POPULATION AND MICROHABITAT USAGE OF MALABAR SLENDER LORIS (*Loris lydekkerianus malabaricus*) IN HUMAN MODIFIED PLANTATIONS OF KOTTAYAM DISTRICT, KERALA, INDIA

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DISSERTATION

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POOKODE, WAYANAD, KERALA, INDIA

DECLARATION

I hereby declare that this dissertation titled **"Population and microhabitat usage of Malabar Slender Loris (*Loris lydekkerianus malabaricus*) in human modified plantations of Kottayam District, Kerala, India"** is a bonafide record of research work done by me during the course of my Masters research program and that the dissertation has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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TABLE OF CONTENTS

Chapter	TITLE	Page No.
1.	INTRODUCTION	1-2
2.	REVIEW OF LITERATURE	3-11
	2.1. CLASSIFICATION AND EVOLUTION OF PRIMATES IN THE WORLD	3-4
	2.2. PRIMATE ECOLOGY AND BEHAVIOR	4-5
	2.3. PRIMATE CONSERVATION	5-6
	2.4. NOCTURNAL PRIMATES BEHAVIOR	6-8
	2.5. LORIS TAXONOMY	8-9
	2.6. POPULATION ESTIMATION	9-11
3.	MATERIALS AND METHODS	12-17
	3.1. STUDY AREA	12-13
	3.2. STUDY METHOD	14-15
	3.3. SURVEY TECHNIQUES	15-16
	3.3. POPULATION DENSITY	16
	3.4. THE STUDY ANIMAL	17
	3.5. STATISTICAL ANALYSIS	17
4.	**RESULTS**	18-23

	4.1. ENCOUNTER RATE	18
	4.2. NUMBER OF SIGHTINGS ACROSS TIME PERIOD OF SAMPLING	19
	4.3. PERCENTAGE SIGHTINGS OF LORIS ACROSS DIFFERENT TIME	19
	4.4 POPULATION DENSITY	20
	4.5 SEX-RATIO	20
	4.6 RELATION BETWEEN TREE HEIGHT AND HEIGHT AT WITH LORIS SPOTTED	21
	4.7 RELATION BETWEEN GBH AND HEIGHT AT WITH LORIS SPOTTED	22
	4.8 PERCENTAGE SIGHTINGS ACROSS DIFFERENT GIRTH CLASSES	23
5.	**DISCUSSIONS**	24-27
	5.1. ENCOUNTER RATE	24-25
	5.2. POPULATION	25
	5.3. TIME OF SIGHTINGS	25-26
	5.4. RELATION BETWEEN TREE HEIGHT AND HEIGHT AT WHICH LORIS WAS SPOTTED	26
	5.5. RELATION BETWEEN GIRTH AT BREAST HEIGHT (GBH) AND HEIGHT AT WHICH LORIS WAS SPOTTED	26-27
6.	**SUMMARY**	28-29
7.	**REFERENCES**	30-36
8.	**ABSTRACT**	37

LIST OF TABLES

Table No.	TITLE	Page No.
1.	Sampling locations in different habitat	15-16
2.	Sightings of Malabar Slender Loris (*Loris lydekkerianus malabaricus*) in the plantations of Kottayam district (Total distance walked= 21.29 km)	19
3.	Regression equation to investigate the effect of height of tree on spot height of loris in Kottayam district	23
4.	Regression equation to investigate the effect of height of tree and height at which loris was spotted	24

LIST OF FIGURES

Table No.	Title	Page No.
1.	Number of sightings of loris across time period from 19:00 hrs to 24:00 hrs at Kottayam district, Kerala, during the study period	20
2.	Mean height at which Loris was spotted (m) on different plant species (n=34) in the study area	21
3.	Relation between the tree height (log) and height at which loris was spotted (m) in the study area	22
4.	Relation between the tree girth at breast height (GBH) and height at which loris was spotted	23
5.	Percentage of sightings of loris at different girth classes of tree in the study area	24

LIST OF PLATES

Table No.	Title	Page No.
1	Map of Kottayam district showing transect locations (mid-point of transect) used for loris survey	14
2	Map showing the location of loris sighted and buffer area around each sightings (1km buffer)	17
3	Malabar Slender Loris (*Loris lydekkerianus* m*alabaricus*) sightings from study area	29
4	Study areas	30
5	Habitat fragmentation and data collection	31

1. INTRODUCTION

Slender lorises are small nocturnal prosimians that are endemic to India and Sri Lanka (Roonwal and Mohnot, 1977). According to current taxonomic classification, *Loris lydekkerianus*, the Gray Slender Loris, inhabits southern India, and north-central Sri Lanka and *Loris tardigradus*, the Red Slender Loris, inhabits southwestern Sri Lanka (Groves, 2001; Brandon-Jones *et al*., 2004). Two subspecies of the slender loris are recognized in southern India: a dry-forest and Eastern Ghats mountain range form, the Mysore Slender Loris (*Loris lydekkerianus lydekkerianus*), and a wet-forest and the Western Ghats mountain range form, the Malabar Slender Loris (*Loris lydekkerianus malabaricus*) (Roonwal and Mohnot, 1977; Schulze and Meier, 1995; Groves, 2001).

Habitat loss, hunting and trapping for folk medicine have been identified as major survival threats to the Slender Loris in India, as is common with many lorisiform primates. Little is known about the distribution and ecology of the Slender Loris (Nekaris and Bearder, 2007). Although more recent population surveys have identified Slender Loris presence and abundance in the state of Karnataka and in some parts of Tamil Nadu, Andhra Pradesh and Kerala (Singh *et al*., 1999; Singh *et al*., 2000; Kumar *et al*., 2002; Kumar *et al*., 2006), the distribution of the species is still unknown for a large part of southern India.

Malabar Slender Loris (*Loris lydekkerianus* m*alabaricus*) occurs along the west coast and in the wet forests of the Western Ghats in Karnataka, Kerala and Tamil Nadu. Nekaris *et al*. (2008) did not survey these areas, but the species survives very well in the rubber (*Hevea brasiliensis)* plantations at Kottayam district. Hence, a study was conducted on this sub-species so as to establish baseline information on its population abundance, that would enable to formulate management or conservation plans for this elusive species outside protected areas.

Malabar Slender Loris (*Loris lydekkerianus* m*alabaricus*) is listed as a "Near Threatened" species and the population status and distribution are uncertain

for this sub-species as per the IUCN endangered species category (Nekaris *et al*., 2008). The species has not been reported from the south of Palghat Gap (Kumara *et al.*, 2006). Hence this study will help update the status and distribution in the IUCN category.

Although primary tropical forest habitats are now facing serious reduction or degradation, there has been a significant increase in the global extent of plantations, including those in or adjacent to protected areas (FAO, 2009). Though tropical plantations and modified forests can support a variety of taxa, sometimes in higher abundance and richness than in primary habitat (Barlow *et al*., 2007).

For arboreal species in particular, habitat modifications, such as those resulting from plantations, can have significant impacts (Laurance, 1990; Umapathy & Kumar, 2000). In addition, nocturnal and diurnal species in the same community may respond to habitat disturbance differently (Laurance *et al*., 2006), but studying nocturnal arboreal mammals presents an additional set of challenges owing to difficulties in estimating their abundance.

To understand how a nocturnal arboreal primate responds to habitat disturbance, we compared the abundance of the Malabar Slender Loris (*Loris lydekkerianus malabaricus)* in habitats representing a wide range of disturbance like non-forest plantations. And also assessed their use of the vegetation within different habitats.

2. REVIEW OF LITERATURE

2.1 CLASSIFICATION AND EVOLUTION OF PRIMATES IN THE WORD

Szalay and Catz (1973) identified Madagascan lemurs and lorisiform primates are closely related to one another and also reported the complexity on primate evolution.

According to Dene *et al.* (1976) lorisiformes is composed of three groups which diverge at a family level, ie. Galagidae, Lorisidae, and Perodicticidae.

Szalay *et al*. (1987) conducted the phylogenetic diagnosis of the order primates and its various supraspecific taxa, with definitional procedures. The authors suggested that the order, which they divided into the semiorders Paromomyiformes and Euprimates, is clearly diagnosable on the basis of well-corroborated information from fossil records.

Kappeler (1991) observed that prosimians as a group showed more variability in sexual size dimorphism. Among the prosimian infraorders, the lorisiforms were significantly more dimorphic than the lemuriforms.

Shoshani *et al.* (1996) did the comparative study of morphologic and molecular characters of primates. They confirmed that tarsiers are closely related to lemurs and lorises.

Schaik and Kappeler (1997) suggested that permanent male-female association in primates served to reduce the risk of infanticide by strange males whenever females and infants were closely associated. The changes in litter size and activity, in contrast, were not significantly associated with evolutionary changes in male-female association.

Muller and Thalmann (2000) says that nocturnal prosimians are mostly seen alone during their nightly activities and therefore termed solitary foragers, but that did not mean that they are not social. The authors established a classification

based on spatial relations and sociality in order to describe and cope properly with the social organisation patterns of the different species of nocturnal prosimians and other mammals that do not forage in cohesive groups.

Yoder *et al.* (2001) studied the lorisiform phylogeny, and they used the incongruence length difference (ILD) test to assess conflict among three independent data sets. They observed an inverse relationship between congruence and phylogenetic accuracy.

Kappeler and Schaik (2002) studied the evolutionary processes and mechanisms that gave rise to the diversity of primate social systems. They defined social organization, social structure and mating system as distinct components of a social system.

Masters *et al.* (2005) studied the evolution of this enigmatic group using molecular and morphological data for all four well established genera: Arctocebus, Loris, Nycticebus and Perodicticus.

Perry *et al*. (2007) used a molecular population genetics approach to test evolutionary hypotheses for the two intact opsin genes of the fully nocturnal Aye-Aye (*Daubentonia madagascariensis*), a highly unusual and endangered Madagascar primate.

2.2 PRIMATE ECOLOGY AND BEHAVIOR

Sellers (1996) observed that the members of the subfamily Lorisidae were never seen to leap. The author investigated the anatomical specializations that were behind the absence of leaping in their locomotion repertoire. A predictive mechanical model of leaping was developed using the lesser bush baby, *Galago moholi*, as a size-matched leaping prosimian comparison.

Nekaris (2001) studied predator defense and feeding ecology models and described the relatively slow climbing locomotion of the Lorisinae.

Nekaris and Rasmussen (2001) studied the feeding ecology of Mysore Slender Loris (*Loris lydekkerianus lydekkerianus*). The authors suggested that the consumption of insects inferred to be toxic was accompanied by an elaborate behavioral repertoire of sneezing, slobbering and urine-washing.

Sexual selection theory predicted that females selected high-quality males with whom to mate; therefore, females should mate preferentially with countermarking males. The role of countermarking in intra-male competition and female mate choice in the Pygmy Loris were examined (Fisher *et al.*, 2002).

Nekaris (2003) noted that *Loris lydekkerianus lydekkerianus* showed a promiscuous copulatory pattern, maintained social networks via frequent loud calls, interacted socially throughout the night with all age classes, and slept socially.

Kumara *et al.* (2004) observed that foraging technique in Slender Loris was different from what was known before.

Nekaris *et al.* (2005) suggested that the most common tree species used by lorises was *Humboldtia laurifolia*. Twenty-seven families belonging to 40 species were recorded, of which 45 percent were endemic, 40 percent native, and 7.5 percent introduced. *Humboldtia laurifolia* had a mutualistic relationship with ants, thereby providing abundant food for lorises.

Boyle *et al.* (2009) examined the accuracy of minimum convex polygon (MCP), adaptive kernel (AK) and fixed kernel (FK) estimators by comparing home range estimates of Northern Bearded Saki Monkeys (*Chiropotes satanas chiropotes*) living in forest fragments and continuous forest in the Brazilian Amazon area.

Roy *et al.* (2010) investigated the vegetation pattern and tree species occupancy of one of the prime primate habitats in the central Western Ghats.

2.3 PRIMATE CONSERVATION

Herrera *et al.* (2004) suggested that fragile sites were considered structural features of mammalian chromosomes and a commonly repeated hypothesis was that they were evolutionarily conserved. The authors tested this hypothesis by establishing the subchromosomal homology of regions harbouring fragile sites in the chromosomes of humans, *Macaca fascicularis* and *Mandrillus sphinx*.

Streicher (2005) suggested the Pygmy Loris was a highly adapted animal, which had developed numerous strategies to survive in a seasonally hostile environment.

Pliosungnoen *et al.* (2010) compared the density and microhabitat selection of a nocturnal arboreal primate, the *Nycticebus bengalensis* in mostly undisturbed, evergreen tropical forests to those in 15–18 years old Acacia/Leucaena plantations with significant secondary regrowth, and <15 years old plantations with little regrowth. Based on estimates derived from distance sampling, loris densities in older plantations were nearly identical to primary forest (4.26 vs. 4.00 lorises per square kilometer), although encounter rates were three times higher in the older plantations probably owing to the lower detection probability in the more complex vegetation of the primary forest.

Fam *et al.* (2014) suggested that the Greater Slow Loris *Nycticebus coucang* had proven to be an elusive animal in Singapore, evading even the prolific British colonial animal collectors. In recent decades, sightings of the Slow Loris have increased remarkably, and these have coincided with an increase in nocturnal surveys. Past trade-record discrepancies, as well as the sighting in the wild of a non-native Slow Loris species, point to the importance of Singapore for global Slow Loris conservation. The first ever ecological survey was documented in this paper, highlighting the difficulty of studying the Slow Loris in the wild, in habitats hemmed in by urban development, as well as the urgency of further work on Singapore’s most poorly studied primate.

2.4 NOCTURNAL PRIMATE BEHAVIOR

Rasmussen and Izars (1988) observed that a broad range of variation in body size, brain size and metabolic rate occurred within the primate family Lorisidae, thus providing an opportunity to examine the relationship of these three parameters to variation in growth and life history traits.

Erkert (1989) suggested from the results of chronobiological studies in *Aotus lemurinus (trivirgatus) griseimembra, Galago garnettii, Galago senegalensis,* and *Microcebus murinus,* that inferences could be made on the most suitable lighting conditions for nocturnal primates kept in captivity.

Brothers (1990) studied the brain activity in monkeys looking at pictures of faces, facial expressions, and body movements, which revealed regions of apparent specialized responsiveness to visual social stimuli.

Goodman *et al.* (1993) observed that it was rare for predators to take primates and that most cases involved relatively large diurnal primates.

Sterling and Richard (1995) noted that nocturnal species had typically received cursory attention in comparative analyses of primate social organization, and that it had been assumed that their social organization was both less complex and more homogeneous than that of diurnal forms.

Barton *et al.* (1995) observed that the neocortex was larger in diurnal than in nocturnal primates, and among diurnal haplorhines its size was positively correlated with the degree of frugivory. These ecological correlates reflected the diverse sensory-cognitive functions of the neocortex.

Bearder (1999) observed that the nocturnal and diurnal species differed markedly in terms of their sensory and perceptual abilities, but they shared a high brain relative size in association with long periods of gestation, development of the young, and life span.

Thalmann (2001) did a comparative field study on the feeding behavior of the gregarious *Avahi occidentalis* and the solitary-but-social *Lepilemur edwardsi* to evaluate hypotheses relating to their social organization and food resources.

Wiens (2002) studied the social organization, infant care system, and diet of the Slow Loris *Nycticebus coucang*, a nocturnal arboreal prosimian primate, in the Malaysian rainforest.

Bearder *et al.* (2003) developed a check list and summary of what was known of the variation in infant contact, sleeping site preference and aspects of social cohesion in the nocturnal primates of Africa.

Nekaris (2003) studied the life history parameters of Slender Lorises in captivity and observed conflicting results regarding gestation length, birth seasonality, interspecies variation in litter size and the degree of parental care given to offspring.

Nekaris (2005) examined the feeding behavior of *L. lydekkerianus lydekkerianus* in relation to hypotheses regarding visual predation of insects. The authors observed that the type of prey caught on terminal branches (Lepidoptera, Odonata, Homoptera) differed significantly from those caught on middle branches (Hymenoptera, Coleoptera).

Bearder *et al.* (2006) examinesd the importance of vision in the lives of nocturnal primates in comparison to diurnal and cathemeral species.

Nekaris (2006) suggested that the persistent use of the word ‘‘solitary’’ to describe nocturnal primate social behavior was inappropriate as increasing studies were revealing sophisticated levels of social interactions among nocturnal primates.

Swapna *et al*. (2009) estimated the extent of exudativory behavior in *Nycticebus bengalensis* and examined whether exudates could be considered as fallback foods.

Nekaris (2014) wondered why lorises had such huge forward-facing eyes, strange steady climbing locomotion, tiny dependent babies, and a bite that potentially could kill a human.

2.5 LORIS TAXONOMY

Braune *et al.* (1995*)* studied the structure and perception of male advertisement calls of three nocturnal, dispersed living mouse lemur species, the Grey Mouse Lemur (*Microcebus murinus*), the Golden-brown Mouse Lemur (*M. ravelobensis*) and the Goodman's Mouse Lemur (*M. lehilahytsara*).

Andriaholinirina *et al*. (2006) studied the number of species within the Malagasy genus *Lepilemur* and their phylogenetic relationships was noted to be disputed and controversial. In order to establish their evolutionary relationships, a comparative cytogenetic and molecular study was performed.

Nekaris and Jaffe (2007) suggested that since the 1950s, Sundaland was thought to be inhabited by a single slow loris species, the Greater Slow Loris (*Nycticebus coucang*). Early taxonomical as well as recent morphological and genetic studies, however, point to at least three species native to this region: *N. coucang*, *N. menagensis* and *N. javanicus*.

Nekaris *et al.* (2010) reviewed feeding ecology of Asian lorises and African pottos, with emphasis on the importance of exudate feeding.

Cheng *et al.* (2011) proposed a novel methodology for re-identification, based on pictorial structures.

Munds *et al.* (2013) explored facemask variation in the Bornean Loris (*N. menagensis*). Differing facemask patterns was particularly influenced by the

amount of white on the face, in animals significantly clustered together by geographic regions, separated by notable geographic boundaries.

2.6 POPULATION ESTIMATION

Purvis (1995) presents an estimate of the phylogeny of all 203 species of primates.

Sterling and Ramaroson (1996) noted that the accurate assessment of the remaining species' geographical distribution, population sizes and population dynamics directly influenced conservation management decisions such as location and size of potential reserves as well as management of existing reserves.

Peres (1999) prescribe a set of practical guidelines and recommendations for conducting line-transect surveys of tropical forest primates.

Nekaris and Jayewardene (2004) suggested significantly fewer sightings occurred within protected areas than were made outside them. Animal densities varied across habitat type with the highest density of lorises occurring in the dry zone in monsoon forests. Presence of *Loris* was positively associated with insect presence, and negatively associated with primary forest with little undergrowth. Taxa differed in their ability to thrive on the edge of human habitations.

Blackham (2005) suggested that no significant difference was found between the transects in the average diameter at breast height of trees per plot, total number of trees per plot or number of trees of diameter at breast height of between 1 cm and 4 cm. This diameter at breast height of between 1 cm and 4 cm was thought to be the preferred size of support for tarsier locomotion.

Ciani *et al.* (2005) conducted an eight-year-long census and habitat evaluation of the *Macaca sylvanus* population in a 484-km2 area of the central region of the Middle Atlas Mountains in Morocco.

Kumara *et al.* (2006) estimated relative abundance of Slender Lorises via direct sightings. Two subspecies, *Loris lydekkerianus lydekkerianus* and *L. l. malabaricus*, with different morphological traits, occured in the eastern drier region and the western wet region of the state, respectively.

Radhakrishna *et al*. (2006) assessed the distribution and conservation status of Bengal Slow Lorises (*Nycticebus bengalensis*) in Assam and Meghalaya in northeastern India. They surveyed forest reserves, plantations, tea estates, and areas bordering forests in 10 districts of the 2 states and sighted Slow Lorises in only 4 districts in Assam. Disturbances caused by tree felling, road kills by speeding vehicles, trapping and hunting were identified as the chief survival threats to the species.

Nekaris *et al.,* (2008) recommended taking into account the species' heterogeneous distribution, their social structure, the use of red lights as opposed to white lights whilst surveying, and to make use of their vocalisations when surveying Slow Lorises.

Gamage *et al.* (2009) studied the habitat selection criteria, population density and the habitat availability of *L. t. tardigradus* in Kottawa Arboretum.

Thorn *et al.* (2009) applied ENM to carry out an anthropogenic risk assessment and set conservation priorities for three threatened species of Asian Slow Loris

Pliosungnoen *et al*. (2010) observed that planted forests had greatly increased in the tropics, but their conservation value while assumed to be low, was largely unknown. Authors compared the density and microhabitat selection of a nocturnal arboreal primate, the Bengal Slow Loris (*Nycticebus bengalensis*), in mostly undisturbed, evergreen tropical forests.

Starr *et al.* (2010) studied local knowledge on the distribution, ecology of, and threats to the species by interviewing hunters, traders and wildlife protection

staff, and to verify this information using a spotlighting survey in three major reserves in Mondulkiri Province, Cambodia.

Munds *et al.* (2013) suggested that tarsiers were impacted by the presence of Slow Lorises in their habits, and these populations should be monitored, especially as habitat sizes dwindled and resources continued to become scarce.

Nekaris and Stengel (2013) present population data in relation to ecology from eight sites, and related these data to an ecological niche model using MAXENT in order to predict what type of habitat was suitable for the Red Slender Loris.

3. MATERIALS AND METHODS

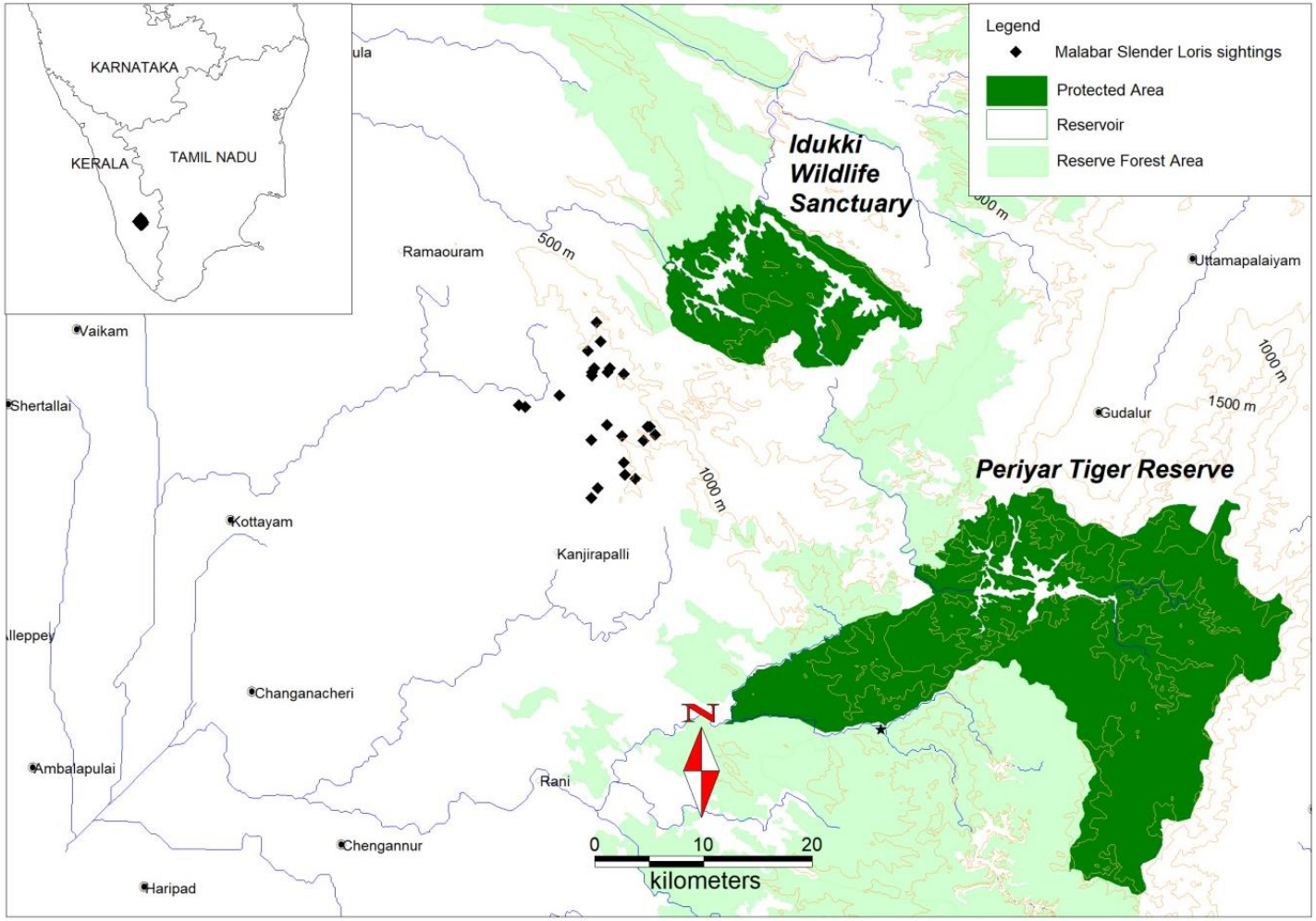
3.1 STUDY AREA

The study was carried out in Rubber Plantations of Meenachil Taluk, Kottayam District of Kerala. Kottayam District is situated in central part of Kerala State of India. The district is bordered by Ernakulam in the north, Idukki in the east, Alapuzha in west and Pathanamthita district in South. Kottayam District lies between North Latitude 9°20′ and 9°52′ and East Longitude 76°21′ and 77°0′. Geographic area of the district is 2203 km^2 with forest cover of 4.58% of total area (Annon, 2010). Rubber plantation is the predominant vegetation in the district with 1151 km^2 (52%) of area under plantation (Annon, 2014).

Malabar Slender Loris (*Loris lydekkerianus* m*alabaricus*) is abundant in the Rubber plantations of Meenachil Taluk, especially in Poonjar area (Fig.1). Poonjar is further divided into Poonjar Thekkekara, Poonjar Vadakkekkara and Poonjar Nadubhagam villages. Two main tributaries of Meenachil River originate in Poonjar hills and join at Erattupetta. There are number of waterfalls and rivulets that traverse through the hills. Kunnonny, Adivaram, Pathampuzha, Kaippally are some of the nearest villages. The total geographical area of village is 5562 hectares. Poonjar Thekkekara has a total population of 19,470 people. There are about 4,642 houses in Poonjar Thekkekara village. Agricultural plantations and livestock's are the main source of income for the local people. Local villagers cultivate plantation crops like Rubber (*Hevea brasiliensis*), Coffee (*Coffea sp.*, Banana (*Musa sp.*) and Coconut (*Cocos nucifera*). This study strictly focused in Rubber, Teak (*Tectona grandis*) and Coffee plantations, where the leaf or branch connectivity was available for the free movement of lorises.

The spacing recommended for rubber plant is 4.9/m x 4.9/m (420 plants/ha) in square planting or 6.7/m x 3.4/m (445 plants/ha) in rectangular planting. Coffee is planted in rows 2 m apart with plants 1.5 m apart within the row. So, leaf connectivity or branch connectivity is easily available for movement of lorises.

PLATE-1: Map of Kottayam District showing transect locations (mid-point of transect) used for loris survey.



3.2 METHOD

The abundance of lorises was estimated using line transect method (Sutherland, 2002). A total of 22 transects of varying length of 500 m to two kilometer was laid in five different types of habitat based on nature of plantations such as, Coffee plantations, Rubber Plantations, Mixed plantations, Rubber & Coffee plantations and Rubber & Teak plantations.

Table 1: Sampling locations in different habitat

S. No	Place	Habitat	Start Point		End Point	
			Latitude	Longitude	Latitude	Longitude
1	Adivaram	Rubber Plantation	9.66575	76.87348	9.66738	76.88042
2	Adivaram- Kodunga road	Rubber Plantation	9.65868	76.87775	9.65367	76.88082
3	Chennad Malika	Rubber Plantation	9.61422	76.82962	9.61172	76.82642
4	Kaippally	Rubber Plantation	9.65797	76.85025	9.65463	76.85785
5	Kaippally (1)	Rubber & Teak Plantation	9.65388	76.86817	9.65953	76.8649
6	Kaippally (Edamala)	Rubber Plantation	9.66733	76.83752	9.66282	76.84457
7	Kondoor	Rubber Plantation	9.68362	76.76353	9.68573	76.76472
8	Kunnonny	Mixed Plantation	9.62213	76.8612	9.6197	76.85718
9	Kunnonny (road)	Rubber Plantation	9.63547	76.85173	9.63782	76.85195
10	Mukkuzhi	Rubber Plantation	9.65457	76.82412	9.64932	76.828
11	Nadakkal	Rubber Plantation	9.69175	76.79778	9.69412	76.79902
12	Ottayitti (Vagamon rd.)	Coffee Plantation	9.71007	76.85127	9.71	76.85695
13	Pathampuzha	Rubber Plantation	9.62537	76.85258	9.62625	76.8536

14	Poonjar- Adivaram rd.	Rubber Plantation	9.66582	76.8717	9.6691	76.86932
15	Teekoy (Adukkam rd.)	Rubber Plantation	9.73708	76.83232	9.73492	76.82458
16	Teekoy (estate)	Mixed Plantation	9.71157	76.82492	9.70867	76.82473
17	Teekoy (illikkalkallu)	Rubber & Teak Plantation	9.75313	76.8286	9.75938	76.82323
18	Teekoy (illikkalkallu1)	Rubber & Teak Plantation	9.71492	76.82653	9.72717	76.83235
19	Teekoy (Mangalagiri-1)	Rubber Plantation	9.71503	76.83985	9.71125	76.83818
20	Teekoy (Thalanad)	Rubber Plantation	9.72933	76.82162	9.73527	76.82092
21	Valyachanmala rd	Rubber Plantation	9.68208	76.76875	9.67848	76.77188
22	Vengathanam	Rubber Plantation	9.6058	76.82418	9.6043	76.8273

3.3 SURVEY TECHNIQUES

Field survey was carried out over two sessions from May 2017 to July 2017. The index used for estimating relative abundance was animal encounter rate, or 'sightings' per km (Anonymous, 1981; Sutherland, 2002). Other researchers have successfully used this method for other species of prosimians (Ganzhorn, 1995), and for Slender Loris surveys in India (Rao, 1994; Nekaris, 1997; Lindburg *et al*., 1999; Kumar *et al*., 2000). The method has also been increasingly used for surveys of mammals when a wide area was covered over a short time (White and Edwards, 2000). A transect was walked each night which was randomly selected to avoid bias (White and Edwards, 2000). The distinct loud call of the loris was not counted. Only direct sightings were counted as individuals. All transects were walked twice at a speed of 400 m/h by a group of two people to minimise disturbance to the animals (Charles-Dominique and Bearder, 1979).

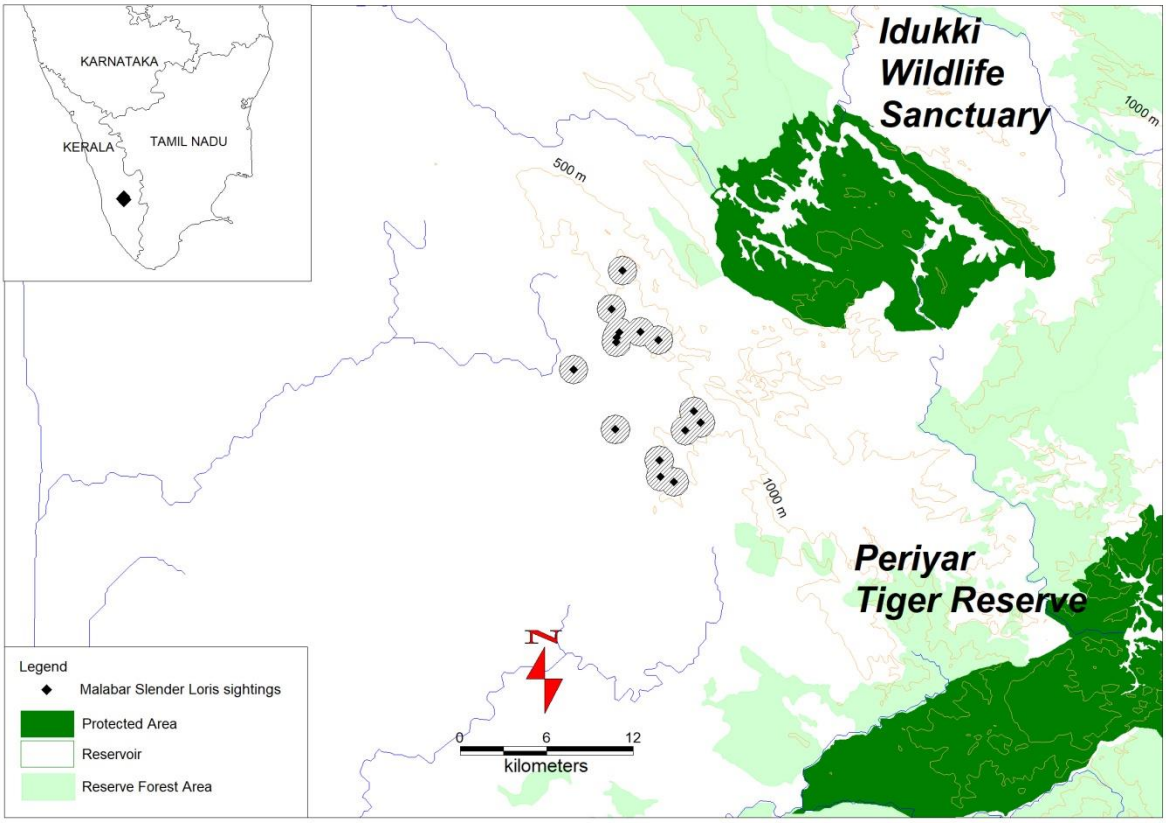
All the surveys were conducted on foot every night from 19:00 hrs to 24:00 hrs. All levels of vegetation were scanned using Petzl 4.5 V headlamps with a combination of red and white torches (Nekaris, 2003). The animals were first spotted by their red tapetal reflection to light. On sighting a Slender Loris, data such as time, location, number of individuals, clear photographs to determine sex, latitude-longitude with GPS (Garmin GPS 72H), tree height, loris spot height, and name of tree species were recorded. Further, the tree was marked with a ribbon for further data collection at day time.

Data relevant to the survey included transect length, distance travelled along transect, animal spotted height, vegetation type, animal spotted time, identification of the tree, GBH of the tree, age class of the animal and vegetation height. Local villagers and plantation workers were interviewed, regarding loris sightings and their awareness about lorises in the area. Number of sightings per kilometer was calculated, by dividing number of sightings divided by distance walked.

3.4 POPULATION DENSITY

Estimated home range of Slender Loris varies from 1 ha. to 3.6 ha. in the southern Western Ghats (Nekarias, 2002). Based on this ranging behavior buffer area of each sighting was used to estimate population size. Minimum population size was estimated using buffer area of 1000 m around each loris sighting location (Plate 2) that resulted in the sampling area of 35.4 km^2.

PLATE-2: Map showing the location of sighting of loris and buffer area around each sighting (1 km buffer)



3.5 STUDY ANIMAL

The Slender Loris, *Loris lydekkerianus* is one of the two nocturnal primates found in India. Two subspecies which are recognized so far are the Mysore Slender Loris, (*Loris lydekkerianus lydekkerianus*) and the Malabar Slender Loris, (*Loris lydekkerianus malabaricus*) inhabiting the dry and wet forests of the Eastern and Western Ghats, respectively. The general body color is reddish in *L.l. malabaricus* and gray in *L. l. lydekkerianus*. The circumocular patch is very narrow in *L. l. lydekkerianus* and broad in *L. l. malabaricus*. The white rim between the darker preauricular hair and circumocular patch is broad in *L. l. lydekkerianus* and narrow in *L. l. malabaricus* (Kumar and Singh, 2006). The body weight of both male and female adult *L.l. malabaricus* is 180 g (Kumar and Singh 2006). *L.l. malabaricus* is listed as “Near Threatened species” in the IUCN red list.

4. RESULTS

Population and microhabitat use of Malabar Slender Loris (*Loris lydekkerianus malabaricus*) in the human modified landscape (rubber plantations) at Kottayam District of Kerala were studied from May 2017 to July 2017. A total 34 sightings were recorded in 14 transects out of 22 transects that were surveyed. The length of transect varied from 400 m to 2000 m depending on terrain and accessibility (Table-1).

4.1 ENCOUNTER RATE

Table-2: Sightings of Malabar Slender Loris (*Loris lydekkerianus malabaricus*) in the plantations of Kottayam District (Total distance walked = 21.29 km) from May 2017 to July 2017

S. No.	Place	Individuals/ (km± SE)
1	Adivaram	0.40
2	Adivaram- Kodunga rd.	0.50
3	Chennad Malika	-
4	Kaippally	-
5	Kaippally (1)	1.72
6	Kaippally (Edamala)	-
7	Kondoor	-
8	Kunnonny	1.98
9	Kunnonny (road)	1.01
10	Mukkuzhi	0.35
11	Nadakkal	1.35
12	Ottayitti (Vagamon rd.)	1.37
13	Pathampuzha	3.85
14	Poonjar- Adivaram rd.	-
15	Teekoy (Adukkam rd.)	-
16	Teekoy (estate)	3.89
17	Teekoy (illikkalkallu)	0.65
18	Teekoy (illikkalkallu1)	0.25
19	Teekoy (Mangalagiri-1)	0.77
20	Teekoy (Thalanad)	1.74
21	Valyachanmala rd	-
22	Vengathanam	-
	Total	**1.55±0.422**

There were 14 transects in which lorises were spotted and resulted in higher sighting probability (0.63). A total distance of 21.29 km was surveyed to estimate abundance of loris from May 2017 to July 2017. The mean number of lorises sighted per kilometer walked (encounter rate/km) were 1.55±0.42. Though loris abundance did not vary significantly across different transect lines ($t=0.009$; $df=12$; $p>0.05$), lower encounter rate was recorded in Illikkalkallu (0.25/km) and higher encounter rate in Pathampuzha and Teekoy Estate (3.8/km). Out of 22 transects surveyed, lorises were not spotted in eight (Table 2).

4.2 NUMBER OF SIGHTINGS ACROSS TIME PERIOD OF SAMPLING

All the surveys were conducted on foot every night from 19:00 hrs to 24:00 hrs. Loris were sighted more at dusk (between 19:30 hrs and 22:00 hrs) and the number of sightings declined afterwards (Fig. 2). Number of sightings was low at 19:00 and increased to a maximum at 20:00 to 20:30 hrs (32.4%) which again declined gradually to 20.6 %, 8.8 % and 8.8 % at 20:30, 21:00 and 21:30 hours, respectively. The numbers of sightings were low after 22:30 hours. We did not have samples after 24:00 hrs.

4.3 PERCENTAGE SIGHTINGS OF LORIS ACROSS DIFFERENT TIME

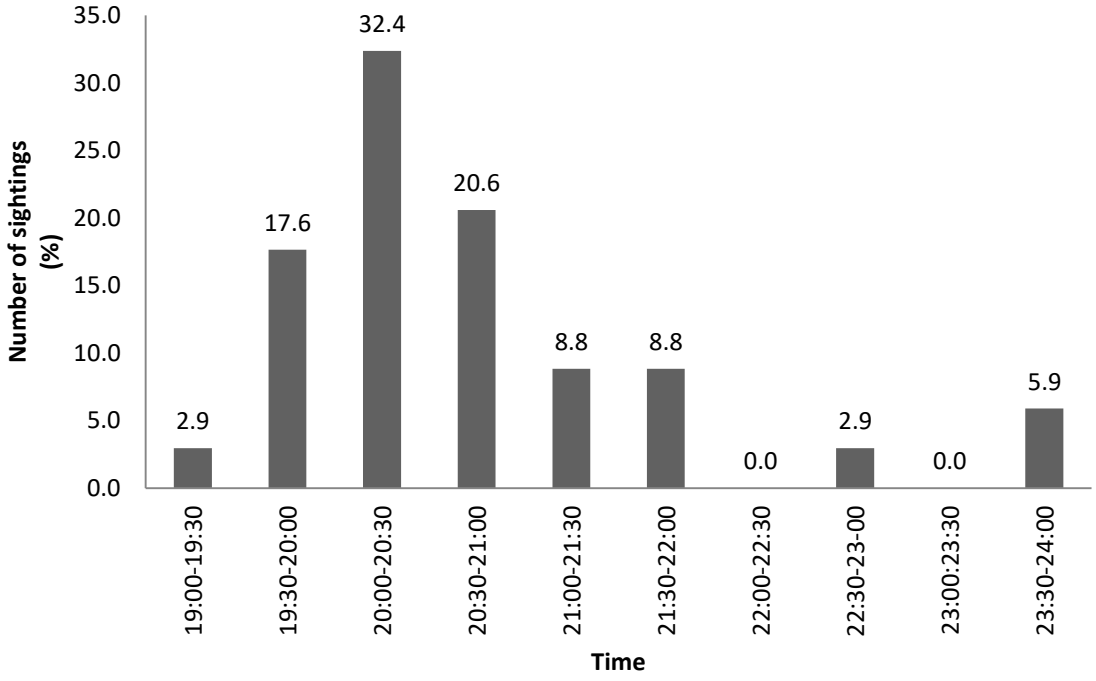


Fig.1: Number of sighting of loris across time period from 19:00 hrs to 24:00 hrs at Kottayam District, Kerala during the study period (from May 2017 to July 2017)

4.4 POPULATION DENSITY

Total sampling area was estimated using buffer of 1000 m around each loris sighting location. Minimum population density was estimated using this buffer area. Estimated population density of loris in the study area was 0.97/km^2.

4.5 SEX-RATIO

The sex of the animals was determined based on sighting of external genitalia. Of the total 34 individual sightings, 82.4% of animals could be sexed.

Sex were not determined in six animals. Based on completely classified animals, the sex ratio was 1:1 ratio.

Lorises were sighted in five tree species namely, *Coffea* sp., *Hevea brasiliensis, Macranga pelteta, Terminalia paniculata* and *Vepris bilocularis*. The height at which lorises were spotted was highest in both Rubber tree (*Havea brasiliensis*) and *Terminalia paniculata* with mean height of 8.35±0.49 m and 8.22 m, respectively (Fig.3). Height at which lorises were spotted varied significantly in different plant species and ranged from 3 m to 12 m ($F=4.95$; $df=33$; $p<0.05$). Mean height of spotting was low in the *Coffea* sp. and *Vepris bilocularis* with mean value of (4~4.5 m). Majority of sightings (67.6%) were in *H. brasiliensis,* followed by *Coffea* sp. and *Macranga pelteta*.

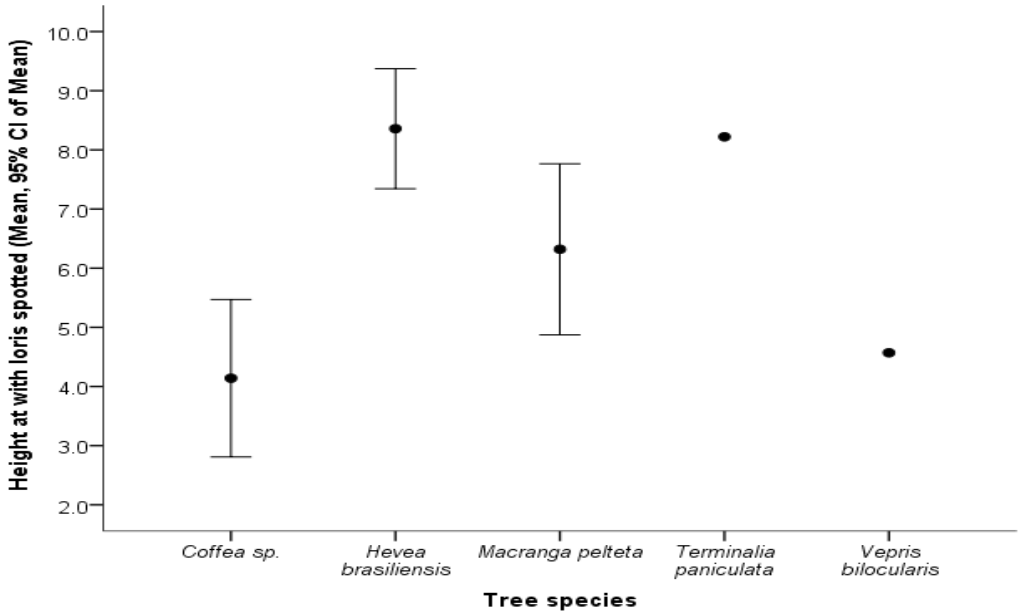


Fig. 2: Mean height at which Loris spotted (m) in different plant species (n=34) in the study area

4.6 RELATION BETWEEN TREE HEIGHT AND HEIGHT AT WITH LORIS WAS SPOTTED

The height at which lorises spotted in relation to tree height were analysed using linear regression model. Tree height was linearly related to the spotting

height (R^2=0.58; Fig. 4). The model was highly significant and explained 58 % of variability. The strength of the relation of inferred from the standardized partial regression co-efficient value of 0.73 (Table-2). Hence, with increase of height the height at which lorises were spotted increased linearly. Lorises preferred to forage on smaller branches searching insects that were being attracted to tender leaves of rubber tree.

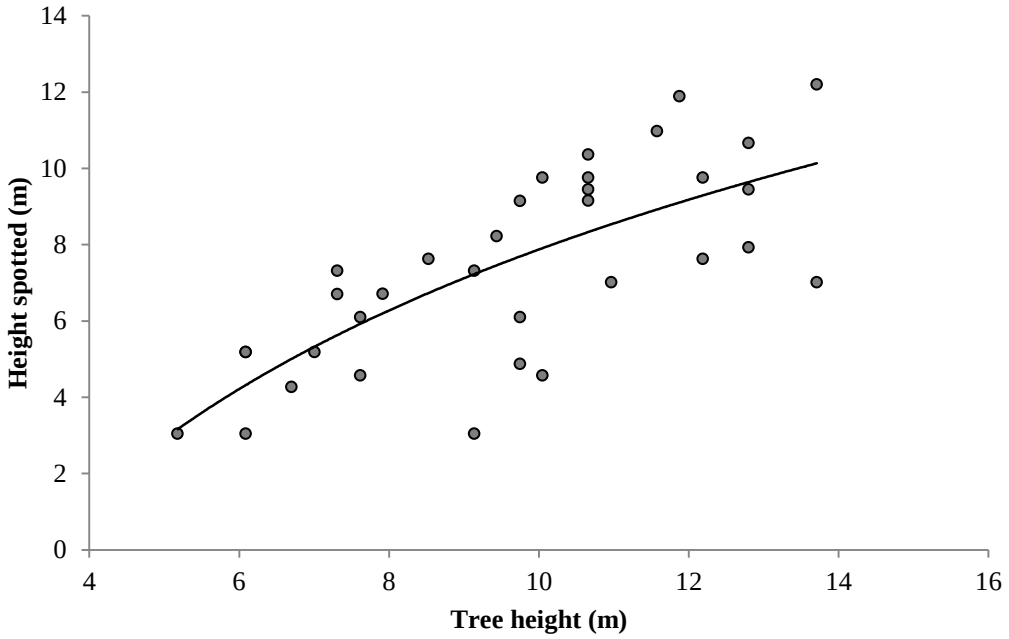


Fig. 3. Relation between the tree height (log) and height at which lorises were spotted (m) in the study area

Table-3: Regression equation to investigate the effect of tree height on loris spotted height in Kottayam District.

Independent Variable	Predictor	Un-standardized Coefficients		SPRC*	t	Sig.	model (r^2)	P
		B	Std. Error	Beta				
Height spotted (m)	(Constant)	-8.612	2.622		-3.284	0.002	58%	F=21.88; df=33; p<0.001
	Tree height (m) Log	7.160	1.166	0.735	6.140	0.000		

*-Standardized Partial Regression Co-efficient

4.7 RELATION BETWEEN GBH AND HEIGHT AT WHICH LORIS SPOTTED

The relation between the tree girth at breast height (GBH) and height at which lorises were spotted showed positive linear relation (Fig. 4). The model was highly significant and explained 59% of variability. Further standardized partial regression co-efficient value (0.60) indicating positive relation between girth at breast height and height at which lorises were spotted (Table-3). Though there was linear relationship, greater numbers of sightings fell in girth at breast height class between 40 and 60 cm.

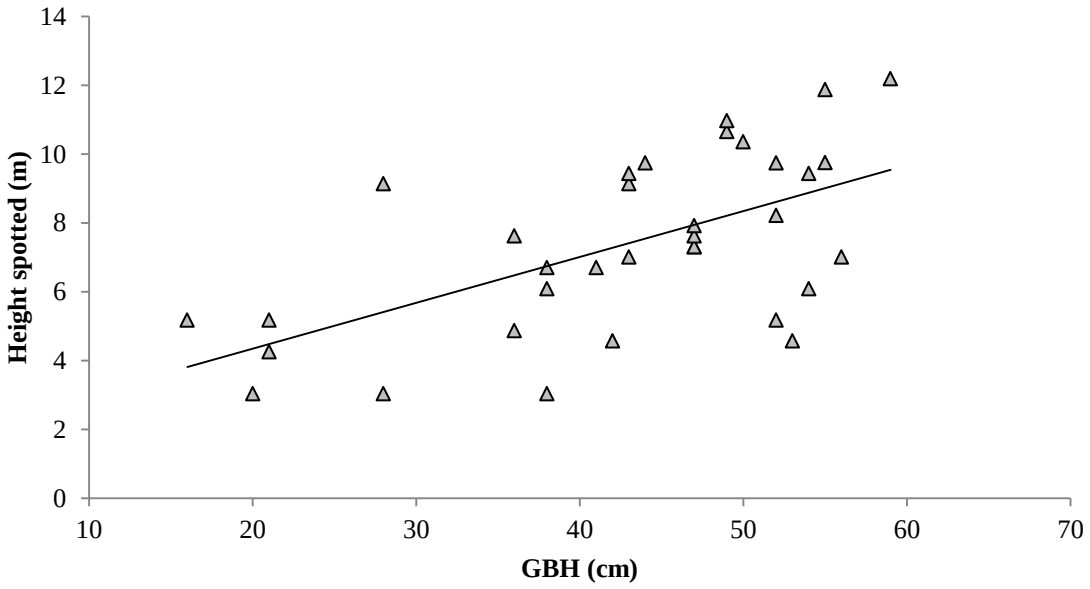


Figure-4: Relation between the tree girth at breast height (GBH) and height at which lorises were spotted

Table-4: Regression equation to investigate the effect of height of tree and height at which lorises were spotted

Model	Independent Variable	Un-standardized Coefficients		SPRC*	t	Sig.	model (r^2)	P
		B	Std. Error	Beta				
Height spotted (m)	(Constant)	1.686	1.400		1.204	0.237	0.597	F=17.71; df=33; p<0.00
	Girth at Breast Height (cm)	0.133	0.032	0.597	4.209	0.000		

*- Standardizes Partial Regression Co-efficient

4.8 PERCENTAGE SIGHTINGS ACROSS DIFFERENT GIRTH CLASSES

Apart from the tree species, influences of girth class on number of sightings are plotted in Fig. 5. Lorises showed highest preference (82%) for the girth class of 45 to 65 cm. Other size class of trees were less preferred with percent number of sightings less than 9%. Majority of sightings were on rubber trees, with preference of larger size classes indicating their preference for larger size class trees.

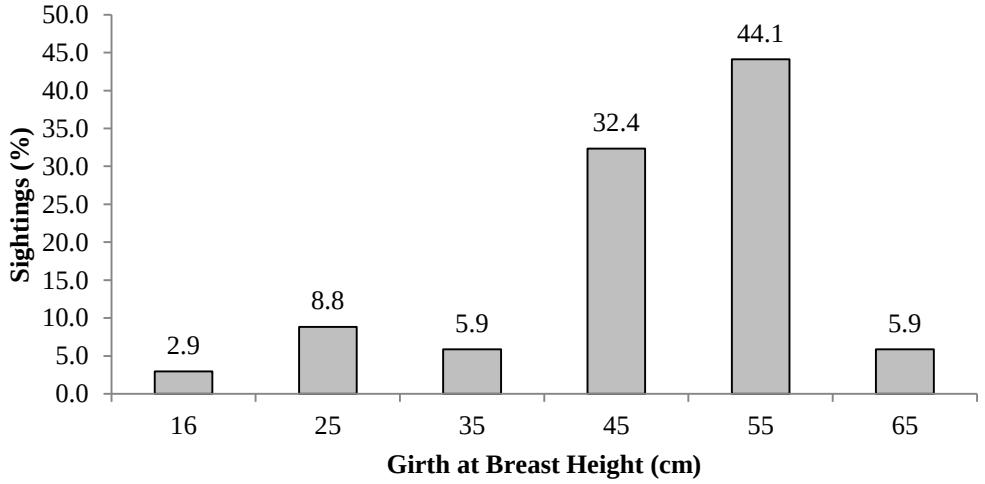
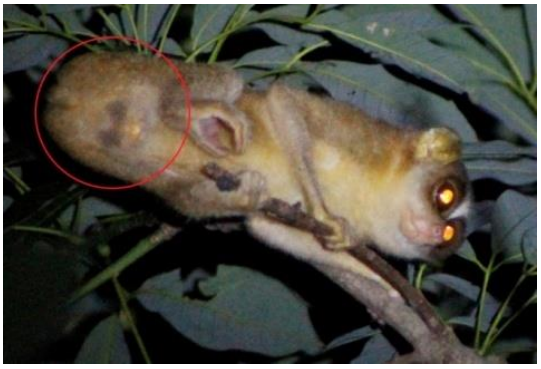


Fig. 5. Percentage of sightings of lorises at different girth classes of trees in the study area

PLATE 3 - Malabar Slender Loris (*Loris lydekkerianus* m*alabaricus*) sightings from study area

Malabar Slender Loris (*Loris lydekkerianus* m*alabaricus*)



Loris lydekkerianus m*alabaricus* (Male)

Loris lydekkerianus m*alabaricus* (Female)

Rubber plantation

Mixed Plantation

PLATE:4- Study areas

Teak Plantation

Rubber Plantation

Coffee Plantation

Mixed

Rubber and Teak

Rubber and Coffee

PLATE 4 - Habitat fragmentation and data collection

Day-time data collection

Settlements in the periphery of the plantation

Rubber tree felling- a threat to lorises

Re-plantation of rubber tree

5. DISCUSSION

Slender Lorises are nocturnal primates occurring in India and Srilanka (Groves, 2001). Among two sub-species of Grey Slender Loris, *Loris lydekkerianus malabaricus* was studied at rubber plantations of Kottayam District of Kerala. This was the first study of lorises outside the forest area in Kerala and it is reported higher density from Kottayam district. Either earlier studies failed to observe plantations or studies have not been carried out outside forest areas especially in rubber plantations or surveys were carried out in vehicle where a chance for detection is very less (Kumara *et al*., 2004; Radhakrishnan and Kumara, 2011).

5.1 ENCOUNTER RATE

Overall encounter rate of loris was 1.55±0.42 with highest number of encounters in Pathampuzha and Teekoy Estates (3.9/km). The mean encounter rate during the study was higher than the encounter rate reported from forest areas of Kerala (Radhakrishnan and Kumara, 2011). The highest recorded encounter rate of loris was from Aralam Wildlife Sanctuary (1.44/km) (Radhakrishnan and Kumara, 2011). In adjacent area of Karnataka, encounter rate of loris was 0.2/km in the forest areas and 0.47/km in Cardamom plantations (Kumara *et al*., 2004). But these values are not directly comparable since surveys were carried out in vehicle. Relative abundance of Slender Loris based on foot survey in Kalakkad Mundanthurai Tiger Reserve in Tamil Nadu was 0.03 animals per km in Teak plantations, *Eucalyptus* sp. or *Bombax* sp. and 2.5/km in mixed forests (Kar Gupta, 1998). Hence, the present study revealed higher encounter rate of Slender Loris in rubber plantations in Kottayam District of Kerala. Higher encounter rates indicate higher abundance of Slender Loris in this region. Lorises are territorial animals which have overlapping territories ranging from 1.7 to 3.7 ha depending on sex (Nekeris, 2000). Habitat openness might have influenced on number of sightings or probability of detections of loris in plantations than forest area.

Higher abundance may be due to high density lorises in Rubber plantations of Kottayam. We used similar survey method used in forest area with red light to get the presence of loris (Singh, *et al.*, 1999). Since lorises are territorial, their spacing mechanism would allow them to spread out. Roaming males range over a large area that overlap with the territory of several males and females ranges. Further, there is less predator abundance in Rubber plantation

especially Common Palm Civets (*Paradoxurus hermaphroditus*) and Owls. Common Palm Civet (*Paradoxurus hermaphroditus*) is a predatory species of lorises and were spotted at the time of survey. Rubber tree with thin long branches could not support civets, though they were observed to move freely on larger tree trunks with horizontal branches. Hence, rubber tree characteristics such as thin long branches, production of tender leaves that attracts several insect species and lower predator density could enable lorises to survive in higher abundance in plantations of Kottayam District.

5.2 POPULATION

Estimated population density of lorises in the Kottayam District was 0.97/km, estimated based on number of sightings and area sampled rather than transect method. Transect method could not be directly applied as there was no visibility at the time of surveys. Still this method is in practice to estimate loris density in India (Rao, 1994; Nekaris, 1997; Lindburg *et al*., 1999; Kumar *et al*., 2000). The animals were spotted using red colored spot light based on tapetal reflection. Since detection of individual in transect was less than one, this method may not be applied to estimate density Buckland *et al*. (1993). Hence minimum population density was estimated using this buffer area. The estimated density of loris ($0.97/km^2$) was high when compared to adjacent forest areas such as Periyar Tiger Reserve and Idukki Wildlife Sanctuary ($0.1/km^2$; Radhakrishna *et al*., 2011). Higher abundance can be attributed to availability of suitable habitat (Rubber plantation), and lower predator density. Estimated population density of loris was much higher than Northern and Central Kerala (0.25/km; Radhakrishna *et al*., 2011). The estimated density was almost similar in all fourteen transect surveyed and there was no significant variation in the density among transects. IUCN status of the species is "Near Threatened" (Nekaris *et al*., 2008) due to 30 % decline of the population throughout its distributional range, hunting and habitat loss. The present study identifies Rubber plantations as potential distributional areas of loris. Hence, it is essential to conduct surveys in human modified landscapes such as plantations of Teak (*Tectona grandis*), Cardamom (*Elettaria cardamomum*), Rubber (*Hevea brasiliensis*), Coffee (*Coffea* sp.) and other plantations as potential habitat for loris (Kar Gupta, 1998; Kumara *et al*., 2004; present study). Further studies on ranging and foraging behavior of lorises will shed light on conservation of this elusive species in non forest areas.

5.3 TIME OF SIGHTINGS

Lorises were surveyed from 18:00 hrs to 24:00 hrs in the study area. A peak in number of sightings was observed between 19:30 hrs and 21:00 hrs. Time spent on observations across the survey period was equal, so number of detections peaked during this period. Similar period of activity peak were reported on *Loris l. lydekkerianus* based on instantaneous scan sampling method in Dindigul District of Tamil Nadu (Nekaris, 2001). In general, most of their time spent being inactive (36%) than active 19% (Radhakrishnan, 2001). It has also been reported that dark and lightphases of the moon influenced their activity, with them being inactive during the light phase and active during dark phase. The animals were found to be cryptic, showing bouts of immobility on sight, either they move rapidly or motionless in cover.

5.4 RELATION BETWEEN TREE HEIGHT AND HEIGHT AT WHICH LORISES WERE SPOTTED

Height at which lorises were spotted was linearly related to the height of the tree. The model was highly significant and explained 58 per cent of variability. In the deciduous forests, the height at which lorises were spotted was 2 to 5 m. Profound seasonal variation in the height at which which lorises were spotted has been reported from Kalakkad Mundanthurai Tiger Reserve (KMTR) (Kar Gupta, 2007). Further, sexual variation in the habitat use pattern has been reported with females and territorial males using closed canopy in riverine and moist deciduous forests, whereas roaming males ranged close to open canopy in deciduous forest (Kar Gupta, 2007). In this study, linear increase in spot height was found with tree height and tree species. Lorises were observed to forage on slender branches of the tree with greater foliage cover. Hence, preference of smaller branches near foliage could be a factor that increased height at which the animals were spotted with respect to tree height.

5.5 RELATION BETWEEN GIRTH AT BREAST HEIGHT (GBH) AND HEIGHT AT WHICH LORISES WERE SPOTTED

The relation between the tree girth at breast height (GBH) and height at which lorises were spotted showed positive linear relation. The model was highly significant and explained 59 per cent of variability. Both tree height and girth at breast height are related variables, with

increase of tree height girth at breast height also increase due to annual increase in the tree girth due to growth. Hence, there is linear relation between tree height and girth at breast height these factors, can not be loaded together when building model with multiple regression, thus these factors were analysed separately. Further, greater number of sightings fell in girth at breast height class between 40 and 60 cm. This has important implication on management plans. Rubber trees that reaches girth at breast height above 100 cm are being felled due to reduced productivity of latex. If felling is continued in large scale, the existing population of loris will face local extinction at Kottayam District. Lorises are slow moving animals, they are unable to move fast or climb down at the time of felling. Clear felling leads to isolation of population into smaller pockets. Thus, these animals are vulnerable to local extinction.

Felling of Rubber trees when they reach maximum girth class in large scale could harm the population of Slender Lorises. Hence, it is recommended that management plans should consider not to allow felling of trees in rubber plantations on a large scale. Selective felling of trees of particular girth class or leaving some trees without felling could be recommended to enable the survival of lorises. Many of the local people were not aware of the presence of Malabar Slender Loris. Hence, it is recommended to conduct awareness programmes for local people about the species, their role in ecosystem as pest control agents, their conservation significance, and other beneficial effects to ensure long-term survival of these species outside protected area.

Insect species such as Scale insects (*Saissetia nigra*), Striped Mealy bug (*Ferrisiana virgata*), bark feeding catterpiller (*Aetherastic circulata*), Achari (Mite, *Hemitarsonemus dorsalis*) and a Molluse (Slug, *Mariaellae dussumieri*) were considered as pest that causes considerable damages to Rubber trees and reduction in production of latex (Rubber board 2002). Lorises are being insectivourous helps to controls insect pest. Further studies on foraging behaviour and diet could shed light on how these lorises helps to control pest. These beneficial aspects of lorises need to be disseminated to local people to ensure their support in conservation of lorises.

6. SUMMARY

Slender Lorises are nocturnal primates occurring in India and Srilanka. This could be the first attempt of studying Malabar Slender Lorises in rubber plantations of Kottayam District. Malabar Slender Lorises (*Loris lydekkerianus* m*alabaricus*) are very hard to detect and are an extremely shy sub species of Slender Loris reported from South India.

Overall encounter rate of Slender Loris was 1.55±0.42 during the study with highest number of encounters in Pathampuzha and Teekoy Estates (3.9/km). The mean encounter rate was higher than encounter rate reported from forest areas of Kerala. Higher encounter rate of the animal during the study could indicate higher abundance of Slender Loris in this region. Rubber tree characteristics such as thin long branches, production of tender leaves and lower predator density could enable lorises to survive in higher abundance in rubber plantations.

Estimated population density of the animal in the study area was 0.97/km based on number of sightings and area sampled rather than following the transect method. The present study identified rubber plantations as potential distributional areas of Malabar Slender Loris (*Loris lydekkerianus* m*alabaricus*). Hence, it is essential to survey in human modified landscapes such as plantations of Teak (*Tectona grandis*), Cardamom (*Elettaria cardamomum*), Rubber (*Hevea brasiliensis*), Coffee (*Coffea* sp.) and other plantations as potential habitats for lorises. Further studies on the ranging and foraging behavior of these animals would shed light on conservation of this elusive species in non-forest areas.

Lorises were surveyed from 18:00 hrs to 24:00 hrs in the study area. A peak in number of sightings was observed between 19:30 hrs and 21:00 hrs. Time spent on observations across the survey period was equal. Hence, the peaking of the number of detections during this period was not by chance.

In this study, there was linear increase in spot height with tree height and tree species. Lorises were observed to forage on slender branches of the tree with greater foliage cover. Hence, preference of smaller branches near foliage could be a factor that increased height of spotting the animals with respect to tree height.

Greater number of sightings fell in girth at breast height class between 40 and 60 cm. This observation has important management implications. Rubber trees that reached girth at breast height above 100 cm were being felled due to reduced productivity of latex. If felling is allowed to continue in large scale, the existing population of Malabar Slender Lorises could face local extinction at the Kottayam District. Selective felling of trees of particular girth class or leaving some trees without felling could be recommended to enable the survival of lorises.

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POPULATION AND MICRO HABITAT USAGE OF MALABAR SLENDER LORIS (*Loris lydekkerianus* m*alabaricus*) IN HUMAN MODIFIED PLANTATIONS OF KOTTAYAM DISTRICT, KERALA, INDIA

ROSHIN TOM

(15-02MS-001)

Abstract of Dissertation Submitted in Partial Fulfillment of the Requirement for the Degree of

MASTER OF SCIENCE

(Wildlife Studies)

Faculty of Veterinary and Animal Sciences Kerala

Veterinary and Animal Sciences University

2017

ABSTRACTS

A survey was conducted on Malabar Slender Lorises (*Loris lydekkerianus* m*alabaricus*) in rubber plantations of Kottayam District of Kerala. The field Survey was carried out over two sessions from May 2017 to July 2017 and the index used for estimating relative abundance was animal encounter rate or 'sightings' per km. Overall encounter rate of Slender Loris was 1.55±0.42, with highest number of encounters in Pathampuzha and Teekoy Estates (3.9/km). The study showed a high encounter rate of Slender Loris in rubber plantations in the study area. Estimated population density of the animals was 0.97/km based on number of sightings and area sampled rather than transect method. The study identified rubber plantations as potential distributional areas of Malabar Slender Loris (*Loris lydekkerianus* m*alabaricus*). This indicated that it is essential to surveyhuman modified landscapes such as plantations of teak (*Tectona grandis*), cardamom (*Elettaria cardamomum*), rubber (*Hevea brasiliensis*), coffee (*Coffea* sp.) and other plantations as potential habitats for loris.

A peak in number of sightings of the animal was observed between 19:30 hrs and 21:00 hrs. There was a linear increase in spot height with tree height and tree species. Greater number of sightings fell in girth at breast height class between 40 and 60 cm, a finding which has an important management implication.

CENTRE FOR WILDLIFE STUDIES

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POOKODE, WAYANAD, KERALA, INDIA

KERALA VETERINARY AND ANIMAL SCIENCES UNIVERSITY

Faculty of College of Veterinary and Animal Sciences

PROGRAMME OF RESEARCH WORK FOR DISSERTATION FOR MASTERS DEGREE

(Vide Rule 25(b) of Post Graduate Regulations 1998)

1. Title of Dissertation

"Population and microhabitat usage of Malabar Slender Loris (*Loris lydekkerianus malabaricus*) in human modified plantations of Kottayam District, Kerala, India"

2a. Title of departmental/KVASU research project of which this forms a part

Nil

2b. Code No. if any, and order by which the departmental/KVASU research project is approved

Nil

3a. Name of the student

Roshin Tom

3b. Admission No.

15-02MS-001

4a. Name of the Major Advisor (Guide)

Dr. George Chandy

4b. Designation

Officer in Charge,

Centre for Wildlife Studies,

College of Veterinary and Animal Sciences, Pookode, Wayanad – 673576.

5. Objectives of the study

1. To estimate the population of Slender Loris in plantations of Kottayam district.
2. To identifying, Factors influencing loris detection.
3. To identify the threats to loris populations outside protected areas.

6. Practical/Scientific utility

General statement:

Malabar Slender Loris (*Loris lydekkerianus* m*alabaricus*) . It occurs along the West coast and in the Wet forests of the Western Ghats in Karnataka, Kerala and Tamil Nadu. Nekaris *et al*., (2008) did not surveyed these areas, but the species survives well in the Rubber (*Hevea brasiliensis)* plantations at Kotayam district. Hence the proposed study will be first study on this sub-species and will provide baseline information on population, foraging and ranging behavior that will enable to formulate management or conservation project of this elusive species outside protected areas.

Loris is listed as a Near Threatened species and the population status and distribution is uncertain for this sub-species in the IUCN endangered species category (Nekaris *et al*., 2008). Even the species has not been reported from the South of Palgat Gap. Hence the proposed study will help to update the status and distribution in the IUCN category.

International trade of this species is banned by being listed in CITES. Loris is also protected from local hunting, hence it is comes under Appendix II, and classified under Schedule I of the Indian Wildlife Act (1972). But the survival and hunting outside the protected areas makes them vulnerable for hunting and poaching.

Further studies of behavior and ecology are needed to better understand the habitat

requirements (Nekaris and Jayewardene 2004) and conservation of this species outside protected areas with local support. Further the proposed study will help to revive the status of the species.

The proposed study will also provide information on threats to lorises due to hunting and poaching. Human-slender loris interaction, how people behave to their presence in their land will help to make conservation education program in areas with abundant lorises.

7.Important publications on which the study is based

Frank Wiens studied behavior and ecology of wild slow loris, their social organization, infant care system and diet. He studied nocturnal primate behavior and tried to explain them. He observed that slow loris have extremely low frequencies of direct encounters with one another and how they formed stable social groups characterized by the occurrence of home range overlap and friendly interactions between members that were separated from other social groups.

Sindhu Radhakrishnan and Mewa Singh (2002) studied home range and ranging pattern in slender loris. They observed that, males have significantly larger home range than the females. The ranging pattern involved minimal female intrasexual overlap, large male intrasexual overlap and large intersexual overlap.

The social behavior of the nocturnal prosimian Loris *Tardigradus lydekkerianus* in its natural habitat was studied by Sindhu Radhakrishnan and Mewa Singh (2002). They observed that lorises are not easily discernible because individuals are usually found alone rather than in groups, and intraspecific communication is typically displaced in time and space. Consequently, variables like intersexual and intrasexual home range overlap, sleep group formations, presence or absence of matriarchies, and forms of communication employed are used to infer the type of social organisation of the species. Chemical and vocal signals play an important role in its social organization and the brachial gland is the major scent gland in the slender loris. Individuals were identified by distinctive physical markings on their bodies and locomotory idiosyncrasies.

8. Outline of the technical program

This study will be carried out from March 2017–June 2017 in the plantations of Kottayam district, Kerala. The vegetation of the study area is Rubber, Teak and coffee plantations.

Population of loris will be estimated using line transect method. Study area will be divided into grids 500m^2. Grids will be stratified based on plantation types and human occupied places. From the each strata sub-samples will be taken randomly and a transect length of 500m will be surveyed at night for call and direct sighting.

7. Main items of observations to be made

1. Number of individuals form the non-forest plantations.
2. Identification of the plant which loris first spotted, height of the tree, height were loris first spotted.
3. GPS reading were the loris spotted first.

7. Facilities

1. **Existing**:
   Camera, Torches, GPS, Measuring Tape

2. **Additional facilities required**:
   Tracker

8. Duration of study:
One Semester

9. Financial estimate

Trackers : Rs 20,000

10. Signature of student

11. Signature of Major Advisor

Place:

Date:

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KVASU,

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15. Name, designation and signature of members of the Advisory Committee

Members

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Appendix 1

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Karnataka, India. *International Journal of Primatology, Vol. 27, No. 4.*

Appendix II

Time frame of Work

Semester I

1. Collection of literature

Semester II

2. Collection of literature

Semester III

1. Collection of literature
2. Review of literature
3. Planning of research programme
4. Submission of synopsis

Semester IV

1. Preparation of manuscript
2. Research work
3. Interpretation of results
4. Dissertation preparation and submission

CERTIFICATE

Certified that the research project has been formulated observing the stipulations laid down under the Prevention of Cruelty to Animals Act (Amendment, 1998)

Place: **Dr. George Chandy**

Date: **(Guide)**

CURRICULUM VITAE

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Publication Made	:	Nil
Membership in Professional Bodies	:	Nil