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HABITAT QUALITY AND AVAILABILITY OF THE WESTERN CEYLON SLENDER LORIS, *Loris tardigradus tardigradus* IN THE KOTTAWA ARBORETUM

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ABSTRACT

The red slender loris, *Loris tardigradus* is one of the three primate species endemic to Sri Lanka. Currently there are two recognized subspecies of the red slender loris, *L. t. tardigradus* and *L. t. nycticeboides*. Of these *L. t. tardigradus* (Western Ceylon slender loris) inhabits rainforests in the southwestern region of the island while *L. t. nycticeboides* (Ceylon mountain slender loris) is restricted to the montan zone. Kottawa Arboretum harbors one of the few remaining *L. t. tardigradus* populations in the country. This study was conducted to determine the population density, habitat selection citeria and to assess the habitat availability of *L. t. tardigradus* in the Kottawa Arboretum. Using the line transect method, 34 sightings were made over a period of 21 months. Based on these observations the density of Western Ceylon slender loris in the Kottawa Arboretum and habitat selection criteria were ascertained. The calculated density of *L. t. tardigradus* in the Kottawa Arboretum is 41-animals/ km^2. The average height of trees preferred by *L. t. tardigradus* is 13.97 m ± 6.02. Most of the time lorises were observed at a height range of 3.5-15 m above the ground level. Average height from the ground level where *L. t. tardigradus* were observed to occupy the tree was 8.64 m ± 5.00. Of the 50 tree species recorded in the Kottawa Arboretum, *L. t. tardigradus* was found to utilize only 16 species.

KEY WORDS: Density, habitat availability, habitat selection, *L. t. tardigradus*, low land rain forest

INTRODUCTION

Sri Lanka, with a total land area of 65,610 km^2 is a tropical island situated in the Indian Ocean. The southwestern region of Sri Lanka, encompassing approximately 20,000 km^2, is the only aseasonal ever wet region in the whole of South Asia (Ashton & Gunatilleke, 1987; Gunatilleke *et al.*, 2005). This region is referred to as the wet zone of Sri Lanka and receives up to 3000 mm of rainfall annually. Wet-zone of Sri Lanka along with the Western Ghats of India is designated as one of the world's 11 biodiversity "hyperhot" hotspots, in demand of extensive conservation investment (Myers *et al.*, 2000; Brookes *et al.*, 2002). However, agro ecosystems and human settlement cover most of the land area in the wet-zone of Sri Lanka (Pemadasa, 1996; Ashton *et al.*, 1997; Gamage, 2005). A burgeoning human population, demand for subsistence land, and a high proportion of endangered and endemic species within Sri Lanka's wet zone have resulted in its being declared a critically endangered eco-region (Mill, 1995; Nekaris *et al.*, 2005).

The slender loris (*Loris*) is a small nocturnal prosimian primate endemic to Sri Lanka and South India. The forests of Sri Lanka are home to two species of slender loris (*Loris tardigradus* and *L. lydekkerianus*), with four currently recognized subspecies, *L. t. tardigradus, L. t. nycticeboides*, *L. l. nordicus*, and *L. l. grandis* (Osman Hill, 1953; Groves, 2001; Nekaris & Jayewardene, 2003). The red slender loris, *Loris tardigradus* is endemic to Sri Lanka (Groves, 2001; Nekaris &

Jayewardene, 2003; Nekaris et al., 2005). The conservation status of this species (*L. tardigradus*) has since been elevated to the Endangered category (IUCN, 2004). According to Nekaris & Jayewardene, (2003) the Western Ceylon slender loris, *L. t. tardigradus* only inhabits rainforest in the southwestern region of the island while the other sub species *L. t. nycticeboides* is restricted to the montane region above 2000 m. Preliminary abundance estimates of *L. t. tardigradus* showed that these lorises are patchily distributed, even within a single forest reserve (Nekaris & Jayewardene, 2003; Nekaris *et al.*, 2005).

The Kottawa Arboretum is a part of Kottawa-Kombala forest reserve and is classified as a lowland rainforest (Pemadasa, 1996; Ashton *et al.*, 1997). Kottawa Arboretum harbors one of the few remaining Western Ceylon slender loris *L. t. tardigradus* populations in the country. Very few studies have focused on the ecology of *L. t. tardigradus* except one study that has been done in Masmullah proposed forest reserve (Nekaris *et al.*, 2005; *Pers. Com.* Bernede). Thus, the overall aim of this study is to determine the density, habitat selection criteria and habitat availability for *L. t. tardigradus* in the Kottawa Arboretum.

MATERIALS AND METHODS

Study site

Kottawa Arboretum is a part of Kottawa-Kombala forest reserve, which is situated in the southern region of Sri Lanka and belongs to Yakkalamulla Divisional Secretariat Division of Galle District (6°05' N and 80°18' E). The extent of the Arboretum is approximately 20ha and it is classified as a lowland rainforest (Pemadasa, 1996). Remnants of Dipterocarpus forest occur in the Arboretum site. Secondary forest occurs where the original forest cover has been removed due to logging. Some of the logged areas are replanted with pinus trees (*Pinus caribaea*), by the Forest Department (Gamage, 2005).

The study taxon

L. t. tardigradus is the smallest of the slender lorises, weighing 85-172g (Nekaris *et al.*, 2005). On the basis of museum specimens, Groves (2001) recently distinguished it from other slender lorises. It occurs only in the southwestern region of Sri Lanka (Nekaris, 2003; Nekaris & Jayewardene, 2003; Nekaris *et al.*, 2005).

Population density

This study was carried out from August 2003 to April 2005, using the fixed line transect method. Five line transects, each 200 m long separated by 50 m was marked in the study site. These transect's were repeated 19 times during the sampling period. Along the transect the distance to the animal was visually observed and the angle between the animal and transect was measured using a compass. Density was calculated using the following equation. $D = f \sum n_i / 2L$ (Sutherland, 1996), where D is density, L is length of the transect; n_i is numbers of animals recorded in the recognized zones, and $f = a_1 + 1/ d_t$ where $a_1 = 2 (\sum \cos g_i / d_t \sum n_i)$ and d_t is distance beyond which data were truncated; $g_i = \pi n_i d_i / d_t$; and $d_i = z_i \sin \varnothing_i$, where z_i is

distance of the *i*th animal when first observed, $\varnothing_i$ is angle to *i*th animal when first observed, d_i is perpendicular distance from transect line to *i*th animal.

Observation of loris habitat use

Focal animal instantaneous point sampling method was used to obtain behavior data (Charles-Dominique & Bearder, 1979; Nekaris *et al.*, 2005). Headlamps fitted with red filters were used to minimize disturbance to the animal. Data regarding habitat use was recorded upon first spotting an animal. The type of data collected included substrate size, substrate angle, height from the ground level, tree height, and tree type (Nekaris, 2001; Nekaris *et al.*, 2005).

Vegetation sampling

The plot-less sampling technique (Sutherland, 1996) was used to ascertain the density of tree species of the study sites. 30 sampling points were chosen randomly in the study site. At each point two sticks were placed perpendicular to each other to demarcate four quadrates. In each quadrate the nearest tree (girth >10cm) from the point and the nearest neighbor of the tree (girth > 10cm) in the same direction was identified. Then identity of the plant species, distance from the point to the tree, distance between plant and its nearest neighbor, circumference at breast height and the estimated tree height was recorded. Furthermore, the percentage arboreal continuity of each tree was measured using the following scale 0-1.5, 1.5-3.5, 3.5-5.0, 5.0-10.0, 10-15 & 15 < meters (Nekaris *et al.*, 2005; Gamage, 2005). In addition microhabitat characteristics of each of the following strata 0-1.5, 1.5-3.5, 3.5-5.0, 5.0-10.0, 10-15 & 15< meters (nature, size, orientation and the presence or absence of vines and epiphytes within the strata) was recorded. In each quadrate percentage of saplings on the ground was determined using the Braun-Blanquet scale (Sutherland, 1996).

Floral density was calculated using the T-square method (Sutherland, 1996). The equation used was $D = m^2 / (2.828 \sum x_i \sum z_i)$, where D is tree density (trees/ha), m is number of sampling points, x_i is distance from the sampling point (m), and z_i is distant to the nearest neighbor (m). A test of random distribution was determined using the equation, 't' = $\{\sum [x_i^2 / (x_i^2 + z_i^2 / 2)] - m / 2\}$ (12/m), where a value greater than 1.96 indicates a non-random distribution (Sutherland, 1996). Basal area was calculated using the equation, Ba = (2 x CBH/ 4) x D, where Ba is the basal area, CBH is circumference at breast height, and D is tree density (Sutherland, 1996).

RESULTS

Population density

During the observation period a total of 36 sightings (data points) of *L. t. tardigradus* were recoded however two sighting (data points) were omitted for calculations due to difficult to identify the tree. The unit density of *L. t. tardigradus* at the Kottawa Arboretum was found to be 41-animals/ km^2. Therefore the estimated population size of *L. t. tardigradus* in the Kottawa Arboretum (extent 20 ha) is approximately 8 animals.

Floral composition of the study area

The 240 trees surveyed during the vegetation study represented 50 species that belongs to 25 families. Of these 37 species (74%) are endemic to Sri Lanka while the remaining 13 (26%) can be defined as native species (Table 1). The most abundant tree species recorded was *Acronychia pedunculata* (n = 27; 11.3%). Other relatively common species included *Lijndenia capitellata* (n = 21; 8.8%), *Agrostistachys coriacea* (n = 11; 4.5%), and *Mangifera zeylanica* (n = 10; 4.2%). All other tree species were encountered less than 10 times during the survey period. The calculated tree density of all trees in the sample was 1917 trees/ha. The calculated 't' value for the test of random distribution was +21.48. The average height of trees in the sample was 8.19 m ± 6.55, with a minimum of 2.5m and a maximum of 40m. The average CBH was 34.38 cm ± 52.64; with a minimum of 10 cm and a maximum of 305 cm. The tallest tree (40 m) recorded from the study site was *Dipterocarpus hispidus* with a CBH of 305 cm. The most common tree species, *Acronychia pedunculata*, had an average height of 4.96 m ± 0.84, and a CBH of 17.48 cm ± 4.03. The average basal area of the trees was 94.0 ± 220.4 m^2/ha. Density of ground cover between nearest neighbor trees was determined 120 times using the Braun-Blanquet scale. The average density was 2.1 ± 1.8 %.

Table 1. Tree species (>10 cm CBH) recorded using the plot-less sampling technique in the Kottawa Arboretum. (Abbreviations: En = endemic, Na = native).

Family	Species name	Common name	Count	%	Status
Anacardiaceae	*Campnosperma zeylanicum*	Aridda	8	3.33	En
Anacardiaceae	*Mangifera zeylanica*	Atamba	10	4.17	En
Anacardiaceae	*Semecarpus nigro-viridis*	Gatabadulla	6	2.50	En
Anacardiaceae	*Semecarpus subpeltata*	Kabarabadulla	7	2.92	En
Anacardiaceae	*Semecarpus walkeri*	Badulla	6	2.50	En
Annonaceae	*Xylopia championii*	Dathketiya	1	0.42	En
Arecaceae	*Caryota urens*	Kithul	1	0.42	Na
Burseraceae	*Canarium zeylanicum*	Kekuna	3	1.25	En
Celastraceae	*Bhesa ceylanica*	Pelan	4	1.67	En
Celastraceae	*Kokkoona zeylanica*	Kokum	2	0.83	En
Clusiaceae	*Calophyllum bracteatum*	Walukeena	3	1.25	En
Clusiaceae	*Calophyllum moonii*	Dombakeena	2	0.83	En
Clusiaceae	*Calophyllum thwaitesii*	Batukeen	8	3.33	En
Clusiaceae	*Garcinia quaesita*	Goraka	5	2.08	En
Clusiaceae	*Mesua thwaitesii*	Diyana	5	2.08	En
Dilleniaceae	*Dillenia retusa*	Godapara	7	2.92	En
Dilleniaceae	*Schumacheria alnifolia*	Kakiriwara	8	3.33	En
Dipterocarpaceae	*Dipterocarpus glandulosus*	Dorana	2	0.83	En
Dipterocarpaceae	*Dipterocarpus hispidus*	Buhora	3	1.25	En
Dipterocarpaceae	*Dipterocarpus zeylanicus*	Hora	7	2.92	En
Dipterocarpaceae	*Shorea affinis*	Beraliya	4	1.67	En
Dipterocarpaceae	*Stemonoporus canalicuculatus*	Mandora	3	1.25	En
Dipterocarpaceae	*Vateria copallifera*	Hal	2	0.83	En
Euphorbiaceae	*Agrostistachys coriacea*	Beru	11	4.58	En
Euphorbiaceae	*Bridelia moonii*	Pathkela	6	2.50	En
Euphorbiaceae	*Chaetocarpus castanocarpus*	Hedawaka	5	2.08	Na
Flacourtiaceae	*Homalium zeylanicum*	Liyan	2	0.83	Na

Flacourtiaceae	*Hydnocarpus octandra*	Waldeul	1	0.42	En
Icacinaceae	*Stemonurus apicalis*	Uruhonda	4	1.67	En
Lauraceae	*Cryptocarya wightiana*	Gulmora	1	0.42	Na
Lauraceae	*Litsea gardneri*	Thalan	1	0.42	En
Melastomataceae	*Lijndenia capitellata*	Pinibaru	21	8.75	En
Melastomataceae	*Memecylon capitellatum*	Velikaha	3	1.25	En
Moraceae	*Artocarpus nobilis*	Badidel	2	0.83	En
Myrtaceae	*Syzygium makul*	Aluboo	3	1.25	En
Myrtaceae	*Syzygium neesianum*	Panukera	2	0.83	En
Myristicaceae	*Horsfieldia irya*	Eriya	9	3.75	Na
Myristicaceae	*Horsfieldia iryaghedhi*	Ruk	7	2.93	Na
Myristicaceae	*Myristica dactyloides*	Malaboda	3	1.25	Na
Ochnaceae	*Ochna lanceolata*	Bokera	2	0.83	Na
Oleaceae	*Chionanthus zeylanica*	Gerieta	1	0.42	Na
Rhizophoraceae	*Anisophyllea cinnamomoides*	Velipenna	2	0.83	En
Rhizophoraceae	*Carallia brachiata*	Dawata	4	1.67	Na
Rubiaceae	*Timonius flavescens*	Angana	1	0.42	En
Rutaceae	*Acronychia pedunculata*	Ankenda	27	11.25	Na
Sapotaceae	*Palaquium grande*	Kiripedda	2	0.83	En
Sapotaceae	*Palaquium petiolare*	Kirihambiliya	2	0.83	En
Symplocaceae	*Symplocos coronata*	Uguduhal	2	0.83	En
Thymelaeaceae	*Gyrinops walla*	Walla	5	2.08	Na
Verbenaceae	*Vitex altissima*	Milla	4	1.67	Na

A total of 28 climbers were identified. They are, *Dalbergia lattifolia* (Fabaceae) (n=6; 21.4%). *Salacia reticulata* (Hippocrateaceae) (n=4; 14.3%), *Pandanus* sp. (Pandanaceae) (n=4; 14.3%). *Dalbergia pseudo-sisoo* (Fabaceae) (n=3; 10.7%). *Tetracera sarmentosa* (Dilleniaceae) (n=3; 10.7%), *Coscinium penistratum* (Menispermaceae) (n=3; 10.7%). *Gyrinops walla* (Thymelaeaceae) (n=3; 10.7%), *Smilax zelanica* (Smilacaceae) (n=1; 3.6%) and *Entada phaseoloides* (Fabaceae) (n=1; 3.6%).

Usage of trees by *L. t. tardigradus*

Of the 50 tree species recorded in the Kottawa Arboretum, *L. t. tardigradus* was found to utilize only 16 species (Figure 1). Among the trees species preferred most are *Dillenia retusa*, *Chaetocarpus castanocarpus*, *Horsfieldia iryaghedhi* and *Mesua thwaitesii*. Of the four most abundant tree species, *Acronychia pedunculata*, *Lijndenia capitellata*, *Agrostistachys coriacea* and *Mangifera zeylanica* only two species (*Lijndenia capitellata*, and *Mangifera zeylanica*) were used by *L. t. tardigradus* and even then these trees were used sparsely. A detailed description of the trees on which *L. t. tardigradus* was seen is given in table 2.

Characteristics of substrate used by *L. t. tardigradus*

The average height of the trees used by *L. t. tardigradus* was 13.97 m ± 6.02 (range 3-28 m). Average height from the ground level where *L. t. tardigradus* were observed to occupy the tree was 8.64 m ± 5.00 (range 1-22 m). Most of the time (n = 27; 79%) lorises were seen to occupy a position in the range of 3.5-15 m above the ground level (Figure 2). Only on 2 occasions were loris seen at a height greater than 20 m from the ground level.

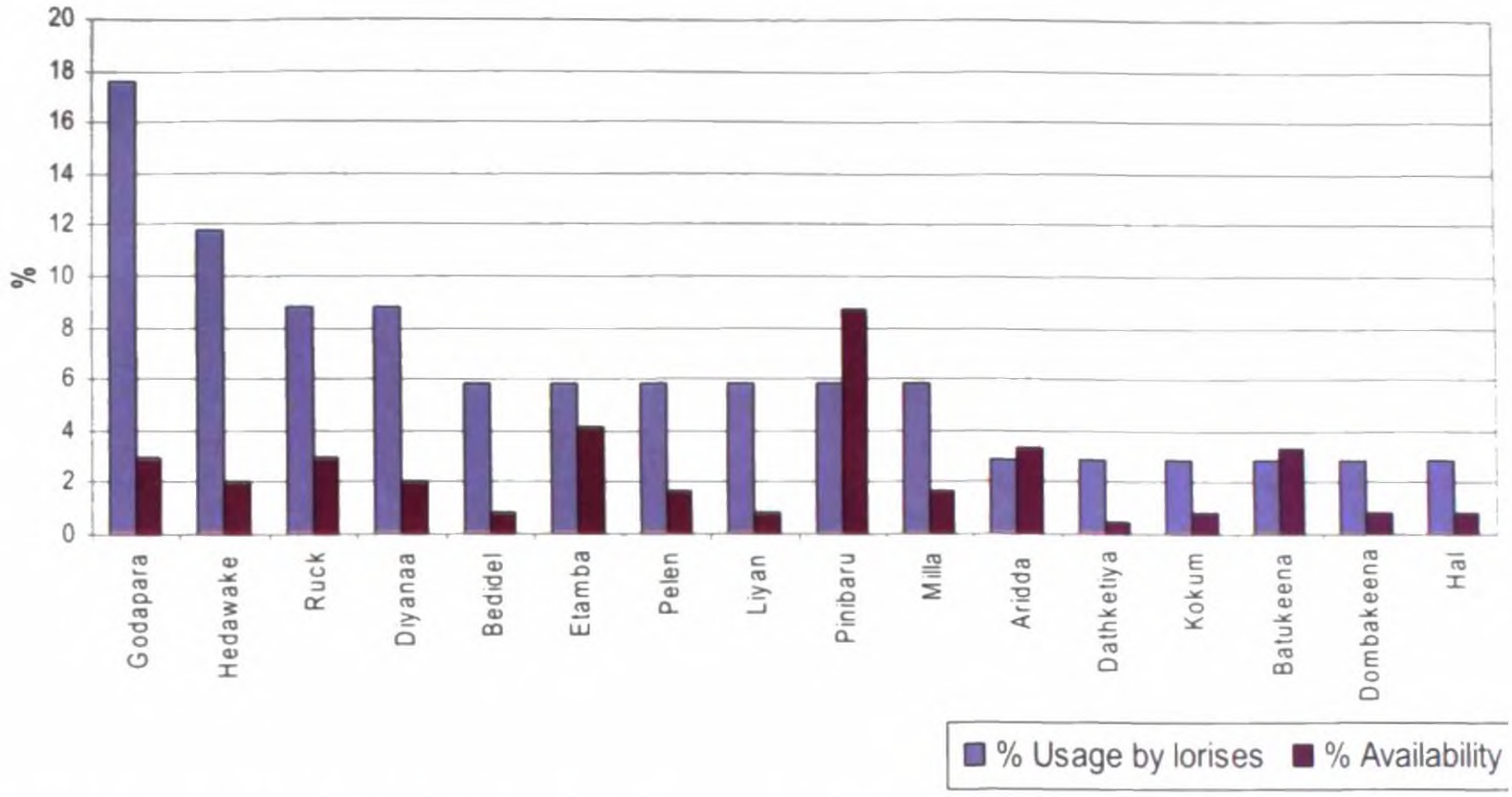


Figure 1. Tree availability at Kottawa Arboretum and frequency of utilization by *L. t. tardigradus* (n = 34).

Table 2. Frequency and percentage at which slender lorises were encountered on different plant species (n = 34).

Species	Common name	Frequency of usage	Average height	
			Tree	Occupied
Dillenia retusa	Godapara	6	13.8 ±3.5	9.0 ±2.8
Chaetocarpus castanocarpus	Hedawake	4	14.0 ±4.9	8.2 ±3.3
Mesua thwaitesii	Diyanaa	3	14.3 ±4.0	8.0 ±2.0
Horsfieldia iryaghedhi	Ruck	3	11.3 ±3.1	6.0 ±1.0
Artocarpus nobelis	Bedidel	2	20.5 ±6.4	14.0 ±8.5
Vitex altissima	Milla	2	13.5 ±2.1	9.5 ±2.1
Homalium zeylanicum	Liyan	2	12.0 ±2.8	6.5 ±0.7
Lijndenia capitellata	Pinibaru	2	3.0 ±0.0	1.5 ±0.7
Mangifera zeylanica	Etamba	2	17.0 ±11.3	9.0 ±7.1
Bhesa ceylanica	Pelen	2	9.0 ±1.4	4.5 ±0.7
Campnosperma zeylanicum	Aridda	1	15	15
Xylopia chamionii	Dathketiya	1	7	3
Kokkoona zeylanica	Kokum	1	26	18
Calophyllum thwaitesii	Batukeena	1	17	12
Calophyllum moonii	Dombakeena	1	28	22
Vateria copallifera	Hal	1	16	14

The available substrate was grouped into four categories according to the diameter as twigs (≤ 1 cm), small branches (2 – 5 cm), medium sized branches (6 – 10 cm) and large branches (≥ 10 cm). *L. t. tardigradus* showed a higher preference for branches or twigs (n = 27; 76 %) followed by vines (n = 6; 15 %). *L. t. tardigradus* were seen rarely on tree trunks (Figure 3).

The available substrate was grouped into three categories according to the orientation as vertical, horizontal and oblique. *L. t. tardigradus* showed a higher

preference to oblique and horizontally oriented substrates compared to vertical oriented substrates (Figure 4).

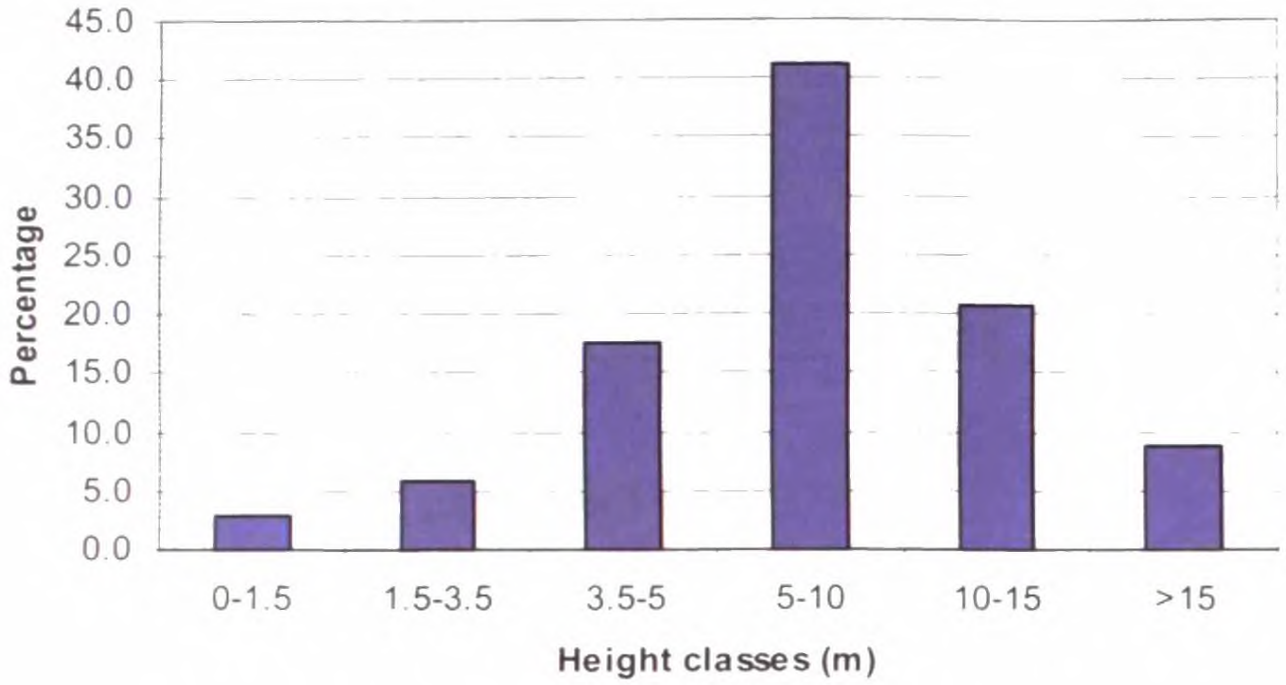


Figure 2. Vertical distribution of *L. t. tardigradus*

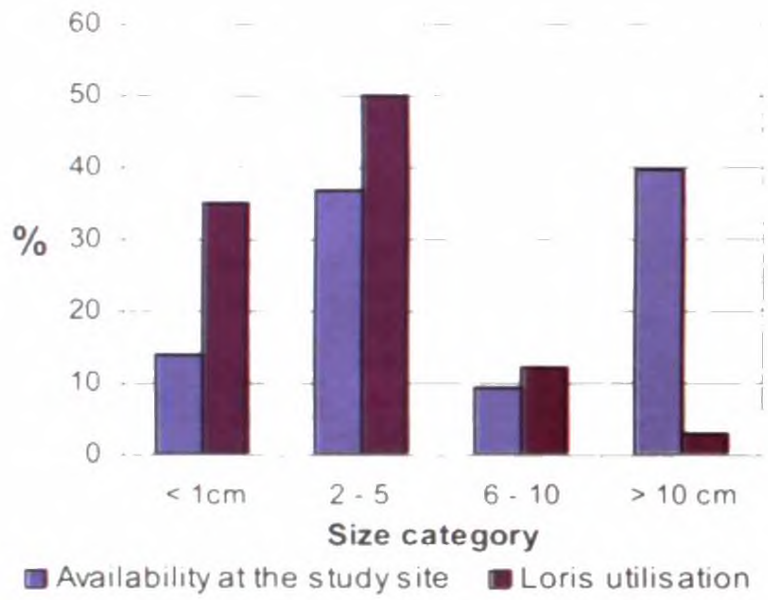


Figure 3. Substrate size availability and usage by *L. t. tardigradus*

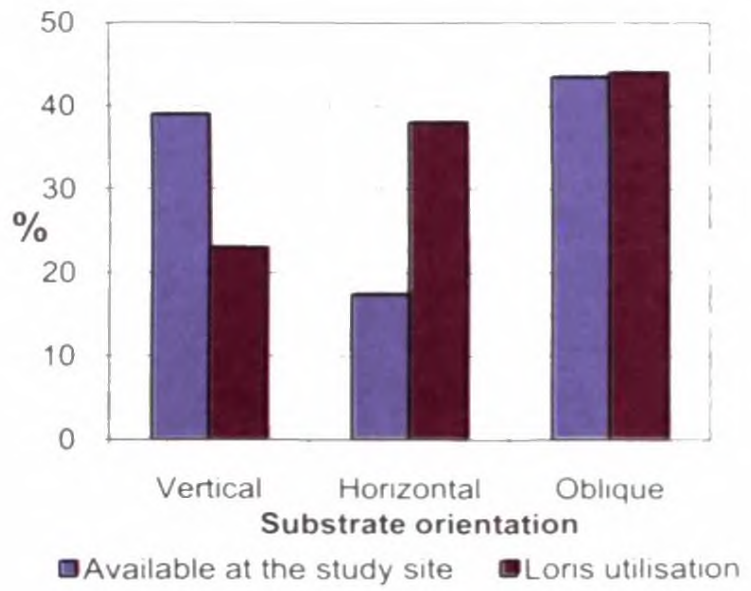


Figure 4. Orientation of the available substrate and usage by *L. t. tardigradus*

Habitat structure

The vertical axis of the Kottawa Arboretum was divided into six height classes and the tree availability, substrate continuity, substrate availability and the nature of the available substrate within each of these height classes was investigated to ascertain the habitat availability of *L. t. tardigradus* within the Kottawa Arboretum.

***Tree availability*:** Percentage of trees that reach the maximum height of each of the six height classes was determined to asses the density of the available substrate. All the trees studied were taller than 1m. After 1m the number of trees reaching the maximum height of the height class decreased gradually. A significant reduction occurs after 3.5m (figure 5).

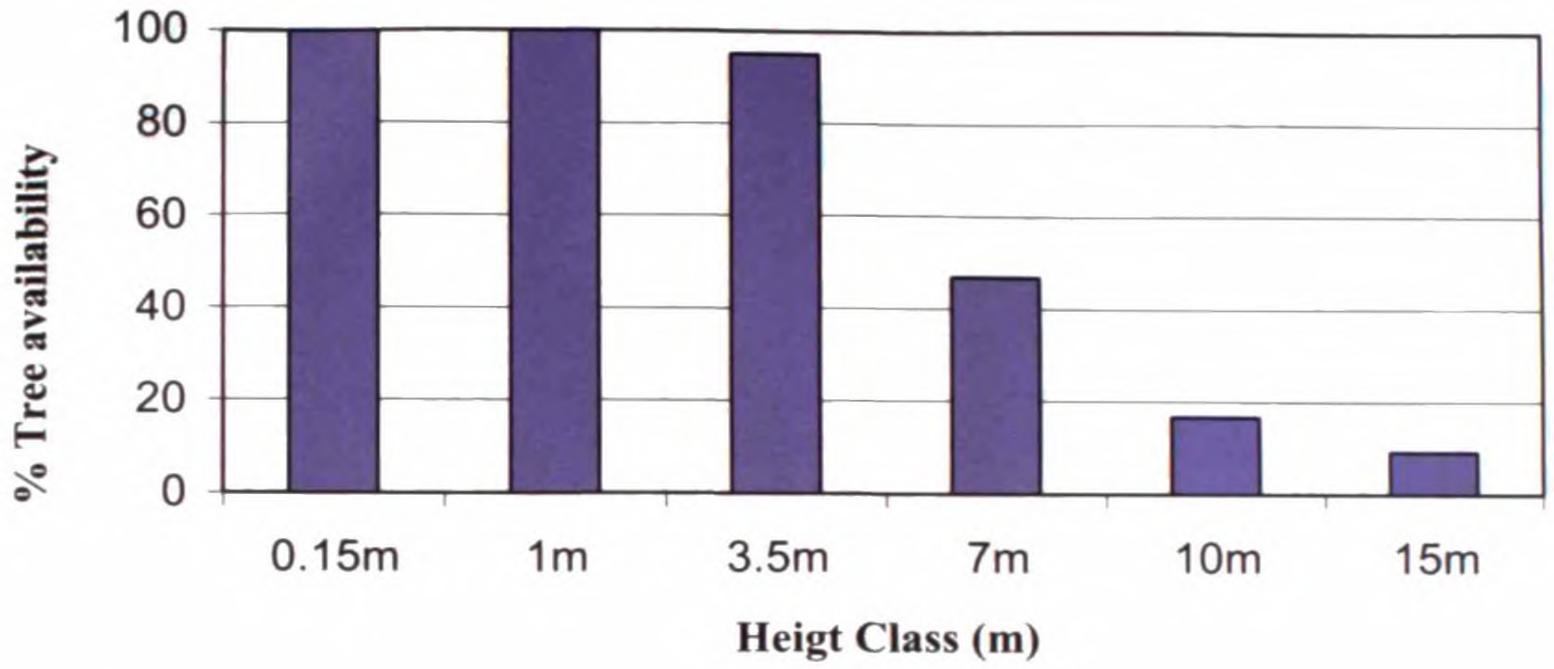


Figure 5. Percent tree availability at different height classes in the Kottawa Arboretum

Substrate Continuity: Substrate continuity was present in all of the height classes. The height classes 3.5-5m (23%) and 5-10m (22%) had the highest percentage of substrate continuity (Figure 6).

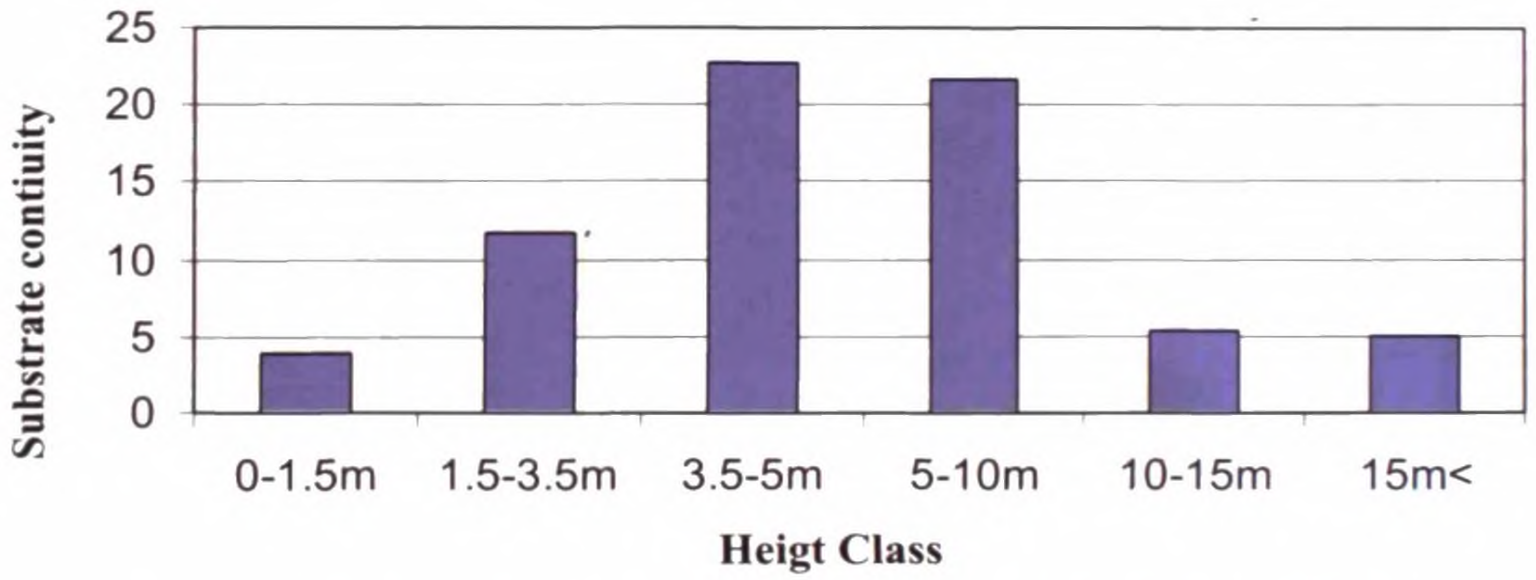
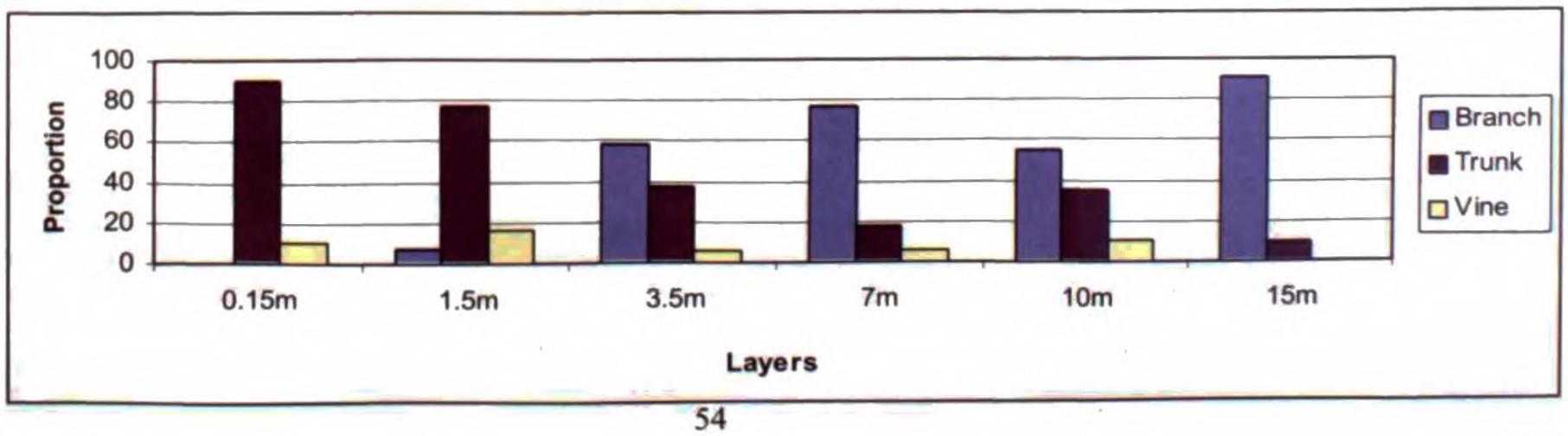


Figure 6. Percent substrate continuity at different height classes in the Kottawa Arboretum

Habitat quality and availability: The habitat quality of Kottawa Arboretum was analyzed based on the habitat selection criteria (type of substrate, orientation and the girth) observed in this study for *L. t. tardigradus*. The habitat quality for lorises was found to be highest between 3.5 m – 10 m height range (Figures 7, 8 and 9). However, the habitat quality between 10m to 15 m was also found to be suitable for lorises.



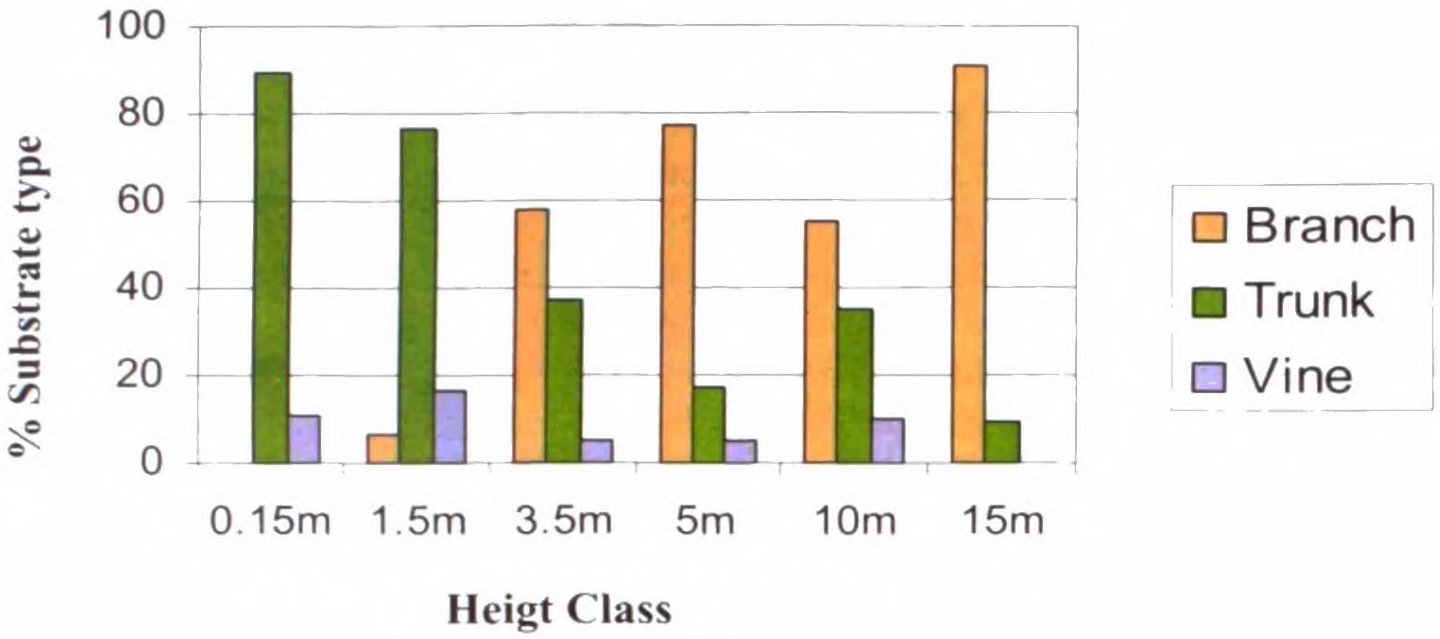


Figure 7. Percentage availability of different substrate types at the different heights of the vertical axis at Kottawa Arboretum.

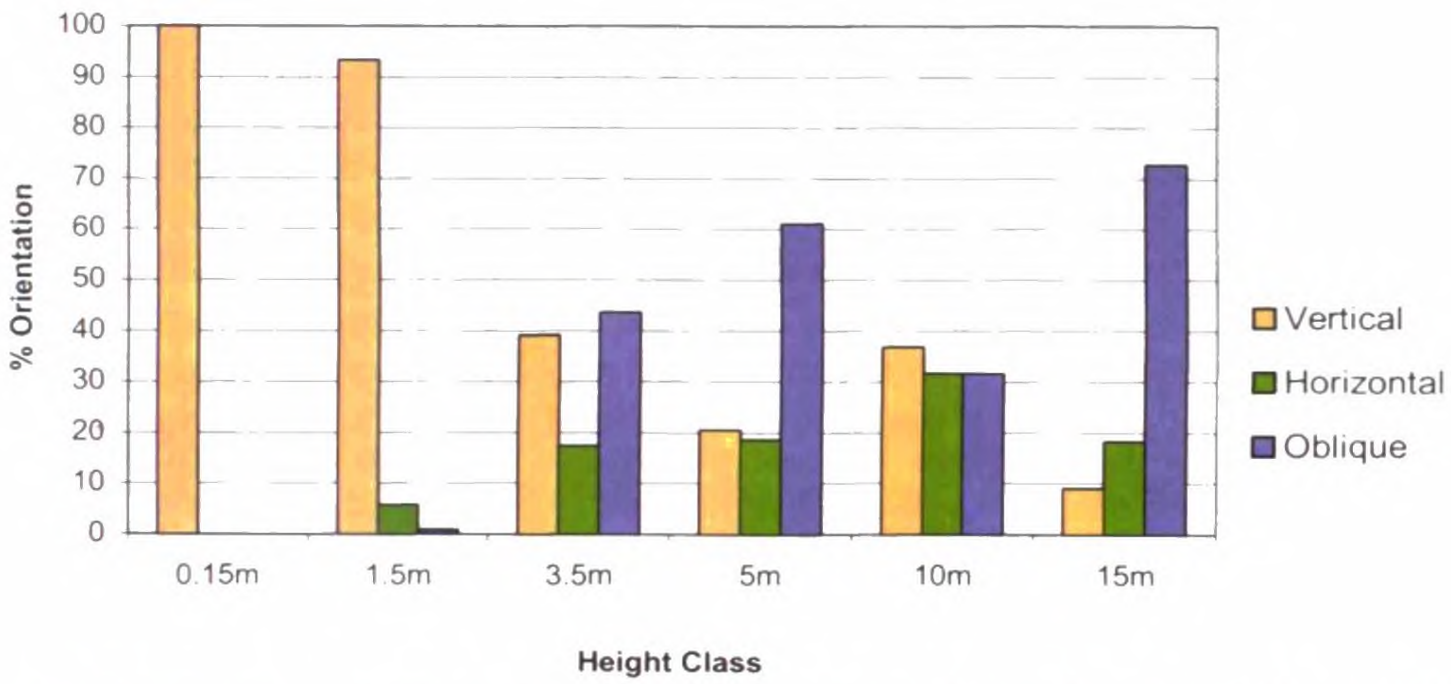


Figure 8. Percentage orientation of substrate types in the different heights of the vertical axis at Kottawa Arboretum.

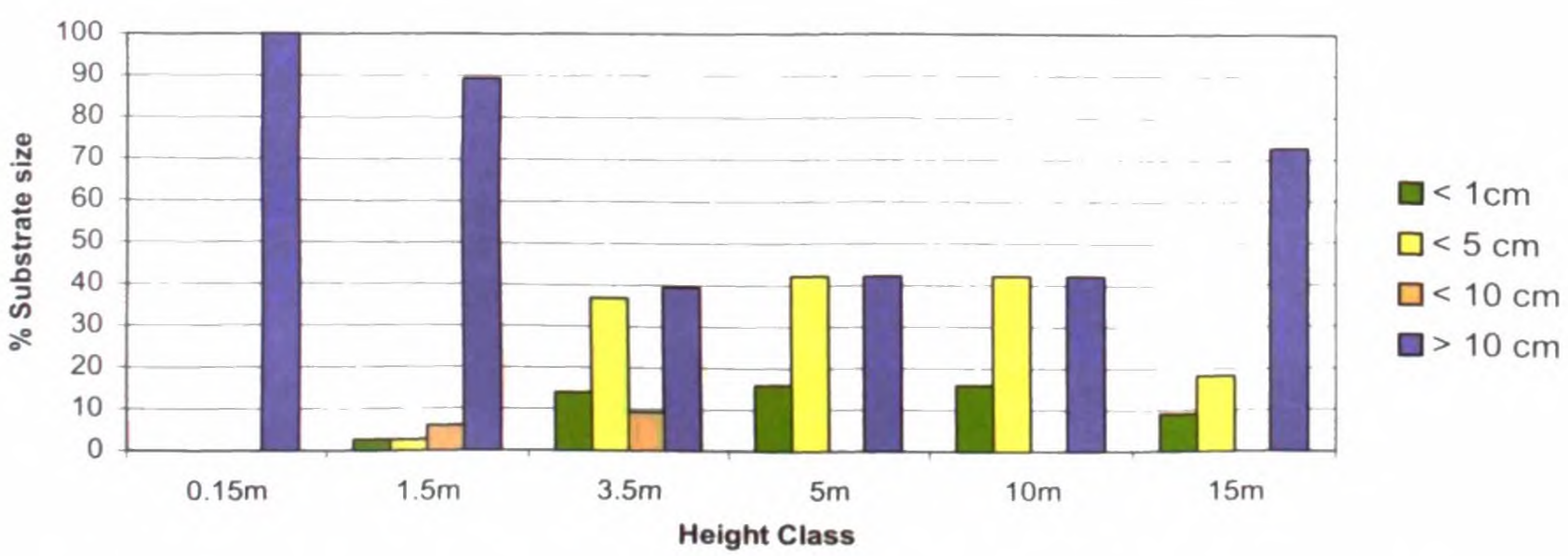


Figure 9. Available substrate size at different heights of the vertical axis at Kottawa Arboretum.

DISCUSSION

Population density of *L. t. tardigradus* recorded in the Kottawa Arboretum during this study (41-animals/ km^2) is three times greater than the population density recorded at Massmulla Proposed Forest Reserve (13 animals/ km^2) by Nekaris & Jayewardene (2004) who notes that it is the highest population density of *L. t. tardigradus* recorded in Sri Lanka. This indicates that the habitat quality of Kottawa Arboretum is much better than Masmulla Proposed Forest Reserve even though it is smaller in size. Therefore, a detailed investigation of the habitat selection criteria of lorises was conducted. Based on these observations habitat quality and availability in the Kottawa Arboretum for lorises was evaluated.

The floral sampling results show that the Kottawa Arboretum has high species diversity. Climbers, which provide good substrate for lorises (Nekaris *et al.*, 2005) were associated with more than 10% of the trees sampled in the study site. However, increased number of climbers indicates that the forest had been subjected disturbance (Ashton *et al.*, 2001). Furthermore, the basal area values recorded are lower than the values expected from a primary forest which once again indicates that the area has been subjected to selective logging (Bhuyan *et al.*, 2003). However, compared to Massmulla Proposed Forest Reserve, Kottawa Arboretum appears to be less disturbed due to two reasons. First, the basal area value is higher than the values recorded for Massmulla Proposed Forest Reserve (Nekaris *et al.*, 2005). Second, no introduced plant species were recorded in the tree sample (n=240) of Kottawa Arboretum.

Based on the tree usage by *L. t. tardigradus* it can be concluded that they show a higher preference towards trees such as *Chaetocarpus castanocarpus* and *Dillenia retusa*, which generally grow in disturbed forests. Analysis of habitat preferences of *L. t. tardigradus* showed a higher preference for small branches and twigs that are obliquely or horizontally oriented.

Nekaris (2001) and Demes *et al.*, (1990), argues that continuity of arboreal substrate is important for slender loris locomotion. An analysis of the three dimensional structure of the Kottawa Arboretum in terms of continuity of habitat and habitat characters such as type, orientation and girth of the available substrate indicates that the highest habitat quality and availability is in the height range 3.5m to 15m. This is consistent with the field observations where the highest number of loris sightings were made at this height range with the average height from the ground level where *L. t. tardigradus* were observed to occupy was 8.64 m ± 5.00.

A few potential predators were also observed at the study site such as golden palm cat (*Paradoxurus zeylonensis*), rusty spotted cat (*Prionailurus rubiginosus*), fishing cat (*Prionailurus viverrinus*), brown fish owl (*Ketupa zeylonensis*), forest eagle owl (*Bubo nipalensis*) and Indian python (*Python molurus*).

Even though the size of the estimated population of western Ceylon slender Loris, *L. t. tardigradus* at Kottawa Arboretum is small, the high density observed indicates that the habitat quality is very high. Thus Kottawa Arboretum can be considered as an important site for the conservation of western Ceylon slender Loris, *L. t. tardigradus*. However, at present Kottawa Arboretum exists as a small isolated forest patch as the Galle-Udugama road separates it from closest large forest track, the

Kombala Kottawa forest reserve. Thus long term conservation of this population may require linking of Kottawa Arboretum with the Kombala Kottawa forest reserve through a suitable land use type.

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REFERENCES

Ashton, P.M.S. & Gunatilleke, C.V.S. (1987). New light on the plant geography of Ceylon I. Historical plant geography. Journal of Biogeography. **14**: 249-285.

Ashton, P.M.S., Gunatilleke, N., Zoysa, M.D.De, Dassanayake, N., Gunatilleke, I.A.U.N. & Wijesundera, S. (1997). A field Guide to the Common Trees and Shrubs of Sri Lanka. W.H.T. Publications Ltd, Colombo.

Ashton, P.M.S., Gunatilleke, C.V.S., Singhakumara, B.M.P. & Gunatilleke, I.A.U.N. (2001). Restoration pathways for rain forest in southwest Sri Lanka: review of concepts and models. Forest Ecology and Management **154**: 409-430.

Bhuyan, P., Khan, M.L. & Tripathi, R.S. (2003). Tree diversity and population structure in undisturbed and human-impacted stands of tropical wet evergreen forest in Arunachal pradesh, Eastern Himalyas, India. Biodiversity and Conservation. **12**: 1753-1773.

Brookes, T.M., Mittermeier, R.A., Mittermeier, C.G., Fonseca, G.A.B.Da, Rylands, A.B., Konstant, W.R., Flick, P., Pilgrim, J., Oldfield, S., Magin, G. & Hilton-Taylor, C. (2002). Habitat loss and extinction in the hotspots of biodiversity. Conservation Biology. **16**: 909-923.

Charles-Dominique, P. & Bearder, S.K. (1979). Field studies of lorisid behavior: Methodological aspects, in Doyle *et al.* (eds), The Study of Prosimian Behavior. Academic Press, New York. 5629-5667.

Demes, B., Jungers, W.L. & Nieschalk, U. (1990). Size and speed related aspects of quadrupedal walking in lorises: a comparison of gait characteristics and locomotor stresses in *Loris tardigradus* and *Nycticebus coucang*, in Jouffroy *et al.* (eds), Gravity, Posture and Locomotion in Primates II. Sedicesimo Publishers, Florence.175-197.

Groves, P.C. (2001) Primate Taxonomy. Smithsonian Institution Press, Washington D.C.

Gamage, S.N. (2005). A comparative study on Biodiversity of selected manmade and Natural habitats in low country wet zone of Sri Lanka. MPhil thesis. Faculty of Agriculture, University of Ruhuna. Kamburupitiya Sri Lanka.

Gunatilleke, I.A.U.N., Gunatilleke, C.V.S. & Dilhan, M.A.A.B. (2005). Plant biogeography and conservation of the southwestern hill forests of Sri Lanka. The Raffles Bulletin of Zoology, Supplement No. **12**: 9-22

IUCN, (2004). Redlist. Available at: < URL: http://www.redlist.org

Myers, N., Mittermeier, R.A., Mittermeier, C.G., Fonseca, G.A.B.Da & Kent, J. (2000). Biodiversity hot spots for Conservation Priorities. Nature. **403:** 853-858.

Nekaris, K.A.I. (2001). Activity budget and positional behavior of Mysore slender loris (Loris tardigradus lydekkeriaus): implications for "slow climbing" locomotion. Folia Primatologica **72:** 228-241.

Nekaris, K.A.I. (2003). Observations on mating, birthing and parental care in three subspecies of slender loris in the wild (*Loris tardigradus* and *Loris lydekkerianus*) Folia Primatologica. **72:** 228-241.

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

Nekaris, K.A.I. & Jayawardena, J. (2004). Survey of Slender loris (Primates, Lorisidae Grey, 1821: *Loris tardigradus* Linnaeus, 1758 and *Loris lydekkerianus* Cabrera, 1908) in Sri Lanka. Journal of Zoology. **262:** 327-338.

Nekaris, K.A.I., Liyanage, W.K.D.D. & Gamage, S.N. (2005). Influence of forest structure and composition on population density of the red slender loris *Loris tardigradus tardigradus* in Masmullah proposed forest reserve, Sri Lanka. Mammalia **69(2):** 201-210.

Mill, R.R., (1995). Regional overview: Indian Subcontinent, in Davis *et al.* (eds). Center of Plant Diversity: a Guide to Strategy for their Conservation. Volume 2: Asia, Australia and the Pacific. World Wildlife Fund for Nature and the IUCN Press, Cambridge: 62-135.

Osman Hill, W.C. (1953). Primates. Comparative Anatomy and Taxonomy. *I. Strepsirrhini.* Edinburgh University Press, Edinburgh.

Pemadasa, A. (1996). The green mantle of Sri Lanka. Tharanjee Prints, Nawinna, Maharagama, Sri Lanka. 242 p.

Sutherland, J.W. (1996). Ecological census techniques. Cambridge University Press.UK. 336 p.