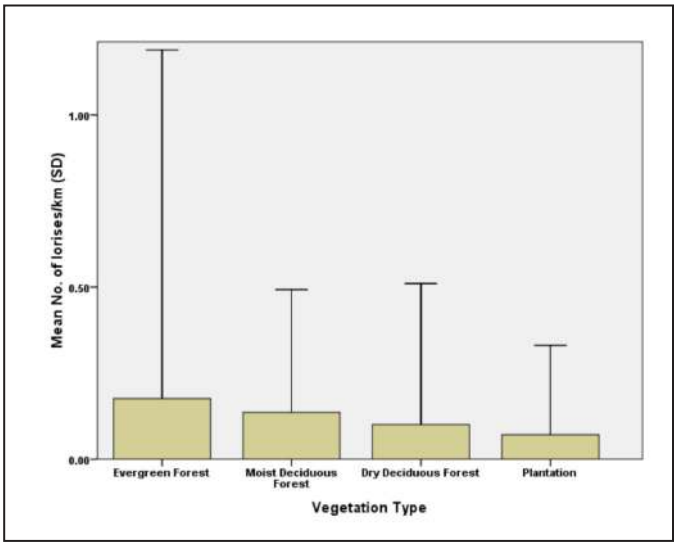

Figure 6. Mean number of lorises seen in different vegetation types in Kerala (from this study and Radhakrishna *et al.* 2011).

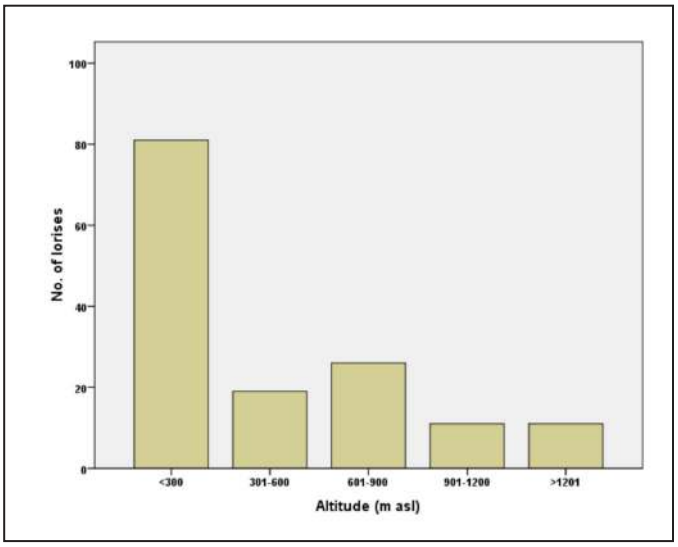

Figure 7. Number of lorises seen at different elevations in Kerala (from this study and Radhakrishna *et al.*2011).

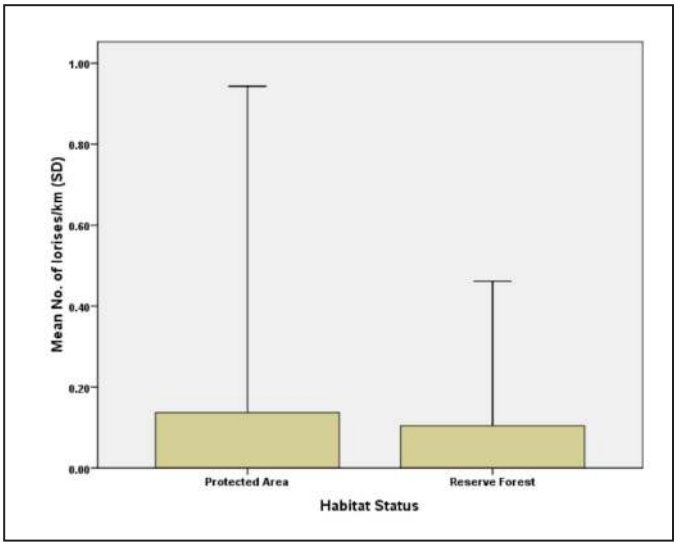

Figure 8. Mean numbers of lorises in areas with different protected status in Kerala (from this study and Radhakrishna *et al*. 2011).

of the two subspecies of slender loris in Kerala. The range of *L. l. malabaricus* is evidently confined to the western slopes of the Western Ghats. The Ariankavu pass and the Palghat gap have created a major barrier, resulting in separate populations for *L. l. malabaricus*. For this reason, the population of *L. l. malabaricus* in Kerala should be considered as three subpopulations: (1) lorises in the Neyyar Wildlife Sanctuary in the southern tip to the south of the Ariankavu pass; (2) lorises north of the Ariankavu pass up to south of the Palghat Gap; and (3) those north of the Palghat gap up to the Aralam Wildlife Sanctuary. The population of the Aralam Wildlife Sanctuary is contiguous with the population in Karnataka (Kumara *et al.* 2006).

In spite of considerable efforts, lorises were not seen in the large tracts of evergreen forest in the Parambikulam and Periyar tiger reserves. If there are lorises in these reserves, they would be contiguous through the low elevation forests of the region. Although some reports indicate that lorises occur in these forests (Easa and Balakrishnan 1990; Nameer 2000; Nameer *et al.*2007), there is no evidence based on confirmed sightings. If lorises are present they must be very scarce. Lorises in Kerala are very largely confined to forested areas and department-owned plantations. We presume that they have been eliminated elsewhere, or are at best persisting in very low numbers along the fringes of forests and privately owned plantations and cultivated areas.

The relative abundance of *L. l. malabaricus* in most of the forest divisions of Kerala is <0.2 lorises/km, except at the Aralam Wildlife Sanctuary, Konni, Thiruvanthapuram, Nemmara and Chimmoney. These areas, which had a higher abundance, had degraded evergreen forests with a well-developed shrub layer; probably an important factor that enhances the availability of foods such as insects (Kumara *et al.*2006). However, high abundance should not be adopted as a criterion for planning the conservation initiatives, since they are largely confined to the state's forested areas. The major goal for the protection of Kerala's lorises should be protection of their habitats throughout the state, wherever they occur.

In Kerala, *L. l. lydekkerianus* is confined to forests around the Palghat gap, the Chinnar Wildlife Sanctuary, Kumily Range and the Neyyar Wildlife Sanctuary. These areas have relatively dry forests as they are situated in rain shadow areas contiguous with the dry forests of the eastern slopes. The population in Chinnar Wildlife Sanctuary may be isolated from the nearest population of *L. l. malabaricus*. The population of *L. l. lydekkerianus* present south of Palghat and in the Neyyar Wildlife Sanctuary is, however, contiguous with the population of *L. l. malabaricus*. Further studies on these two populations might throw light on how the ranges of these two subspecies overlap or interdigitate, and their possible hybridization and interactions.

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Literature Cited

Easa, P. S. and M. Balakrishnan. 1990. Population ecology and management problems of large mammals in the Parambikulam Wildlife Sanctuary. In: *Conservation in Developing Countries: Problems and Prospects*, J. C. Daniel and J. S. Serrao (eds.), pp.162–174. Proceedings of the centenary seminar of the Bombay Natural History Society, Bombay, India.

Kumara, H. N., M. Singh and S. Kumar. 2006. Distribution, habitat correlates and conservation of *Loris lydekkerianus* in Karnataka, India. *Int. J. Primatol.* 27: 941–969.

Nameer, P. O. 2000. Birds of Peechi-Vazhani Wildlife Sanctuary: A Survey Report. Technical Report, Nature Education Society and Kerala Forest Department, Kerala, India.

Nameer, P. O., J. Praveen and K. V. Uthaman. 2007. Bird Diversity of Siruvani and Muthikulam Hills, Southern Western Ghats. Technical Report, Kerala Forest Department, Kerala, India.

Nekaris, K. A. I. and J. Jayewardene. 2003. Pilot study and conservation status of the slender loris (*Loris tardigradus* and *Loris lydekkerianus*) in Sri Lanka. *Primate Conserv.* (19): 83–90.

Radhakrishna, S., H. N. Kumara and R. Sasi. 2011. Distribution patterns of slender loris subspecies (*Loris lydekkerianus*) in Kerala, southern India. *Int. J. Primatol.* 32: 1007–1019.

Singh, M., D. G. Lindburg, A. Udhayan, M. A. Kumar and H. N. Kumara. 1999. Status survey of slender loris *Loris tardigradus lydekkerianus* in Dindigul, Tamil Nadu, India. *Oryx* 33: 31–37.

Singh, M., M. A. Kumar, H. N. Kumara and S. M. Mohnot. 2000. Distribution and conservation of slender lorises (*Loris tardigradus lydekkerianus*) in southern Andhra Pradesh, South India. *Int. J. Primatol.* 21: 721–730.

Sterling, E .J. and M. G. Ramaroson. 1996. Rapid assessment of the primate fauna of the eastern slopes of the Réserve Naturelle Intégrale d'Andringitra. *Fieldiana Zool., n. s.* 85: 293–303.

Walsh, P. D. and L. J. T. White. 1999. What it will take to monitor forest elephant populations. *Conserv. Biol.* 13: 1194–1202.

Authors' addresses:
Ramamoorthy Sasi, Department of Anthropology, University of Madras, Chepauk Campus, Chennai 600005, India, e-mail: <sasi2882@gmail.com>, and **Honnavalli Nagaraj Kumara**, Sálim Ali Centre for Ornithology and Natural History, Anaikatty (PO), Coimbatore 641108, India, e-mail: <honnavallik@gmail.com>.

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