Influence of Forest Structure and Composition on Population Density of the red slender loris *Loris tardigradus tardigradus* in Masmullah Proposed Forest Reserve, Sri Lanka

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ABSTRACT
Few studies address the influence of habitat disturbance on Sri Lanka's fauna, including the endemic red slender loris *Loris tardigradus tardigradus*. Masmullah Proposed Forest Reserve harbours one of few remaining red slender loris populations, and is considered a 'biodiversity hotspot'. Using plotless sampling, we sampled 387 trees to ascertain density, and to record traits influential to loris presence. The most common tree species was *Humboldtia laurifolia,* occurring at 676 trees/ha, with overall density at 1077 trees/ha. Twenty-seven families belonging to 40 species were recorded, of which 45% were endemic, 40% native, 7.5% introduced. *Humboldtia laurifolia* has a mutualistic relationship with ants, providing abundant food for lorises. Substrates available at 3.5 m (height preferred by lorises), were small (less than 5 cm^2), the size preferred by lorises. Vines and branches provided continuous passage, and trees held a number of potential sleeping sites. The characteristics of the forest are ideal for lorises, but the abundance of this habitat as measured by basal area is small, typical of severe degradation associated with chronic human disturbance. Continued illegal deforestation will impact severely already fragmented loris populations.

KEY WORDS
Strepsirrhini,
prosimian,
Loris tardigradus,
habitat disturbance,
Humboldtia laurifolia,
Formicidae.

RÉSUMÉ

Influence de structure et de composition des forêts sur la densité de la population du loris grêle rouge Loris tardigradus tardigradus *dans la Forêt Proposée de Masmullah, Ceylan.*

Peu d'études abordent l'influence des troubles de l'habitat sur la faune de Ceylan, y compris le loris grêle rouge endémique, *Loris tardigradus tardigradus*. La réserve forestière proposée de Masmullah abrite l'une des quelques populations de loris grêle rouge, et est considérée comme un « point chaud » de la biodiversité. En utilisant la méthode dite du « plotless sampling » nous avons recensé 387 arbres afin d'établir la densité et de noter les traits physiques caractéristiques associés à la présence de loris grêles. L'espèce d'arbre la plus commune était *Humboldtia laurifolia*, présente à raison de 676 arbres/hectare, sur une densité d'arbres égale au total à 1 077 arbres/ha. 27 familles appartenant à 40 espèces ont été recensées. Parmi elles 45 % étaient endémiques, 40 % indigènes et 7,5 % furent introduites. *Humboldtia laurifolia* montre une relation mutuelle avec les fourmis, fournissant ainsi une abondante nourriture aux loris grêles. Les supports disponibles à une hauteur de 3,5 m (hauteur préférée des loris), étaient petits (moins de 5 cm^2), la taille préférée des loris. Les vignes et les branches fournissaient un passage continu tandis que les arbres contenaient plusieurs sites de repos potentiels. Les caractéristiques de la forêt sont idéales pour les loris, mais l'abondance de cet habitat, mesuré en tant que superficie de base, est petite, ce qui est caractéristique d'une dégradation sévère et résultant de troubles chroniques causés par les humains. Une déforestation illégale et continue aura un impact sévère sur les populations déjà fragmentées de loris grêles.

MOTS-CLÉS
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INTRODUCTION

Sri Lanka exhibits higher densities of flowering plants, amphibians, reptiles, and mammals than most countries in the Asian region (Kumar *et al.* 1999). Of 3370 flowering plants, 90%, including 740 endemic species, are restricted to the tropical rainforest of the island's southwestern Wet Zone (MacKinnon & MacKinnon 1986). 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 ecoregion (Erdelen 1988, Mill 1995, Olson & Dinerstein 1998). This already threatened biodiversity, in combination with predicted heavy extinction rates, has resulted in this zone's designation as one of the world's 11 biodiversity "hyperhot" hotspots, in demand of extensive conservation investment (Myers *et al.* 2000, Brookes *et al.* 2002). Decades of civil unrest have resulted in a paucity of studies of the fauna and flora of this biodiversity rich country (e.g. Erdelen 1988, Mill 1995, Santiapillai & Wijeyamohan 2003). In particular, little information is available regarding the affects of habitat disturbance on Sri Lanka's fauna.

Two species of slender lorises *Loris tardigradus* and *L. lydekkerianus*, small nocturnal primates, are found in Sri Lanka. The red slender loris *L. tardigradus* is one of three primate species endemic to Sri Lanka (Groves 2001, Nekaris & Jayewardene 2003). The Southwestern Ceylon slender loris, *Loris t. tardigradus*, has a restricted range in the dwindling rainforests of the southwest of the island (Nekaris & Jayewardene 2003) where only 3% of forest cover remains (Mill 1995), most of which is highly disturbed (MacKinnon & MacKinnon 1986). Up till now, *L. t. tardigradus* has been located in only eleven small and isolated forest patches, giving it the status of Endangered. Preliminary abundance estimates of this species showed that slender lorises are patchily distributed, even within a single forest reserve (Nekaris & Jayewardene 2004). The species seems to be restricted to early stage secondary growth forest, occurring in low densities in areas of late stage secondary growth (nearly all primary growth forest in southwestern Sri Lanka has been logged (MacKinnon & MacKinnon 1986), and not occurring at all in areas impacted severely by humans (e.g. farms and villages).

The most abundant population of *L. t. tardigradus* (13 animals/km^2) was located in a forest disturbed by human impact, Masmullah Proposed Forest Reserve in Sri Lanka's Southern Province (Nekaris & Jayewardene 2004). Masmullah Proposed Forest Reserve is one of the last remaining forest patches belonging to a region that is considered not only the most floristically rich area in Sri Lanka, but also in South Asia (Ashton & Gunatilleke 1987; Gunatilleke & Gunatilleke 1990). No intensive study has been conducted of this forest or its fauna. Thus, the purpose of this study was to characterise the forest in areas of high loris density, including aspects of the microhabitat, which might influence the density of this endangered primate.

FIG. 1. — Map of Sri Lanka showing the location of Masmullah Proposed Forest Reserve.

MATERIAL AND METHODS

STUDY SITE

Masmullah Proposed Forest Reserve is situated in the southern region of Sri Lanka and belongs to Kamburupitiya and Thihagoda Divisional Secretariat Divisions of Matara District (Fig. 1). The forest officially measures 769 ha and is classified as a moist monsoon forest (Ashton *et al.* 1997). It is an isolated forest patch and surrounded by a buffer zone consisting of introduced pine trees (*Pinus caribaea*). As a proposed forest reserve, it is subject to only minimal protection by Forest Department authorities, although it is included in a Forest Department silviculture scheme (Gunatilleke & Gunatilleke 1990). Thus, in addition to selective legal logging, surrounding villagers commonly utilise this forest for their needs, such as rice cultivation, fuel wood, timber, liquor production, hunting and medicines, resulting in a large human impact on vegetation (MacKinnon & MacKinnon 1986, Ashton *et al.* 2001, pers. obs.). Further perturbation comes from the placement of trap guns and live electric wires, set from evening to early morning, in order to deter or kill larger wildlife (particularly wild boar) for either bush meat or to limit damage to extensive illegal paddy fields within the reserve (Pabla & Mathur 2001, Santiapillai & Wijeyamohan 2003).

THE STUDY TAXON

Loris t. tardigradus is the smallest of the slender lorises, weighing 85-172 g. Groves (2001) only recently distinguished it from other slender loris taxa on the basis of museum specimens. Behavioural and ecological parameters further validate this distinction (Coultas 2002, Nekaris 2003, Nekaris & Jayewardene 2003). It occurs only in the southwest of Sri Lanka, where some preliminary studies have been conducted (Nekaris 2003, Nekaris & Jayewardene 2003).

Observations of Slender Loris Habitat Use

Behavioural observations of slender lorises were carried out during the course of surveys in July 2001, April 2002, August/September 2002, December 2002, and August/September 2003. Because of dense rainforest conditions, data reported here come from the behaviour of the animal at the first moment it was contacted by observers (c.f. Charles-Dominique & Bearder 1979, Nekaris 2001). Data regarding habitat use recorded upon first seeing an animal included: substrate size, substrate angle, animal height, tree height, and tree type (when identified) (Nekaris 2001). Statistical analyses were conducted with SPSS V.11.0, with probability set at $p \leq 0.05$.

Botanical Sampling

Plotless sampling was used to ascertain density of tree species (Sutherland 1996). As slender lorises commonly move on very small trees, a tree was defined as having a minimum girth at breast height of 3.5 cm. Distance was measured between 100 trees, the closest individual tree, and their nearest neighbours in a randomly chosen plot within an area of high loris density. Tree density was calculated using the T-square method. The equation used was $N_T = n^2/ 2\Sigma (x_i)[\sqrt{2} \sum (z_i)]$, where N_T is density, n is the number of trees sampled, x_i is the variance in point to tree distance, and z_i is the variance in T-square distance from the tree to its neighbour (Krebs 1999). A test of random distribution was run using the following equation: "t" = $[\Sigma\{x_I^{\,2}/(x_I^{\,2} + z_I^{\,2}/2)\} - m/2]\sqrt{(12/m)}$, whereby any value above 1.96 indicates a non-random distribution (Sutherland, 1996). The area covered by the plotless sampling measured 627 m × 923 m.

Classification of trees, including the extent to which humans use them, follows Ashton *et al.* 1997. Although other authors consider *Humboldtia laurifolia* to be an endemic species to Sri Lanka (Krombein *et al.* 1999), the designation of "native» from Ashton *et al.* 1997 is used here for continuity. Data related to tree density included: species and family names, distance from the previous tree and to the nearest neighbour, tree height, and girth (circumference) of the trunk at breast height (CBH). CBH was divided by π to yield diameter at breast height (DBH), and was used to calculate basal area using the equation $CBH^2/4\pi$. An additional 87 trees were sampled at random to further characterise the forest patch, and availability of potential loris habitat.

Because continuity of arboreal substrate is important for slender loris locomotion (Nekaris 2001, Demes *et al.* 1990), the amount of ground cover between nearest neighbour trees was estimated. The Braun-Blanquet scale was used to calculate the relative density of saplings with DBH < 3.5 cm and herbaceous vegetation between nearest neighbour trees (Kent & Coker 1992). Relative abundance was measured as: 1 = < 5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, and 5 = 75-100% cover. Presence or absence of vines on each tree sampled also was recorded qualitatively, recording names of taxa present, but not numbers of individuals.

We also collected data on several ecological variables that have been proposed to influence slender loris distribution. Lorises typically move at approximately 3.5 m off the ground (Nekaris 2001, Nekaris & Jayewardene 2003). Thus, we recorded availability of supports at this height, including size and orientation. Presence or absence of suitable sleeping sites, including vine or branch tangles and tree holes was noted (c.f. Bearder *et al.* 2002). Presence or absence of ant or termite colonies, the preferred food of loris, and of gum, another potential food source, were recorded (Nekaris & Rasmussen 2003).

RESULTS

Loris Substrate Use

We collected 89 data points at the moment of first contact. Slender lorises used trees measuring 6.0 m ± 3.69 (range 0-17 m), and were most often seen at 3.4 m ± 2.53 (range 0-10 m) ($t = 14.979$, $df = 83$, $p < 0.0001$). On only 11 occasions were lorises seen on trees 10 m off the ground or higher. Substrate sizes (*n* = 79) used were: twig - ≤ 1 cm (43%), small - ≤ 5 cm (30.4%), medium - ≤ 10 cm (10.1%), and the ground (3.8%), with a preference for the smaller gauged branches (χ^2 = 44.395, df = 4, p < 0.0001). Vines were considered separately, and were all less than 5 cm; they were used 12.7% of the time. At the moment of first contact lorises were never observed on a substrate or tree trunk greater than 10 cm; instead they used vines that provided vertical pathways. Orientation of substrates (*n* = 77) used by slender lorises included: oblique (42.9%), horizontal (33.8%), vertical (19.5%), and the ground (3.9%), with oblique branches used more than other orientations (χ^2 = 25.135, df = 3, p < 0.0001). Tree species used by slender lorises are summarised in Table 1. Clearly, the species used most often by slender lorises was the 'ant tree' – *Humboldtia laurifolia* (Leguminaceae), on which they were observed 28.6% of sample points (*n* = 18), followed by *Arctocarpus nobilis* (Moraceae), used 15.9% of the time (*n* = 10) (χ^2 = 107.810, df = 18, p < 0.0001).

Botanical Composition

Of 387 surveyed trees, 27 families belonging to 40 species were recorded, of which 45% were endemic, 40% native, 7.5% introduced, with a remaining 7.5% for which no information was available, or the tree was unidentified. Of 286 individuals counted, 65.7% represented native species, 26.7% endemic species, 4.2% introduced species, with no information available for the remaining 3.8%.

The most abundant species recorded (*n* = 144) and representing 50.3% of counts was *Humboldtia laurifolia* (Leguminosae). Other relatively common species included: *Canthium dicoccum* (Rubiaceae) (3.5%, n = 10), *Casearia zeylanica* (Flacourtaceae) (3.5%, n = 10), *Dipterocarpus hispidis* (Dipterocarpaceae) (3.5%, n = 10), and *Melia azadirachta* (Meliaceae) (2.8%, n = 8). All other tree species were counted 7 times or less and are shown in Table 2.

The average height of trees in the sample was 5.3 m ± 4.32, with a minimum of 1.2 m and a maximum of 25 m. Twenty (50%) of the 40 recorded species had averages below 5.3 m. The average CBH was 20.2 cm ± 26.33; minimum was 3.5 cm with a maximum of 160 cm. The average DBH was 6.5 cm ± 8.39. The most common tree, *H. laurifolia,* had an average height of 3.9 m ± 1.19, and a DBH of 3.9 ± 2.4.

The average basal area of 185 trees was 83.3 ± 207.06 m^2/ha. Basal area of the 3 most common families was: 13.7 ± 19.12 m^2/ha (*n* = 98;

Table 1. — Frequency and percentage (of all plants, and of those which could be identified) at which slender lorises were encountered on different plant species (n = 86).

Family	Species	Percentage	Percentage of Identified Species	Frequency
	Unidentified	29.1		26
Leguminosae	*Humboldtia laurifolia*	20.9	28.6	18
Moraceae	*Arctocarpus nobilis*	11.6	15.9	11
Apocynaceae	*Alstonia macrophylla*	7.0	9.5	6
Verbenaceae	*Lantana camara*	5.8	7.9	5
Unknown	unidentified vines	4.7	6.3	5
Leguminosae	*Dalbergia* spp.	4.7	6.3	4
ground	Ground	3.5	4.8	3
Meliaceae	*Melia azadarachta*	3.5	4.8	3
Myristicacae	*Horsfieldia iryaghedi*	2.3	3.2	2
Dilleniaceae	*Dillenia retusa*	2.3	3.2	2
Euphorbiaceae	*Chaetocarpus castanocarpus*	2.3	3.2	2
Dipterocarpaceae	*Shorea* sp.	1.2	1.6	1
Euphorbiaceae	*Bridelia retusa*	1.2	1.6	1
Rutaceae	*Aronychia pedunculata*	1.2	1.6	1
Gramineae	*Bambusa vulgaris*	1.2	1.6	1

TABLE 2. — Floristic composition of sampled plots of the Masmullah Proposed Forest Reserve. Status: N = native, E = endemic, I = introduced

Family	Species	Count	Percent	DBH (CBH/π)	Status
Leguminosae	*Humboldtia laurifolia*	144	50.3	3.9 ± 2.4	N
Flacourtiaceae	*Casearia zeylanica*	10	3.5	1.7 ± 0.6	E
Rubiaceae	*Canthium dicoccum*	10	3.5	2.9 ± 2.95	E
Meliaceae	*Melia azadirachta*	8	2.8	9.3 ± 7.74	N
Dipterocarpaceae	*Dipterocarpus hispidis*	10	3.5	35.5 ± 21.84	E
Leguminosae	*Dalbergia spp.*	7	2.4	2.9 ± 1.21	Unknown
Euphorbiaceae	*Chaetocarpus castanocarpus*	7	2.4	1.6 ± 0.32	N
Euphorbiaceae	*Macaranga peltata*	7	2.4	5.9 ± 4.31	N
Anacardiaceae	*Semecarpus obovata*	6	2.1	35.5 ± 14.14	E
	Pinus	6	2.1	26.8 ± 7.43	I
Burseraceae	*Canarium zeylanicum*	5	1.7	9.2 ± 9.41	E
Celestraceae	*Bhesa ceylanica*	5	1.7	21.2 ± 17.15	E
Apocynaceae	*Alstonia macrophylla*	5	1.7	19.8 ± 12.52	I
Rhizophoracea	*Anisophyllea cinnamomoides*	5	1.7	8.2 ± 10.79	E
Moraceae	*Arctocarpus nobilis*	5	1.7	23.6 ± 12.84	E
Flacourtiaceae	*Homalium zeylanicum*	4	1.4	1.7 ± 0.35	N
Euphorbiaceae	*Aporusa lindleyana*	4	1.4	4.7 ± 2.73	E
Dilleniaceae	*Dillenia retusa*	4	1.4	17.2 ± 18.16	E
Myristicaceae	*Horsfieldia iryaghedhi*	3	1.0	14.3 ± 15.53	E
Theaceae	*Ternstroemia japonica*	3	1.0	2.4 ± 0.97	N
Dilleniaceae	*Tetracera sarmentosa*	2	0.7	4.0 ± 0.23	Unknown
Verbenaceae	*Vitex altissima*	2	0.7	17.0 ± 2.03	N
unidentified	unknown	2	0.7		Unknown
Myrsinaceae	*Ardisia willisi*	2	0.7	2.6 ± 0.79	E
Thymelaeaceae	*Gyrinops walla*	2	0.7	10.3 ± 6.62	N
Myrtaceae	*Szygium cumini*	2	0.7	1.8 ± 0.56	N
Euphorbiaceae	*Antidesma alexiteria*	2	0.7	3.3 ± 1.13	N
Olacaeae	*Strombosia ceylanica*	2	0.7	2.1 ± 0.23	E
Sapindaceae	*Dimocarpus longan*	2	0.7	3.0 ± 0.68	N
Rutaceae	*Acronychia pedunculata*	1	0.3	28.7	N
Annonaceae	*Xylopia parvifolia*	1	0.3	15.0	E
Euphorbiaceae	*Bridelia moonii*	1	0.3	3.8	E
Apocynaceae	*Pagiantha dichotoma*	1	0.3	7.6	N
Apocynaceae	*Walidda antidysenterica*	1	0.3	4.5	E
Euphorbiaceae	*Fahrenheitiea zeylanica*	1	0.3	1.8	N
Verbenaceae	*Tectona grandis*	1	0.3	11.6	I
Celestraceae	*Pleurostylia opposita*	1	0.3	3.5	N
Cornaceae	*Mastixia tetrandra*	1	0.3	1.6	E
Palmae	*Calamus zeylanicus*	1	0.3	1.9	E

Leguminosae), 57.7 ± 177.98 m^2/ha (n = 14; Euphorbiaceae), and 2.6 ± 1.54 m^2/ha (n = 11; Flacourtiaceae). The largest basal areas were calculated for families represented by small samples, and were not common in the measured stand: 796.2 m^2/ha (n = 1, Moraceae and n = 1, Myristaceae) and 644.9 m^2/ha (n = 1, Rutaceae). Thus despite being the most abundant family containing the most abundant species, the basal area covered by Leguminosae is relatively small.

Density of ground cover between nearest neighbour trees using the Braun-Blanquet scale was recorded 186 times and showed the following distribution: 5-25% cover (60%), 25-50% cover (26%) and 50-75% cover (14%). Of 49 climbers associated with sampled trees, the following taxa were identified: *Dalbergia* sp. (Leguminosae) (59.2%), *Smilax zeylanica* (Smilacaceae) (10.2%), *Piper argyrophyllum* (Piperaceae) (8.2%), *Coscinium penestratum*

(Menispermaceae) (6.1%), and *Tetracera sarmentosa* (Dilleniaceae) (6.1%). The remaining 10.2% could not be identified.

The density of the most common tree species (*H. laurifolia*) was 676 trees/ha, calculated with the T-square method. All other tree species had a density 404 trees/ha, and the average tree density of all trees in the sample was 1077 trees/ha. The calculated "t" value for the test of random distribution was greater than + 2.0 for all calculations (+ 5.0 – *H. laurifolia*, + 11.3, trees other than *H. laurifolia* and + 7.7, all trees combined), indicating a non-random distribution.

Of 272 tree species sampled, 40.4% are used in some way by humans (Ashton *et al.* 1997). This figure does not include *H. laurifolia* (*n* = 144).

Microhabitat of Area

286 trees measured 3.5 m or higher. The trunk was the available substrate at this height 11.3% of the time, followed by vines (35.1%), and branches (53.6%). Size availability of branches included: twigs < 1 cm (36.4%), small < 5 cm (33.8%), medium < 10 cm (17.9%), and large > 10 cm (11.9%).

When comparing substrate size availability with substrate use, a significant relationship was found in that slender lorises use the larger substrate categories less and smaller substrate classes more than expected by chance (χ^2 = 32.194, df = 5, p<0.001) (Fig. 2). Substrates were orientated in the following proportions: oblique (39.1%), vertical (30.5%), and horizontal (30.5%). There is no significant relationship between availability of orientation and loris substrate use, suggesting that lorises make use of available substrates relatively equally.

Potential Food Items

Of 186 trees surveyed, only 3% produced visible gum. Colonies of ants and termites, however, were found on 81% of trees surveyed, with only 19% of trees showing no obvious association with these colonial insects.

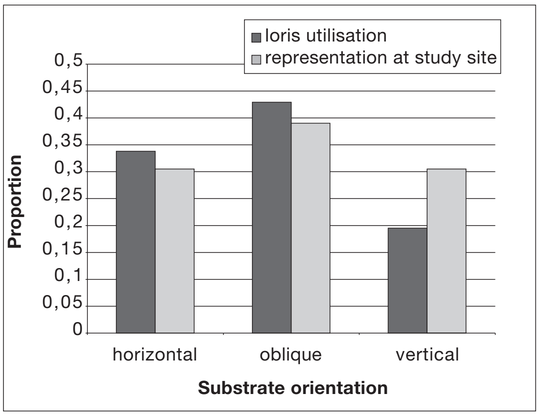

FIG. 2A. — Comparison of slender loris arboreal substrate use in terms of orientation, compared to support availability.

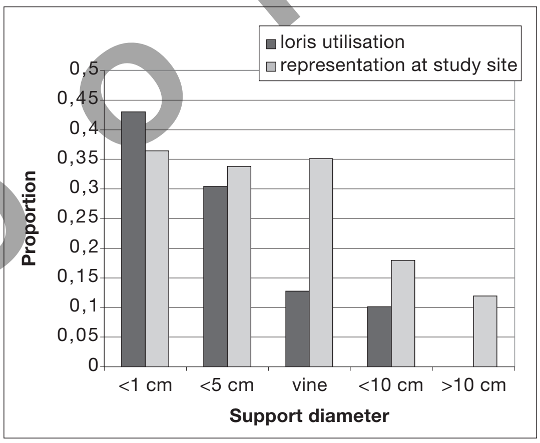

FIG. 2B. — Comparison of arboreal support size availability at Masmullah Proposed Forest Reserve and use by slender lorises.

Based on prior experience of slender loris sleep site preferences, we checked each tree for dense tangles, thick leaf cover, and tree holes. Of 186 trees, only 35 (19%) appeared to offer adequate sleeping places for slender lorises.

DISCUSSION

The results of this study suggest that the Masmullah Proposed Forest Reserve is highly disturbed as the result of chronic human degradation (Ashton *et al.* 2001). In particular, a high percentage of late-successional understory species accompanied by invasive vines and ferns, with few late-successional subcanopy trees, is characteristic of the sampled plots (Oliver & Larsen 1996, Ashton *et al.* 2001). These percentages, in combination with overall low average basal area, also are indicative of damage due to logging and unrestricted and open accessibility of the forest (Vetaas 1993, Bhuyan *et al.* 2003). Although removal of the largest timbers may be the chief cause of this degradation, pressure by villagers is extremely high on this small forest patch (Gunatilleke & Gunatilleke 1990, Pabla & Mathur 2001).

Slender lorises were never spotted in the villages on the outskirts of Masmullah Proposed Forest Reserve, were seen only once near one of the monasteries, and were infrequent in areas of later stage growth, where selective logging was evident (Nekaris & Jayewardene 2004). Red slender lorises, in all areas where they have been observed, differ from the larger bodied allopatric *L. lydekkerianus nordicus* of the dry zone of Sri Lanka in their inability to exist in areas of human disturbance (Nekaris & Jayewardene 2003). The finding of highest loris densities in areas where trees (*H. laurifolia*) least disturbed by humans are in abundance further supports this conclusion.

Humboldtia laurifolia, a rain forest understory species, is found throughout the wet lowlands of Sri Lanka (Ashton *et al.* 1997). In general, it is reported to be a gregarious tree species occurring in clumps of ten to over 100 individuals. This tree occurred in non-randomly distributed clumps in the Masmullah Proposed Forest Reserve. Despite the forest's harbouring relatively dense populations of lorises, these primates rarely occur outside patches of *Humboldtia*.

Humboldtia laurifolia has a mutualistic relationship with a variety of insects that reproduce and live within hollow stems characterised by internodal domatia with single, consistently placed entry holes. The primary residents of these internodes are ants (Koptur 1991). Fourteen different ant taxa, including the most dominant species *Technomyrmex albipes*, have been identified within these internodes (Krombein *et al.* 1999). This species alone is capable of occurring in colonies of 1-3 million individuals, in general to the exclusion of other ant taxa (Yamauchi *et al.* 1991). The presence of 14 ant taxa "packed" into *H. laurifolia* internodes is considered a rare example of spatial tolerance (Krombein *et al.* 1999).

In addition to ants, the pre-formed entry holes characterising the stems of *H. laurifolia* also allow for a surprisingly large suite of insect cohabitants (Krombein & Norden 1997, Krombein *et al.* 1999). Slender lorises, including those in the Masmullah Forest, are almost exclusively insectivorous, and have been observed to select formicids above all other prey items (Nekaris & Rasmussen 2003, Nekaris & Jayewardene 2003).

Climbers were associated with 13% of the trees sampled, which were on average 2.9 m apart. 88.9% of trees sampled provided some type of continuous substrate between trees at the height at which lorises most commonly move. Although these too indicate forest disturbance (Ashton *et al.* 2001), they also provide a favoured and continuous substrate for slender lorises. Even though predator density was low, movement on the ground still resulted in predation on slender lorises (Bearder *et al.* 2002). Potential predators occurring at this site include brown fish owl (*Ketupa zeylonensis*), rusty spotted cat (*Prionailurus rubignosa phillipsi*), golden palm civet (*Paradoxurus zeylonensis*) and the Ceylonese krait (*Bungarus ceylonicus*) (pers. obs). It has been suggested that the unique stealthy climbing locomotion of lorisines in general allows them to move silently on small sized substrates which would not easily sustain a potential predator's weight (Sussman 1999), thus making connecting branches vital for predator avoidance.

Only a small percentage of trees in the sampled area contained potential sleeping sites for lorises. Preliminary observations of sleeping site selection have been made for two populations of red slender lorises, at this site and at Bangamukanda Estate, Galle District (Nekaris 2003, Nekaris unpub. data). Sleeping site selection seems to parallel that of the Mysore slender loris (Bearder *et al.* 2002) in that sleeping trees are reused on a regular basis. This is unlike other lorisines, which regularly change their sleeping sites (e.g. Bearder *et al.* 2003; Kappeler 1998). Thus, a small proportion of potential sleeping sites does not seem to hinder slender loris populations in this forest.

This preliminary study illustrates that elevated red slender loris densities occur in patches of the Masmullah Proposed Forest Reserve characterised by high numbers of clustered *H. laurifolia*. Substrate availability is made continuous by presence of vines and lianas as well as relatively high densities of trees of the preferred loris height from the ground (3.5 m) and CBH (< 5 cm). The high food availability associated with *H. laurifolia* allows this endangered primate to persist in small well-defined clusters, away from areas of highest human degradation.

CONCLUSION

A high percentage of the understory species *H. laurifolia* in the absence of other late-successional dominant canopy species, is indicative of a type of chronic human disturbance, from which it is difficult for a forest to recover (Ashton *et al.* 2001). This tree species lives in colonies, resulting in small patches of "good loris" habitat, isolated from other such patches. Slender lorises were seen on a number of late-successional and canopy tree species (e.g. *Shorea, Alstonia*), suggesting that they will indeed use other areas of the forest if disturbance by human impact was lessened. Growing population pressure and subsequent subsistence requirements necessitate immediate instigation of restoration programmes, which in such a highly disturbed environment, can take years to propagate (Ashton *et al.* 2001; Weerakoon 2001). Further studies are clearly necessary to preserve the diversity, and to begin reforestation plans, in this rapidly disappearing semi-protected forest, in a highly valuable floristic region.

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