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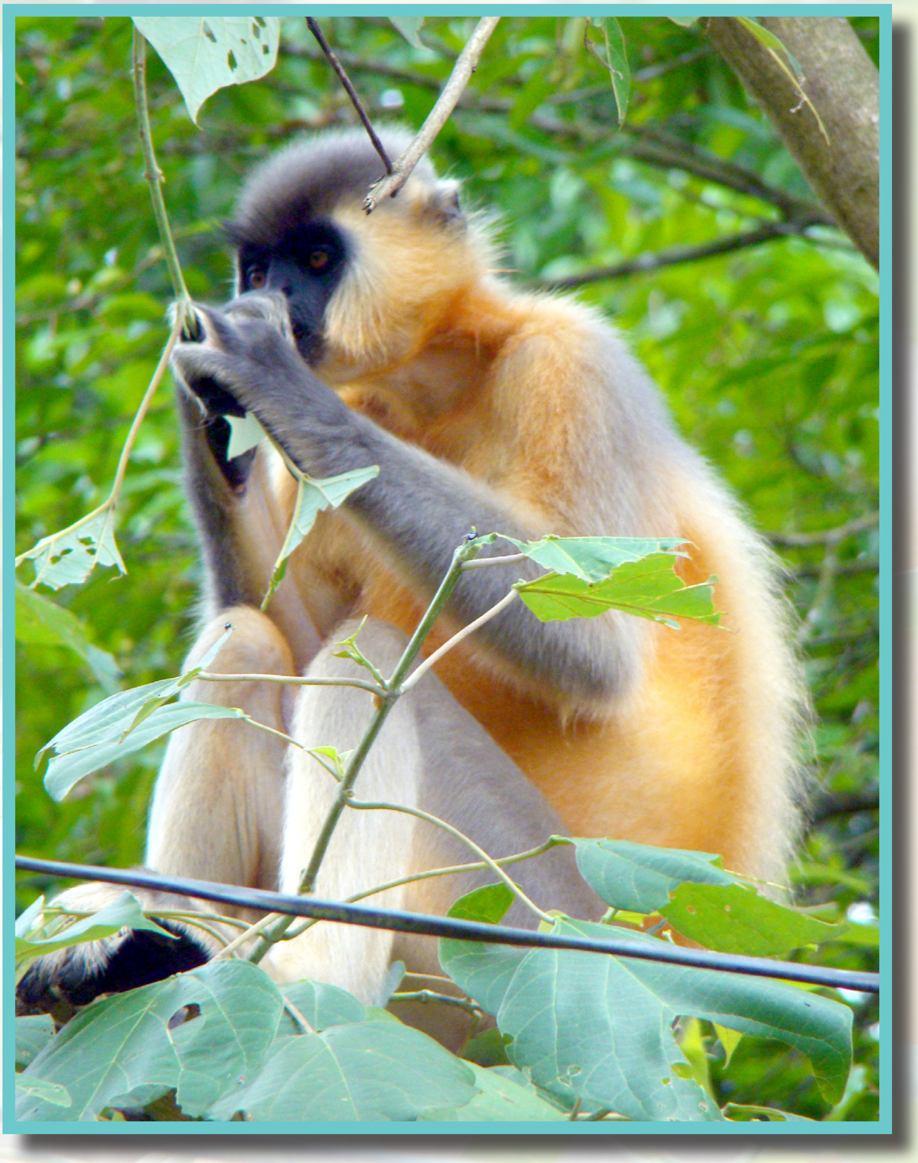

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Adult Capped langur *Trachypithecus pileatus.* Photo by Narayan Sharma

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FOREWORD

Welcome to another issue, broad in taxonomic and geographic scope. It includes ecological papers on Phayre's Leaf-monkey in Thailand, Sangihe Island Tarsiers near Sulawesi and Bornean Orangutans in central Kalimantan, a report on Bangkok's forgotten Long-tailed Macaque population, and an exploration of attitudes to primates in Manipur, northeast India.

As ever we've had mixed news for Asian primate conservation in recent times, exemplified by the global orang-utan stronghold in Sumatra's remarkable Leuser Ecosystem, Banda Aceh, Indonesia. Unfortunately a draft Aceh Spatial Plan and Government Regulation (Qanun RTRW Aceh) looks set to fragment Leuser, with roads, mines, oil palm and timber concessions, which could greatly impoverish the forest and the ecosystem services it provides. On the plus side, illegal forest burning in Tripa Peat Swamps in Leuser led to a landmark court ruling, hefty fine and forest restoration order against palm-oil company PT Kallista Alam. Still, the Spatial Plan could replace this with legal losses, and we can only hope the decision-makers will think again.

Similar hope surrounds a global initiative, United for Wildlife, to clamp down on illegal wildlife trade. Although more focused on the flagship species of Africa, the improved coherence against Asia's smuggling syndicates, coupled with more concerted and nuanced public-engagement efforts, could help tip the balance against the criminal threats to primates and other species. If so it will come too late, alas, for some Asian primate populations, including China's last Northern White-cheeked Gibbons which have now probably disappeared from Yunnan.

There have been some conservation gains. The forests of Sirsi-Honnavara in India's Western Ghats have been declared the "Aghanashini Lion-tailed Macaque Conservation Reserve," having been found a key stronghold of the Lion-tailed Macaque. In taxonomic news, recent additions to the recorded Asian primate fauna are the Kayan River Slow Loris *Nycticebus kayan* of central and northern Borneo and the Mishmi Hills Western Hoolock Gibbon *Hoolock hoolock mishmiensis* from northeast India.

The 25th Congress of the International Primatological Society will be in Asia in 2014, in Hanoi, with the theme "Meeting the Challenges of Conserving Primate Diversity." One area expected to be discussed is primate-human conflict, which has made the news in various countries, and was discussed at the Asia for Animals Conference in January. Issues like the controversial mass cull of Long-tailed Macaques in Malaysia, and the ongoing problems of orang-utans in agro-landscapes, prompt the question: is a more compassionate conservation possible?

We end by paying tribute to one of the world's great primatologists and primate conservationists, Alison Jolly, who died in February 2014. Alison's contribution was immense: from pioneering theory on the influence of social complexity on intelligence and early recognition of female dominance in lemurs, through a great corpus on the Ring-tailed Lemurs of Berenty, and a string of children's books. Above all she fought for conserving these species and their habitats, and did so with spirit, good humour and modesty. She'll be greatly missed.

Editors

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DIET OF PHAYRE’S LEAF-MONKEY IN THE PHU KHIEO WILDLIFE SANCTUARY, THAILAND

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ABSTRACT

Trachypithecus is reported to rely more on leaves, and predicted to eat more mature leaves, than other Asian colobines. I therefore predicted that leaves should dominate the diet of Phayre’s Leaf-monkeys *Trachypithecus phayrei* (Blyth). To test this, I conducted five 20-minute focal samples each month (June 2004 to May 2005) for all adult monkeys in three social groups (N=23), with instantaneous sampling of behavior at one-minute intervals (N=24,439). Based on feeding time, the percentage of instantaneous samples within each dietary category, leaves were the dominant food item (46.2%) as predicted, with young leaves (31.3%) eaten more than mature leaves (12.4%). Fruit represented 39.5% of the diet, with monkeys consuming seeds and pulp from immature fruits (23.9%) more than mature fruits (12.6%). Flowers comprised 8.9% of the diet, while bamboo shoots, insects, and other items represented less than 5%. Insects and bamboo shoots were important for a period of less than two months. Diet varied across the year, with immature fruits becoming important as immature leaves disappeared from the diet. Most food items came from 28 plant genera, many of which are consumed throughout the year. *Trachypithecus phayrei* consumed more mature leaves than reported for *Presbytis* and *Nasalis*, providing support for stronger adaptation to a leaf diet.

Keywords: Asian colobines, folivorous diet, Phayre’s Langur, *Trachypithecus phayrei*, *Trachypithecus*

INTRODUCTION

Colobines receive the name “leaf-eating monkeys” from their dietary preference for the consumption of leaves. This preference derives from a set of anatomical adaptations shared across taxa that allows them to maximize their nutritional intake from difficult-to-digest leaves. These adaptations include molar teeth with high cusps and ridges for breaking down leaf cellulose, and multi-chambered stomachs with associated symbiotic bacteria that aid in the degradation of plant fibers while maximizing opportunities to absorb carbohydrates and proteins (Kay & Davies, 1994). This adaptive morphological complex allows Asian colobines to subsist on the ubiquitously-available leaves found in a wide variety of forest habitats. Consequently, leaves feature prominently in the diets of many Asian colobines.

While specialized teeth and stomachs allow Asian colobines to digest nutritionally-challenging mature leaves, many Asian colobines demonstrate a behavioral bias towards selecting young leaves, which are lower in plant fiber, and therefore easier to break down in the mouth and stomach, and have fewer plant secondary compounds, making them easier to digest (Yeager & Kool, 2000). For example, 46% of the total feeding time of *Trachypithecus auratus* (É. Geoffroy) is directed towards the acquisition and consumption of young leaves (Kool, 1992; 1993).

Asian colobines complement their leafy diets with additional food items. Like many other primate species, fruits and seeds make up an important part of colobine diets. Many Asian colobines appear to target fruits when they are immature, avoiding the negative effects that the fruits’ simple sugars have on the ability of the stomach’s microflora to break down the cellulose in leaves (Waterman & Kool, 1994). Asian colobines show a similar preference for the seeds of immature fruits, as the seeds of mature fruits typically contain greater concentrations of plant secondary compounds, which are known to interfere with digestion and absorption of nutrients (Waterman & Kool, 1994). When *Trachypithecus vetulus* (Erxleben) consumed fruits, for example, they targeted fruits that were unripe, dry and fibrous, rather than ripened fruits (Hladik, 1977), and *Rhinopithecus avunculus* (Dollman) consumed more immature fruits than mature ones (Le *et al*., 2007). In addition to fruits and seeds, Asian colobines may also consume soil and gum (Oates *et al*., 1980), but typically not animal matter (Oates *et al*., 1980; Stanford, 1991), with the exception of Hanuman langurs *Semnopithecus entellus* (Dufresne), for whom insects made up 2.8% of the annual diet.

The dietary preferences of Asian colobine species varies seasonally, in response to environmental changes in food abundance, patch density and distribution, and food quality. When preferred foods such as mature fruits and young leaves are scarce, Asian colobines shift their diets to include more low-quality, subsistence items such as mature leaves (Hladik, 1977; Newton, 1992; Bennett & Davies, 1994).

In addition to preferences for particular categories of food, Asian colobines also demonstrate preferences for particular food species. For example, *T. vetulus* was found to consume 23 different plant species over the course of a study, yet 70% of the annual food intake came from only three species (Hladik, 1977). Even Asian colobines with a broader diet demonstrate strong preferences for only a few plant species; *Trachypithecus johnii* (J. Fischer) consumed 102 different plant species, yet 45% of their diet came from only three species (Oates *et al*., 1980). Preference for particular food items is typically measured with a selectivity index, and is calculated as the ratio of the prevalence of a food species in the monkey's diet to the prevalence of the food species in the environment (Krebs, 1989). Preferred or selected foods occupy much of the feeding time, but are relatively less common in the environment. For example, *Trachypithecus francoisi* (Pousargues) in China chose a large proportion of their diet from ten plant species, and only three of these were among the ten predominant species at the site (Zhou *et al*., 2009). Also, when Asian colobines rely heavily on a few particular species of plants, different parts of each plant are harvested at different times of the year. Some trees, for example, are sources of young leaves, flowers, and fruits, depending on phenological condition (Hladik, 1977).

While it is possible to generalize about the diet of Asian colobines, there is also a lot of variation in feeding behavior across taxa. A big part of the variation arises from the broad geographic distribution of Asian colobines, which range from Pakistan and India to China, and down to Borneo (Groves, 2001). And while many species occupy tropical or sub-tropical forests in these areas, others live in extreme habitats, such as high-altitude, high-latitude, or karst rock formations (Li *et al*., 2009; Zhou *et al*., 2009; Workman, 2010).

Potentially important taxonomic variation in diet can be found in members of the genus *Trachypithecus*, which consume a greater amount of leaves than do most other Asian colobines (Kirkpatrick, 2011). Anatomical specialization may explain this preference, as members of the genus *Trachypithecus* have more effective shearing crests on molar teeth, and larger forestomachs than other Asian colobines, both of which are adaptations for breaking down the hard-to-digest cellulose found in leaves, and in mature leaves particularly (Kay & Hylander, 1978; Chivers & Hladik, 1980; Davies, 1991; Chivers, 1994; Kirkpatrick, 2011). Kirkpatrick hypothesizes that these adaptations make *Trachypithecus* better adapted to digest leaves than other Asian colobine genera, leading to the expectation that leaves should feature in the diets of *Trachypithecus*. Additionally, an unstated implication here is that these adaptations could permit a heavier reliance on mature leaves for *Trachypithecus*, as the anatomical adaptations appear to aid in the digestion of cellulose, found in higher proportions in mature leaves than in immature leaves (Milton, 1979). Kirkpatrick (2011) suggests that the mechanical ability of *Trachypithecus* to consume leaves may drive niche separation where *Presbytis* species overlap with *Trachypithecus*. It also may explain the broad distribution of species of *Trachypithecus*, allowing them to shift to leaves in marginal environments (Kirkpatrick, 2011). Kirkpatrick does note an important exception to this hypothesis, however; based on an eight-month study *T. auratus* does not consume more leaves than do other sympatric Asian colobine species (Rodman, 1978; Ruhiyat, 1983; Kool, 1993; Kirkpatrick, 2011). Other more recent research seems to support a preference in *Trachypithecus* for leaves, but also indicates a preference for young leaves over mature leaves, despite their anatomical specializations. These data come primarily from studies of monkeys living in marginal environments characterized by limestone karst rock formations, perhaps leading to phenotypic differences compared to monkeys found in non-karst evergreen tropical forests (Li *et al*., 2009; Zhou *et al*., 2009; Workman, 2010).

In this paper, I present the dietary and ecological data collected on three groups of *Trachypithicus phayrei* (Blyth) studied across a full year in a seasonal, subtropical habitat in northeastern Thailand, and examine the diet in light of Kirkpatrick's hypothesis that *Trachypithecus* species derive a higher proportion of their annual diet from leaves, and his hypothesis of a heavier reliance on the more difficult-to-digest mature leaves, compared with other Asian colobines, particularly the closely related *Presbytis* species.

METHODS

Data were collected at the Phu Khieo Wildlife Sanctuary (N16°05-35', E101°20-55'), located in northeastern Thailand (Fig. 1). The Phu Khieo Wildlife Sanctuary is part of the Western Isaan Forest Complex, and covers an area of approximately 5,948 km^2. The study site, Huai Mai Sot, is located within the center of the sanctuary (N16°27', E101°38') at an altitude of 600-800 meters above sea level, and is characterized by a mosaic of forest types, including dipterocarp forest, bamboo stands, primary and secondary wet forest, and dry evergreen forest (Borries *et al*., 2002). The field site is also home to White-handed Gibbons *Hylobates lar* (Linneaus), Assamese Macaques *Macaca assamensis* M'Clelland, Southern Pig-tailed Macaques *Macaca nemestrina* (Linnaeus), Rhesus Macaques *Macaca mulatta* (Zimmermann), and the Bengal Loris *Nycticebus bengalensis* (Lacépède); Stump-tailed Macaques *Macaca arctoides* (I. Geoffroy) have been only rarely encountered.

I studied the diets of three groups of *T. phayrei*, designated as PA, PB, and PS, whose ranges were entirely within the study area. With the help of project field assistants, I followed each group for one week each month from June 2004 to May 2005. For each follow, I conducted five 20-minute focal observations on each adult male and female monkey in the group, using a stratified random design with observations spread evenly throughout the daylight hours. During the focal observations, I conducted instantaneous sampling of the focal subject's behavior at one-minute intervals. When focal subjects were engaged in a foraging or feeding behavior (feeding, handling a food object, or reaching for the next food object), I recorded the category of food (leaves, fruit, animal matter, etc.), the phenophase of plant parts (immature or mature), and the parts of the plants consumed (leaves, petiole, flowers, flower buds, etc.). With the help of assistants, I then marked the feeding patch for later data collection.

At the end of each week with a group, a field assistant and I returned to all of the marked feeding patches. As an estimate of crown volume and potential productivity, we measured the diameter of each tree at breast height (DBH, an effective approximation of patch size: Chapman, 1992). We collected plant samples for identification. Botanical samples were identified by two Thai botanists, Dr Wichan Ed-thong and Tosaporn Naknakled. Where identifications differed, I present the identifications from Dr Ed-thong who compared them to botanical samples available at Botany Department of Kasetsart University.

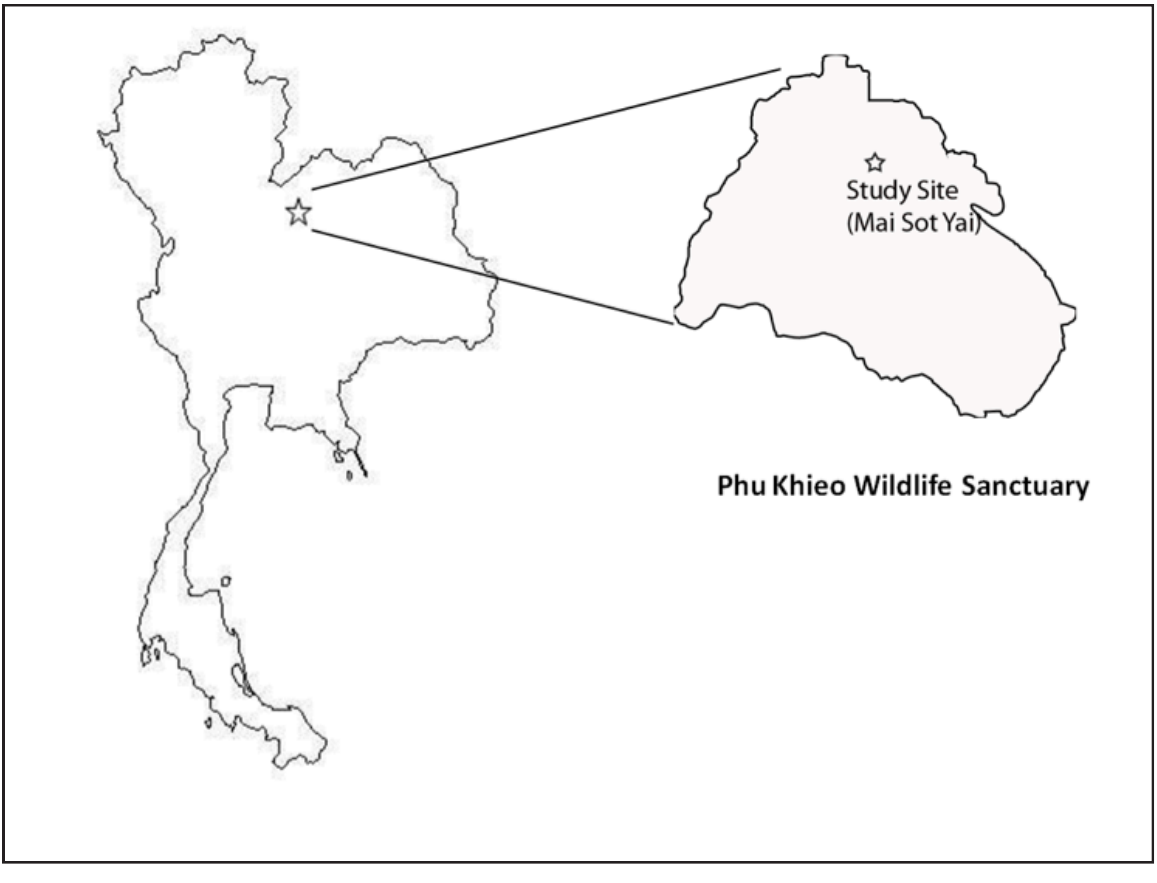

Fig. 1. Location of the Phu Khieo Wildlife Sanctuary, Thailand.

I calculated time spent feeding as the percentage of instantaneous sample points in which focal monkeys actively consumed food items, divided by the total number of sample points. The relative importance of particular food items is calculated as the total number of instantaneous sample points feeding on that food item, divided by the total number of instantaneous sample points during which feeding was observed.

At the time of the study, three 50 m x 50 m botanical plots had been established within the home ranges of the three groups. Within each plot, local botanists identified all trees with DBH greater than 10 cm and all climbers with DBH greater than 5 cm. I calculated the relative density of each species as the number of stems of that species within the plots, divided by the total number of stems of the respective size category within the plot. Systematic phenological data for these plant species had not begun at the time of this research, and thus, phenological data are not available; the results of this project were used to inform future phenological data collection.

I calculated a selectivity index to measure the preference of the focal subjects for particular plants. Because of difficulties of correlating species identifications between botanical plots and those plants sampled in the diet of focal subjects, I calculated selectivity at the generic level rather than the species level. While some selectivity indexes use basal area to estimate abundance of each plant type, the mix of trees and climbers in the plots and diet made comparisons between each difficult. Therefore, I relied on the proportion of individual stems to represent the abundance of plant species in the environment. The selectivity index was consequently calculated as the proportion of each genus as represented in the diet, divided by the proportion of each genus as represented in the botanical plots (Krebs, 1989). For each genus, a selectivity index of greater than one is taken to represent a preferred food item, while a selectivity index of less than one represents food items that are avoided. I ranked each genus for preference in the diet as well as representation in the botanical plots, and tested correlations between these ranks using Spearman's Rank correlation. All statistical tests were conducted using the JMP 8.0.1 statistical package (Copyright 2009 SAS Institute Incorporated).

RESULTS

During the year of data collection on focal animals of the three groups, I collected a total of 24,439 instantaneous sample points, of which 29% (7197 samples) included observations of focal subjects engaged in feeding or food-processing behavior. For all data collected across the year, leaves were the most important food item (46%), followed by fruits (39.5%), and flowers (8.9%), with all other feeding categories consisting of less than 5% of the annual diet (Table 1). Phayre's Leaf-monkeys consumed more young leaves than mature leaves, and immature fruits were consumed more than mature fruits (Table 1). While many of the young fruits were consumed whole, for most young fruits, only the immature seeds were consumed.

Table 1. Annual diet of Phayre's Leaf-monkeys.

Food Category	Percentage of Annual Diet
Leaves (all)	46.2%
Young leaves	31.3%
Mature leaves	12.4%
Fruit (all)	39.5%
Immature fruit	23.9%
Mature fruit	12.6%
Flowers	8.9%
Animal matter	3.6%
Shoots	0.2%
Drink	0.4%
Bark	0.3%
Wood	0.2%
Salt lick	0.5%
Pith	0.1%
Gum	<0.1%
Unidentified	0.3%

The categories Leaves (all) and Fruit (all) include food items of unknown maturity or ripeness.

The monthly proportion of feeding categories varied seasonally across the year, with different feeding categories becoming important in the diet during different months throughout the year (Table 2). The percentage of young leaves in any particular month is inversely correlated with the percentage contribution of immature fruits in that month (Spearman's Rho=-0.7552, p=0.0045), while all other pair-wise comparisons of food categories showed no statistically significant correlations.

Table 2. Monthly variation in diet composition of Phayre's Leaf-monkeys.

	Mature fruit	Young fruit	Mature leaves	Young leaves	Flowers	Bamboo shoots	Proportion of monthly diet
Jun. 2004	8.8%	3.5%	50.8%	18.8%	4.6%	0.4%	86.9%
Jul. 2004	8.7%	23.0%	18. 7%	25.7%	1.2%	2.3%	79. 7%
Aug. 2004	14.7%	49.0%	2.3%	9.3%	1.5%	0.4%	77.3%
Sep. 2004	34.2%	17.8%	9.1%	10.3%	5.3%	1.6%	78.3%
Oct. 2004	24.8%	28.1%	18.7%	20.5%	1.1%	0.0%	93.2%
Nov. 2004	3.0%	41.5%	21.5%	22.4%	0.5%	0.0%	88.9%
Dec. 2004	13.0%	25.9%	21.7%	23.7%	5.1%	0.1%	89.6%
Jan. 2005	10.2%	51.8%	19.0%	5.8%	3.3%	0.0%	90.2%
Feb. 2005	5.8%	0.8%	3.6%	62.5%	12.6%	0.0%	85.4%
Mar. 2005	15.0%	2.4%	0.5%	29.7%	50.0%	0.0%	97.8%
Apr. 2005	3.8%	0.0%	2.7%	91.0%	0.3%	0.0%	97.8%
May 2005	0.0%	5.3%	13.5%	64.9%	9.8%	0.0%	93.5%

The percentage contribution of young leaves in a month is inversely correlated with the percentage contribution of young fruits in the diet. (Spearman's Rho=-0.7552, p=0.0045). All other pair-wise comparisons are non-significant. The dry season begins in mid-October, and continues through March, while the wet season runs from April through September.

While Phayre's Leaf-monkeys fed primarily in trees (67% of the total feeding patches), they also spent a large amount of time feeding in climbers (28% of the total feeding patches), with the rest of their foraging efforts dedicated to feeding in epiphytes and stranglers. Feeding trees vary greatly in size, with mean DBH of 38.8 cm (N=86, SD=23.1). Though infrequent, Phayre's Leaf-monkeys also feed on or close to the ground when consuming bamboo shoots or soil, or when drinking water from creeks or from standing water.

The Phayre's Leaf-monkeys consumed parts from an average of 18.8 different plant species per month. Over the one-year study period, the monkeys consumed plant parts from more than 117 different plant species, comprising more than 43 different families. A majority of the feeding effort, however, was concentrated on only a few of these, with only 18 families and 22 species contributing more than 1% of the annual diet (Table 3), and only two species contributing more than 5% of the annual diet. Overall, 58.6% of the annual feeding time was spent consuming parts of these 22 species.

The results of selectivity analysis are presented in Table 4. Not all trees represented in the diet were also represented in the botanical plots. The results for the remaining 41 genera are presented here. These 41 genera represent 78% of the annual diet for Phayre's Leaf-monkeys. Twenty-eight genera, accounting for 66% of the annual feeding time, were represented at a higher proportion in the diet than in the botanical plots, and 13 at a lower proportion.

DISCUSSION

Phayre's Leaf-monkeys living in the Phu Khieo Wildlife Sanctuary in northeastern Thailand relied most heavily on leaves in their diet. Phayre's Leaf-monkeys spent most of their feeding time consuming young leaves and immature fruits and seeds, which together comprised 55.2% of the annual diet (Table 1). While leaves in general occupied almost 50% of the total annual feeding time, mature leaves accounted for only 12.4%, or 25% of all time eating leaves. This pattern contrasts with several published studies of this genus that show an equal or greater reliance on mature leaves, compared with immature leaves. For example, for *T. vetulus*, mature leaves were the most important food item, comprising 40% of the annual diet and 66% of the leaf diet (Hladik, 1977), with a similar proportion representing the annual diet of *T. pileatus* (Stanford, 1991). However, it does fit with observations from other studies of *Trachypithecus*. *Trachypithecus auratus* consumed more young leaves than mature leaves (46% compared with <10%) (Kool, 1993), as did *T. francoisi* (39% cf. 14%) (Zhou *et al*., 2006), *T. pileatus*

Table 3. Plant species comprising more than 1% of the annual diet based on number of feeding observations, with their individual and cumulative contribution to diet.

Family	Species	Plant part consumed	% of total diet	Cumulative contribution to total diet
Leguminosae	*Afzelia xylocarpa* Kurz	yl, fl, le, se, ex	10.7%	10.7%
Leguminosae	*Millettia leucantha* (Kurz) Craib	yl, fl	8.9%	19.5%
Moraceae	*Maclura cochinchinensis* (Lour.) Corner	yl, ml	4.5%	24.0%
Leguminosae	*Peltophorum dasyrrhachis* (Miq.) Kurz	se	4.3%	28.3%
Ulmaceae	*Ulmus lanceifolia* Roxb. ex Wall.	fl, yl, imm wh	2.6%	30.9%
Rubiaceae	*Psydrax umbellata* (Wight) Bridson	wh, imm wh	2.6%	33.5%
Leguminosae	*Dalbergia oliveri* Prain	se, imm se, yl	2.5%	35.9%
Leguminosae	*Bauhinia* sp.	yl, se	2.0%	37.9%
Leguminosae	*Albizia lebbeck* (L.) Benth.	imm wh, imm se	1.9%	39.8%
Asclepiadaceae	*Streptocaulon* sp.	ml, yl, wh	1.9%	41.7%
Leguminosae	*Albizia myriophylla* Benth.	imm se	1.7%	43.4%
Moraceae	*Artocarpus lakoocha* Roxb.	wh	1.7%	45.1%
Apocynaceae	*Amalocalyx microlobus* Pierre ex Spire	yl, ml, imm se	1.7%	46.8%
Ebenaceae	*Diospyros bejaudii* Lecomte	yl	1.6%	48.4%
Moraceae	*Ficus drupacea* Thunb.	wh	1.6%	50.0%
Labiatae	*Vitex* sp.	yl, ml, imm wh	1.6%	51.6%
Leguminosae	*Pterocarpus macrocarpus* Kurz	fl, yl, imm wh	1.5%	53.1%
Annonaceae	*Alphonsea elliptica* Hook.f. & Thomson	imm wh	1.3%	54.4%
Malpighiaceae	*Hiptage gracilis* Sirirugsa	yl, ml	1.1%	55.5%
Fagaceae	*Quercus augustinii* Skan	imm wh, wh	1.1%	56.6%
Sterculiaceae	*Pterocymbium macranthum* Kosterm.	unk	1.0%	57.6%
Euphorbiaceae	*Suregada multiflora* (A.Juss.) Baill.	imm wh, ml	1.0%	58.6%

Key: imm=immature, wh=whole fruits, se=seeds, ex=exocarp, yl=young leaves and leaf buds, ml=mature leaves, fl=flowers and flower buds, unk=unknown.

“Cumulative contribution to diet” refers to the total percentage of observations contributed by the important species up to and including the species mentioned.

Table 4. Selectivity Index for genera in the diet of Phayre's Leaf-monkeys.

Genus	Minimum number of species	Proportion of plot stems	Proportion of annual diet	Selectivity Index
Afzelia	1	0.13%	14.45%	108.62
Peltophorum	1	0.07%	4.68%	70.34
Canthium	2	0.07%	3.08%	46.34
Albizia	3	0.13%	4.53%	34.02
Artocarpus	1	0.13%	2.23%	16.76
Millettia	1	0.80%	11.39%	14.27
Gmelina	1	0.07%	0.79%	11.83
Atalantia	1	0.07%	0.77%	11.50
Vitex	2	0.27%	2.14%	8.05
Dehaasia	1	0.07%	0.44%	6.57
Ficus	6	0.86%	5.27%	6.09
Ulmus	1	0.66%	3.46%	5.19
Dalbergia	2	0.73%	3.76%	5.14
Adenanthera	1	0.13%	0.42%	3.12
Ziziphus	1	0.07%	0.20%	2.96
Xanthophyllum	1	0.07%	0.17%	2.63
Psydrax	1	0.13%	0.33%	2.46
Siphonodon	1	0.13%	0.31%	2.30
Pterocarpus	1	0.40%	0.92%	2.30
Celtis	1	0.20%	0.44%	2.19
Walsura	1	0.13%	0.28%	2.14
Bauhinia	3	1.20%	2.43%	2.03
Quercus	1	0.93%	1.40%	1.50
Schefflera	1	0.33%	0.48%	1.50
Sapium	1	0.53%	0.74%	1.40
Suregada	1	0.07%	0.09%	1.40
Bombax	3	0.27%	0.33%	1.23
Apodytes	1	0.33%	0.35%	1.23
Sterculia	1	0.27%	0.24%	0.90
Ventilago	2	1.40%	1.18%	0.84
Rourea	1	0.66%	0.42%	0.62
Garcinia	3	2.12%	1.29%	0.60
Aporosa	1	0.66%	0.22%	0.33
Cananga	1	0.40%	0.13%	0.33
Tarennoidia	1	0.33%	0.09%	0.26
Mitrephora	1	2.73%	0.61%	0.22
Diospyros	4	13.44%	2.54%	0.19
Tetrastigma	1	2.26%	0.33%	1.14
Drypetes	1	4.86%	0.52%	0.11
Cratoxylum	1	1.60%	0.07%	0.04

The proportion of the plot stems is calculated as the number of stems for each genera found within the botanical plots for trees greater than 10 cm DBH and climbers greater than 5 cm DBH. Proportion of the annual diet is calculated as the number of instantaneous samples for all focal subjects feeding on a particular genus, divided by the total observed feeding time for all focal subjects. The selectivity index is calculated as the proportion in the annual diet divided by the proportion in the plot stems, where a value greater than one indicates a preference and a value below one indicates avoidance.

(Blyth) (57% cf. 6%) (Solanki *et al*., 2008) and *T. obscurus* (Reid) (36% cf. 22%) (Curtin, 1976). The lower reliance on mature leaves for Phayre's Leaf-monkeys in this study was evident across all months and seasons, with the exception of June 2006 (Table 2). While these data do support the hypothesis that dietary and digestive adaptations in *Trachypithecus* may permit a reliance on leaves in the diet, they do not fit the implication that anatomical adaptations should necessarily lead to a preference for mature leaves.

These data, however, are consistent with the implication of Kirkpatrick's hypothesis that *Trachypithecus* relies more heavily on the more difficult to digest mature leaves than do other Asian leaf-monkeys. Many studies of the diets of *Presbytis* and *Nasalis* suggest that mature leaves contribute less than 10% of the annual diet (Kirkpatrick, 2011). Observations of Phayre's Leaf-monkeys at the Phu Khieo Wildlife Sanctuary fit with other observations of *Trachypithecus* indicating an (albeit slightly) higher reliance on mature leaves, even when they are not the most important food item (Curtin, 1980).

One factor potentially contributing to the high proportion of young leaves in the annual diet of Phayre's Leaf-monkeys is that there are few competing folivorous species present in the Phu Khieo Wildlife Sanctuary (Hassel-Finnegan *et al*., 2008). For example, *T. obscurus* at Kuala Lompat, Malaysia, consumed more mature leaves than *Presbytis melalophos* (Raffles) at the same site (Curtin, 1980), presumably due to resource competition, as both species were seen to compete directly in shared resources (Curtin, 1980). The main dietary competitors at Phu Khieo Wildlife Sanctuary are *H. lar*, and several species of *Macaca*, all known to be primarily frugivorous when food sources are available and abundant (Thierry, 2007). Competing folivores are, therefore, not present at the site.

Across the year, Phayre's Leaf-monkeys spent most of their feeding time consuming young leaves and immature fruits and seeds, together comprising 55.2% of the annual diet (Table 1). As is consistent with the reported dietary preferences of many other Asian colobine monkeys (Curtin, 1980; Davies *et al*., 1988; Bennett & Davies, 1994; Yeager & Kool, 2000), Phayre's Leaf-monkeys consumed young leaves (31.3% of the annual diet) more than twice as often as mature leaves (12.4% of the annual diet) (Table 1). When whole fruits were consumed, they tended to be mature, typically fleshy, but not particularly sugary species such as *Ficus drupacea* Thunb., *Artocarpus lakoocha* Roxb. and *Quercus augustinii* Skan (pers. obs.). The second most important food item in the diet was immature seeds. Phayre's Leaf-monkeys frequently discarded the tough outer exocarps of immature fruits to consume immature seeds contained inside, to such a degree that it may be appropriate to describe them as seed predators (Davies, 1991).

The diet of Phayre's Leaf-monkeys varied across months in the year (Table 2). During this study, there was an inverse relationship between the quantities of immature fruits and young leaves in the diet. Most of the immature fruits were consumed during the dry season, which ran from October 2004 to March 2005. During these months, young-leaf consumption was low. Towards the end of the dry season, however, young leaves became increasingly important in the diet, as did flowers. It was during this time of the year that the common, small trees of *Millettia leucantha* Kurz were simultaneously presenting young leaves and flowers, and the Phayre's Leaf-monkeys spent a lot of time moving from tree to tree consuming both.

Other foods were seasonal for Phayre's Leaf-monkeys. Bamboo shoots were consumed during the wet season from June through August 2004. The monkeys descended close to the ground in large bamboo stands in order to break off bamboo shoots, which they broke open to consume the moist pith inside. While the annual and even monthly bamboo-shoot consumption time remained low, the monkeys invested a great deal of energy breaking into the bamboo shoots, suggesting they were a prized item. Feeding on bamboo is not described for most Asian colobines, with the exception of *T. johnii* (Oates *et al*., 1980), *Presbytis rubicunda* (Müller) (Davies, 1991) and *Rhinopithecus bieti* Milne-Edwards (Yang & Zhao, 1991).

Like a few other Asian colobines, Phayre's Leaf-monkeys also consumed animal matter during parts of the year (Oates *et al*., 1980; Davies, 1991; Stanford, 1991; Newton, 1992). During the month of September 2004, the leaf-monkeys spent part of the day traveling from one *Hopea ferrea* Laness. tree to another in *Hopea*-dominant forest to consume the unidentified caterpillars that had hatched on those trees. During this month, caterpillar consumption made up 25% of the diet, similar to the amount of caterpillar consumption seen in a single month's diet for *S. entellus* at the Kanha Tiger Reserve, India (Newton, 1992). Insects contributed less than one percent of the annual diet, however, which is consistent with relative unimportance of insects to most Asian colobines.

Phayre's Leaf-monkeys have a diet that is at the higher end of diet diversity for Asian colobine monkeys, though by no means the most diverse. The study subjects consumed 117 different plant species, from more than 43 different families (Table 3), and had a diet that was similar in species breadth to that of *T. johnii* at Kakichi (Oates *et al*., 1980) and *T. francoisi* at Nonggang Nature Reserve (Zhou *et al*., 2006). By comparison, other year-long studies found that *T. vetulus* consumed only 28 plant species at Polonnaruwa (Hladik, 1977) and *T. pileatus* consumed 35 at Madphur (Stanford, 1991). The number of plant species consumed is almost certainly a reflection of the productivity and diversity of the habitats. For example, tree-species diversity has been shown to be high in dipterocarp forests of Southeast Asia (Whitmore, 1984), and dietary diversity appears to be lower in leaf-monkeys living in habitats dominated by karst limestone formations (Zhou *et al*., 2006; Li *et al*., 2009; Workman, 2010). The Huai Mai Sot study area used by the Phayre's Leaf-monkeys in this study is characterized by a patchy array of habitat types, varying from open dipterocarp forest, *Hopea*-dominant forest, primary and secondary wet forest, and forest dominated by large bamboo stands. This patchy habitat may contribute to floral diversity, leading to the broad diet diversity of the monkeys in this study.

Phayre's Leaf-monkeys concentrate their feeding efforts on only a few of the 117 different plant species that they consume, a pattern seen in other Asian primate species (Oates *et al*., 1980; Davies, 1991; Zhou *et al*., 2006; Li *et al*., 2009; Zhou *et al*., 2009), with 22 species making up almost 60% of their annual diet, and the top three species making up almost 25% of the annual diet (Table 3). Twenty-eight genera, accounting for 42 species in the diet, could be considered to be preferred by Phayre's Leaf-monkeys, with selectivity indexes greater than 1.0 (Krebs, 1989). The rest are consumed less often than they are encountered. The most preferred genus, with the single species *Afzelia xylocarpa* (Kurz) Craib, is consumed year-round, and serves as a source of young leaves, flowers, and immature seeds. This pattern of heavy reliance on a few available tree species year-round is typical for Asian colobine monkeys (Hladik, 1977; Curtin, 1980; Oates *et al*., 1980; Zhou *et al*., 2006; Li *et al*., 2009; Zhou *et al*., 2009).

Despite Kirkpatrick's suggestion that *Trachypithecus* may differ dietarily from other Asian colobines, these data support the assertion that *T. phayrei* fit the overall dietary pattern for Asian Leaf-monkeys.

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REFERENCES

Bennett, E.L. and Davies, A.G. 1994. The ecology of Asian colobines. **In**: *Colobine Monkeys: Their Ecology, Behaviour and Evolution*, G. Davies and J. Oates (eds.), pp. 129-171, Cambridge University Press, Cambridge, UK.

Borries, C., Larney, E., Kreetiyutanont, K. and Koenig, A. 2002. The diurnal primate community in a dry evergreen forest in Phu Khieo Wildlife Sanctuary, Northeastern Thailand. *Natural History Bulletin of the Siam Society* **50**: 75-88.

Chapman, C.A. 1992. Estimators of fruit abundance of tropical trees. *Biotropica* **24**: 527-531.

Chivers, D.J. 1994. Functional anatomy of the gastrointestinal tract. **In**: *Colobine Monkeys: Their Ecology, Behaviour, and Evolution*, G. Davies and J. Oates (eds.), pp. 205-227, Cambridge University Press, Cambridge, UK.

Chivers, D.J. and Hladik, C.M. 1980. Morphology of the gastrointestinal tract in primates: comparisons with other mammals in relation to diet. *Journal of Morphology* **166**: 337-386.

Curtin, S.H. 1976. Niche separation in sympatric Malaysian leaf-monkeys (*Presbytis obscura* and *Presbytis melalophos*). *Yearbook of Physical Anthropology* **20**: 421-439.

Curtin, S.H. 1980. Dusky and banded leaf monkeys. **In**: *Malayan Forest Primates. Ten Years' Study in a Tropical Rain Forest*, D.J. Chivers (ed.), pp. 107-145, Plenum Press, New York, USA.

Davies, A.G. 1991. Seed-eating by red leaf monkeys (*Presbytis rubicunda*) in dipterocarp forest of northern Borneo. *International Journal of Primatology* **12**: 119-144.

Davies, A.G., Bennett, E.L. and Waterman, P.G. 1988. Food selection by two south-east Asian colobine monkeys (*Presbytis rubicunda* and *Presbytis melalophos*) in relation to plant chemistry. *Biological Journal of the Linnean Society* **34**: 33-56.

Groves, C. 2001. *Primate Taxonomy*. Smithsonian Institution Press, Washington D.C., USA.

Hassel-Finnegan, H.M., Borries, C., Larney, E., Umponjan, M. and Koenig, A. 2008. How reliable are density estimates for diurnal primates? *International Journal of Primatology* **29**: 1175-1187.

Hladik, C.M. 1977. A comparative study of the feeding strategies of two sympatric species of leaf monkeys: *Presbytis senex* and *Presbytis entellus*. **In**: *Primate Ecology: Studies of Feeding and Ranging Behaviour in Lemurs, Monkeys and Apes*, T.H. Clutton-Brock (ed.), pp. 323-353, Academic Press, New York, USA.

Kay, R.F. and Hylander, W.L. 1978. The dental structure of mammalian folivores with special reference to Primates and Phalangeroidea (Marsupialia). **In**: *The Biology of Arboreal Folivores*, G.G. Montgomery (ed.), pp. 173-191, Smithsonian Institution Press, Washington D.C., USA.

Kay, R.N.B. and Davies, A.G. 1994. Digestive physiology. **In**: *Colobine Monkeys: Their Ecology, Behaviour and Evolution*, A.G. Davies and J.G. Oates (eds.), pp. 229-249, Cambridge University Press, Cambridge, UK.

Kirkpatrick, R.C. 2011. The Asian Colobines: Diversity Among Leaf-Eating Monkeys. **In**: *Primates in Perspective*, C.J. Campbell, A. Fuentes, K.C. MacKinnon, S.K. Bearder and R.M. Stumpf (eds.), pp. 189-202, Oxford University Press, New York, USA.

Kool, K.M. 1992. Food selection by the silver leaf monkey, *Trachypithecus auratus sondaicus*, in relation to plant chemistry. *Oecologia* **90**: 527-533.

Kool, K.M. 1993. The diet and feeding behavior of the silver leaf monkey (*Trachypithecus auratus sondaicus*) in Indonesia. *International Journal of Primatology* **14**: 667-700.

Krebs, C.J. 1989. *Ecological Methodology*. Harper and Row, New York, USA.

Le, K.Q., Duc, N.A., Tai, V.A., Wright, B.W. and Covert, H.H. 2007. Diet of the Tonkin snub-nosed monkey (*Rhinopithecus avunculus*) in the Khau Ca area, Ha Giang Province, Northern Vietnam. *Vietnamese Journal of Primatology* **1**: 75-83.

Li, Y., Ding, P., Huang, C., Jiang, P. and Wood, C. 2009. Dietary response of a group of Francois' langur *Trachypithecus francoisi* in a fragmented habitat in the county of Fusui, China: Implications for conservation. *Wildlife Biology* **15**: 137-146.

Milton, K. 1979. Factors influencing leaf choice by howler monkeys: a test for some hypotheses of food selection by generalist herbivores. *American Naturalist* **114**: 362-378.

Newton, P. 1992. Feeding and ranging patterns of forest hanuman langurs (*Presbytis entellus*). *International Journal of Primatology* **13**: 245-285.

Oates, J.F., Waterman, P.G. and Choo, G.M. 1980. Food selection by the South Indian leaf-monkey, *Presbytis johnii*, in relation to leaf chemistry. *Oecologia* **45**: 45-56.

Rodman, P.S. 1978. Diets, densities, and distributions of Bornean primates. **In**: *The Ecology of Arboreal Folivores*, G.G. Montgomery (ed.), pp. 465-478, Smithsonian Institution Press, Washington D.C., USA.

Ruhiyat, Y. 1983. Socio-ecological study of *Presbytis aygula* in west Java. *Primates* **24**: 344-359.

Solanki, G.S., Kumar, A. and Sharma, B.K. 2008. Feeding ecology of *Trachypithecus pileatus* in India. *International Journal of Primatology* **29**: 173-182.

Stanford, C.B. 1991. The diet of the capped langur (*Presbytis pileata*) in a moist deciduous forest in Bangladesh. *International Journal of Primatology* **12**: 199-216.

Thierry, B. 2007. The Macaques: A double-layered social organization. **In**: *Primates in Perspective*, C.J. Campbell, A. Fuentes, K.C. MacKinnon, M. Panger and S.K. Bearder (eds.), pp. 224-239, Oxford University Press, New York, USA.

Waterman, P.G. and Kool, K.M. 1994. Colobine food selection and plant chemistry. **In**: *Colobine Monkeys: Their Ecology, Behaviour and Evolution*, G. Davies and J. Oates (eds.), pp. 251-284, Cambridge University Press, Cambridge, UK.

Whitmore, T.C. 1984. A vegetative map of Malesia. *Journal of Biogeography* **11**: 461-471.

Workman, C. 2010. Diet of Delacour's langur (*Trachypithecus delacouri*) in Van Long Nature Reserve, Vietnam. *American Journal of Primatology* **72**: 317-324.

Yang, S. and Zhao, Q.-K. 1991. Bamboo leaf-based diet of *Rhinopithecus bieti* at Lijiang, China. *Folia Primatologica* **72**: 92-95.

Yeager, C.P. and Kool, K. 2000. The behavioral ecology of Asian colobines. **In**: *Old World Monkeys*, P.F. Whitehead and C.J. Jolly (eds.), pp. 496-521, Cambridge University Press, Cambridge, UK.

Zhou, Q., Huang, Z., Wei, X., Wei, F. and Huang, C. 2009. Factors influencing interannual and intersite variability in the diet of *Trachypithecus francoisi. International Journal of Primatology* **30**: 583-599.

Zhou, Q.H., Wei, F.W., Li, M., Huang, C.M. and Luo, B. 2006. Diet and food choice of *Trachypithecus francoisi* in the Nonggang Nature Reserve, China. *International Journal of Primatology* **27**: 1441-1460.

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Semnopithecus vetulus (Erxleben) and *Semnopithecus johnii* (Fischer) were until recently classified as members of the genus *Trachypithecus*, but due to genetic studies reclassified as members of *Semnopithecus* (Zinner *et al.,* 2013). However, both genera are closely related (Roos *et al*., 2011).

REFERENCES

Roos, C., Zinner, D., Kubatko, L.S., Schwarz, C., Yang, M., Meyer, D., Nash, S.D., Xing, J., Batzer, M.A., Brameier, M., Leendertz, F.H., Ziegler, T., Perwitasari-Farjallah, D., Nadler, T., Walter, L. and Osterholz, M. 2011. Nuclear versus mitochondrial DNA: evidence for hybridization in colobine monkeys. *BMC Evolutionary Biology* **11**: 77.

Zinner, D., Fickenscher, G., Anandam, M., Bennett, E.L., Davenport, T.R.B., Davies, N., Detwiler, K.M., Engelhardt, A., Eudey, A.A., Gadsby, E.L., Groves, C.P., Healy, A., Karanth, K.P., Molur, S., Nadler, T., Richardson, M., Riley, E.P., Rylands, A.B., Ting, N., Sheeran, L.K., Wallis, J., Waters, S.S., Whittaker, D. and Roos, C. 2013. Old World monkeys (Cercopithecidae). **In**: *Handbook of the Mammals of the World. Vol. 3: Primates*, R.A. Mittermeier and D.E. Wilson (eds.). Lynx Edicions, Barcelona, Spain.

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HOW ORANGUTANS CHOOSE WHERE TO SLEEP: COMPARISON OF NEST-SITE VARIABLES

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ABSTRACT

Primates spend a significant proportion of their lives at sleeping sites, and the selection of a secure and stable nest tree can be crucial for the individual's survival and fitness. This study examined nesting site preferences of Southern Bornean Orangutans *Pongo pygmaeus wurmbii* (Tiedemann) in a degraded peat-swamp forest in the Sabangau catchment, Central Kalimantan, Indonesia. Orangutan nests were identified during transect walks. Orangutans most frequently nested in trees in the families Anacardiaceae and Elaeocarpaceae. Orangutans preferentially chose trees with stilt roots or buttresses. We suggest that orangutan nest site selection is driven by comfort and stability rather than predator avoidance. The findings underline the importance of conserving habitat not only for food species, but also for nest-site species.

Keywords: location choice, nest tree, *Pongo*, security, sleeping-site

INTRODUCTION

Orangutans are arboreal apes with a geographic distribution limited to Borneo and Sumatra. Like other large-bodied apes, orangutans build night nests (MacKinnon, 1974; Morrogh-Bernard *et al.*, 2003; Ancrenaz *et al.*, 2004; Russon *et al.*, 2007; Morrogh-Bernard, 2009) which they rarely re-use. Day nests are constructed less frequently than night nests (van Schaik *et al.*, 1995; Ancrenaz *et al.*, 2004; Mathewson *et al.*, 2008): on average once every eight days in Borneo (Husson *et al.*, 2009). They are generally looser and have lower structural complexity than night nests; no differences have been noted in tree species used for day versus night nests.

Perhaps because of their large size, Bornean Orangutans *Pongo pygmaeus* (Linneaus) are thought to have few natural predators, and only records for predation by Sunda Clouded Leopards *Neofelis diardi* (G. Cuvier) have been reported (MacKinnon, 1974; van Schaik, 1983; van Schaik & van Hooff, 1996). Anderson (1998) posited that large apes are perhaps less concerned with predation avoidance than might be true of smaller primates, and instead favour nest trees that offer a comfortable place for the night (e.g. sites protected from wind and rain). Orangutans may sleep low in the forest canopy so that they are protected from wind and rain as well as evening and morning sun, but their relatively high body mass could also reduce the suitability of higher branches (Anderson, 1998).

Here we investigate characteristics of nest sites selected by the Southern Bornean Orangutan *Pongo pygmaeus wurmbii* (Tiedemann) in the Sabangau catchment, Central Kalimantan, Indonesia. The Bornean Orangutan is listed by the IUCN Red List as Endangered (Ancrenaz *et al.*, 2008) due to habitat loss and fragmentation, forest fires, hunting and the pet trade. Sabangau catchment is home to what may be one of the world's largest populations, with 6,000 orangutans (Morrogh-Bernard *et al.*, 2003) at a density of 2.28 individuals/km^2 - thus Sabangau supports a moderate density of orangutans compared with other sites (range 0.06 to 7.04, mean 1.98: Husson *et al.*, 2009). The area has been selectively logged (Page *et al.*, 1999) and thus availability of suitable nest sites may have been reduced. Various external loads and internal stresses act on trees and may affect their stability (Mattheck, 1994), i.e. their susceptibility to swaying in the wind. Orangutans might thus be expected to prefer trees with larger diameters and other features that increase stability (e.g. buttressed or stilted rooting systems).

METHODS

Study area

This work was carried out in the northern Sabangau forest, Central Kalimantan, Indonesia (Fig. 1), one of the largest peat-swamp forests in the world (Page *et al.*, 1999; Harrison *et al.*, 2010) and specifically in the Natural Laboratory of Peat-swamp Forest (S2.31° and E113.90°), operated by the Center for International Cooperation in Management of Tropical Peatland (CIMTROP). Data were collected throughout the year and all age-classes of orangutan nests were included. Behavioural and ecological studies at the site date from 2003 for orangutans (Morrogh-Bernard *et al.*, 2003).

Data collection

Data used in the present study were collected between July and September 2008. DR collected data on 180 orangutan nest trees which were located by transect walks (three transects of 2 km were walked twice each [separated by 30 days] for a total extent of 12 km). For this study nest trees were considered only where the orangutans exclusively used branches from a single tree to build the nest (120 of 180). Cases where more than one tree was used to make a nest were removed from the dataset, as it was not always clear which of these trees was the main support tree from which to measure tree characteristics. Data were not available on which age/sex class made the nest nor whether it was a day or night nest.

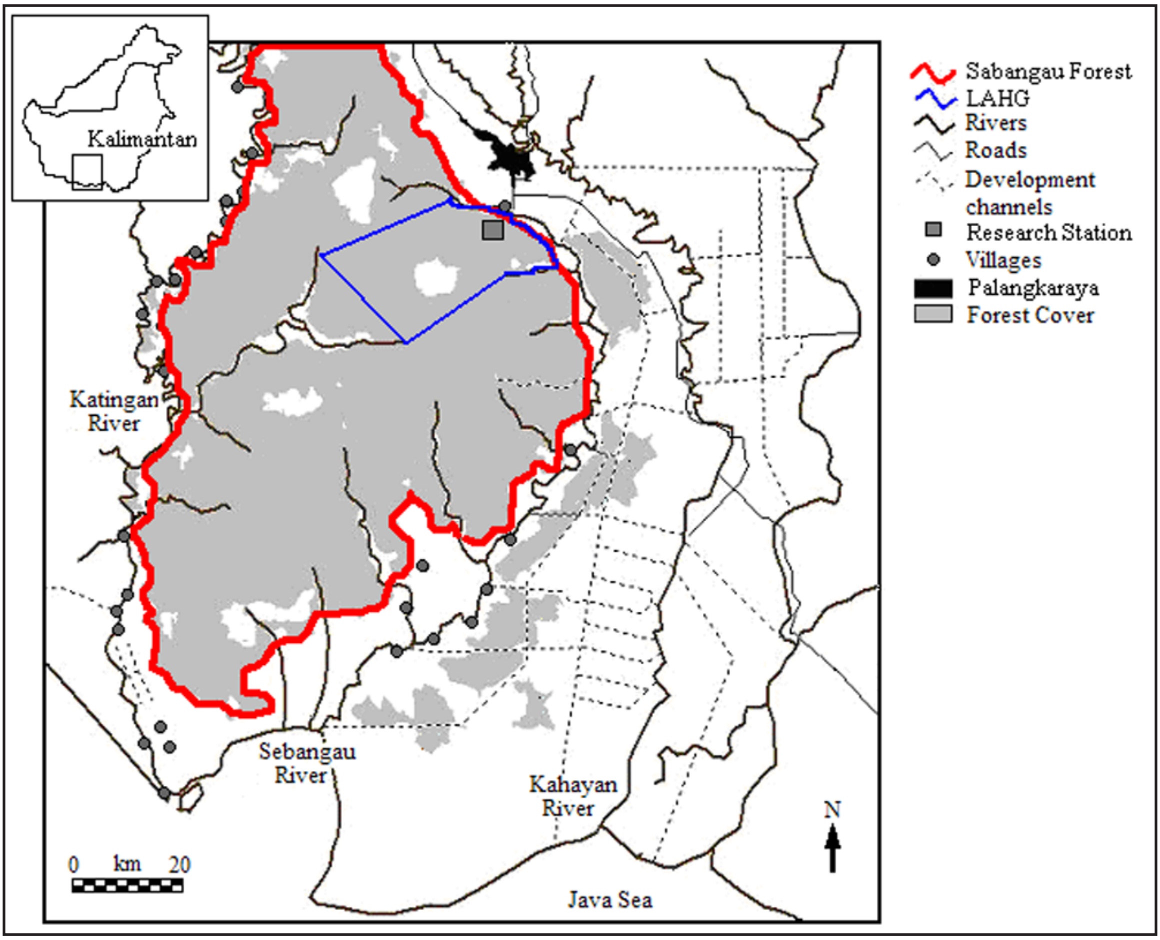

Fig. 1. Location of the Natural Laboratory for Peat-swamp Forest in the northeast of Sabangau catchment (in blue box)

All nest trees were identified to species level by knowledgeable local assistants, as well as using detailed species lists and descriptions for the study area (Harrison *et al.*, 2010). Data from six long-term phenology plots were used to determine whether the nest tree species are consumed by orangutans, and these plots were used to obtain the general abundance of tree species throughout the study site. Tree height class was visually estimated (1-5 m, 6-10 m, 11-15 m, 16-20 m, 21-25 m, 26-30 m, 31-35 m, 36-40 m or >40 m: Cheyne, 2010) following extensive training, and results averaged for analysis. Each tree's diameter at breast height (DBH) and basal circumference was measured. Basal circumference (Law *et al.*, 2008) was used as an indicator of the total area on the ground covered by the tree and an indicator of the spread of the weight of the tree and the accompanying supporting roots.

The trunks were qualitatively categorized as "buttress", "stilt" or "straight". The subjective categorization of canopy cover, root system, and exposure (the estimated percentage of the tree exposed to the wind) was made by DR for all orangutan nest trees. "Control" trees surrounding each nest tree were measured for all the above variables to provide data on general features of trees that were available but not selected, compared with those chosen by the apes (150 control trees >13 m).

Data analysis

Data was analysed in relation to tree family, tree height (in 5 m categories), canopy cover above the nest, root system, DBH, basal circumference (a proxy for stability), exposure (the inverse of the percentage of the tree canopy surrounded on a horizontal plane by canopy from other trees), and angle of the tree to the ground.

For individual predictor variables we used MANOVA to determine whether nest trees differed significantly from non-nest trees. Which variables were responsible for the preference given to a species was then tested by means of a multivariate analysis in the form of a Discriminant Function Analysis to identify any relationships between the significant variables and the degree of selection. Due to small sample sizes in some tree height classes, tree height data were analysed only descriptively. Statistical tests were carried out using SPSS 17.0, R 2.10.1 and OpenOfficeCalc, and MANOVA were two-tailed with α set at 0.05. Sample sizes for orangutan nest trees were always the same (N=120 nest trees and N=150 control trees).

RESULTS

Tree families

The 120 nest trees belonged to 52 species, in 14 or more families (three trees could not be identified). The largest proportion of orangutan nest trees belonged to the family Anacardiaceae (N=27 of 120; 22.5%). Orangutans slept in food-species trees on 75% of occasions (90 of 120 trees) and these trees contained edible parts on 40% of occasions (36 of 90 trees). Of the principal available canopy trees defined by Page *et al.* (1999), only four (22%) were used as nest trees and these belonged to the families Clusiaceae and Annonaceae. Of these four species, three (*Xylopia fusca* Maingay ex Hook.f. & Thomson, *Calophyllum hosei* Ridl. and *C. sclerophyllum* Vesque) are food species, but did not contain edible food parts at the time they were used as nest trees. Of the 52 species, eight species were found to be nested-in at proportions significantly different to those at which they are found in the forest as a whole. Of these, six (Table 1) showed a positive association (i.e. had a positive Jacob's D coefficient), but together these accounted for 52% of nest site selections. Only two species (*C. hosei* and *Palaquium leiocarpum* Boerl.) showed a significant negative association (Table 1).

Table 1. Tree species with significant positive or negative Jacob's D associations by nesting orangutans.

Species	Local name	Jacob's D
Diospyros areolata King & Gamble	Malam Malam	1.00
Elaeocarpus mastersii King	Mangkinang	0.92
Litsea grandis var. rufofusca (Kosterm.) Ng	Tampang	0.79
Campnosperma coriaceum (Jack) Hallier f.	Terontang	0.71
Tetranthera elliptica (Blume) Nees	Medang	0.65
Lithocarpus sp. 3	Pampaning Bayang 1	0.48
Calophyllum hosei Ridl.	Jinjit	-0.67
Palaquium leiocarpum Boerl.	Hangkang	-0.77

Individual predictor variables

Orangutan nest trees were lower than the surrounding canopy (mean nest tree height=15.1±SE0.43 m; range 1-5 to 31-35 m, N=120; mean control tree height=20.1±SE0.43 m; range 1-5 to 31-35 m, N=150). Exposure did not significantly predict presence of nests (Wilks' λ=0.997, F [0.328], p>0.05) but a closed canopy did (Wilks' λ=0.836, F [5.546], p<0.001). Trees with buttress or stilt roots (thus by association a large basal area) contained nests significantly more often than trees with no above-ground roots (Wilks' λ=0.973, F [8.610], p<0.005). Vertical trunks with respect to the ground were significantly more likely to contain nests than angled trunks (Wilks' λ=0.982, F [5.517], p<0.05). Orangutans made a nest in trees with large DBH significantly more often than in small DBH trees (Wilks' λ=0.845, F [5.419], p<0.05).

Discriminant Function Analysis

The DA method indicated that nest tree choice was most strongly related to the percentage canopy cover, the angle of the trunk, the root system of the tree and tree DBH (Table 2).

DISCUSSION

There was no evidence that orangutans were selecting trees to avoid predation, but indirect evidence showed that they were selecting sites based on comfort, specifically protection from wind and rain. Orangutans did show a clear preference for trees with larger diameter and features (e.g. buttressed or stilted rooting systems, and larger basal area) which reduce swaying in the wind (Nicoll & Ray, 1996; Soethe *et al.*, 2006).

Orangutans may choose comparatively low nest locations within the tree so that they are protected from strong wind, rain and sun (Anderson, 1984). Tree height tends to be proportional to DBH (Law *et al.*, 2008). Our results indicate that there is a positive relationship with DBH, i.e. orangutans select trees with a large DBH, despite the preference for lower tree height. Ancrenaz *et al.* (2004) found that in logged forest, tall trees were preferred for nesting sites, and most nests were in the upper part of the tree crown, where more leaves were available, and where the apes were not directly exposed to sunlight or rain. While the trees selected by Sabangau orangutans were not very high, they represented the upper crown and to this extent our findings support the results of Ancrenaz *et al.* (2004).

Six species made up 52% of nest tree selections, suggesting they may be especially attractive to nesting orangutans. Conversely two relatively abundant species, *C. hosei* and *P. leiocarpum*, were used less than expected by chance.

The importance of nest trees as a key component in orangutan habitats needs to be highlighted and prioritised for any habitat conservation initiative. Further investigation would be justified for this reason, including behavioural data and data on the individual orangutans which made the nest, to tease out differences in sex, or whether females with infants select nest sites for safety over stability.

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Table 2. DA analysis (Wilk's Lambda) of four tree characteristics.

Step	Variable entered	Wilk's Lambda Statistic	Exact F Statistic	df1	df2	Sig.
1	Canopy cover	0.813	64.821	1	165	0.000
2	Angle of basal trunk	0.795	38.070	2	163	0.000
3	Root system	0.755	31.621	3	161	0.000
4	DBH	0.632	16.802	4	157	0.000

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REFERENCES

Ancrenaz, M., Calaque, R. and Lackman-Ancrenaz, I. 2004. Orangutan nesting behavior in disturbed forest of Sabah, Malaysia: Implications for nest census. *International Journal of Primatology* **25**: 983-1000.

Ancrenaz, M., Marshall, A., Goossens, B., van Schaik, C., Sugardjito, J., Gumal, M. and Wich, S. 2008. *Pongo pygmaeus.* **In**: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>. Downloaded on 15 January 2013.

Anderson, J.R. 1984. Ethology and ecology of sleep in monkeys and apes. *Advances in the Study of Behavior* **14**: 165-230.

Anderson, J.R. 1998. Sleep, sleeping sites, and sleep-related activities: awakening to their significance. *American Journal of Primatology* **46**: 63-75.

Cheyne, S.M. 2010. Behavioural ecology and sociobiology of gibbons (*Hylobates albibarbis*) in a degraded peat-swamp forest. **In:** *Indonesian Primates,* Supriatna and S.L. Gursky (eds.), pp. 121-156. Springer, New York, USA.

Harrison, M.E., Husson, S.J., D'Arcy, L.J., Morrogh-Bernard, H.C., Cheyne, S.M., van Noordwijk, M.A. and van Schaik, C.P. 2010. *The Kalimantan Forests and Climate Partnership*. Palangka Raya, Indonesia.

Husson, S.J., Wich, S.A., Marshall, A.J., Dennis, R.D., Ancrenaz, M., Brassey, R., Gumal, M., Hearn, A.J., Meijaard, E., Simorangkir, T. and Singleton, I. 2009. **In**: *Orangutans: Geographic Variation in Behavioural Ecology and Conservation*, S. A. Wich, S. Suci Utami Atmoko, T. Mitra Setia and C.P. van Schaik (eds.), pp. 77-96. Oxford University Press, Oxford, UK.

Law, B.E., Arkebaue, T., Campbell, J.L., Chen, J., Sun, O., Schwartz, M., van Ingen, C. and Verma, S. 2008. *Terrestrial Carbon Observations: Protocols for Vegetation Sampling and Data Submission.* Global Terrestrial Observing System, Rome, Italy.

MacKinnon, J. 1974. The behaviour and ecology of wild orangutans *(Pongo pygmaeus). Animal Behaviour* **22**: 3-74.

Mathewson, P.D., Spehar, S.N., Meijaard, E., Nardiyono, Purnomo, Sasmirul, A., Sudiyanto, Oman, Sulhnudin, Jasary, Jumali and Marshall, A.J. 2008. Evaluating orangutan census techniques using nest decay rates: Implications for population estimates. *Ecological Applications* **18**: 208-221.

Mattheck, C. 1994. Design in nature. *Interdisciplinary Science Reviews* **19**: 298–314.

Morrogh-Bernard, H.C. 2009. *Orangutan Behavioural Ecology in the Sabangau Peat-swamp Forest.* PhD Dissertation, Cambridge University, UK.

Morrogh-Bernard, H., Husson, S., Page, S.E. and Rieley, J.O. 2003. Population status of the Bornean orangutan *(Pongo pygmaeus)* in the Sebangau peat swamp forest, Central Kalimantan, Indonesia. *Biological Conservation* **110**: 141-152.

Nicoll, B.C. and Ray, D. 1996. Adaptive growth of tree root systems in response to wind action and site conditions. *Tree Physiology* **16**: 891-898.

Page, S.E., Rieley, J.O., Shotyk, Ø.W. and Weiss, D. 1999. Interdependence of peat and vegetation in a tropical peat swamp forest. *Philosophical Transactions of the Royal Society of London B* **354**: 1885-1807.

Russon, A.E., Handayani, D.P., Kuncoro, P. and Ferisa, A. 2007. Orangutan leaf-carrying for nest-building: Toward unraveling cultural processes. *Animal Cognition* **10**: 189-202.

van Schaik, C.P. 1983. Why are diurnal primates living in groups? *Behaviour* **87**: 120-144.

van Schaik, C., Azwar, P. and Priatna, D. 1995. Population estimates and habitat preferences of orangutans based on line transects of nests. **In**: *The Neglected Ape,* R.D. Nadler, B. Galdikas, L. Sheeran and N. Rosen (eds.), pp. 129-147. Plenum Press, New York, USA.

van Schaik, C.P. and van Hooff, J.A.R.A.M. 1996. Towards an understanding of the orangutan's social system. **In**: *Great Ape Societies,* W.C. McGrew, L.F. Marchant and T. Nishida (eds.), pp. 3-15. Cambridge University Press, Cambridge, UK.

Soethe, N., Lehmann, J. and Engels, C. 2006. Root morphology and anchorage of six native tree species from a tropical montane forest and an elfin forest in Ecuador. *Plant and Soil* **1**: 173-185.

OBSERVATIONS OF WILD SANGIHE ISLAND TARSIERS *Tarsius sangirensis*

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ABSTRACT

Sangihe Island Tarsiers were first described in 1897 from a remote island approximately equidistant between Sulawesi and Mindanao. Subsequently, this taxon was almost completely neglected for nearly 100 years. I conducted brief surveys of *Tarsius sangirensis* in December 1995 and January 1996, and then again in July 1997. These tarsiers are clearly taxonomically separable from all other known tarsier populations at the species level. They are larger in many measurable characteristics and the tarsiers my team encountered exhibited peculiar behaviour, which I interpret as predator avoidance. Primary habitat is almost completely replaced on the island; nevertheless, my team found tarsiers in a number of highly disturbed areas. Between loss of habitat, human disturbance, and their limited extent of occurrence it can be surmised that these tarsiers are a particular priority for primate conservation.

Keywords: behaviour, biogeography, playback experiments, Sangihe, Sangir, Sulawesi, taxonomy, vocal duets

INTRODUCTION

Meyer (1897) described a tarsier, *Tarsius sangirensis*, from Sangihe Island (sometimes spelled Sangir), a volcanic island approximately midway between the northern tip of Sulawesi and the southern end of Mindanao. Following that description, *T. sangirensis* was variously treated as a subspecies of *T. tarsier* (Erxleben, 1777) (=spectrum [Pallas, 1778]) (e.g. Elliot, 1913; Sody, 1949; Hill, 1955) or as a junior synonym of that taxon (e.g. Niemitz, 1984). More recently, a few investigators working independently have offered evidence for recognizing *T. sangirensis* as a full species (e.g. Feiler, 1990; Shekelle *et al*., 1997; Groves, 1998), recommendations that were accepted in subsequent taxonomic work (e.g. Groves, 2001; Brandon-Jones et al., 2004). The purpose of this report is to report observations of wild populations of this recently re-elevated species.

METHODS

Data were collected from wild Sangihe Island Tarsiers during a field expedition to Sangihe from 20 to 28 December 1995, and a second trip from 10 to 18 July 1997. Observations were made of free-ranging tarsiers during surveys that were conducted to locate tarsier nest sites suitable for trapping tarsiers. No attempt was made to randomize the survey regime.

Tarsier vocalizations were recorded using either a Sony WMD 6C with a Sennheiser MKE 300 or a Sony TR-600 Hi8 Camcorder, with either the internal microphone or with the Sennheiser MKE 300. Tarsiers were trapped in mist nests, or caught by hand. Two different net configurations were used. The first is a 30-denier black nylon net, three feet by 42 feet, with 1.25-inch mesh (nets are sized and sold in imperial measurements). The second net is a 50-denier black nylon net, six feet by 18 feet, with 1.5-inch mesh. Neither of these net configurations was optimal. Tarsiers can climb on these nets, and sometimes rip the netting. Thus, a tarsier that entered these nets had to be quickly caught and transferred to a holding sack, or they would free themselves within a few moments. Playback speakers (Sony SRS 77G) were positioned behind the nets, and recordings of the tarsiers were used to lure them into the mist nets. Optimal time for catching tarsiers in mist nets was between 18:00 and 19:00 h. Nets were monitored continuously. Animals that entered the nets (bats, birds, and tarsiers accounted for virtually all trappings) were removed immediately. Trapped tarsiers were transferred to cloth bird bags for temporary holding. Tarsiers were manually restrained during data collection. No sedatives were used or warranted.

Observations on trapped tarsiers included: body weight (Avinet precision spring scale S300), skull length and testicle size (Tajima carbon fiber vernier calipers), tail length (Scale), characteristics of pelage and gross morphology, and hair samples for genetic analysis; fecal and ejaculate samples were collected opportunistically. In some cases, tarsiers that were trapped at night were held until daylight for superior photographic documentation. In such cases, tarsiers were given food (grasshoppers and/or house geckos). Tarsiers were released at the point of capture. The WGS84 geographic coordinates of the capture site were determined with a Sony IPS-760 global positioning system. We scored trapped tarsiers based on characters and descriptions culled from the tarsier literature that putatively diagnose tarsiers and can be easily assessed on a live tarsier; primarily from Niemitz (1979), Musser & Dagosto (1987), and Niemitz *et al*. (1991).

Data from recaptures and subsequent observations of trapped and released tarsiers suggest that tarsiers were not harmed by these procedures. Neither is there evidence that any other vertebrate that entered the nets was harmed.

RESULTS

Sangihe Island Tarsiers are known locally as '*sengkasi*', '*senggasi*', or (rarely) '*higo*'. Tarsiers were located in secondary forest, mixed-species tree gardens, coconut groves, mangrove, and in villages. Six tarsiers, from six different sleeping sites, were trapped. The six captured tarsiers were two adult males, one adult female (not pregnant), one sub-adult male, one sub-adult female, and one pregnant adult female. Body weights for these tarsiers were 150, 120, 143, 124, 123, and 157 g respectively. Maximum cranial length for the lighter of the two adult males was 42 mm, while his tail length was 294 mm. Owing to an unfortunate accident in the field, some data on the other five tarsiers (trapped during the first survey trip) were lost, but it was recalled that the tail length for each of them exceeded the 300 mm limit of the scaled ruler (Table 1).

The coats of these tarsiers were golden brown on the back, and white on the stomach. Two adults, the heavy male and the pregnant female, had light grey fur on their faces. The fur was less woolly than tarsiers from Sulawesi and more even in colour tone. All of the trapped tarsiers had the postauricular white spots, and the paranasal black spots, that are common to all Sulawesi tarsiers. The tarsi were thinly furred on the plantar surface, while the dorsal surface was virtually hairless. The fur on the tarsi was also very short. The tail was scaly, like tarsiers from Sulawesi, and had fine, short fur that resembled neither the nearly hairless tail of *Carlito syrichta* (Linnaeus) nor the much hairier tail of Sulawesi tarsiers (Fig. 1).

Nine tarsier groups were surveyed and followed to their sleeping sites. Sleeping group sizes were six, three, two, two, two, two, two, two, one, one, and one. Sleeping sites of these tarsiers include vine-covered trees of various species, exposed bamboo stalks, exposed sago palm fronds (*Metroxylon sagu* Rottb.), coconut trees, and leafy areas in tall trees of various species. Previously it was reported (Leksono *et al*., 1997) that tarsiers did not sleep in coconut trees. Following the second field trip to Sangihe, and a review of our earlier notes, it was determined that Sangihe Island Tarsiers very likely do, on occasion, nest in coconut trees. One group of five tarsiers was observed

Table 1. Morphometrics of Sangihe Island Tarsiers.

#	Age-sex class	Body weight (g)	Head length (mm)	Tail length (mm)	Testicle size (mm)
1	A♂	150	Data lost	>300*	Data lost
2	A♀	143	Data lost	>300*	-
3	SA♀	123	Data lost	>300*	-
4	SA♂	124	Data lost	>300*	-
5	Pregnant A♀	157	Data lost	>300*	-
6	A♂	120	42	294	17 x 9

*Data lost

Fig. 1. Four images of *T. sangirensis* showing reduced furriness of the tail and tarsi, less woolly fur, greyish face, postauricular and paranasal spots, golden brown dorsal fur and nearly white ventral fur.

traveling together just prior to dawn. This group split up into at least three sleeping groups and chose separate sleeping sites, one on a bamboo stalk, two on a sago palm frond about 30 m away from the first, and the other two were not observed in their sleeping site (Table 2).

These tarsiers perform duet calls, as do other tarsiers of the *T. tarsier* complex. The duet call is variably performed in the morning or the evening. On no occasion were dawn duet calls given at the sleeping site. The duet call is characterized by a two-note female phrase that seemingly prompts numerous single-note male phrases in response (Fig. 2).

DISCUSSION

Sangihe Island Tarsiers can be grouped with the *Tarsius tarsier* complex with a high degree of confidence based on the following characters: presence of the duet call; presence of the postauricular white spots; presence of the paranasal black spots; light fur along the length of the tail; tail scaly and lacking a specialized sitting pad; grooming claw shorter and more claw-like; and presence of large sleeping groups (up to six individuals in *T. sangirensis*). Additionally, there is robust genetic evidence to support the hypothesis that *T. sangirensis* forms a clade with other Sulawesi tarsiers, distinct from Philippine and Western tarsiers (Shekelle, 2003). Indeed, the results of this study are interesting when compared with previous descriptions of *T. sangirensis*. For example, these findings support Meyer's (1897) original description of the taxon, noting that *T. sangirensis* can be diagnosed by having less fur on the tail and tarsi. They further support the observation of Elliot (1913) that these tarsiers may have a pale, light grey face (Note, however, that while this morphotype was present in some Sangihe Island Tarsiers, it is also present in some other tarsiers from the *T. tarsier* complex, and there are some indications that it may indicate a mature, older individual). The large body sizes of these tarsiers are not reported by others, but upon close inspection of the data tables in Musser & Dagosto (1987) it can be seen that their sample of *T. sangirensis* had the greatest skull length of any tarsier. It is also likely that these tarsiers have the longest tails of all tarsiers, but, curiously, this fact is not supported by studies of museum specimens (Musser & Dagosto, 1987; Groves, 1998). Also, Groves (1998) suggested that the postauricular white spots common to all members of the *T. tarsier* complex may be absent in *T. sangirensis*. My data refute this assertion, but do indicate that the white spots are reduced, and sometimes darker in colour.

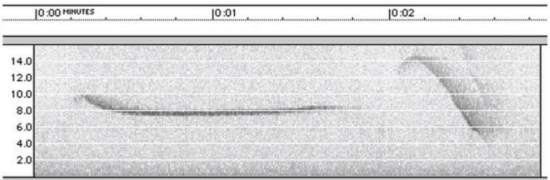
Characters that confidently diagnose these tarsiers from other members of the *T. tarsier* complex are: different duet call; tail fur much less and shorter; tarsi fur less and shorter; body size larger. Characters that less confidently diagnose these tarsiers are: postauricular white spot smaller and sometimes darker-coloured; more white fur around lips; head sometimes has light grey fur; body with predominately golden brown fur and less mottled (woolly) in appearance; tail longer (though perhaps not when scaled to body size); sleeping group often differs from traveling group; and distinct sleeping site preference (very high on exposed stalks of bamboo,

Table 2. Group size, composition, and sleeping sites at Sangihe Islands.

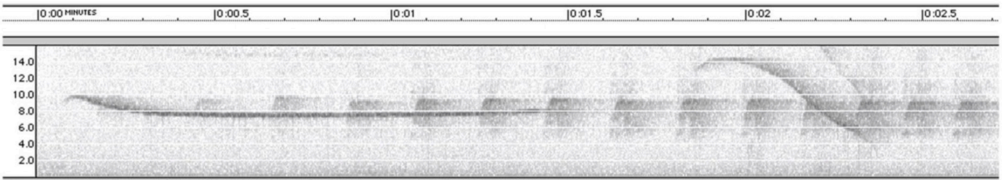
Site #	Minimum size	Composition	Sleeping site	Habitat
1	6	At least 2 A♀ & at least 2 A♂	Vine covered tree	Mixed tree garden, overgrown
2	1	A♂ (46)	High on bamboo stalk	Village
3	2	1 A♀ & 1 A♂	Top coconut tree	Coconut monocrop, well-cleared
4a*	2	A♀ (47) & 1 other	Top of sago palm frond	Mixed tree garden, by small river
4b*	1	1	High on bamboo stalk	Same
4c*	2	2	?	Same
5	2	1 A♀ & 1 A♂	Vine covered tree	Mixed tree garden, overgrown
6	2	1 A♀ & 1 SA♀ (48)	High on bamboo stalk	Village
7	1	1 SA♂ (49)	Low on bamboo stalk	Cleared field
8	3	1 pregnant A♀ (50) & 2 others	Leafy area at top of ~20 m tree	Mixed tree garden, overgrown
9	2	1 A♀ & 1 other	Tall tree	Mangrove
10	2	1 A♀ & 1 A♂	Bamboo	Village

*members of 4a, 4b, and 4c were seen traveling together and are assumed to be part of the same social group.

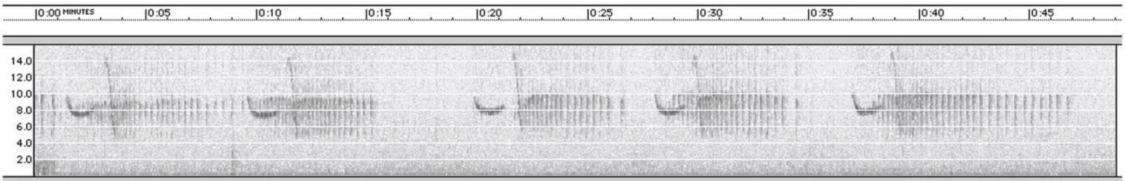
Sangihe Acoustic Form



Two note female phrase



Two note female phrase and thirteen male notes



Duet fragment with five female phrases

Fig. 2. Duet calls of the Sangihe Island Tarsiers.

sago palm, or tree tops). Characters that appear to be diagnostic of these tarsiers upon more thorough investigation are: eyes larger; paranasal black spots smaller; grooming claws thinner and more curved; and tail pigment dark relative to hand and feet pigment.

Of interest for conservation, virtually every person we spoke with not only knew of *senggasi*, but had either trapped *senggasi*, or knew someone who had trapped *senggasi*. Many people asked if we were looking to buy tarsiers. One older man said that he recently sold a tarsier for IDR 2,500 (about US$1 at the time). He had the understanding that the tarsier was going to be taken to the Philippines. Many people suggested there was an active flow of animals from Sangihe to the Philippines. We encountered another man who showed us a rare, endemic cuscus (possibly *Ailurops ursinus* [Temminck, 1824]) he had trapped and that he reportedly planned to sell to someone from the Philippines for IDR 50,000 (about US$20 at the time). Other evidence exists of an active black market between Sangihe and the Philippines, notably in Filipino alcoholic beverages. Although tarsiers appeared to be common on Sangihe, the active black market on the island is cause for some concern.

It is most likely that the trapped tarsiers in this study belonged to different social groups, but defining tarsier social groups on this island is problematic since groups that travel together at night did not always sleep together. Thus, it is likely that Sangihe Island Tarsier sleeping groups are not good estimators of social group size and composition, and in this way, they differ behaviourally from other species of the *T. tarsier* complex. Very little primary forest remains on Sangihe Island, and what little remains is quite remote. We did not survey that habitat, but Riley (2002) reports tarsiers there. It is possible that lack of forested land, combined with greater pressure from human predation, is related to the differences in social groupings and sleeping site preferences reported here. Comparisons with tarsiers in the remaining primary forest fragments are warranted.

Shekelle and Salim (2011) assessed the conservation status of *T. sangirensis* as Endangered B1ab(ii,iii) based upon the small extent of occurrence, the loss of almost all original habitats, the high human population density, and the lack of protection areas. Considering further the issues I report here, including anti-predator behaviour exhibited by Sangihe Island Tarsiers, the many reports of trapping tarsiers by humans, and the apparent black market, these beautiful and charismatic primates should be considered a special priority for tarsier conservation.

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REFERENCES

Brandon-Jones, D., Eudey, A.A., Geissmann, T., Groves, C.P., Melnick, D.J., Morales, J.C., Shekelle, M. and Stewart, C-B. 2004. Asian Primate Classification. *International Journal of Primatology.* **25**(1): 97-164.

Elliot, D.G. 1913. *A Review of the Primates* (Monograph Series). American Museum of Natural History, New York, USA.

Feiler, A. 1990. Ueber die Säugetiere der Sangihe- und Talaud-Inseln der Beitrag A.B.Meyers für ihre Erforschung (Mammalia). *Zoologische Abhandlungen der Staatlisches Museum für Tierkunde in Dresden* **46**: 75-94.

Groves, C.P. 1998. Systematics of tarsiers and lorises. *Primates* **39**: 13-27.

Groves, C.P. 2001. *Primate Taxonomy.* Smithsonian Institution Press, Washington D.C., USA.

Hill, W.C.O. 1955. *Primates: Comparative Anatomy and Taxonomy. II. Haplorhini: Tarsioidea.* Edinburgh University Press, Edinburgh, UK.

Leksono, S.M., Masala, Y. and Shekelle, M. 1997. Tarsiers and agriculture: thoughts on an integrated management plan. *Sulawesi Primate Newsletter* **4**(2): 11-13.

Meyer, A.B. 1897. Säugethiere vom Celebes- und Philippinen-Archipel, I. *Abhandlungen und Berichte der Kaiserlich Zoologische und Anthropologische-Ethnologische Museum zu Dresden* **6**(I-VIII): 1-36.

Musser, G.G. and Dagosto, M. 1987. The identity of *Tarsius pumilus*, a pygmy species endemic to the montane mossy forests of Central Sulawesi. *American Museum Novitates* **2867**: 1-53.

Niemitz, C. 1979. Results of a field study on the Western tarsier (*Tarsius bancanus borneanus* Horsfeld, 1821) in Sarawak. *Sarawak Museum Journal* **27**: 171-228.

Niemitz, C. 1984. Taxonomy and Distribution of the Genus *Tarsius* Storr, 1780. **In**: *Biology of Tarsiers*, Niemitz, C. (ed.), pp. 1-16. Gustav Fischer, Stuttgart, Germany.

Niemitz, C., Nietsch, A., Warter, S. and Rumpler, Y. 1991. *Tarsius dianae*: A New Primate Species from Central Sulawesi (Indonesia). *Folia Primatologica* **56**: 105-116.

Riley, J. 2002. Mammals on the Sangihe and Taluad Islands, Indonesia, and the impact of hunting and habitat loss. *Oryx* **36**: 288-296.

Shekelle, M. 2003. Taxonomy and Biogeography of Eastern Tarsiers. PhD dissertation, Washington University, St. Louis, USA.

Shekelle, M. and Salim, A. 2011. *Tarsius sangirensis*. **In**: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 08 June 2013.

Shekelle, M., Leksono, S.M., Ichwan, L.L.S. and Masala, Y. 1997. The natural history of the tarsiers of North and Central Sulawesi. *Sulawesi Primate Newsletter* **4**(2): 4-11.

Shekelle, M. & Leksono, S.M. 2004. Rencana Konservasi di Pulau Sulawesi: Dengan Menggunakan Tarsius Sebagai ‘Flagship Taxon’. *Biota* **9**: 1-10.

Shekelle, M., Groves, C., Merker, S. and Supriatna, S. 2008. *Tarsius tumpara*: a new tarsier species from Siau Island, North Sulawesi. *Primate Conservation* **23**: 55-64.

Sody, H.J.V. 1949. Notes on some Primates, Carnivora, and the Babirusa from the Indo-Malayan and Indo-Australian regions. *Treubia* **20**:121-185.

A PREVIOUSLY UNREPORTED LONG-TAILED MACAQUE (*Macaca fascicularis*) POPULATION IN BANGKOK, THAILAND

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Keywords: isolated population, *Macaca fascicularis fascicularis*, Samae Dam, Thin Kao Khun Kala, urban macaques

INTRODUCTION

The Long-tailed Macaque *Macaca fascicularis* (Raffles) is the most widespread non-human primate species in Thailand and throughout Southeast Asia (Fooden, 1995). It is also the most successful, occupying both natural and human-modified habitats that include evergreen forests, mangrove forests, swamps, beach and riparian forests, agricultural lands, public parks, temples, and various human-dominated landscapes. It has been categorised as Least Concern by the *IUCN Red List of Threatened Species* (Ong & Richardson, 2008).

In Thailand, free-ranging populations of *M. fascicularis*, and to a lesser extent *M. arctoides* (I. Geoffroy), *M. assamensis* M'Clelland, *M. leonina* (Blyth), *M. mulatta* (Zimmermann) and *M. nemestrina* (Linnaeus), can be found outside Thailand's National Protected Areas System, albeit mostly persisting as isolated populations and typically associated with Buddhist temples (Aggimarangsee, 1992). Although a number of records of the species outside the National Protected Areas System have been documented (e.g. Aggimarangsee, 1992; Fooden, 1995; Malaivijitnond & Hamada, 2008), there appear to be other remnant populations that have escaped such documentation.

One such population can be found in the Bang Khun Thian District of Bangkok Municipality. A literature search did not reveal any scientific publication describing this population, although there have been a few anecdotal reports of the population in local newspapers and online (http://en.wikipedia.org/wiki/Bang_Khun_Thian_District [downloaded on 1 July 2013]). Here we describe what may possibly be the last, isolated, free-ranging population of *M. fascicularis*, and of any non-human primate, in Bangkok.

OBSERVATIONS AND FINDINGS

The site (N13°37'37", E100°26'55"), locally known as 'Thin Kao Khun Kala', is located along the Suk Sawat-Bang Khun Thian Road in the Samae Dam Sub-district of Bang Khun Thian District of Bangkok Municipality, to the southwest of Bangkok City (Fig. 1). The site is also known as 'See Yaek Khun Kala' or the Khun Kala Intersection. The site primarily comprises a swamp with a few patches of standing trees; it is enclosed by the road, the Sanam Chai Canal, and some agricultural land, factories and housing areas. At the immediate site, there are three small islands located in the wider portion of the canal, and some tourist facilities, namely the pavilions and walkways (including a pedestrian bridge). There is also a small monument dedicated to 'Khun Kala', a monkey that was saved (through the provision of veterinary services) by His Majesty King Bhumibol Adulyadej upon hearing that the monkey had one of its hands stuck in a coconut and was suffering from severe infections (Virakul & Meinasut, 2007). Designated as a public park, the site and the monkeys come under the jurisdiction and protection of the Bang Khun Thian District Authorities. Some vendors are also located at the site, typically selling peanuts, banana fritters, and soft drinks, which visitors and passers-by often purchase to feed the monkeys.

The *M. fascicularis* population at this site is highly habituated to humans; therefore, it was possible to observe its members very closely. Opportunistic observations were carried out from 4 March to 22 June 2012. On each visit, attempts were made to determine the size of the population and the social units, and their age-sex composition. Information on their behaviour and ecology, such as range use and diet, was also opportunistically gathered through actual observations and interviews with local residents, primarily the food

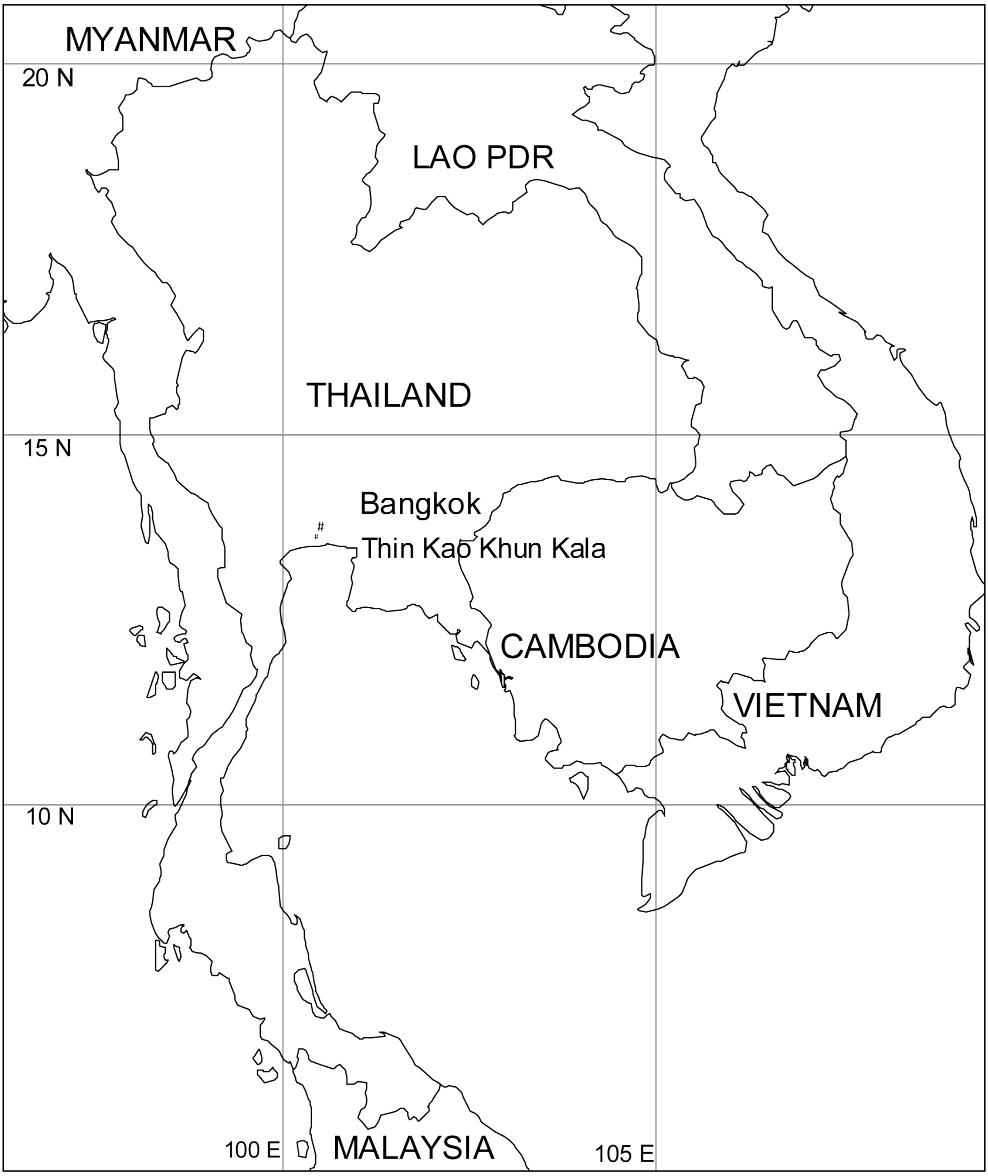

Fig. 1. Location of study site.

vendors based at the site.

Based on known geographic distribution (Groves, 2001), the *M. fascicularis* population at this site belongs to the subspecies *M. fascicularis fascicularis* (Raffles). However, given frequent releases of *Macaca* species and *M. fascicularis* sub-species outside their geographic ranges and their subsequent hybridization (Aggimarangsee, 1992; Malaivijitnond & Hamada, 2008; RB, pers. obs.), it cannot be determined (without close morphological and genetic analyses) whether the individuals belonging to this population are all purebred *M. f. fascicularis*.

Repeated censuses (until 22 June 2012) yielded a population of at least 131 individuals, from three multi-male multi-female units (MMUs) (Table 1). The population was not evenly distributed across the MMUs: MMU-1 (n=72) was almost twice the size of MMU-2 (n=41), and MMU-2 was slightly more than twice the size of MMU-3 (n=18). Smaller sub-units within these MMUs were also observed, but their identification and age-sex composition could not be determined consistently. Nevertheless, MMU-2 could be easily distinguished by the presence of two young juvenile albinos (a male and a female), and MMU-3 by an adult male with an amputated right forelimb.

Table 1. Age-sex composition of the *M. fascicularis* population and individual multi-male units (MMUs) at Thin Kao Khun Kala.

	MMU-1				MMU-2				MMU-3				
Age / Sex	♂	♀	?	n	♂	♀	?	n	♂	♀	?	n	N
Adult	5	33	3	41	2	21	-	23	2	7	1	10	74
Sub-adult	-	1	-	1	-	1	-	1	-	-	-	-	2
Older juvenile	2	1	2	5	-	1	-	1	1	-	-	1	7
Younger juvenile	5	4	2	11	1	3	-	4	4	-	-	4	19
Infant	2	1	11	14	4	4	4	12	-	-	3	3	29
N	14	40	18	72	7	30	4	41	7	7	4	18	131
A♂:A♀	1:6.6				1:10.5				1:3.5				1:6.8
♂:♀	1:2.2				1:4.3				1:1				1:2.8

?=sex indeterminate

Excluding individuals whose sex could not be determined, the sex ratio for the population was 1:6.7 for the adults only and 1:2.8 for all age categories, although this ratio varied across the MMUs (Table 1).

The combined home range of the population during the study was calculated to be approximately seven hectares, which translates to a density of 18.7 individuals per hectare. The home range was determined by drawing a convex polygon joining the extreme locations of the population's area of occupancy. The population's range was reportedly far greater in the past, prior to the various recent and ongoing housing and infrastructure development. The home ranges of the MMUs during the study period overlapped completely, but all three units had discrete nighttime sleeping sites.

All food items observed being ingested by various individuals (excluding the suckling infants) during the study period comprised items that were provisioned by visitors and local residents, and visitors made up the bulk of those who provisioned the monkeys. Some visitors (including passers-by, usually from the windows of their vehicles) would either bring along with them the provisioned foods or purchase these from the local vendors, whereas local residents typically provisioned the monkeys with leftover foods. Provisioning could be observed daily, although the degree of provisioning was significantly more on weekends and public holidays. Provisioned foods included both natural and processed foods (Table 2).

Table 2. List of provisioned food items.

Natural foods	Processed foods
Banana	Banana fritters
Coconut	Boiled rice
Cucumber	Bread
Durian	Energy drink
Maize	Packet milk
Mango	Potato chips
Orange	Sweet potato fritters
Papaya	Maize chips
Peanut	Wafer
Rambutan	
Watermelon	

On weekdays, there would typically be two vendors selling sodas, bananas, banana fritters, and peanuts; and more vendors on weekends and public holidays, selling fruit, ice cream, and other snacks. Some visitors and passers-by would purchase the foods solely for themselves, some solely for the monkeys, and others for themselves and the monkeys.

Given the amount of food provisioned and the nature of Thais, it is unlikely that the population was quantitatively lacking in food. Similar observations have been made (Aggimarangsee, 1992) for most semi-provisioned macaque populations living commensally with humans in Thailand. However, Aggimarangsee (1992) also observed that provisioned foods often cause monkeys to suffer from health issues such as malnutrition, disease, obesity, and hair loss; and they became highly dependent on provisioned foods. Several adults and juveniles at the study site were similarly observed to suffer from obesity and some hair loss (Fig. 2), and the population likewise appeared to be dependent on provisioning.

Currently, the Thin Kao Khun Kala *M. fascicularis* population appears to be threatened by reduced natural

Fig. 2. An obese adult male consuming bottled coconut water and meat (© R. Boonratana).

habitats and motor accidents. In addition, the health of the population is marred by excessive provisioning of carbohydrate-rich and sugar-rich processed foods and reduced physical activity (due to the lack of need to forage for foods). Long-term health risks include overpopulation and inbreeding depression (due to isolation), and diseases associated with their unhygienic living conditions and close contact with humans (which could equally affect human visitors and residents).

These threats and health risks are apparently universal among (especially isolated) macaque populations in Thailand that are living commensally with humans, and largely dependent on provisioned foods (see Aggimarangsee, 1992; Malaivijitnond & Hamada, 2008). At some destinations, there are occasional reports of the species and its congeners captured as pets, locally consumed, or traded, but this is usually limited to sites not associated with Buddhist temples. In the early 1990s there was apparently no designated agency responsible for protecting monkey colonies found outside the protected area system (Aggimarangsee, 1992).

More than a decade and a half later, Malaivijitnond & Hamada (2008) reported there was still no effective long-term management programme to protect these macaques, merely a few short-term and rather ineffective responses provided by the local authorities, such as translocation and contraception. To conserve such macaque colonies, they further proposed a long-term multi-stakeholder plan that incorporates educational programmes, controlled provisioning and translocations, well-managed contraception programmes, curbing the release of pet monkeys, and protection of unique phenotypes.

It is hoped that the reporting of this population will generate interest among researchers to study, among various possibilities, the effects of isolation on the species' demographics, social structure, behaviour and genetics; the parasitic load of a macaque population living commensally with humans; and disease transmission between the macaques and local human residents or other domestic life.

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REFERENCES

Aggimarangsee, N. 1992. Survey for semi-tame colonies of macaques in Thailand. *Natural History Bulletin of the Siam Society* **40**: 103-166.

Fooden, J. 1995. Systematic review of Southeast Asia longtail macaques, *Macaca fascicularis* (Raffles, 1821). *Fieldiana Zoology* **81**: 1-206.

Groves, C. P. 2001. *Primate Taxonomy*. Smithsonian Institution Press, Washington DC, USA.

Malaivijitnond, S. and Hamada, Y. 2008. Current situation of Long-tailed Macaques (*Macaca fascicularis*) in Thailand. *The Natural History Journal of Chulalongkorn University* **8(2)**:185-204.

Ong, P. and Richardson, M. 2008. *Macaca fascicularis* ssp. *fascicularis*. **In**: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 26 May 2013.

Virakul, S. and Meinasut, C. 2007. พระมหากรุณาธิคุณต่อวิชาชีพสัตวแพทย์. http://www.epofclinic.com/wizContent.asp?wizConID=153 &txtmMenu_ID=7. Downloaded on 20 November 2012.

ATTITUDES TOWARDS PRIMATES AND PRIMATE CONSERVATION IN MANIPUR, NORTHEAST INDIA

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ABSTRACT

In many regions across the world, where people and primates are found in close proximity, the attitudes of people towards primates impacts the latter's survival to a great extent. Northeast India is part of a global biodiversity hotspot and has the highest primate diversity in the country. This region is also home to over 140 ethnic groups, whose customs and traditions critically affect wildlife conservation practices. We conducted an informant-based survey in Manipur in Northeast India to investigate people's awareness of primate species and their attitudes towards primate conservation. We interviewed a total of 120 individuals across six districts of the state and collected information on primate species presence as well as the nature of human-primate interactions. The results of our study provide valuable information on the extent of primate presence in Manipur and factors affecting their future existence in this region.

Keywords: attitudes, conservation, hunting, Manipur, Northeast India, primates

INTRODUCTION

Wildlife conservation is heavily dependent on people's attitudes towards wild animal species, particularly in regions where human settlements are found in close proximity to wildlife reserves (Kellert *et al*., 1996; Mishra, 1997; Shelley *et al*., 2012). Human attitudes towards wildlife are influenced by fundamental values, interactions with as well as knowledge about the species (Kellert, 1991; Kaltenborn & Bjerke, 2002; Vaske *et al*., 2009). When interactions with wildlife result in economic loss due to crop and material damage, or in physical injury and death, people tend to perceive wildlife presence as intolerable (Hill, 1999, 2004; Chhangani & Mohnot, 2004). Social customs such as hunting, for sport or ceremonial purposes, also mould beliefs regarding the utility and preservation of wildlife species (Parry & Campbell, 1992). Negative attitudes towards wildlife, and reckless land use changes, threaten the conservation and survival of wildlife outside protected forest reserves, the integrity and viability of the reserves, and the biodiversity they were established to conserve (Kirubi *et al*., 2000). Hence understanding people's attitudes towards wildlife species and encouraging them to participate in biodiversity conservation measures are crucial to ensure ecologically sustainable development and wildlife conservation (Infield, 2001; Sekhar, 2003).

Northeast India, comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura, is categorized under the Indo-Burma global biodiversity hotspot (Myers *et al*., 2000). Home to ten primate species, this region contains the highest primate diversity in the country. Culturally too, the region is very diverse, with approximately 145 tribes residing within this area, and the customs and traditions of these groups critically impinge upon the wildlife conservation practices that are required here (Aiyadurai, 2011). Many of the indigenous communities have strong animist traditions, and they hunt primate species for food, religious and cultural purposes, significantly affecting the latter's population densities and continued existence in this region (Choudhury, 2006; Mishra *et al*., 2006; Srivastava, 2006). The remote and inaccessible terrain of many areas within this region and recurrent insurgency problems contribute to the overall poor infrastructure conditions which have hindered the wider application of wildlife studies here. Additionally, many states of Northeast India have large areas of Unclassified Forests that are almost completely controlled by local communities (Dasgupta & Symleih, 2006). State forest department laws regarding protection of wildlife can rarely be enforced with any success in these forests and the success of any wildlife conservation programme is almost completely dependent on the voluntary participation of the people living near these forests.

Although many studies have documented the various ways in which humans and primates interface in

Northeast India, ranging from hunting and crop-raiding to ethnozoology (Solanki & Chutia, 2004; Mishra *et al*., 2006; Sinha *et al*., 2006; Aiyadurai *et al*., 2010; Aiyadurai, 2011), there has been no focused attempt to understand perceptions of indigenous communities regarding primate species presence and human-primate interactions in this region. Hence we conducted an informant-based survey in the state of Manipur, with the objective of investigating local people's knowledge regarding primate species presence and their attitudes towards primate conservation in this part of Northeast India. More specifically we aimed to (i) determine how aware people were of the existence of various primate species in their neighbourhood, and (ii) assess the nature of human-primate interactions in the state.

STUDY AREA

Manipur (23.80°N to 25.68°N and 93.03°E to 94.78°E) in Northeast India is bordered by the states of Nagaland, Mizoram and Assam in the north, southwest and west respectively, and by Myanmar in the east and south. Physiographically the state can be divided into three main sectors: the Eastern hill ranges, Western hill ranges and the Imphal Valley that separates the hill ranges in the central plains. The climate is tropical monsoon and the vegetation is largely tropical wet evergreen and semi-evergreen in the lower- and middle-elevation areas. The forests are dominated at medium elevations by tree species like Needlewood *Schima wallichii* Choisy, Khasi Pine *Pinus khasyana* Griff., Teak *Tectona grandis* L.f., Queen's Flower *Lagerstroemia flos-reginae* Retz., and bamboo varieties *Bambusa balcooa* Roxb., *Bambusa khasiana* Munro and *Melocanna humilis* Roep. ex Trin, and at high elevations by Red Oak *Quercus serrata* Murray, Uningthou *Phoebe lanceolata* (Nees) Nees and Katus *Castanopsis tribuloides* (Sm.) A.DC. (updated from Champion & Seth, 1968). Of the 35-odd ethnic groups in Manipur, the non-tribal Meiteis, Pangans and immigrants constitute 66% of the state's population (Shimray, 2001). The valley region is dominated by the Meitei community which are predominantly Hindu whereas the hilly region is occupied by various tribal communities, notably the Naga and the Kuki-Chin-Zomi groups, with distinctive cultures and traditions (Shimray, 2001).

Seven species of primates (Assamese Macaque *Macaca assamensis* M'Clelland, Rhesus Macaque *M. mulatta* [Zimmerman], Stump-tailed Macaque *M. arctoides* [I. Geoffroy], Northern Pig-tailed Macaque *M. leonina* [Blyth], Capped Langur *Trachypithecus pileatus* [Blyth], Hoolock Gibbon *Hoolock hoolock* [Harlan] and the Bengal Slow Loris *Nycticebus bengalensis* [Lacépède]) are reported to be present in Manipur; however there have been very few primate-focused studies in the state and consequently, little information is available about the geographic range or density of the various species present (Choudhury, 2001). Although 78% of Manipur's geographical area is covered by forests (extending largely across the hill ranges), less than 24% of this comes under the government controlled Protected Area network (FSI, 2011). A predominant part of the forest cover in the state (approximately 68%) has been categorized as Unclassified Forests (FSI, 2011) resulting in widely varying degrees of primate protection levels across the state.

METHODS

We conducted our study across six districts in Manipur: Imphal East, Imphal West and Bishnupur which are situated at lower elevations in the valley region and Churachandpur, Senapati and Chandel at higher elevations in the hilly region (Fig. 1). From February to April 2012 we surveyed 24 villages across the six districts, namely Mahabali, Uyumpok, Irinbung, Takhel, Leikrinthabi, Iroishemba, Phayeng, Game, Konung, Leimram, Thanga, Keibul Lamjao, Kom Keirap, Reandeilung, Tolbung, Guitemuan, Sapermeina, Chalkot, Leimakhong, Seikul, Mitong , Komlathabi, Kwata and Moreh. We selected the villages based on their location near forest areas and relatively high accessibility of roads or trails. We used a combination of purposive and random sampling techniques to identify respondents for our study; about 50% of the respondents were selected based on suggestions by village headmen regarding individuals who hunted regularly and were well acquainted with forest areas.

The questionnaire consisted of three parts: the first part comprised questions about the occurrence of various primate species and the frequency of their sightings, while the second part focused on human-primate interactions, particularly hunting and provisioning practices, and the extent of primate crop-raiding. We used photographs of primates to aid correct identification by respondents and prompt them for detailed morphological descriptions. The last part of the questionnaire collected information on the socio-economic status of the respondents. Apart from the questionnaire responses, we also encouraged respondents to narrate myths or taboos concerning primate species and describe cultural practices and beliefs related to primates.

To detect differences in attitude between the hill and

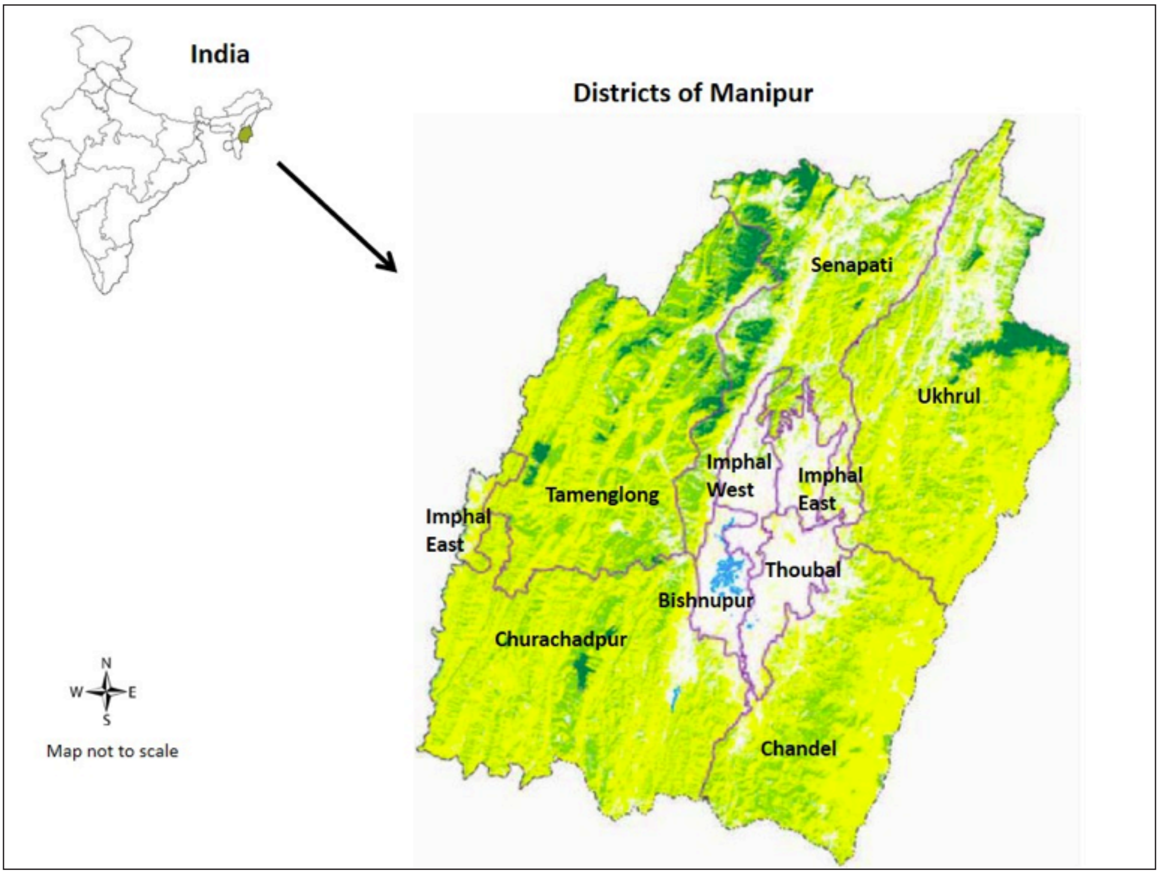

Fig. 1. Districts of Manipur (Redrawn based on map in FSI, 2009)

valley respondents with respect to primate conservation, chi-square analysis was applied to the distribution among the different questionnaire responses.

RESULTS

We interviewed a total of 120 individuals (five people from each village), of whom 88 were men and 32 women. Study respondents were in the age range 30 to 80 years and more than 90% of them had lived in the study location for more than 30 years. About half the respondents (52%) belonged to indigenous communities and all of these are Christians, while the remainder were from the Meitei community and are Hindus. Respondents from the valley region were predominantly Hindus (92%), while respondents from the hill region largely practised Christianity (95%). The primary occupation of most of the study participants was agriculture and/or livestock herding (55%); a smaller number were self-employed in small-scale businesses (38%) and a few were employees in government services (7%).

Primate species occurrence

Out of 120 respondents, 105 attested to the presence of at least one of five primate species that occurred in the forest areas around their villages – Rhesus Macaque, Bengal Slow Loris, Hoolock Gibbon, Capped Langur and Pig-tailed Macaque. Primate species occurrence was not uniform though: 26% of respondents reported just one species (Rhesus Macaque); 16% reported two (Rhesus Macaque and Bengal Slow Loris); while 25% reported three (these two plus either Capped Langur or Hoolock Gibbon). About 19% reported all four of these species and only 2% claimed the presence of five species, including the Pig-tailed Macaque. Thirteen percent of the respondents said that no primate species occurred around their villages. Some respondents were aware of the existence of the Stump-tailed Macaque and the Assamese Macaque, but none reported the species' presence in their areas.

Thus the Rhesus Macaque was the most commonly reported species, with 88% of the respondents reporting that the species existed in their neighbourhood or in

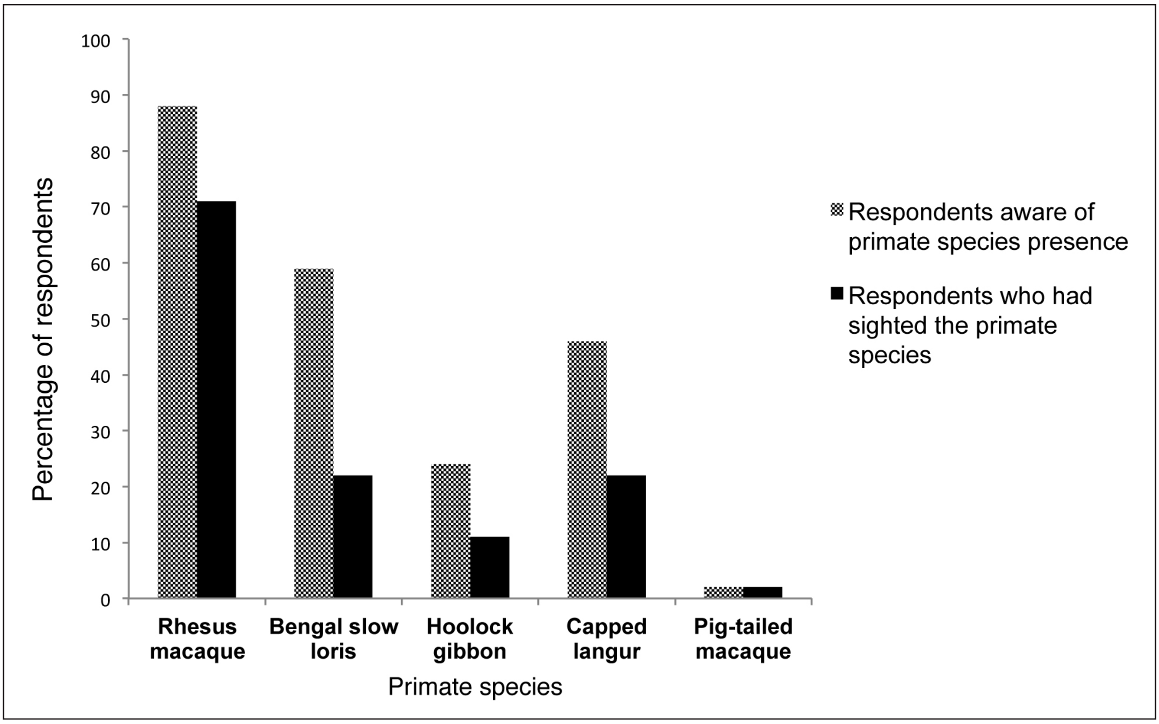

Fig. 2. Percentage of respondents (n=120) reporting primate species presence

the nearby forest and 71% of the individuals confirming that they had actually sighted the species (Fig. 2). The Pig-tailed Macaque was the least-known species with only 2% of the respondents confirming that it was present in nearby forest areas.

In terms of extent of distribution, the Rhesus Macaque was reported by people in all six districts (17 villages), while the Bengal Slow Loris was stated to occur near 15 villages in five districts. The Capped Langur was described to occur near 11 villages in Senapati and Churachandpur Districts, and the Hoolock Gibbon near five villages in Chandel, Churachandpur and Senapati Districts; however the Pig-tailed Macaque was reported by only two respondents in one village, in Churachandpur District.

Human-primate interactions

Respondents revealed the existence of many cultural taboos and myths concerning primate species. For example, eating the brain of the Rhesus Macaque is believed in many communities to impart strength to postnatal women, while consuming the flesh of Bengal Slow Loris is thought to cause illness among some tribal communities. A popular myth amongst many ethnic groups concerning the Hoolock Gibbon is that Hoolock individuals give birth to offspring every full moon and die every new moon, thus continuing the cycle of life. Apart from such beliefs, study participants identified three main ways in which people interacted with primate species: 1) Macaque provisioning; 2) Crop-raiding by primates; and 3) Hunting of primates by humans.

Macaque provisioning

This was restricted to the Mahabali area in Imphal West District and was particularly practised by people belonging to the Hindu community. Only Rhesus Macaques were provisioned; study respondents did not identify other primate species as being associated with provisioning practises. In Kunung, Bishnupur District we observed that the Rhesus Macaque population was protected from hunting by the local community. Strict penalties were imposed by the village elders on anyone who harmed or disturbed the macaques in any way.

Primate crop-raiding

Less than half the respondents (48%) attested that primate crop and kitchen-raiding occurred, and these said that economic losses due to this were rather minimal. More people in Senapati, Churachandpur and Chandel Districts expressed discomfort over primate crop- and kitchen-depredations than people in other districts (Table 1). Only Rhesus Macaques were involved in crop-raiding; respondents clarified that al-

Table 1. Primate crop-raiding in Manipur

District	Main crops damaged	Primate species	Number & percentage of respondents	Level of damage reported*
Imphal East	Rice, maize	Rhesus Macaque	6 (30%)	Low
Imphal West	Rice, maize	Rhesus Macaque	4 (20%)	Low
Bishnupur	Rice, maize	Rhesus Macaque	3 (15%)	Low
Senapati	Rice, maize & vegetables	Rhesus Macaque	17 (85%)	Low
Churachandpur	Rice, maize & vegetables	Rhesus Macaque	12 (60%)	Low
Chandel	Rice, maize & vegetables	Rhesus Macaque	16 (80%)	Low

* Options offered were "negligible, low or high"

though the Capped Langur was a crop depredator in earlier times, it was not so anymore.

Primate hunting

Most of the study respondents (80%, n=96) agreed that primate species were hunted for meat, sport, or ritualistic purposes in the study area. Rhesus Macaque (71%, n=85) and Bengal Slow Loris (41%, n=49) were hunted most often, followed by Capped Langur (6%, n=7) . Twenty-three percent of the study respondents identified themselves as hunters and reported using licensed guns to hunt wildlife. Of these individuals, 46% preferred to go hunting once in a month, 40% twice a month and 14% rather infrequently. Practically all the hunters were from the hilly districts; only one was from a valley district. Respondents in the Senapati District stated that they avoided hunting primates relative to other mammals; however respondents in other villages of the hilly region affirmed that it was a status symbol to kill macaques. Study participants also revealed that it was easier to kill macaques as they were often seen on forest edges and sometimes in crop-fields, whereas langur individuals were more difficult to hunt as they remained in the dense parts of the forests and high up in the canopy.

Primate conservation

Respondents reported that primate species density had significantly decreased over the last five years; indeed in villages like Takhel and Uyumpok in Imphal East District, people revealed that the forests around their villages were totally devoid of any primate population. When questioned on factors driving loss of primates, a significant difference was observed between respondents from the hilly districts and those from the valley districts (χ^2=18.87, d.f.= 2, p<0.0001), particularly with respect to their attitudes towards hunting. Most of the respondents in the hilly districts (78%) identified habitat loss due to logging, human encroachment and shifting cultivation as being primarily responsible for a decrease in primate density; or declined to comment on the matter (20%). Very few hill people considered hunting as a factor responsible for decrease in primate density (5%). People from the valley districts, on the other hand, saw both habitat loss (83%) and hunting (37%) as causing a decrease in primate density. Very few valley respondents were unwilling to answer the question (5%).

Differences were also recorded when respondents were asked their opinion on wildlife conservation (χ^2=57.11, d.f.= 2, p<0.0001). Most people (87%) from the hilly districts declined to comment or avoided answering the question. The few people who answered the question replied that it was important to preserve forest habitats (12%). People from the valley districts, in contrast, replied that it was necessary to preserve forest habitats (45%), ban wildlife hunting (28%) and care for the welfare of all animals (5%). Very few valley people (17%) declined to comment on the issue.

DISCUSSION

Informant-based surveys of indigenous communities living in and near forest areas have proven to yield valuable ecological information about animal distribution and abundances, wildlife declines and change and loss in forest cover over long periods of time (Hunter & Brehm, 2003; Basset, 2005; Rajamani & Marsh, 2010; Pillay *et al*., 2011). Such techniques are particularly useful in regions where intensive or long-term studies are difficult to conduct either due to civil conflicts or other accessibility issues (Sahoo *et al*., 2013). Apart from gaining knowledge about plant/animal behaviour and distribution, informant surveys also provide deep insights into local people's attitudes towards particular species and their perceptions regarding wildlife conservation. The results of our survey provide valuable information regarding the presence and distribution of primate species in the study area. Although a total of seven primate species are reported to be present in Manipur (Choudhury, 2001), data from our study indicate that at least three of these species (Assamese Macaque, Stump-tailed Macaque and Pig-tailed Macaque) are absent in many regions of the state, or present only in very low numbers. Remarkably, a good majority of the respondents reported the presence of the Bengal Slow Loris, a cryptic, nocturnal species that is understood to be present in low densities through much of Northeast India (Radhakrishna *et al*., 2006, 2010; Swapna *et al*., 2010). Information from study respondents also suggests that in Manipur, the Hoolock Gibbon is restricted to the forests of the hill districts.

Based on the study results, we strongly highlight the need for intensive primate population surveys in Manipur to clarify the conservation status of the Assamese Macaque, Stump-tailed Macaque, Pig-tailed Macaque, Hoolock Gibbon and Bengal Slow Loris in the state.

Crop-raiding by primates and retaliatory hunting by humans is a significant threat affecting primate populations in many parts of India (Singh, 2000; Southwick & Siddiqi, 2001; Singh & Rao, 2004; Sinha *et al*., 2006; Kumara *et al*., 2010); however this is not a significant source of conflict in Manipur. Instead, hunting for sport or cultural practices appears to be an important threat affecting the continued survival of primate species in Manipur. Hunting wildlife is more prevalent in the hilly districts than in the valley districts; unfortunately, as the forest cover in Manipur is mostly restricted to the hilly districts, these areas are also crucial habitats for some of the primate species such as Stump-tailed Macaque, Pig-tailed Macaque, and Hoolock Gibbon. The results of our study indicate a sharp divide in attitudes towards hunting animals and wildlife conservation between people in the hilly districts and those in the valley districts. More crucially, respondents whose cultural customs involve wildlife hunting failed to acknowledge hunting as a major factor that threatens primate populations. Although this is not an unusual finding – Aiyadurai (2011) for example points out how some indigenous communities in Northeast India perceive wildlife as an inexhaustible resource that remains unaffected by hunting pressures – insights from these observations not only underscore the urgent need for wildlife management measures in these regions, but also emphasise that only a very nuanced understanding of hunting as a cultural practice can aid us in working towards solutions that address this very crucial threat to primate populations in Northeast India .

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REFERENCES

Aiyadurai, A., Singh, N.J. and Milner-Gulland, E.J. 2010. Wildlife hunting by indigenous tribes: a case study from Arunachal Pradesh, Northeast India. *Oryx* **44**: 564-572.

Aiyadurai, A. 2011. Wildlife hunting and conservation in Northeast India: a need for an interdisciplinary understanding. *International Journal of Galliformes Conservation* **2**: 61-73.

Bassett, T.J. 2005. Card-carrying hunters, rural poverty, and wildlife decline in northern Côte D'Ivoire. *The Geographical Journal* **171**: 24-35.

Champion H.G. and Seth, S.K. 1968. *A Revised Survey of the Forest Types of India*. Govt. of India Press, New Delhi, India.

Chhangani, A.K. and Mohnot, S.M. 2004. Crop raid by Hanuman Langur *Semnopithecus entellus* in and around Aravallis, (India) and its management. *Primate Report* **69**: 35-49.

Choudhury, A.U. 2001. Primates in northeast India: an overview of their distribution and conservation status. *ENVIS Bulletin: Wildlife & Protected Areas, Non-Human Primates of India* **1**(1): 92-101.

Choudhury, A. 2006. The distribution and status of Hoolock Gibbon, *Hoolock hoolock*, in Manipur, Meghalaya, Mizoram, and Nagaland in northeast India. *Primate Conservation* **22***:* 79-87.

Dasgupta, J. and Symlieh, H.J. 2006 Trends in tenure arrangements for forest and their implications for sustainable forest management: the need for a more unified regimes: case study from Meghalaya, India. Understanding forest tenure in South and Southeast Asia. Forestry Policy and Institutions Working Paper 14. Accessed from http://www.fao.org/docrep/009/

j8167e/j8167e00.htm

FSI, 2009. *State of Forest Report*. Forest Survey of India, Dehra Dun, India.

FSI, 2011. *State of Forest Report*. Forest Survey of India, Dehra Dun, India.

Infield, M. 2001. Cultural values: a forgotten strategy for building community support for protected areas in Africa. *Conservation Biology* **15**: 800-802.

Hill, C.M. 1999. Conflict of interest between people and baboons: crop raiding in Uganda. *International Journal of Primatology* **21**: 299-315.

Hill, C. 2004. Farmers' perspectives of conflict at the wildlife-agriculture boundary: some lessons learned from African subsistence farmers. *Human Dimensions of Wildlife* **9**: 279-286.

Hunter, L.M. and Brehm, J. 2003. Qualitative insight into public knowledge of, and concern with, biodiversity. *Human Ecology* **31**: 309-320.

Kaltenborn, B.P. and Bjerke, T. 2002. The relationship of general life values to attitudes toward large carnivores. *Human Ecology Review* **9**: 55-61.

Kellert, S., Black, M., Rush, C.R. and Bath, A.J. 1996. Human culture and large carnivore conservation in North America. *Conservation Biology* **10**: 977-990.

Kellert, S. 1991. Japanese perceptions of wildlife. *Conservation Biology* **5**: 297-308.

Kirubi, C., Wamicha N. and Laichena J. 2000. The effects of wood fuel consumption in the ASAL areas of Kenya: the case of Marsabit forest. *African Journal of Ecology* **38**: 47-52.

Kumara H.N., Kumar, S. and Singh M. 2010. Of how much concern are the 'least concern' species? Distribution and conservation status of bonnet macaques, rhesus macaques and Hanuman langurs in Karnataka, India. *Primates* **51**: 37-42.

Mishra, C. 1997. Livestock depredation by large carnivores in the Indian Trans-Himalaya: conflict perceptions and conservation prospects. *Environmental Conservation* **24**: 338-343.

Mishra, C., Madhusudan, M.D. and Datta, A. 2006. Mammals of the high altitudes of western Arunachal Pradesh, eastern Himalaya: an assessment of threats and conservation needs. *Oryx* **40**: 1-7.

Myers N., Mittermeier, R.A., Mittermeier, C.G., Da Fonseca, G.A. and Kent, J. 2000. Biodiversity 'Hotspots' for conservation priorities. *Nature* **403**: 853-858.

Parry, D. and Campbell, B. 1992. Attitudes of rural communities to animal wildlife and its utilization in Chobe Enclave and Mababe Depression, Botswana. *Environmental Conservation* **19**: 245-252.

Pillay, R., Johnsingh, A.J.T., Raghunath, R. and Madhusudan, M.D. 2011. Patterns of spatiotemporal change in large mammal distribution and abundance in the southern Western Ghats, India. *Biological Conservation* **144**: 1567-1576.

Radhakrishna, S., Goswami, A. B. and Sinha, A. 2006. Distribution and conservation of *Nycticebus bengalensis* in northeastern India. *International Journal of Primatology* **27**: 1-12.

Radhakrishna, S., Datta-Roy, A., Swapna, N. and Sinha, A. 2010. Population survey of the Bengal Slow Loris, *Nycticebus bengalensis*, in Meghalaya, Northeast India. *Primate Conservation* **25**: 105-110.

Rajamani, L. and Marsh, H. 2010. Using parallel regional- and local-scale initiatives to inform conservation management of rare wildlife: a case study of the dugong *Dugong dugon* in Sabah, Malaysia. *Endangered Species Research* **13**: 17-23.

Sahoo, S., Puyravaud, J. and Davidar, P. 2013. Local knowledge suggests significant wildlife decline and forest loss in insurgent affected Similipal Tiger Reserve, India. *Tropical Conservation Science* **6**: 230-240.

Sekhar, N.U. 2003. Local people's attitudes towards conservation and wildlife tourism around Sariska Tiger Reserve, India. *Journal of Environmental Management* **69**: 339-347.

Shelley V., Treves, A. and Naughton, L. 2011. Attitudes to wolves and wolf policy among Ojibwe tribal members and non-tribal residents of Wisconsin's wolf range. *Human Dimensions of Wildlife* **16**: 397-413.

Shimray, U.A. 2001. Ethnicity and socio-political assertion: the Manipur experience. *Economic and Political Weekly* **36**: 3674-3677.

Singh, M. 2000. Animal behaviour. **In**: *Psychology in India Revisited: Developments in the Discipline, Volume 1: Physiological Foundation and Human Cognition*, Pandey, J. (ed.), pp. 19-57. Sage, New Delhi, India.

Singh, M. and Rao, N. 2004. Population dynamics and conservation of commensal bonnet macaques. *International Journal of Primatology* **25**: 847-859.

Sinha, A., Kumar, R.S., Gama, N., Madhusudan, M.D. and Mishra, C. 2006. Distribution and conservation status of the Arunachal Macaque, *Macaca munzala*, in western Arunachal Pradesh, northeastern India. *Primate Conservation* **21**: 145-148.

Solanki, G.S. and Chutia, P. 2004, Ethno zoological and socio-cultural aspects of Monpas of Arunachal Pradesh. *Journal of Human Ecology* **15**: 251-254.

Southwick, C.H. and Siddiqi, M.F. 2001. Status, conservation and management of primates in India. *ENVIS Bulletin: Wildlife and Protected Areas, Non-human Primates of India* **1**(1): 81-91.

Srivastava, A. 2006. Conservation of threatened primates of north-east India. *Primate Conservation* **20**: 107-113.

Swapna, N., Radhakrishna, S., Gupta, A. K. and Kumar, A. 2010. Exudativory in the Bengal Slow Loris (*Nycticebus bengalensis*) in Trishna Wildlife Sanctuary, Tripura, Northeast India. *American Journal of Primatology* **71**:1–9.

Vaske, J.J., Shelby, L.B. and Needham, M.D. 2009. Preparing for the next disease: The human-wildlife connection. **In**: *Wildlife and Society: The Science of Human Dimensions*, M.J. Manfredo, J.J. Vaske, P.J. Brown, D.J. Decker and E.A. Duke, (eds.), pp. 244-261. Island Press, Washington DC, USA.

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Hohmann, G.M. and Fruth, B. 1995. Loud calls in great apes: sex differences and social correlates. **In**: *Current Topics in Primate Vocal Communication*, E. Zimmerman, J.D. Newman and U. Juergens (eds.), pp. 161-184. Plenum Press, New York, USA.

Book

Niemitz, C. 1984. *The Biology of Tarsiers*. Gustav Fischer, Stuttgart, Germany.

Thesis/Dissertation

Barrett, E. 1984. *The Ecology of some Nocturnal, Arboreal Mammals in the Rainforests of Peninsular Malaysia.* PhD dissertation, Cambridge University, UK.

Report

Eudey, A.A. 1987. *Action Plan for Asian Primate Conservation: 1987–1991.* IUCN/SSC (Species Survival Commission) Primate Specialist Group, Gland, Switzerland.

Electronic Database

Nadler, T., Timmins, R.J. and Richardson, M. 2008. *Trachypithecus germaini.* **In**: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>. Downloaded on 1 June 2012.

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