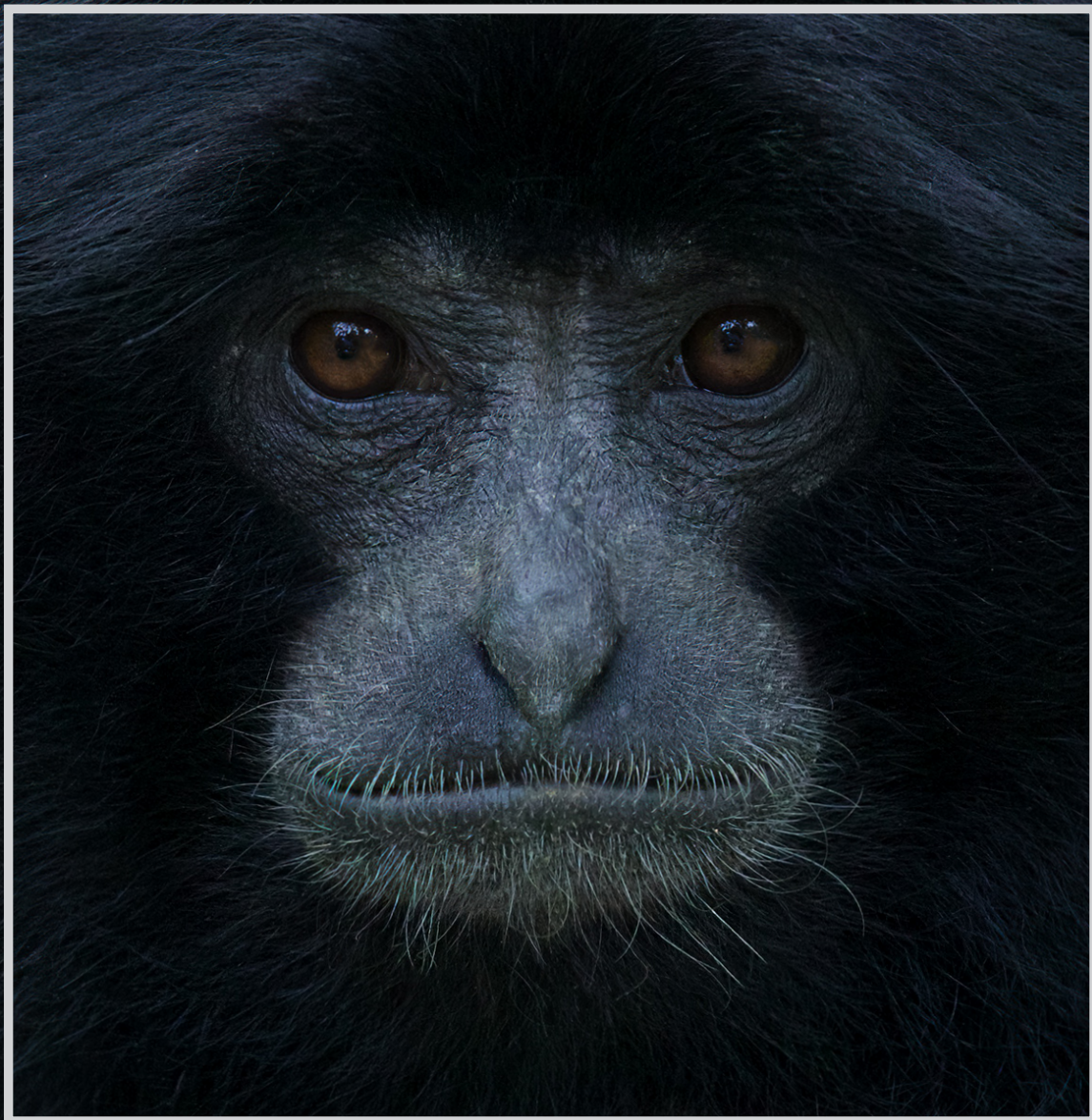


Volume 9 Number 1 2021

ISSN 1979-1631

Asian Primates Journal

A Journal of the Southeast Asia, South Asia and China Sections of the IUCN SSC Primate Specialist Group



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Solitary female Siamang *Symphalangus syndactylus* at Gunung Ulu Kali (Tititwangsa Range), Peninsular Malaysia. Photo by Peter Ong (on a mission to photograph all Malaysia's primates).

ASIAN PRIMATES JOURNAL is made possible by the Primate Action Fund administered by Re:wild under a grant from the Margot Marsh Biodiversity Foundation; and produced in collaboration with IUCN Species Survival Commission and SeAPA (Southeast Asian Primatological Association)



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The Asian Primates Journal wishes to acknowledge the following persons and agencies/institutions for disseminating or covering the costs of dissemination of the journal in the following countries:

China	Bosco Chan & Kadoorie Conservation China, Kadoorie Farm & Botanic Garden
India	Dilip Chetry & Aaranyak Ajith Kumar
Japan	Michael Huffman
Indonesia	Rahayu Oktaviani & Javan Gibbon Research and Conservation Project
Lao PDR	Wildlife Conservation Society Lao PDR
Malaysia	Sabapathy Dharmalingam & The Bukit Merah Orang Utan Island Foundation Justine Vaz & The Habitat Foundation
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EDITORIAL: WE NEED TO DECOLONISE PRIMATOLOGY AND PRIMATE CONSERVATION

The colonial origins of primatology and wildlife conservation have had a lasting legacy (Domínguez & Luoma, 2020; Rodrigues, 2020). Nonhuman primates are almost all endemic to tropical and subtropical landscapes, and primarily persist in areas inhabited by rural and indigenous people, while white citizens of high-income nations are overrepresented in ecology and conservation biology (Chaudhury & Colla, 2020). Exclusion of people with other identities, experiences, and world views from decision-making roles in primate research and conservation is unjust and leads to poor outcomes (Blair, 2019; Chaudhury & Colla, 2020; Rubis, 2020). Accordingly, primatologists should work to dismantle scientific imperialism to build a more inclusive and effective discipline.

Erasure of local people and histories from narratives about primates and places is common. Many primates have been assigned names derived from colonial figures (e.g., Raffles Banded Langur, Kloss's Gibbon), thus eclipsing indigenous and local knowledge and longstanding relationships between people and primates (Rubis, 2020). In this way, scientific conventions that appear neutral reinforce colonial power dynamics (Rubis, 2020). "Helicopter science," where scientists from high-income countries or non-indigenous groups extract labour and information from communities without involving them in decision-making or acknowledging their contributions, remains a problem as well. Over 30% of 2011-2015 field primatology publications in leading journals did not acknowledge field assistants or local community contributions (Bezanson & McNamara, 2019), and even when local researchers are listed as coauthors, they may not be treated as full partners in the research process, limiting their opportunities to build research capacity (Nurcahyo & Meijaard, 2018; Covert, 2019). Publications are also biased toward research in national parks and other protected areas (Bezanson & McNamara, 2019), where in many cases, local people, including long-term or indigenous residents of those landscapes, have been rhetorically (Lye, 2004), and sometimes physically (Domínguez & Luoma, 2020), excluded.

To build a more just and inclusive discipline, primatologists in positions of power must do better. Project leaders should acknowledge the contributions of local communities and ensure that participants gain tangible benefits. Established primatologists should recruit and mentor aspiring researchers from Global South nations and marginalized communities (Nurcahyo & Meijaard, 2018) and North-South partnerships should involve shared decision-making (Covert, 2019). The dominance of English, a colonial language, in professional communication can be a barrier to full participation in publishing, conferences, and fundraising (Chaudhury & Colla, 2020), so building capacity in this area is crucial (Nurcahyo & Meijaard, 2018), as is developing better listening skills among primatologists (Staddon et al., 2021).

Editors, panel organizers, and other gatekeepers should

seek contributors, presenters, and reviewers with diverse backgrounds, viewpoints, and experiences, and build capacity where they find it lacking. More fundamentally, we must restructure our thinking about scientific "discovery," the relationship between science and other forms of expertise, and ownership of sites, data, and ideas. The evidence that excluding marginalized communities from participation in primate conservation leads to poor outcomes is overwhelming. What we do with that evidence is up to us.

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SURVEY OF RELATIVE ABUNDANCE OF DIURNAL PRIMATES IN THE GIRITALE NATURE RESERVE, SRI LANKA

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ABSTRACT

Sri Lanka is a biodiversity hotspot that is under high anthropogenic pressure. The long-term survival of its biodiversity, including primates, is under threat. Due to an increased rate of deforestation outside protected areas after the civil war in the northern dry zone, protected areas are key for the long-term persistence of primates. A rapid assessment of the population status of diurnal non-human primates in the Giritale Nature Reserve in the north-central dry zone was conducted using Reconnaissance Transect method from December 2017 to January 2018. *Semnopithecus vetulus philbricki*, *Semnopithecus priam thersites* and *Macaca sinica sinica* were present in the nature reserve. Mean troop sizes for *S. vetulus*, *S. priam* and *M. sinica* were 9.0 ± 1.7 , 21.6 ± 6.7 and 24.5 ± 16.3 , respectively. The highest density was recorded for *M. sinica* (172.9 individuals/km²) while the lowest was for *S. vetulus* (31.8 individuals/km²). The male to female ratio was 1:1 in *M. sinica*, 1:1.3 in *S. priam* and 1:1.5 in *S. vetulus*. The study shows that the Giritale Nature Reserve maintains reproductively active populations of all three diurnal primates, including the Endangered *S. vetulus*, providing a rationale to conduct further research for instituting plans to conserve habitats in Giritale Nature Reserve.

Key words: Primate conservation, reconnaissance transect, *Macaca sinica sinica*, *Semnopithecus vetulus philbricki*, *Semnopithecus priam thersites*

INTRODUCTION

Primates are ecologically (Chapman, 1995), economically (Wilkie & Carpenter, 1999) and culturally (Baker et al., 2009) important mammals (Keane et al., 2012). However, their populations are highly threatened by habitat loss and fragmentation (Cowlshaw & Dunbar, 2000), hunting (Fa & Brown, 2009) and diseases (Köndgen et al., 2008), and now approximately 60% of primate species are classified as Threatened with extinction (Estrada et al., 2017). The need for conservation of primates is of the prime importance, and surveys of wild primate populations are important initial steps in assessing the conservation status of a species and its habitats (Tutin & Fernandez, 1984). In the present study, we assess the status of primates in the Giritale Nature Reserve (GNR) in Sri Lanka to evaluate the importance of the reserve for the conservation of primates.

In Sri Lanka, the most expansive vegetation type is dry mixed evergreen forest, which is found throughout the dry zone of Sri Lanka, accounting for roughly 60% of the island's total land cover (Ashton et al., 1997). These forests are of strategic importance to the conservation of Sri Lanka's primates as they support populations and their ecology (Phillips, 1935). Although these forests are extensive, they experience some of the highest rates of deforestation due to indiscriminate development initiated by the government, population growth in rural areas and the ensuing expansion of agriculture (Perera, 2001; Mattsson et al., 2012). This is especially true for dry forests outside of protected areas. Sri Lanka has one of the highest rates of deforestation in Asia (Dinerstein & Wikramanayake, 1993; Sloan et al., 2014). As a result, the long-term survival of all of Sri Lanka's five primates is under threat. Of these, three

species are endemic and Endangered: Purple-faced Langur *Semnopithecus vetulus* (Erxleben) (Rudran et al., 2020), Toque Macaque *Macaca sinica* (Linnaeus) (Dittus & Watson, 2020) and Red Slender Loris *Loris tardigradus* (Linnaeus) Gamage et al., 2020. The other two species, Tufted Sacred Langur *Semnopithecus priam* Blyth (Singh et al., 2020) and Grey Slender Loris *Loris lydekkerianus* Cabrera (Dittus et al., 2020), are both Near Threatened. *Semnopithecus vetulus* has also been listed among the 25 most endangered primates of the world (Schwitzer et al., 2017).

During over 25 years of civil war, mostly concentrated in the northern dry zone, significant hardships were experienced not only by the human population, but by wildlife as well (Santhiapplai & Wijeyamohan, 2003). Then during the post-civil-war period, the north-central dry zone experienced significant forest modification and fragmentation due to unprecedented infrastructure development with new hotels and extensive road pavement projects in areas including important protected areas like Maduru Oya, Minneriya and Somawathiya National Parks, Giritale and Thrikonamadu Nature Reserves, the Kaudulla-Minneriya jungle corridor and a number of forest reserves. This infrastructure development has accelerated human settlement, crop cultivation and urban development surrounding these protected areas. As a result of rapid deforestation outside of the dry-zone protected area network, the long-term persistence of Sri Lankan primates may be largely dependent on populations inside the protected areas, such as the GNR.

Our understanding of the diversity and the relative abundance of primates within the protected areas in the north-central dry zone of Sri Lanka is poor. While a number of studies have examined the ecology and behaviour of Sri Lankan primates (Dittus, 1975; Vandercone et al., 2004; Dela, 2007; Vandercone et al., 2013; Weeraseskara & Ranawana, 2017), none of these has explored the diversity and relative abundance of primates in protected areas in the north-central dry zone. Here we present data on the relative abundance and some demographic parameters of diurnal non-human primates in the GNR in the north-central dry zone of Sri Lanka.

MATERIALS AND METHODS

Study area

Sri Lanka possesses a remarkably varied topography, with coastal plains, lowland hills and a mountainous

interior (Ashton et al., 1997). The island's equatorial position and its complex topography interact to produce distinct climatic zones: the dry zone (covering 60% of the island), intermediate zone (15%) and the wet zone (25%). This study was conducted in the GNR (7°59' - 8°04'N and 80°52' - 80°54'E), in the north-central dry zone of Sri Lanka, from December 2017 to January 2018. The reserve encompasses an area of 17.92 km² consisting of a habitat mosaic of dry forest (71%), shrubland (12%), grassland (6%), water bodies (1%) and anthropogenic habitats (1%) (Indika & Mahaulpatha, 2013). The reserve experiences an average annual temperature of 26°C and receives an annual rainfall of approximately 1,146 mm (Indika & Mahaulpatha, 2013).

Survey

Although a wide range of primate census techniques have been developed (Leca et al., 2013), opinions are deeply polarized on method selection for estimating primate group densities (Marshall et al., 2008). No methods have been found to be bias-free. The most accurate density estimates are obtained from complete counts (McNeilage et al., 2001; Davenport et al., 2007) or focal group studies of the home range (Chapman et al., 2000; Fashing & Cords, 2000; Marshall et al., 2008). Line transect methods have also been recommended (Plumptre, 2000), yet establishing transects causes habitat disturbance. Hence, this method may be problematic for surveys within protected areas. Furthermore, unhabituated monkeys may violate the mathematical assumptions of transect methods, as they tend to flee from the transect when traversed by observers.

Hence, in our survey we used the Reconnaissance Transect method to estimate the relative abundance of Northern Purple-faced Langur *S. v. philbricki* (Phillips), Sri Lankan Sacred Langur *S. p. thersites* (Blyth) and Dry-zone Toque Macaque *M. s. sinica* (Linnaeus) (Sussman & Phillips-Conroy, 1995; Walsh & White, 1999; Vandercone, 2011). The method is relatively quick and results in minimal habitat disturbance. The basic principle of reconnaissance walks is to walk in a predetermined direction taking the path of least resistance through the survey area (Walsh & White, 1999). Data collection is similar to that of line transects (number of target objects, distance along the line and associated ancillary data), except that perpendicular distances are not recorded and the width of the strip sampled is fixed (usually 1 m either side of the observer) to minimize variation in visibility between habitat types (Kühl et al., 2008). The length of the transect walk

depended on the terrain and land type. Sampling was conducted from 07:00 h to 16:00 h. Natural trails within forested areas were traversed slowly at about 0.5 km/h by two observers, stopping at regular intervals (15 min) to scan surroundings. We stopped whenever we saw or heard monkeys and recorded the locations of groups using a handheld GPS receiver (Magellan Triton 2000), troop size and troop composition including age and sex categories when possible (Sussman & Phillips-Conroy, 1995). To minimize double counting, we also noted pelage colour and physical deformities and other notable features of animals whenever possible. In addition, we mapped the trails (Fig. 1).

Data analysis

The data collected were analyzed using descriptive statistics (mean, standard error of mean and variance). The Recruitment Rate Index (RRI) (Karim et al., 2014) was calculated using $RRI = f_i/f_t$, where, f_i = number of the infants and juveniles and f_t = number of individuals encountered in the study site.



Fig. 1. Area covered within the reserve and locations where we encountered the monkey troops (Google map source: Image ©2020 Maxar Technologies).

RESULTS

We traversed 11.02 km of trails distributed over an area approximately 1 km² in extent. A total of 14 groups were encountered within the sampled area including a *S. v. philbricki* lone male. The group sizes of *S. v. philbricki*, *S. p. thersites* and *M. s. sinica* ranged from 8 to 11, 12 to 27 and 7 to 50, respectively. Group size, composition, RRI and population density estimates of the three diurnal primate species are shown in Table 1. *Macaca sinica sinica* was the most abundant, while *S. v. philbricki* was the least abundant taxon. All groups of the three species observed were multi-male–multi-female groups. Male to female ratios were 1:1 in *M. s. sinica*, 1:1.3 in *S. p. thersites* and 1:1.5 in *S. v. philbricki*.

DISCUSSION

Our study presents the first record of the relative abundance of diurnal non-human primates in GNR, and some of their demographic parameters. Though transect methods have been widely used to estimate the abundance of wild primates (Brugiere & Fleury, 2000; Fashing & Cords, 2000), density estimates of wild primates from transects should be regarded as preliminary due to potential underestimation of group size (Defler & Pintor, 1985; Brugiere & Fleury, 2000).

The group sizes observed for *S. vetulus* and *S. priam* were comparable to those observed in other localities in Sri Lanka (Ripley, 1965; Rudran, 1973; Vandercone, 2011). The group size of *M. sinica* was also comparable to group sizes reported in previous studies (Dittus, 1987). The individual density estimates obtained from our study are comparable with densities reported for colobine monkeys from many study localities in Asia (see Davies, 1994 and Table 2). However, the combined individual density of *S. priam* and *S. vetulus* at Polonnaruwa (250-400 animals/km²) was much higher than the individual density of colobines at GNR. This makes sense, in that the diets of Polonnaruwa populations include substantial quantities of anthropogenic food from local urban waste dumps and provisioning at temples and by tourists. Numerous studies have shown that food availability plays a key role in determining primate biomass and diversity (Kay et al., 1997; Stevenson, 2001; Brugiere et al., 2002). In the case of colobine monkeys, it has been suggested that the availability of digestible mature leaves, a fallback resource for many colobine species, determines their biomass (McKey, 1978). Although the density of frugivorous primates is typically lower than that of folivorous primates, the density of macaques in our

Table 1. Group size, composition, RRI and population density estimates of three primate species in the Giritale Nature Reserve.

Species	Adult male	Adult female	Sub-adult male	Sub-adult female	Juvenile	Infant	Unclassified	Total
<i>S. v. philbricki</i>								
Group 1	2	3	0	0	0	1	2	8
Group 2	3	5	1	1	0	1	0	11
Group 3	2	3	0	0	0	1	2	8
Groups/km ² \approx 4	Individuals/km ² \approx 32			Recruitment Rate Index \approx 0.11				
<i>S. p. thersites</i>								
Group 1	3	4	3	1	0	0	1	12
Group 2	4	11	7	2	0	1	1	26
Group 3	5	7	3	3	0	1	8	27
Group 4	3	5	2	3	0	1	12	26
Group 5	3	10	0	2	1	1	0	17
Groups/km ² \approx 6	Individuals/km ² \approx 127			Recruitment Rate Index \approx 0.05				
<i>M. s. sinica</i>								
Group 1	10	5	3	4	1	0	4	27
Group 2	1	3	3	0	0	0	0	7
Group 3	5	7	3	3	0	1	8	27
Group 4	4	5	3	5	2	2	14	35
Group 5	12	17	8	8	2	3	0	50
Group 6	4	5	2	2	1	4	0	18
Groups/km ² \approx 7	Individuals/km ² \approx 173			Recruitment Rate Index \approx 0.12				

study was higher than that of folivorous langurs. Higher than usual macaque densities could be a result of food provisioning, crop foraging and foraging on food items discarded by villages surrounding the nature reserve.

While *S. vetulus* typically occurs in one-male groups (Rudran, 1973; Vandercone, 2011), all three *S. vetulus* groups observed in this study were multi-male–multi-female. Furthermore, sub-adults and juveniles were scarce or absent in *S. vetulus* groups in comparison with the other two primate species. This pattern seems to be similar to group composition of *S. vetulus* in other localities in Sri Lanka (Rudran, 1973; Vandercone, 2011) and is likely caused by the dispersal of both immature males and females from their natal groups subsequent to male takeover (Rudran, 1973). In the case of *S. priam*, social structure is variable and can be one-male–multi-female or multi-male–multi-female like the present study (Mohnot et al., 1981). As in our study, *M. sinica* is also known to occur as multi-male–multi-female groups (Dittus, 1975, 1977; Vandercone

et al., 2004). In comparison with the langurs, macaque groups have a higher proportion of sub-adults, juveniles, and infants. Macaques tend to have a shorter inter-birth interval (Dittus, 1975) than langurs (Ripley, 1965). The RRI, which is indicative of the portion of new recruits to the population, was 0.12 for *M. sinica*, 0.11 for *S. vetulus* and 0.05 for *S. priam*. Variation in RRI in these monkey species could be influenced by factors such as infant and juvenile survivorship and maturation rate and differences of the inter-birth interval of the species.

Our study shows that the GNR maintains reproductively active populations of all three diurnal primates of Sri Lanka, including the Endangered Purple-faced Langur. The densities of all species were comparable to densities reported from other study localities in Sri Lanka. Anthropogenic activities are not allowed inside the Nature Reserve according to laws and regulations of Sri Lanka except with a license/permit. Yet people are over-exploiting resources by

Table 2. Sub-species population density estimations of three diurnal primate species in Sri Lanka.

Species	Study site	Group size range/ Mean	Individual density Individual/km ²	Source
<i>S. v. monticola</i> (Kelaart)	Horton plains	8.9	92.6	Rudran, 1973
<i>S. v. nestor</i> (Bennett)	Panadura & Piliyandala respectively	13-16 & 12-14	-	Dela, 2007
<i>S. v. vetulus</i> (Erleben)	Galle	10-22	-	Pers. obs., 2018
<i>S. v. philbricki</i> (Phillips)	Polonnaruwa	8.4	215.0	Rudran, 1973
	Kaludiyapokuna	3.6	8.1	Vandercone, 2011
		9.0	31.8	Present study
<i>S. p. thersites</i> (Blyth)	Kaludiyapokuna	5.3	16.7	Vandercone, 2011
		21.6	127.1	Present study
<i>M. s. aurifrons</i> Pocock	Peradeniya	32.3	-	Weerasekara & Ranawana, 2017
<i>M. s. opisthomelas</i> Hill	Hatale	16.0	-	Pers. obs., 2018
<i>M. s. sinica</i> (Linnaeus)	Polonnaruwa	24.8 (8-43)	-	Dittus, 1987
		24.5	172.9	Present study

illegal encroachment and settlements, infrastructure development, commercial agriculture ventures, cattle grazing, illegal hunting, and trading, causing ill-effects on the reserve. Further studies on the behaviour and ecology of these primates should be undertaken to assess factors that contribute to their respective relative abundance in the nature reserve. Similar studies should be conducted in other protected areas to assess diversity and relative abundance of primates.

ACKNOWLEDGEMENTS

We convey our gratitude to the Department of Wildlife Conservation, Sri Lanka for granting permission to carry out the survey. Special thanks go to the Giritale Wildlife Training Center for assisting us in making the survey a success. We are much grateful to all the anonymous reviewers and the editors for their productive comments and suggestions in ways to improve our manuscript.

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STATUS OF PHAYRE'S LANGUR *Trachypithecus phayrei* IN SATCHARI NATIONAL PARK, BANGLADESH

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ABSTRACT

We studied the population status of Phayre's Langur in Satchari National Park, Bangladesh, and threats to this population, from January to December 2016. We recorded 23 individuals in three groups. Group size ranged from four to 12 (mean 7.7 ± 4.0) individuals; all groups contained a single adult male, 1–4 females and 2–7 immature individuals (subadults, juveniles and infants). Habitat encroachment for expansion of lemon orchards by the Tipra ethnic community and habitat degradation due to logging and firewood collection are the main threats to the primates. Road mortality, electrocution and tourist activities were additional causes of stress and mortality. Participatory work and awareness programmes with the Tipra community or generation of alternative income sources may reduce the dependency of local people on forest resources. Strict implementation of the rules and regulations of the Bangladesh Wildlife (Security and Conservation) Act 2012 can limit habitat encroachment and illegal logging, which should help in the conservation of this species.

Key Words: Group composition, habitat encroachment, Satchari National Park.

INTRODUCTION

Phayre's Langur (Phayre's Leaf Monkey, Spectacled Langur) *Trachypithecus phayrei* (Blyth) occurs in Bangladesh, China, India and Myanmar (Bleisch et al., 2020). There are two sub-species, the Bengal Phayre's Langur *T. p. phayrei* (Blyth) and the Shan States Phayre's Langur *T. p. shanicus*, (Wroughton), both of which are Endangered globally (Roos et al., 2014). *Trachypithecus p. phayrei* is restricted to eastern Bangladesh, northeastern India (Assam, Mizoram and Tripura states) and western Myanmar (Roos et al., 2014). *Trachypithecus p. phayrei* is listed as Critically Endangered in Bangladesh as its population has declined by over 80% over the last three generations due to habitat destruction (IUCN Bangladesh, 2015). In Bangladesh, Phayre's Langurs occur in mixed evergreen forests and adjacent plantations, especially bamboo groves, in Sylhet and Chittagong districts, and Chittagong Hill Tracts (IUCN Bangladesh, 2015). They also occur in mixed-species plantations and at lower densities in monoculture teak plantations (Gupta, 1997).

Green (1978) first confirmed the presence of Phayre's Langur in Bangladesh. Gittins & Akonda (1982) extrapolated that there were 1,300 individuals in Sylhet division (northeastern Bangladesh). Khan & Ahsan

(1986) recorded 15 Phayre's Langur groups comprising 205 individuals in the north-east and south-east of Bangladesh. Molur et al. (2003) estimated that less than 100 individuals persisted in Bangladesh based on a study in only two protected areas (Lawachara National Park and Rema-Kalenga Wildlife Sanctuary) in northeastern Bangladesh. However, Ahmed et al. (2020) recorded 376 individuals of Phayre's Langur in five protected areas in northeastern Bangladesh, of which more than 150 were mature individuals. The IUCN estimates that <50 mature individuals persist in each subpopulation in Bangladesh (IUCN Bangladesh, 2015; Molur et al., 2003). However, no comprehensive surveys have yet been done in several potential habitats for Phayre's Langur in Bangladesh. Here, we report the results of the first surveys conducted to determine the group composition and age-sex structure, and to identify the principal threats to the Phayre's Langur population in Satchari National Park.

METHODS

Study area

Satchari National Park (SNP) is a small forest patch (243 ha) in northeastern Bangladesh, located ca.

130 km northeast from the capital city of Dhaka in Chunarughat Upazilla (subdistrict) of Habiganj District (Fig. 1). The word “Satchari” refers to the “seven streams” (locally called “chara”) which flow through the forest (Mukul, 2007). SNP is a semi-evergreen forest (Choudhury et al., 2004) bordered by nine tea estates, rubber plantations, agar plantations, villages, and cultivated fields (Mukul et al., 2017) and is adjacent to the international boundary with Tripura in India. The village named ‘Tiprapara’, a Tripura tribal community of about 24 households, is inside the park (Mukul, 2007), and 18 additional villages are located six to eight kilometres from the park (Mollah et al., 2004). This forest forms a part of the transition zone between the Indian subcontinent and the Indo-Chinese ecological region (Sharma et al., 2005). The area occupies the higher ridges of the northernmost extension of the Dumatila, Tipam and Surma sedimentary rocks, extending from

the Chittagong Hill Tracts through Tripura in India (Al-Razi et al., 2020). The park has undulating topography with slopes and 10-50 m hillocks, locally called *tila*, running from south to north. These slopes are composed of upper tertiary rocks in which sandstones are dominant (Mukul, 2007; Arefin et al., 2011).

The protected area includes 120 ha of primary forest and 90 ha of secondary forest (Mukul et al., 2017). An oil palm *Elaeis guineensis* Jacq. plantation was established on 24.7 ha of the protected area in the mid-1970s (Choudhury et al., 2004; Mukul et al., 2017). A total of 245 wild and cultivated plant species in 183 genera and 72 families have been recorded in the park (Arefin et al., 2011), including 86 species of herbs, 46 shrub species, 73 tree species, 37 species of climbers, and three species of epiphytes (Arefin et al., 2011). Moraceae (18 species) and Poaceae (12 species) are the dominant families (Arefin et al., 2011).

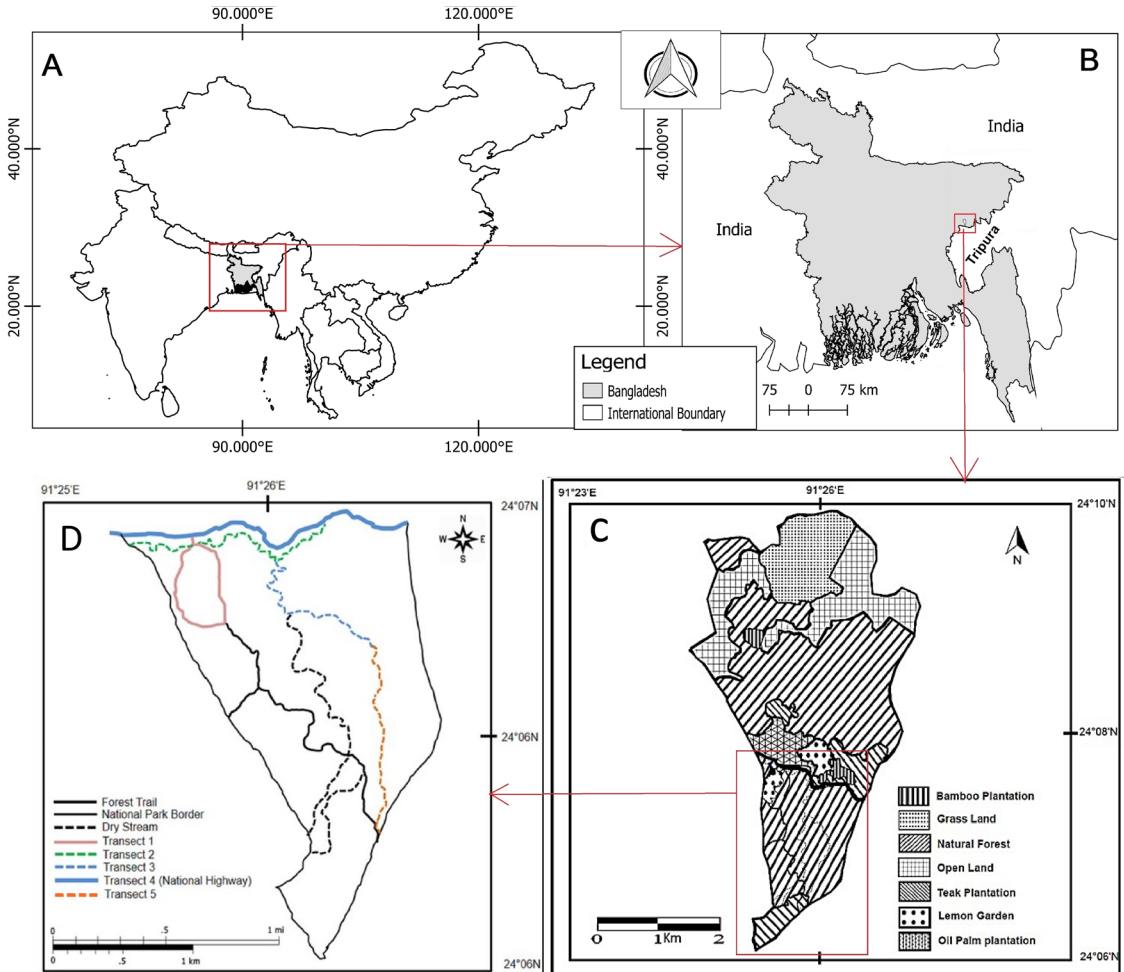


Fig. 1. Satchari National Park, and vegetation types and location of transects in the study area.

Seven plant species that are threatened in Bangladesh, *Amomum aromaticum* Roxb. (Zingiberaceae), *Aquilaria agallocha* Roxb. (Thymeliaceae), *Cymbidium aloifolium* (L.) Sw. (Orchidaceae), *Globba multiflora* Wall. ex Baker (Zingiberaceae), *Holigarna caustic* (Dennst.) Oken (Anacardiaceae), *Rauvolfia serpentine* (L.) Benth. ex Kurz (Apocynaceae) and *Stuednera colocasiodes* Hook. f. (Araceae), occur in the national park (Arefin et al., 2011). One threatened tree fern, *Cyathea gigantean* (Wall. ex Hook.) Holttum, and a threatened gymnosperm, *Gnetum oblongum* Markgr. were also recorded (Arefin et al., 2011). The most common trees are *Lagerstroemia speciosa* (L.) Pers., *Tectona grandis* L.f., *Xylia xylocarpa* (Roxb.) Taub., *Artocarpus chama* Buch.-Ham., *A. lacucha* Buch.-Ham., *Dipterocarpus* spp., *Terminalia bellirica* (Gaertn.) Roxb., *Syzygium* spp., *Ficus* spp., and several bamboo and rattan species. Of the ten primate species that occur in Bangladesh, six (Rhesus Macaque *Macaca mulatta* [Zimmermann], Northern Pig-tailed Macaque *M. leonina* [Blyth], Bengal Slow Loris *Nycticebus bengalensis* [Lacépède], Western Hoolock Gibbon *Hoolock hoolock* [Harlan], Phayre's Langur *Trachypithecus p. phayrei* and Capped Langur *T. pileatus* [Blyth]) persist in this small area (Mukul, 2007; Al-Razi, 2017). Forest villagers, local people, and tea estate labourers depend on resources such as fuelwood and illegally harvested timber from Satchari National Park for their livelihoods (Mukul, 2007; IPAC, 2009). Several wild faunal and floral species have disappeared from SNP, and many more are declining or on the verge of disappearing due to habitat destruction, poaching and over-exploitation (Bangladesh Forest Department, 2016). Livestock grazing, cane and exotic tree plantations

and visitor pressure are additional threats to this forest (Bangladesh Forest Department, 2016).

Data collection

We conducted surveys on 44 days (435 h) from January to December 2016 using the line transect method (Naher & Khan, 2018; Brockelman & Ali, 1987). We established five different transects along existing forest trails, dry streams and on the Dhaka-Sylhet highway (Table 1, Fig. 1). We repeatedly surveyed the transects (Table 1). When a langur individual or group was encountered, we recorded the time, GPS (Garmin eTrex 10) location of the observer at the time of observation (for later calculation of the precise locations of the individuals or groups), and the group size and composition, as well as signs of human disturbance such as woodcutting, grazing, logging, cultivation, bamboo collection (which was illegal), firewood collection, forest fires, and trampling. We counted all group members and classified the langurs as adult males (AM), adult females (AF), sub-adults (SA), juveniles (Juv) or infants (Inf), based on the morphological characters for each age-sex class described by Choudhury (1987), Bhattacharya & Chakraborty (1990) and Gupta (2001). Local forest guides helped identify plant species using the local Bengali name, and a botanist subsequently confirmed the English common and scientific names.

In addition to direct observation, a questionnaire survey was conducted in the study area to determine the threats to Phayre's Langur. Using a semi-structured questionnaire, we interviewed forty people who regularly visited the forest for their daily needs. For each respondent, we recorded age, sex, education

Table 1. Lengths of transects and their vegetation types in Satchari National Park.

Transect no	Transect length (km)	Type of transect	Vegetation	Group recorded	Frequency of transect walks (times/transect)
1	1.64	Human-made trail	Lemon garden, tea garden, higher canopy mixed vegetation	A	12
2	2.1	Human-made trail	<i>Bambusa</i> spp. and <i>Ficus</i> spp. dominant	A, B	9
3	1.4	Dry stream	<i>Bambusa</i> spp. dominant, dense secondary mixed forest	B	13
4	1.74	Highway	Secondary mixed forest, mixed teak forest, agarwood plantation, oil palm plantation	B	16
5	1.0	Dry stream	<i>Bambusa</i> spp. dominant and dense mixed secondary forest	C	9

status, religion, occupation, resources exploited from the forest, and quantity and frequency of exploitation of resources. Focal group discussion (FGD) and knowledge, attitude and practices (KAP) studies were performed in a tea stall in the park to collect information regarding their dependency in the forest. We also interviewed forest staff about threats to the habitat of Phayre's Langurs.

RESULTS

Population and group size

We recorded the presence of 23 individual Phayre's Langurs in three groups (Table 2). Group size ranged from four to 12 individuals (mean 7.7 ± 4.0 ; Table 2;

Fig. 2). The largest group (Group A) was observed in bamboo bushes and areas dominated by *Artocarpus chama*, *A. lacucha* and *Tectona grandis*. The smallest group (Group B) was only observed near Trail Three, where *Bambusa* spp., *A. chama*, *A. lacucha* and *L. speciosa* were dominant. Group C was recorded where *T. bellirica*, *A. chama*, *Aglaia spectabilis* (Miq.) S.S. Jain & S. Bennet, *Careya arborea* (Roxb.) and *Ficus infectoria* Willd. were dominant.

Group composition

Of the 23 individuals, 43.5% were adult, and 56.5% were non-adult (subadult, juveniles and infant) individuals (Table 2). Of the non-adult population, 61.5% were subadults, 23.1% were juveniles, and

Table 2. The age-sex composition of Phayre's Langur at Satchari National Park.

Group	AM	AF	AM:AF	Adults	SA	J	I	Non-adults	Adults: Non-adults	Total
A	1	4	1:4	5	4	1	2	7	5:7	12
B	1	1	1:1	2	2	0	0	2	1:1	4
C	1	2	1:2	3	2	2	0	4	3:4	7
Total	3	7	1:2.3	10	8	3	2	13	1:1.3	23



Fig. 2. Phayre's Langur group at Satchari National Park.

15.4% were infants. In the population, the largest age-sex class was subadults (34.8%), and the smallest was infants (8.7%) (Table 2). All the groups had a single male, but the number of females ranged from one to four (mean = 2.3 ± 1.5 ; Table 2). In all groups, adult females and subadults outnumbered other age groups. Among the adult population, 30% was male, and 70% female (Table 2). Group A had the largest number of females. We recorded two neonates in Group A in early March 2016.

Threats to Phayre's Langur in the study area

The Tipra indigenous community in the national park has converted part of the forest to lemon *Citrus aurantiifolia* (Christm.) Swingle cultivation. This has fragmented the forest and impeded the arboreal movements of the Phayre's Langurs (Fig. 3). Illegal logging of tall trees (12-15m height with 45-50cm DBH) was also seen regularly in areas where forest staff patrolled infrequently. Shegun (*Tectona grandis*), a langur food and resting tree, is targeted by loggers due to strong demand for use in furniture manufacture.

Roadkill was another threat to Phayre's Langurs

in the study area. The Dhaka-Sylhet highway passes through the national park and fragments the potential primate habitat. One road accident was recorded during the study period, causing the death of an adult female with her infant.

Electrical infrastructure also threatened this species in SNP. Phayre's Langurs frequently used the power lines to cross the roads. We recorded an injury to a subadult after an accident involving an uninsulated power line which passes through the forest approaching the highway in SNP. Mortality in langurs occurred due to the short-circuiting of two electric parallel power lines connected by overhanging tails. The adult female and infant that died in the road accident were first shocked while walking on the power line and then fell to the road leading to the road accident.

Langurs and humans also compete for food in the national park. Local boys were seen collecting Jackfruit (*A. heterophyllus*) and Monkey Jack (*A. lacucha*) to sell to tourists. Monkey Jack is a favourite food of Phayre's Langurs. In June to July, ten local boys (10-12 years old) visited the forest daily and collected approximately



Fig. 3. *T. phayrei* leaping across a gap in the bamboo canopy cover as a means of avoiding the forest floor.

Table 3. Comparison of age-sex ratios of Phayre's Langur to an earlier study.

Age-sex ratios	Present study	Khan and Ahsan (1981)
Adult males to adult females	1:2.3	1:2.15
Adults to subadults	1:0.8	1:0.635
Adult females to infants	1:0.3	1:0.035
Adult females to subadults	1:1.14	1:0.93
Juveniles to infants	1:0.7	1:1.67

50 fruits each to be sold for 0.15 USD apiece.

Additional stressors

Firewood collectors entered the forest throughout the year to collect wood to sell. They mainly collected dry leaves and twigs for use as firewood and kindling. But they also cut live branches (young and thin branches with leaves) off of the trees and left them to dry, which reduced the connectivity of the canopy by thinning out the branches and increased the gaps in the canopy cover.

Tourism in national parks increases during winter and festivals such as Eid festival, Puja, National Independence Day, National Victory Day and other holidays. During such festivals, picnicking visitors were observed screaming, shouting and laughing loudly in the forest interior. People were also seen carrying loudspeakers and cooking food at the forest edges.

DISCUSSION

The recorded mean group size (7.7 ± 4.0) in the study area was smaller than group sizes recorded in several previous studies of Phayre's Langurs in the north-east and south-east of Bangladesh (e.g., 12.67 ± 2.46 , Khan & Ahsan, 1981; 13.67 , Khan & Ahsan, 1986; 11.44 ± 5.37 , Ahmed et al., 2020) and northeast India (12.4 individuals, Bose, 2003), but slightly larger than group sizes recorded by Green (1978) in northeastern Bangladesh (5.85 individuals).

Adults were most common age-class in all groups, followed by subadults, juveniles and infants. Almost four decades ago, Khan & Ahsan (1981) also recorded the highest percentages of females (40.4 ± 1) followed by juveniles (26.7 ± 1.9), males (18.5 ± 1.3) and infants (14.5 ± 0.5). Multi-male uni-female groups have been reported in Assam, and multi-male multi-female groups have been reported in Mizoram in India (Bose, 2003). However, no multi-male groups were found in SNP. The proportion of adult individuals (43.5%) in this national park is close to that recorded in five northeastern forests of Bangladesh (47%; Ahmed et

al., 2020). The adult sex ratio at SNP was also similar to those reported earlier in Bangladesh (Khan & Ahsan, 1981; Table 3). However, the study groups at SNP had more juveniles and infants (Table 3), which indicates that this forest is still providing suitable habitats and quality nutrition to the study groups.

Phayre's Langur density at SNP (1.2 groups/km² or 9.5 individuals/km²) was somewhat higher than in previous assessments for northeastern and southeastern Bangladesh (0.18 groups/km² or 2.42 individuals/km², Khan & Ahsan, 1986; 0.56 ± 0.48 groups/km², Ahmed et al., 2020) and north-eastern India (7.6 individuals/km², Gupta & Kumar, 1994; 0.4 groups/km², Adimallaiah et al., 2014).

In this study, groups of Phayre's Langur were recorded in habitat where *A. chama*, *A. lacucha*, *T. grandis*, *L. speciosa*, *T. bellirica*, *Aglaia spectabilis*, *C. arborea*, *F. racemosa* and *Bambusa* spp. were dominant. Previous researchers at this and other sites in Bangladesh have observed Phayre's Langurs consuming plant parts from *A. chama*, *A. lacucha*, and other *Artocarpus* spp., *T. grandis*, *Lagerstroemia* spp., *Bambusa* sp., *F. racemosa* and other *Ficus* spp. (Ahsan & Khan, 1984; Hasan, 2019; Mondal, 2019; Aziz & Feeroz, 2009). They were also frequently observed traveling in bamboos (Bose, 2003). Phayre's Langurs have also been found in forests dominated by *Ficus* sp., *A. chama* and bamboo in Assam and *Terminalia myriocarpa* Van Heurck & Müll. Arg., *F. benghalensis* L., *Bischofia javanica* Blume, *Gmelina arborea* Roxb., *Michelia champaca* (L.) Baill. ex. Pierre and *Polygala jefensis* W.H. Lewis in Mizoram (Bose, 2003). Sightings of Phayre's Langur in bamboo-dominated areas have also been reported in northeastern India (Bose & Bhattacharjee, 2002; Choudhury, 1987, 1994, 1996; Raman et al., 1995; Roonwal & Mohnot, 1977; Wolfheim, 1983) in secondary forests, plantations, primary forests, deciduous forest, and mixed forests with timber and non-timber species (Mukherjee, 1982; Groves, 2001; Molur et al., 2003; Gupta, 2001). Most records of Phayre's Langurs are from secondary forests (46%) followed by plantations (32.2%) and primary

forests (21.4%; Gupta, 1994).

The Tipra community inside the park and the villagers from other nearby villages depend on this forest for forest products, although most are also employed as tea labourers. Eighty percent of the local people around this forest are illiterate and depend on the forest for their livelihoods (IPAC, 2009; Mukul, 2007). Our research identified habitat alteration as the main threat to the forest caused by local people, including the Tipra community. Conversion of forest land to lemon cultivation by the tribal and local people at SNP was also reported by Hasan et al. (2018). Loss of large trees due to logging and firewood collection displaces Phayre's Langurs, and loss of canopy cover limits their movement (Gupta & Kumar, 1994). Illegal logging of large trees at SNP also causes the loss of food plants which threatens the habitat of all wild animals, including primates (Hasan et al., 2018). This species is also threatened in northeastern India by jhum cultivation (Bose, 2003; Choudhury, 2004), habitat degradation due to loss of food trees (Gupta, 1997), deforestation, habitat loss and fragmentation due to conversion of forest to plantation, encroachment into forest areas, etc. (Choudhury, 2013).

We identified road accidents, electrocution, tourist activities and seasonal fruit collection as additional threats to Phayre's Langurs. These results are in line with the results of previous studies for Capped Langur at SNP (Hasan et al., 2018) and elsewhere (Naher et al., 2017). Many mammals in Bangladesh die from vehicular collisions, as many forest areas have been bisected by roads, highways and railways (IUCN Bangladesh, 2015). For example, a previous study in SNP and Lawachara National Park in Bangladesh recorded 12 primate deaths by electrocution and 15 from vehicular collisions in five species of primates (Rhesus Macaque, Northern Pig-tailed Macaque, Capped Langur, Phayre's Langur and Bengal Slow Loris, with the most accidents involving Phayre's Langur [Al-Razi et al., 2019]). Hasan et al. (2018) reported high rates of accidents for many wild animals in SNP on the bypass road from April 2016 to March 2018, including seven individual primates (three Rhesus Macaques, two Pig-tailed Macaques and two Capped Langurs). Road casualties have also been reported for threatened Capped Langurs in Madhupur National Park (Naher et al., 2017), and Bengal Slow Lorises (Choudhury, 1992; Radhakrishna et al., 2006; Kumar and Devi, 2010; Das et al., 2015) in India. Primates have also been killed in road accidents in the Langtang National Park of Nepal (Kumar & Solanki, 2008; Regmi

& Kandel, 2008; Minhas et al., 2010). During the same period, electrocution on uninsulated power lines caused the deaths of 11 individual primates (five adult Capped Langurs, three Phayre's Langurs, two Rhesus Macaques and one Pig-tailed Macaque) at SNP (Hasan et al., 2018). Uncontrolled tourist activities can severely disturb the daily activities and ranging patterns of diurnal mammals (IUCN Bangladesh, 2015). Loud noises and other activities by protected area visitors can drive these mammals out of their home ranges (Naher et al., 2017).

Poaching of Phayre's Langurs by members of other ethnic groups has been reported in north-east India (Bose, 2003), but no hunting was recorded during the study period, and we did not observe any evidence of local people directly harming Phayre's Langurs. Local people expressed interest in participating in the conservation of this species if initiatives are undertaken. Similar interest has been shown for initiatives focused on Capped Langur (Hasan et al., 2018). The Tipra community is entirely dependent on the forest and cultivates lemons in a confined area within the national park (Mukul, 2007), causing habitat destruction. Eight tea estates surrounding the national park attract eco-tourists; however, the labourers from these tea estates are socio-economically marginalised, and depend on the forest for their fuelwood and housing materials (Mukul, 2007). Sawmills and brickfields in and around the national park accelerate forest destruction as the local people illegally collect timber poles from the park and sell them at lower-than-market prices (Mukul, 2007). The forest department should act to close these facilities. Bangladesh Forest Department should consider initiatives to encourage and support the development of alternative income sources for forest-dependent local people to reduce their dependence on destructively-harvested forest products, leading to reduced pressure on the habitat. Use of insulated power lines, maintenance of natural canopy bridges and installation of artificial canopy bridges over the roads and power lines may reduce mortality of Phayre's Langur in this area (Al-Razi et al., 2019). Involvement of local people in sustainable forest management is necessary to conserve this species as well as other wildlife in the park. Government should form partnerships with local people, NGO's and researchers to conserve Phayre's Langur and other primates in SNP.

ACKNOWLEDGMENTS

This study was funded by Nagao Natural Environment Foundation (NEF). We thank the Forest Department, Ministry of Forest and Environment, Bangladesh, for permission to conduct research in Satchari National Park. We are grateful to Dr Susan Lappan, Dr Nadine Ruppert and Prof. Sabir Bin Muzaffar, as well as the reviewers and editors for their insightful comments and suggestions. We thank Md Tanvir Ahmed, Sabit Hasan and Shimul Nath for their field assistance, and forest guards and local people who provided information, including local names of plants, and Prof. Mohammad Zashim Uddin for the confirmation of plant identifications during the study period. Finally, we acknowledge Prof. Farid Ahsan for sharing some research articles regarding this species.

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ISLAND-WIDE DISTRIBUTION OF SRI LANKAN PRIMATES BASED ON A QUESTIONNAIRE SURVEY OF RESIDENTS

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ABSTRACT

Five primate species, representing three genera and 12 subspecies, occur in Sri Lanka. We conducted an island-wide questionnaire survey of primate presence/absence, based on a 5x5 km grid with three questionnaires administered to residents in each cell. Respondents were queried on the presence of Slender Lorises, Toque Macaques, Sri Lankan Sacred Langurs and Purple-faced Langurs in their neighbourhood. Results indicated that Slender Lorises and Toque Macaques were distributed over 88% and 90% of Sri Lanka, respectively, including the wet and dry zones, but with patchy wet-zone distributions. Sri Lankan Sacred Langurs were present over 86% of the island but absent from large parts of the wet zone. Purple-faced Langurs were distributed over 53% of Sri Lanka with a disjunct distribution consisting of a patchy dry-zone presence and a more uniform wet-zone distribution. The maps presented are the first based on a systematic island-wide survey. We discuss the implications of the observed distributions for primate taxonomy and conservation.

Keywords: Distribution-map, *Loris tardigradus*, *Loris lydekkerianus*, *Macaca sinica*, *Semnopithecus priam*, *Semnopithecus vetulus*

INTRODUCTION

Sri Lanka is home to five primate species in three genera. Two species, *Loris tardigradus* (Linnaeus) and *Semnopithecus priam* Blyth are monotypic in Sri Lanka while the other three species together comprise ten subspecies (Table 1). Three species and all subspecies are endemic to the island. *Semnopithecus priam thersites* (Blyth) is Vulnerable (Dittus, 2020), the two subspecies *Semnopithecus vetulus nestor* Bennett (Rudran et al., 2020) and *Macaca sinica opisthomelas* Hill (Dittus & Gamage, 2020) are Critically Endangered, and the other nine Sri Lankan primate taxa are Endangered (IUCN, 2020).

Slender Lorises are strepsirhines and the only nocturnal primates in Sri Lanka. Hill (1953) recognised four subspecies of *Loris tardigradus* in Sri Lanka (*L. t. tardigradus* [Linnaeus], *L. t. grandis* Hill & Phillips, *L. t. nycticeboides* Hill and *L. t. nordicus* Hill) and two subspecies in India (*L. t. lydekkerianus* Cabrera and *L. t. malabaricus* Wroughton). Groves (1998) suggested recognising *L. t. tardigradus* as a full species and the other subspecies of *L. tardigradus* as subspecies of *L. lydekkerianus*. Groves (1998) also could not differentiate

between the subspecies *L. l. nordicus* and *L. l. grandis* on external morphology, including skull measurements. Therefore, he proposed subsuming *L. l. nordicus* under *L. l. grandis*. This leaves Sri Lanka with the endemic species *L. tardigradus* and two endemic subspecies of *L. lydekkerianus*, the latter with two additional subspecies in India (see also Brandon-Jones et al., 2004). Taxonomy of the Sri Lankan Slender Lorises remains in flux, some authors keeping *L. l. nordicus* (Dittus, 2013; Roos et al., 2014), some moving the subspecies *nycticeboides* from *L. lydekkerianus* to *L. tardigradus* (Nekaris & Jayewardene 2004) and some splitting the taxa into additional subspecies, *L. t. parvus* and *L. l. uva* (Gamage et al., 2017). The genetic data presented by Pozzi et al. (2015), confirms the existence of two species of Slender Loris (*L. lydekkerianus* and *L. tardigradus*) both of which occur in Sri Lanka; hence the main issue is the subspecific taxonomy.

The Toque Macaque *Macaca sinica* (Linnaeus) is endemic to Sri Lanka with up to four subspecies being described. Phillips (1935) identified two subspecies, *M. s. sinica* (Linnaeus) and *M. s. aurifrons* Pocock,

Table 1. Primate taxa in Sri Lanka.

Scientific name	Common name	IUCN Red List Status
<i>Loris tardigradus tardigradus</i>	Southwestern Red Slender Loris	Endangered
<i>Loris lydekkerianus grandis</i>	Highland Grey Slender Loris	Endangered
<i>Loris lydekkerianus nordicus</i> (?)	Northern Sri Lankan Grey Slender Loris	Endangered
<i>Loris lydekkerianus nycticeboides</i> (?)	Horton Plains Slender Loris	Endangered
<i>Macaca sinica sinica</i>	Dry-zone Toque Macaque	Endangered
<i>Macaca sinica aurifrons</i>	Pale-fronted Toque Macaque	Endangered
<i>Macaca sinica opisthomelas</i> (?)	Hill-zone Toque Macaque	Critically Endangered
<i>Semnopithecus priam thersites</i>	Sri Lankan Sacred Langur	Vulnerable
<i>Semnopithecus vetulus vetulus</i>	Southern Purple-faced Langur	Endangered
<i>Semnopithecus vetulus monticola</i>	Highland Purple-faced Langur	Endangered
<i>Semnopithecus vetulus nestor</i>	Western Purple-faced Langur	Critically Endangered
<i>Semnopithecus vetulus philbricki</i>	Northern Purple-faced Langur	Endangered

(?) The subspecies taxonomy is still debated.

distinguishing them by differences in bonnet hair colour and hair length of bonnet and back. Hill (1974) added a third subspecies, *M. s. opisthomelas*, in his monograph. Fooden (1979) studied 116 museum specimens of *M. sinica* across Sri Lanka but was unable to distinguish any subspecies morphometrically. However, he found the crown colour pattern exhibited a clear-cut geographic variation, justifying the recognition of two subspecies, *M. s. sinica* (north) and *M. s. aurifrons* (southwest). Fooden (1979) also expressed doubts about the stated origin of the two specimens based on which Hill (1974) described the third subspecies, *M. s. opisthomelas*. Fooden (1979) further stated that tail length, used as justification for a fourth subspecies, *M. s. longicaudata*, described by Deraniyagala (1965), is not a morphological feature used for taxonomy. While Groves (2001) and Brandon-Jones et al. (2004) recognised only two subspecies, Dittus (2013) and Roos et al. (2014) once again recognised *M. s. opisthomelas* as a valid taxon.

The nomenclature of the Sri Lankan Sacred Langur *Semnopithecus priam thersites* has changed over time. Initially classified as *S. entellus thersites* (Phillips, 1935; Groves, 1989; Brandon-Jones et al., 2004) it was subsequently changed to *S. priam thersites* (Groves, 2001; Dittus, 2013; Roos et al., 2014). *S. priam* is divided into three subspecies, with two (*S. p. priam* Blyth and *S. p. anchises* Blyth) occurring in south India. The third subspecies, *S. p. thersites*, is endemic to Sri Lanka. Also, the common name has changed between Hanuman, Indian Grey and Tufted Sacred Langur. In Sri Lanka it is also often referred to as the Grey Langur.

Regardless of the changes in nomenclature, *S. p. thersites* has always been considered to be a single taxon.

The Purple-faced Langur *Semnopithecus vetulus* (Erleben), sometimes also called the Purple-faced Leaf Monkey, is endemic to Sri Lanka. The species initially was placed in the genus *Pithecus* (Phillips, 1935), then changed to *Trachypithecus* (Groves, 1989, 2001) and finally moved to *Semnopithecus* (Brandon-Jones et al., 2004; Roos et al., 2014). The placement of Sri Lanka's *S. p. thersites* and *S. vetulus* in the same genus was also confirmed by a genetic study (Karanth et al., 2008). Four subspecies of *S. vetulus* are recognised (Phillips, 1935; Groves, 2001; Brandon-Jones et al., 2004; Roos et al., 2014), which can be distinguished by their fur coloration (for illustrations see Pethiyagoda et al., 2012). *Semnopithecus v. vetulus* (Erleben) is distributed in the south and southwest of the wet zone, south of the Kalu River; *S. v. nestor* in the lowland wet zone north of the Kalu River; *S. v. monticola* (Kelaart) in the central mountains and *S. v. philbricki* (Phillips) in the dry zone (north and east) (Molur et al., 2003; Roos et al., 2014).

Distribution maps depict the distribution of a taxon for communication and conservation planning and are a key component of species' spatial data (IUCN, 2018). Distribution maps can be developed by point-to-grid mapping of species occurrence data, expert drawn, or predicted with modelling programs such as Maxent which combine information from point occurrence data and environmental variables (Graham & Hijmans, 2006). Point-to-grid mapping can be

based on specimen collection data, direct or indirect detection of the species through physical surveys or questionnaire surveys. In physical surveys of large areas, only a very small fraction of each grid cell can be examined due to logistic constraints. Also, it is highly limited temporally, as surveyors are present at a given location only during the survey, hence the data approximate an instantaneous sample. In contrast, a questionnaire survey of residents investigates species occurrence over a wide spatio-temporal interval as it accesses observations respondents have accumulated over the years. Therefore, questionnaire surveys may have correspondingly higher detection probability. Questionnaire surveys have been used to assess the distribution of a wide range of species, including mountain lions (Berg et al., 1983), wolverines (Groves, 1988), chimpanzees (Sugiyama & Soumah, 1988), sika deer (Kaji et al., 2000), adders (Reading et al., 1996), squirrels (Teangana et al., 2000) and polecats (Baghli & Verhagen, 2003). However, the use of questionnaire surveys may not be effective with cryptic species and those unlikely to be accurately identified by respondents.

Previously published distribution maps for Sri Lankan primates (e.g., Molur et al., 2003; Pethiyagoda et al., 2012) were based on projections from locations where presence was known from expert knowledge and/or locations where presence was confirmed by physical surveys. Here we present the first distribution maps for Sri Lankan primates based on a systematic grid-based island-wide survey.

METHODS

Study area

Sri Lanka is an Indian Ocean island, situated approximately 50 km southeast from the southern tip of the Indian subcontinent. The area of Sri Lanka is 65,610 km². The topography is flat over most of the island, with central mountains reaching 2,500 m. The climate is tropical with precipitation from the southwest and northeast monsoons and inter-monsoonal thunderstorms. The southwest quarter receives rain from both monsoons and is considered the 'wet zone' and the rest of the island, with distinctly seasonal climate, the 'dry zone'. The natural vegetation in the wet zone is wet tropical evergreen forest, grading to montane forest in the mountains, and tropical dry evergreen forest in the dry zone. The wet zone, including the mountains, is densely populated and cultivated, while the dry-zone landscape includes agricultural areas, settlements, and natural forests. Most protected

areas are in the dry zone. Protected areas account for about 26% of Sri Lanka and are administered by the Department of Wildlife Conservation or the Forest Department. People can be legally resident in some protected-area categories such as sanctuaries and 'other state forest'.

Survey

The question of scale is an inherent issue with distribution surveys, with mapping at finer scales identifying smaller areas as occupied. Therefore, the finer the scale of a survey, the more 'accurate' will be the estimated distribution. However, decisions about survey scale must take logistical constraints into consideration, particularly in relation to the extent of the survey area. IUCN recommends scaling estimates of 'Area of Occurrence' (AOO) across all taxa using a grid size of 2x2 km for Red List assessments (IUCN, 2018). We selected a grid size of 5x5 km, as the primate survey was conducted in conjunction with a survey of elephant distribution, for which the grid size was chosen in consideration of elephant home range size and logistical constraints (Fernando et al., in press).

We divided Sri Lanka into 2,742 grid cells of 25 km², each measuring 5x5 km. From February 2011 to July 2015, we conducted a questionnaire survey across the island, interviewing three residents per grid cell. Interview locations within each grid cell were spread out as much as possible, keeping about 1 km away from the edges, to the degree permitted by road access and occurrence of residents. The GPS coordinates of the interview locations along with the answers were recorded on a datasheet. In selecting respondents, we visited each grid cell and chose persons who were long-time residents (>5 years) at the location the questionnaire was administered. Before administering the questionnaire, we engaged the persons in a discussion, asking questions about the area, climate etc. and made a subjective assessment of their knowledge of the surroundings and if they were truthful. If in doubt, the questionnaire was not administered, and a new respondent was selected.

We asked residents about the presence of 'Lorises', 'Macaques', 'Sri Lankan Sacred Langurs' and 'Purple-faced Langurs' in their neighbourhood. As these are morphologically distinct (Fig. 1), and people were universally familiar with their vernacular names, we assumed them to be capable of distinguishing between them. Interviews were conducted in the vernacular Sinhala or Tamil as both languages have specific names for the four taxa. We did not expect people

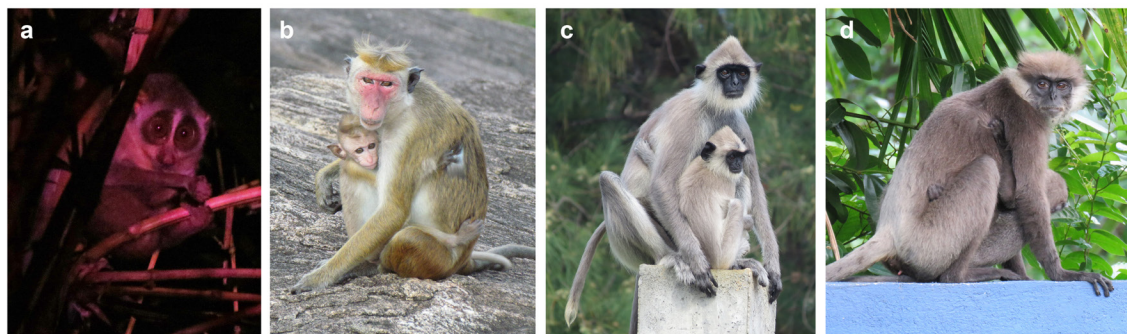


Fig. 1. Primate taxa surveyed in Sri Lanka. (a) *L. lydekkerianus*; (b) *M. sinica*; (c) *S. p. thersites*; (d) *S. vetulus*.

to be able to reliably differentiate the two species of Slender Loris or between any of the subspecies; hence terms identifying them were not included in the query.

The data were analysed in Microsoft Excel and the maps were compiled in QGIS 3.4.7 (QGIS Development Team, 2018). A grid cell with 1–3 positive answers for a species' presence was categorised as 'species present', assuming that heterogeneity of responses reflected spatial heterogeneity within the mapping unit of 25 km² (see Fernando et al., in press, for additional discussion on sampling and interpretation).

A cell without resident people to be interviewed was assigned a state based on the four cells sharing a common boundary with it (first-order neighbourhood). Accordingly, if any of the four adjoining cells had the species, the cell in question was categorised as having the species. Cells assigned states were subsequently considered the same as cells categorised on survey data.

We conducted an additional survey from 10–17 October 2019 to assess error due to respondents confusing *S. p. thersites* and *S. vetulus*. We administered a questionnaire based on a 2x2 km grid to one person per grid, asking about the presence/absence of *S. p. thersites* and *S. vetulus* in their area. After recording their answers, we showed them photographs of the two species and observed if the responses then changed.

RESULTS

Data for the four taxa were collected in a total of 2,209–2,213 grid cells where 6,558–6,583 interviews were conducted for each taxon (Table 2). In 2,150–2,166 grid cells (>97%), three interviews were done. In 38–49 grid cells only two people and in 9–10 grid cells only one person could be interviewed. In 13–17 grid cells, no data was collected due to error (Table 2). In

498 grid cells there were no resident people.

Slender Loris

In 85.3% of the 2,209 grid cells with interview data at least one respondent affirmed the presence of *Loris* sp. in their neighbourhood (Table 3). In 1,234 of these grid cells (65.5%) all three people interviewed reported *Loris* sp. while in 650 grid cells (34.5%) one or two interviewees stated that *Loris* sp. was absent or fewer than three people could be interviewed (Fig. 2). All 498 grid cells without resident people were assigned *Loris* sp. presence, based on first order neighbourhood. Thus, a total of 2,382 grid cells were found to have *Loris* sp., which is 88.0% of Sri Lanka or an area of 59,550 km² (Fig. 3a).

Toque Macaque

In 1,951 grid cells (88.2% of cells from which data were available), at least one person stated that *M. sinica* was present (Table 3), while in 262 grid cells (11.8%) *M. sinica* was absent. In 1,591 grid cells (81.5% of cells in which *M. sinica* presence was reported) all three respondents reported *M. sinica* presence, while in 360 grid cells (18.5%) one or more stated that *M. sinica* was absent or fewer than three people could be interviewed (Fig. 2). All but one of the 498 grid cells without resident people were assigned as *M. sinica* present (Fig. 3b).

Sri Lankan Sacred Langur

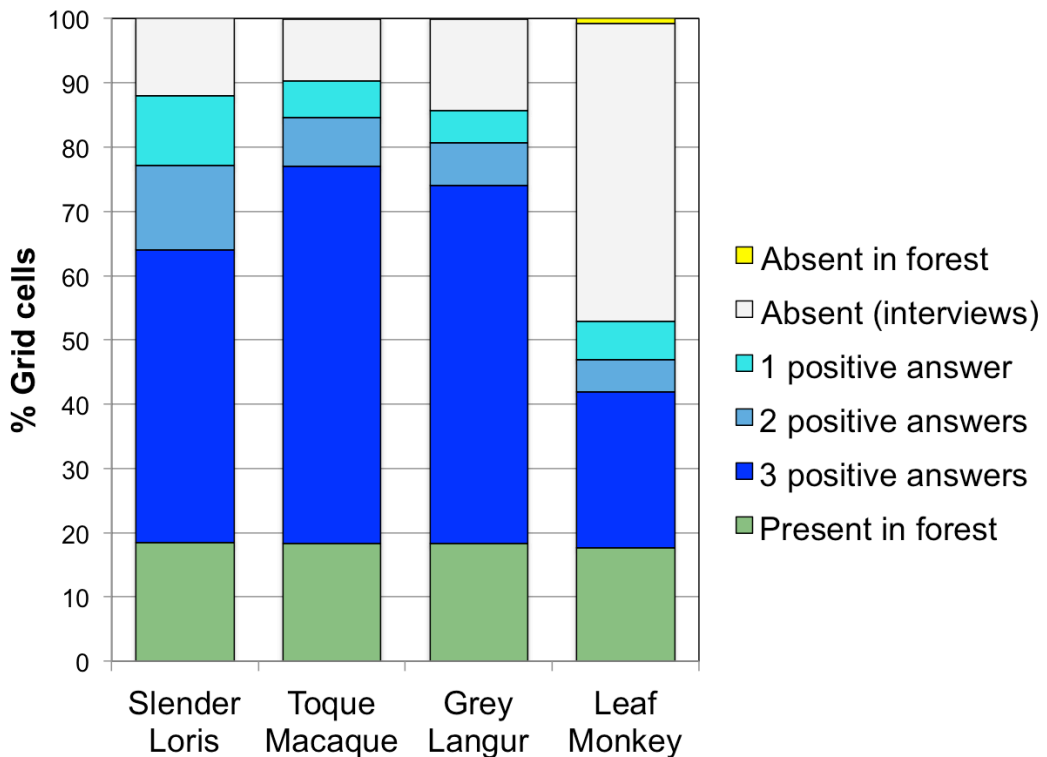
Semnopithecus p. thersites was reported from 1,827 grid cells (82.6% of cells from which data were available). In 1,511 cells (82.7%) all three respondents stated that *S. p. thersites* was present (Table 3). In the other 316 grid cells (17.3%) one or two said that *S. p. thersites* was absent or fewer than three people could be interviewed (Fig. 2). In 386 grid cells (17.4%) all respondents stated that *S. p. thersites* was absent. All but two of the 498 grid cells without people were assigned as having *S. p. thersites* (Fig. 3c).

Table 2. Data collected for the four primate taxa.

Taxon	Interviews	Cells	Interviews per cell			Missing cells
			1	2	3	
<i>L. tardigradus</i> & <i>L. lydekkerianus</i>	6,558	2,209	10	49	2,150	17
<i>M. sinica</i>	6,583	2,213	9	38	2,166	13
<i>S. p. thersites</i>	6,583	2,213	9	38	2,166	13
<i>S. vetulus</i>	6,578	2,212	9	40	2,163	14

Table 3. Results from the interviews and assignment of grid cells without resident people (forest).

Taxon	Interviews		Forest		Total	
	present	absent	present	absent	% present	% absent
<i>L. tardigradus</i> and <i>L. lydekkerianus</i>	1,884	325	498	0	88.0	12.0
<i>M. sinica</i>	1,951	262	497	1	90.3	9.7
<i>S. p. thersites</i>	1,827	386	496	2	85.7	14.3
<i>S. vetulus</i>	954	1,258	479	19	52.9	47.1

**Fig. 2.** Presence/absence in grid cells, based on interviews (absent, 1, 2 or 3 positive answers) or assigned based on neighbouring cells for grid cells without residents (absent or present in the forest). "Forest" refers to grid cells without resident people.

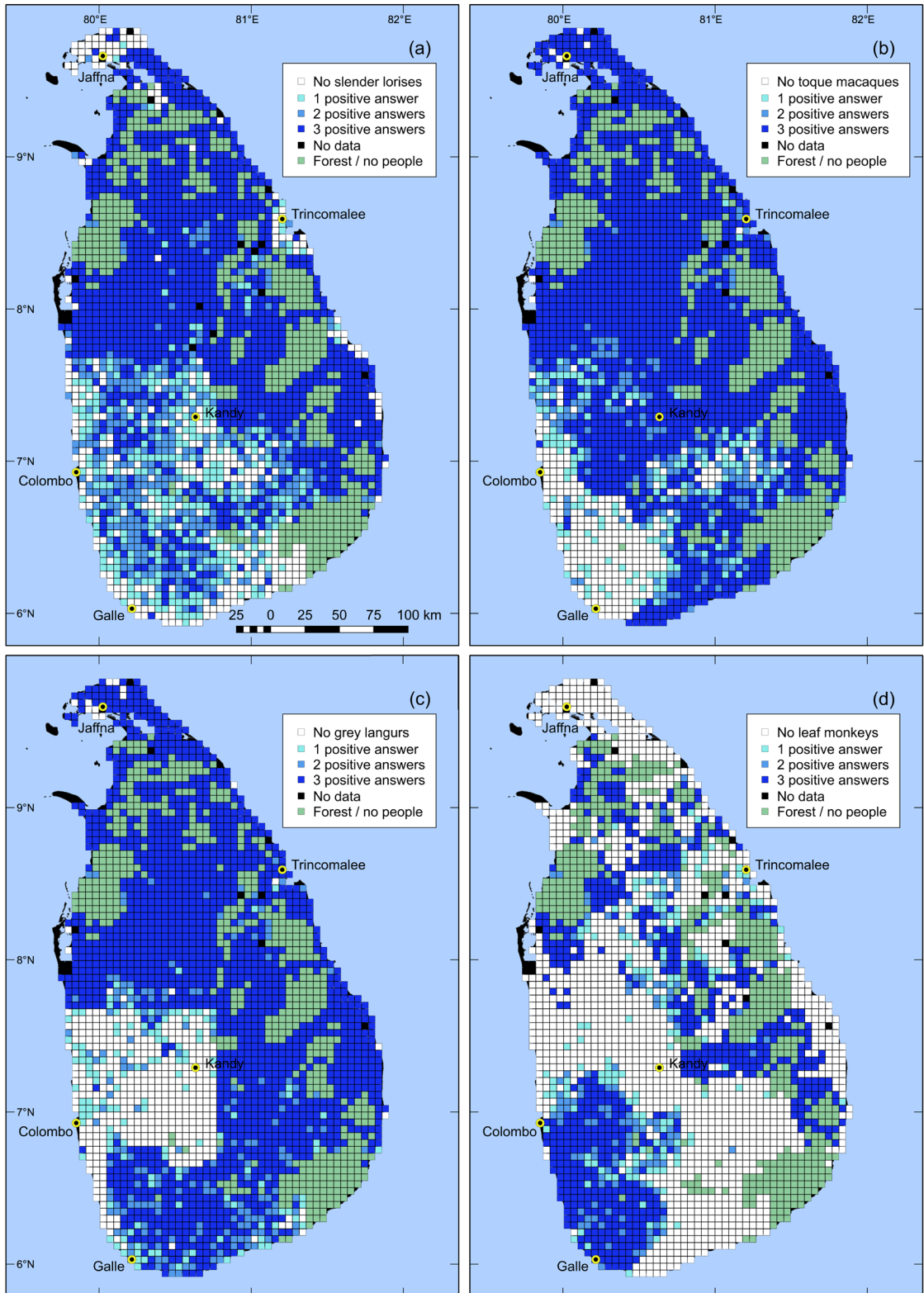


Fig. 3. Distribution maps for (a) *L. tardigradus* and *L. lydekkerianus*; (b) *M. sinica*; (c) *S. p. thersites*; (d) *S. vetulus*.

Purple-faced Langur

Semnopithecus vetulus was scored as present in 954 grid cells (43.1%). Of these, in 657 grid cells (68.9%) all three respondents affirmed the presence of *S. vetulus* (Fig. 2). In the other 297 grid cells (31.1%) one or two people stated that *S. vetulus* was absent or fewer than three people could be interviewed (Table 3). Of the 498 grid cells without residents, 479 grid cells were assigned as *S. vetulus* present (Fig. 3d).

Supplementary survey

Of 82 respondents, 42 (51.2%) stated that neither *S. vetulus* nor *S. p. thersites* were present and three (3.7%) that both species were present. None in either group changed their opinion after the photographs were shown. Seven respondents (8.5%) stated that only *S. vetulus* was present and 30 (36.6%) only *S. p. thersites*. Of these, three people (3.7%) changed their mind after seeing the photographs. One person switched from *S. p. thersites* to *S. vetulus* and the other two changed from *S. vetulus* to *S. p. thersites*.

Discussion

Slender Loris

We found *Loris* sp. range in Sri Lanka to be mostly continuous, with only eight grid cells with the presence of *Loris* sp. (0.3%) not having first or second-order neighbourhood contiguity with other cells with *Loris* sp. presence (Fig. 3a). The somewhat greater proportion of grid cells without unanimous indication of presence may be due to characteristics of the species, such as small size and nocturnal and arboreal behaviour, which may make it less noticeable than the other primate species.

We found that the range encompassed almost the entire island; hence *Loris* sp. was more widespread than previously recognised. The first published distribution map for Sri Lankan *Loris* sp. (Hill, 1953) also showed a continuous range, but with two large vacant areas in the west (Colombo - Kurunegala - Chilaw - along the coast back to Colombo) and east (Trincomalee - Polonnaruwa - Badulla - Ambalantota - along the coast back to Trincomalee). Hill's (1953) map was updated in a review of Lorises by Schulze & Meier (1995), who maintained the two gaps, but expanded the range a little towards the east in the mountains.

From 2001 to 2002 Nekaris & Jayewardene (2004) surveyed 31 sites across Sri Lanka and found *Loris* sp. in 13 locations. One site with *Loris* sp. (Maimbulakanda Nature Reserve) was in the western vacant area and

another (Maduru Oya National Park) in the eastern vacant area of the maps from Hill (1953) and Schulze & Meier (1995). Perera (2008), in a map depicting all historic and recent records of *L. lydekkerianus*, included around a dozen locations in southeast Sri Lanka, suggesting its occurrence over almost the entire eastern vacant area, which was confirmed by our survey.

Toque Macaque

Based on our map, *M. sinica* has a continuous distribution over most of Sri Lanka (Fig. 3b). However, in the Southwest (wet zone) the distribution is very fragmented. This patchy part encompasses almost the entire distribution of the subspecies *M. s. aurifrons* (Fooden, 1979).

The distribution map from Hill (1974) showed *M. sinica* to be present throughout Sri Lanka with parapatry of the two subspecies *M. s. sinica* and *M. s. aurifrons*. The third subspecies *M. s. opisthomelas* was shown as occurring only in Horton Plains, encircled by *M. s. aurifrons* range. In contrast, Fooden's (1979) coarse-grained map depicted a broad intermediate zone not assigned to either, between the two subspecies *M. s. sinica* and *M. s. aurifrons*. It also showed the presence of *M. sinica* all over Sri Lanka.

Molur et al. (2003) presented separate maps for the three subspecies of *M. sinica*. The distribution of the disputed *M. s. opisthomelas* was drawn as a very small area within *M. s. aurifrons* range. They depicted a gap between *M. s. aurifrons* and *M. s. sinica* and also made the range of *M. s. sinica* much smaller than in Fooden (1979). *M. sinica* was shown as absent along the western coast from Colombo to Jaffna in their maps (Molur et al., 2003).

Our map confirms *M. sinica* presence in northwestern Sri Lanka, as indicated by Hill (1974) and Fooden (1979). Although subspecies boundaries are unclear, our distribution data suggest that *M. s. aurifrons* with its smaller and fragmented range, is more threatened than *M. s. sinica*. Since the range of *M. s. opisthomelas* is considered to be extremely small, if a valid taxon, it of course would be the most endangered.

Sri Lankan Sacred Langur

Semnopithecus p. thersites has a continuous distribution throughout the dry zone (Fig. 3c). We found few published studies on *S. p. thersites*. Hardly any distribution maps have been published. Molur et al. (2003) give a rudimentary map showing one continuous range across Sri Lanka's dry zone, leaving out the entire wet zone and most of the North Western

Province (dry zone). Our map shows a much wider distribution of *S. p. thersites*, including parts of the wet zone and the entire North Western Province.

A large part of the wet zone range in our map contains isolated grid cells with within-cell variance in response (Fig. 3c). Our control survey showed that 8.1% of people with only one of the two langur species in their neighbourhood made errors in species assignment. Therefore, the isolated cells in the wet zone indicating *S. p. thersites* presence in our survey may be suspect. The coexistence of two colour morphs has been reported in some *S. vetulus* populations in the southwest of the wet zone (De Silva et al., 2011). Such occurrence may also have caused false positives for *S. p. thersites* in our survey. However, our overall results suggest that Molur et al. (2003) considerably underestimated *S. p. thersites* distribution.

Purple-faced Langur

Our survey shows *S. vetulus* having two geographically disjunct distributions. One range covers large parts of the wet zone in the southwest of Sri Lanka and the other spreads across the dry zone in the east and north of Sri Lanka (Fig. 3d). The dry zone range shown in our map coincides with the distribution of *S. v. philbricki*. The wet zone range would include both, *S. v. nestor* and *S. v. vetulus*, with no obvious boundary between the two. Our survey did not detect *S. vetulus* over most of the distributional range of *S. v. monticola*, as indicated by the localities in the map from Pethiyagoda et al. (2012), which was based on sightings by biologists.

Areas without human presence

Questionnaire surveys depend on the presence of residents and hence cannot be used to sample areas without residents, such as many protected areas. The assignment of presence/absence to grid cells based on first-order neighbourhood was adopted on the premise that species occurrence was not dependent on anthropogenic habitat change. Nekaris & Jayewardene (2004) reported significantly higher sightings of *Loris* sp. outside protected areas than within. Macaques may display human commensalism (Mangalam & Singh, 2013). *Semnopithecus p. thersites* and *S. vetulus* may also benefit from some types of anthropogenic habitat change and adapt to some human-dominated habitats (Ahamed & Dharmaretnam, 2003; Moore et al. 2010). However, none of them can be viewed as synanthropes. Therefore, we feel that the assumption that a species occurring in a grid cell with humans would also occur in a contiguous cell without humans is justified. However, in very large protected areas encompassing regions

significantly different in climatic or physical factors from surrounding areas, some areas may be uninhabitable by particular species. For example, the Wilpattu complex in the northwest and the Yala complex in the southeast have coastal dunes, areas of dense cover, and arid areas. Our survey may have over-estimated primate presence in such situations. Since grid cells without resident people amounted to only 18% of Sri Lanka and the species surveyed are known to be present in many of the protected areas, we assume any consequent error would be slight. Surveying such areas by direct methods would be a useful addition to the data presented here.

Use of questionnaire surveys for assessing the distribution

In determining species distribution, questionnaire surveys assume respondents' knowledge of species presence, violation of which results in false negatives. Awareness of presence is likely to vary by species. Those that are conspicuous, large, diurnal, likely to come in contact with people or are adapted to anthropogenic habitats are more likely to be detected. Correspondingly, cryptic, small, nocturnal species that avoid human habitats and contact are more likely to be missed. In our survey, false negatives are most likely to have occurred with the *Loris* sp. and perhaps some populations of *S. vetulus*.

The occurrence of false positives in questionnaire surveys can occur if the taxon in question is confused with another, which may have been an issue with the distributions of *S. p. thersites* and *S. vetulus* in our survey. Presenting photographs and confirming identity in the survey would decrease such bias.

Another possible source of false positives or negatives would be untruthful responses. Such incidents could occur if respondents perceive positive or negative consequences in admitting presence or absence of the species. For example, if a particular species' presence could result in altering the status or management of an area or people's access to resources. Additionally, people may give fictitious answers due to personal reasons or attitudes towards those administering the questionnaire.

Conducting multiple interviews per mapping unit decreases the impact of false negatives and positives. If one or more positive responses per mapping unit are adopted as the standard of presence, as was done in our survey, the impact of false negatives is minimised. Conversely, taking unanimity of responses to indicate presence reduces the impact of false positives but entails a trade-off due to geographic variation of

presence within a mapping unit. We chose to accept any bias due to false positives, as geographic variation in presence within a grid cell was likely given the relative sizes of our mapping unit and primate home ranges and the importance of detection, rather than non-detection, for conservation.

Taxonomy

Twelve Sri Lankan primate taxa have been described at subspecies level. With the exception of two populations of *S. vetulus*, we did not detect any discontinuities in a distribution consistent with subspecies designations. However, the ability to detect breaks in distribution is related to home range size and the scale of surveying. Home ranges reported for Slender Lorises in India (*L. l. lydekkerianus*) are around 0.9–3.8 ha (Radhakrishna & Singh, 2002; Nekaris, 2003) and those of *S. vetulus* 1–16 ha (Rudran, 1973; Moore et al., 2010; Kumara et al., 2019). We did not find any published home range estimates for *M. sinica*, but home range sizes of other macaque species are in the low hundreds of ha (Izumiyama et al., 2003; Richter et al., 2013; Erinjery et al., 2015; José-Dominguez et al., 2015). Reported home range sizes for *S. priam* have ranged between 7.8 and 9.4 ha in Sri Lanka (Ahamed & Dharmaretnam, 2003; Vandercone et al., 2012) and 45–350 ha in India (Sommer et al., 2002; Chhangani & Mohnot, 2006). Thus, the home range sizes of the species surveyed may extend from less than one ha up to a few hundreds of ha. Given the large disparity between our minimum mapping unit (25 km² or 2,500 ha) and the possible home range sizes of the species surveyed, we may not have detected isolation, particularly in the case of *Loris* sp. and *S. vetulus*.

Genetic connectivity between populations depends on the movement of individuals between them. Dispersal distances could be much higher than the dimensions of home ranges. For example, while the home ranges of *S. entellus* (*S. priam*) groups vary from about 45–350 ha, individual males can move over areas of more than 2,000 ha (Sommer et al., 2002). Gene flow via the transfer of a single reproductive individual per generation (OMPG, one migrant per generation rule) prevents genetic divergence between populations (Mills & Allendorf, 1996). If no breaks in distribution precluding dispersal are present, whether subspecies characters could be maintained is questionable. On the other hand, if parapatric or sympatric populations maintain different suites of morphological characters, it could indicate reproductive isolation, hence specific rather than subspecific differentiation.

Our results emphasise the need to verify Sri Lankan primate taxonomy by conducting comprehensive genetic studies including samples from across their distribution. Similarly, radio-tracking studies could provide accurate information on dispersal and home range size.

Conservation

While our survey shows large and continuous distribution ranges for most of the primates, it is important to keep in mind that the minimum mapping unit was 25 km² and that the maps indicate only the distributional range of the species. It in no way suggests that there are viable populations of the species over the entire distribution range. Nor does our survey provide any indication of densities, hence the abundance, of species. For conservation and management, taking the observed distribution as a baseline, finer scaled surveys should be conducted to obtain higher resolution distribution maps of taxa of concern. Given the extent of overall distributions detected by our survey, the logistics of such an initiative will be formidable and may not be practical for island-wide surveys of any primate species. Therefore, finer scale surveys for conservation efforts directed at specific sites and populations could commence with point locations with known presence and expand outward to assess connectivity and population boundaries.

ACKNOWLEDGEMENTS

We are grateful to Anoma Edirisooriya for entering the data. Helga Schulze and Thomas Geissmann kindly helped us to get old literature. Financial support was provided by the Abraham Foundation. We would like to thank the reviewers and editors for valuable comments that helped improve the manuscript.

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POPULATION STATUS OF NORTHERN PIG-TAILED MACAQUE *Macaca leonina* IN SATCHARI NATIONAL PARK, BANGLADESH

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ABSTRACT

We conducted a status survey of the Northern Pig-tailed Macaque *Macaca leonina* at Satchari National Park in northeastern Bangladesh from January 2017 to March 2018. The 'Complete Count' method was used to determine population size. Potential threats to the macaques were identified through direct observations and questionnaire surveys of the local people. The population comprised 117 individuals (± 13) from three multimale-multifemale groups and six solitary adult males. The group density was 1.2 groups/km², and the group size ranged from 27 to 48 individuals (mean 37 ± 10.5). The mean ratio of adults to non-adults was 1:1.2, and the adult male to female ratio was 1:1. *Macaca leonina* was observed to forage and sleep in the roadside oil palm plantation adjacent to the forest. Habitat loss, fragmentation, roadkill, and electrocution were recorded as threats to macaque survival, and other human activities were identified as potential stressors. Thus, we recommend strictly following the existing management plan (2016-25), monitoring the population, placing speed breakers for vehicles, using insulator-coated power lines and strengthening the capacity of forest departmental staff to conserve *M. leonina* at Satchari National Park.

Keywords: complete count, density, oil palm, primate, conservation

INTRODUCTION

In recent years, global biodiversity has been decreasing catastrophically (Chase et al., 2020). The world's primate populations are declining across large parts of their range due to escalating anthropogenic pressures on primates and their habitats, or infectious diseases (Cotton et al., 2016; Estrada et al., 2017). Alarming, ca. 60% of primates worldwide are now threatened with extinction and ca. 75% have declining populations (Estrada et al., 2017). Collecting baseline information on their distribution, abundance, and population trends is a vital first step in efforts to protect them (Campbell et al., 2016). Once established, population monitoring can enable direct measurement of the effect of local threats and allow assessment of the effectiveness of conservation (Nichols & Williams, 2006; Campbell et al., 2016).

The primate community of Bangladesh consists of one species of Small Ape, one species of Loris, five species of Macaques and three species of Langurs. A limited number of studies have estimated primate populations in Bangladesh (IUCN Bangladesh, 2015). Globally seven out of ten primate species in

Bangladesh are listed under threatened categories by the IUCN Red List of Threatened Species (IUCN, 2020). Nationally, nine primate species are listed under threatened categories, but population data is available for only four species: Western Hoolock Gibbon *Hoolock hoolock* (Harlan), Rhesus Macaque *Macaca mulatta* (Zimmermann), Capped Langur *Trachypithecus pileatus* (Blyth), and Bengal Sacred Langur *Semnopithecus entellus* (Dufresne) (IUCN Bangladesh, 2015). The last record of Stump-tailed Macaque *M. arctoides* (l. Geoffroy) was in 1989, and this species is suspected to be extinct in Bangladesh (Chetry et al., 2020). Only three individuals of Long-tailed Macaque *M. fascicularis* (Raffles) were reported a decade ago from surveys of their known distribution in Bangladesh (Kabir & Ahsan, 2012) but the current status is unknown.

The Northern Pig-tailed Macaque *M. leonina* (Blyth) is listed as a globally Vulnerable (VU) species (Boonratana et al., 2020). Its distribution ranges from north of the Brahmaputra River of eastern Bangladesh and northeastern India to southern Vietnam, Cambodia, China, Lao PDR, Myanmar, and Thailand

(Roos et al., 2014). *Macaca leonina* is declining globally and is predicted to decline by more than 30% in the next three generations (Boonratana et al., 2020). In Bangladesh, *M. leonina* is listed as an Endangered primate. Its population is restricted to a few fragmented forest patches in the northeastern and southeastern regions, occupying an area of about 4,481 km² (IUCN Bangladesh, 2015). Several previous attempts have been made to estimate the population size of *M. leonina* in Bangladesh based on observations. During the 1980s and 1990s, observations ranged from 128–326 individuals with population estimates ranging from 250–1200 individuals (Khan & Ahsan, 1981, 1986; Gittins & Akonda, 1982; Feeroz et al., 1995). In the early 2000s, approximately 350 individuals, including less than 110 adults, were reported to occur in the country (Molur et al., 2003). The most recent assessment, which is likely based on assumptions or old data, estimated a population of less than 1000 individuals (IUCN Bangladesh, 2015). No survey-based *M. leonina* population data have been published in recent decades, but the *M. leonina* population is thought to be in steep decline in Bangladesh, with an estimated decline of more than 20% from 2015 to 2020 (IUCN Bangladesh, 2015).

In recent decades, Bangladesh's forest cover has deteriorated at an alarming rate due to expanding agricultural practice, monoculture plantations and selective logging (Muhammed et al., 2008). Primate habitats and their quality have been diminishing (IUCN Bangladesh, 2015). To initiate site-based, species-specific conservation efforts, it is a prerequisite to have insight into the population status and threats affecting their survival (Campbell et al., 2016). Therefore, the goal of this study was to estimate the total population of *M. leonina*, including group composition, age-sex structure, and threats, at Satchari National Park in Bangladesh.

METHODS

Study Area

Satchari National Park (SNP; 242.91 ha; Fig. 1) is a small part of Raghunandan Hill Reserve Forest (1,520 ha) in northeastern Bangladesh across the border from Tripura state in India (BFD, 2016). The park is within the Sylhet Hills bio-ecological zone, characterized by hilly topography (Nishat et al., 2002). A highway connecting two sub-districts divides the forest patch, and a non-insulated power line passes along the road. Numerous streams crisscross the forest. About 121 ha of SNP consists of natural forest, and the remaining areas were

replanted in 1983–1990 by the Bangladesh Forest Department (BFD, 2016). The forest is semi-evergreen, with approximately 245 species of angiosperm flora (Arefin et al., 2011). There is an Oil Palm *Elaeis guineensis* Jacq. plantation at the northern boundary of the park. SNP supports several globally threatened species such as Western Hoolock Gibbon *H. hoolock*, Phayre's Langur *Trachypithecus phayrei* (Blyth), Bengal Slow Loris *Nycticebus bengalensis* (Lacépède) and Chinese Pangolin *Manis pentadactyla* Linnaeus (Trageser et al., 2017; Hasan et al., 2018; Neha et al., 2020). A village of 24 families from the ethnic *Tipra* community is also located within the park (BFD, 2016). SNP is surrounded by industrial tea plantations. The area has a tropical climate with high rainfall from early June to late September (monsoon) and mild winters from October to March (Neha et al., 2020).

Data collection

The study was conducted at SNP from January 2017 to March 2018. We spent three consecutive days in each month collecting data. We walked five transects for a total distance of 50.2 km (Table 1). Each transect was repeatedly walked between three to eight times. An observer with two assistants moved quietly along the transect at about 1.5 km/h. Population surveys were conducted in between 06:00 h to 11:00 h. We stopped every 100 m for approximately 2–3 minutes and searched for *M. leonina*. We categorized all detected individuals as either in groups or solitary, based on 'Complete Count' methodology (Ross & Reeve, 2011; Campbell et al., 2016). On encounter, we recorded the group size, age-sex of each individual, sighting location, and habitat type. The macaques were classified into four age categories: adult, sub-adult, juvenile and infant. We also photographed the individuals whenever possible.

We estimated the total population by cross-checking the individual counts and the number of *M. leonina* groups encountered at each location. Group sizes fluctuated with dispersal and births. Hence, the last count for each group was used to estimate the *M. leonina* population structure. Lacking enough pictorial evidence of visible markings, individual identification of all the solitary animals was not possible. Instead, we categorized groups based on their age-sex composition and locations. The group encounter rate was calculated by dividing the number of sightings by the total length of transects walked (Sutherland, 2000). The group or individual density in the area was calculated by dividing the total number of groups or individuals by the total area (Sutherland,

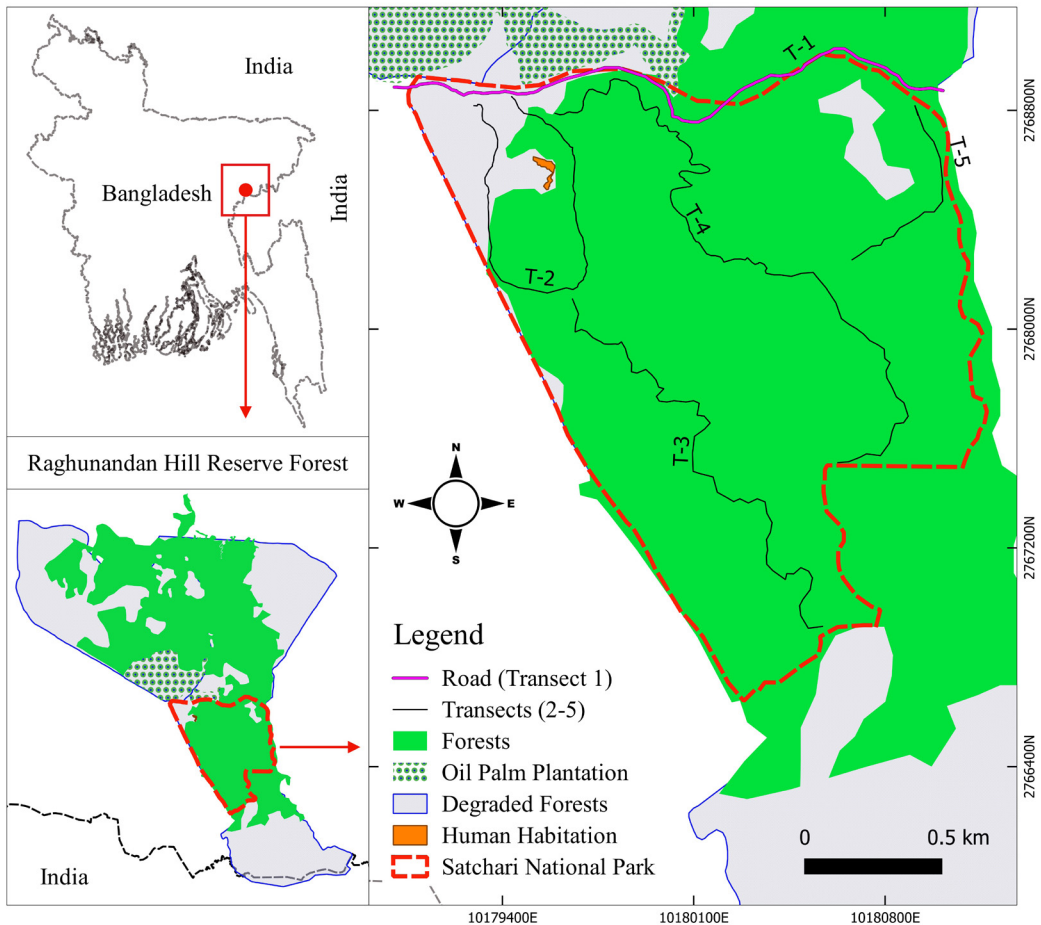


Fig. 1. Map of Satchari National Park showing the *Macaca leonina* survey transects.

2000; Campbell et al., 2016). Solitary individuals were included in the individual density estimations; individuals of unknown sex were excluded from sex ratio calculations. Potential threats to *M. leonina*, and their habitats were identified through direct observation (Naher et al., 2017). We also interviewed stakeholder villagers and staff of Bangladesh Forest Department. The questionnaire focused on the harmful and beneficial aspects of *M. leonina* to villagers and determining the influences of human-macaque interactions (Naher et al., 2017).

RESULTS

A total of 117 ± 13 individuals, comprising three groups and six solitary adult males, were recorded at SNP (Table 2). Group size ranged from 27 to 48 individuals (37.0 ± 10.5). On average, we walked about 1.74 km per day, and the macaque encounter rate

was 0.3 groups/km ($N=16$). The highest number of encounters ($N=7$, 44% of total sightings) was in the oil palm plantation. The group density was 1.2 groups/km², and the individual density was 48.2 individuals/km². The mean ratio of adults to non-adults was 1:1.2. The adult male to female ratio was 1:1. The groups were observed to split into smaller foraging units and then fuse again at sleeping sites. Group 2 was observed feeding and sleeping in the oil palm plantation on transect 1 (Fig. 1). Group 1 was encountered in mixed vegetation and in oil palm plantation. Group 3 was recorded in three vegetation types including forest edges in proximity to Lemon gardens, human settlements, and forest edges. All of the solitary adult males were encountered in mixed vegetation except one on the forest edge. Encounter locations suggested that the home ranges of the groups overlap with each other, especially during the monsoon.

Table 1. Characteristics of *Macaca leonina* survey transects.

Transect	Length (km)	Habitat Type	Disturbance
1	2.1	Road, roadside teak, oil palm plantation and mixed vegetation	Vehicle noise
2	1.69	Mixed vegetation, human habitation, and the edge of tea garden	Human settlements, seasonal tourism
3	1.97	Mixed vegetation, dried stream bed and bamboo	Seasonal tourists, firewood collection
4	2.72	Mixed vegetation, dried stream, Lemon garden and bamboo	Seasonal tourists, firewood collection, and cultivation
5	0.75	Mixed vegetation, tea garden and forest edge	Firewood collection

**Fig. 2.** Threats to *Macaca leonina* at Satchari National Park: (A) and (B) substantial logging, (C) bamboo collection and (D) improper waste disposal by tourists.

Loss of natural forest cover, increasing fragmentation, roadkill, electrocution, habitat disturbance, and human-macaque interactions were recorded as threats towards the long-term persistence of *M. leonina* in SNP. The highway, clearing of forests for agriculture (e.g., Lemon orchards) by the local community, and monoculture plantations have fragmented the forest. Illegal logging and unregulated extraction of firewood

and bamboo were observed (Fig. 2). The highway passes into the forest and has led to high mortality in animals. We found one adult male *M. leonina* killed by a truck on the road in December 2017. The uninsulated power line over the road is also a serious threat to the primates. Twenty-one villagers and forest guards were interviewed (age 37.7 ± 12.1 years; 90% males). Livelihoods of 57% of the respondents ($n=12$)

Table 2. The age-sex composition of *Macaca leonina* population in Satchari National Park.

Groups	Group Size	Adults (A)				Non-adults (NA)				A:NA	Unknown
		AM	AF	AM:AF	SAM	SAF	J	I			
1	36	11	8	1:0.7	4	5	5	3	1:0.9	0	
2	48	7	10	1:1.4	8	7	9	3	1:1.6	4	
3	27	6	5	1:0.8	3	4	5	2	1:1.3	2	
SI	6	6	0		0	0	0	0		0	
Total	117	30	23		15	16	19	8		6	
%		25	20		13	14	16	7		5	
Mean	37	8	7.7	1:0.96	5	5.3	6.3	2.7	1:1.2	2	

SI=Solitary individual; AM=Adult male; AF=Adult female; SAM=Sub-adult male; SAF=Sub-adult female; J=Juvenile; I=Infant.

were directly or indirectly dependent on the forest. They reported being involved in a variety of activities including firewood collection from the forest, Lemon cultivation, living inside the forest and running tourist-based shops. Over half of the respondents (53%) in interviews opined that the *M. leonina* population at SNP is stable. According to 71% of the respondents (n=15), both *M. leonina* and *M. mulatta* raided homesteads for seasonal fruits (e.g., jackfruit, papaya) and the villagers usually tolerate the macaques. Only in cases of extreme detriments, such as damaging sheds, people used bamboo or wooden sticks to repulse the macaques. Interviews suggest that primates are not hunted at SNP. Uncontrolled tourist activities were found to disturb the entire forest ecosystem. From December 2017 to February 2018, when the highest numbers of tourists visited the forest, tourists visiting the park made loud sounds, exploded fireworks, and discarded food waste in the forest. *Macaca leonina* was not observed to be directly provisioned but may have eaten the food left behind by visitors.

DISCUSSION

The present study recorded a total of 117±13 individuals of *M. leonina* at SNP including ca. 53 adult individuals. Without prior population estimates at SNP, it is unclear whether the *M. leonina* population is declining or increasing. Over half of the respondents (53%) in interviews opined that the population is stable. The country's overall population is thought to be in steep decline, and based on the types and intensities of threats, was predicted in 2015 to decline by more than 20% by 2020 (IUCN Bangladesh, 2015). Then again, there is no recent estimate of *M. leonina* abundance in Bangladesh, so the accuracy of this prediction cannot

be assessed.

The numbers of adult males and adult females in the population of SNP were almost equal (adult male to adult female ratio 1:1), which is different from adult sex ratios in previously published data. Khan and Ahsan (1981) found a substantially higher number of adult females than adult males in Bangladesh (adult male to female ratio 1:3). The *M. leonina* individual density at SNP was 48.2 individuals/km², which is higher than earlier estimates in Bangladesh (2.5–6.9 individuals/km²; Feeroz, 2012). Surveys in the Bherjan-Borajan-Podumoni forests of Assam, India revealed densities of 8–33.3 individuals/km² (Choudhury, 2008). A plausible explanation for the higher individual density at SNP is that our survey was confined within the park boundaries, while the home ranges of *M. leonina* groups included the adjoining forests beyond the park area. However, the mean group size of *M. leonina* in SNP was close to reported estimates in and around Bangladesh (Table 3). Group size in primates is dependent on ecological and social drivers (Chapman & Pavelka, 2005). In particular, feeding competition is suggested as a major factor constraining group size in social foragers (Borries et al., 2008). Foraging strategies of *M. leonina* are affected by the distribution and abundance of native fruits (Gazagne et al., 2020). SNP, a small forest, generates limited food, which may cause competition among animals. Competition may involve directly observable interactions (Feeroz, 2012). In the present study, we observed aggression at food sources between two sympatric primates—*M. mulatta* and *M. leonina*. Furthermore, *M. leonina* displaced groups of *H. hoolock*, *T. pileatus* and *T. phayrei* from food plants. *Macaca leonina* has a dietary overlap of 22% with *M. mulatta*, 13% with *T. pileatus* and 43%

Table 3. Comparison of *Macaca leonina* density and group size in and around Bangladesh.

Name of the forest	Group density/km ²	Group size	References
Satchari	1.23	29±18.2 (5–48)	This study
Lawachara		25	Khan & Ahsan, 1981
Unknown	0.04	42.7	Khan & Ahsan, 1986
Namdapha	0.07	15	Chetry et al., 2003
Bherjan-Borajan-Podumoni		16–33	Choudhury, 2008
Lawachara	0.19	20.6±3.9 (15–24)	Feeroz, 2012
Rama-Kalenga	0.25	22±3.6 (19–26)	Feeroz, 2012
Adampur	0.20	19±1.4 (18–20)	Feeroz, 2012
Chunati	0.18	13.5±0.7 (13–14)	Feeroz, 2012
Bhomarighona	0.33	20.8±3.6 (16–25)	Feeroz, 2012
Radhakishorepur		43	Choudhury, 2017 in Boonratana et al., 2020

with *H. hoolock* (Feeroz, 2012) at Lawachara National Park, indicating that these species are potential competitors.

Macaca leonina seems to have adapted well to Oil Palm plantations at SNP. Almost half (44%) of *M. leonina* encounters were in the roadside Oil Palm plantation. *M. leonina* used Oil Palm plantation not only as a food resource but also as a sleeping site. In Malaysia, congeneric *M. nemestrina* forages in Oil Palm plantations but have never been observed to sleep there (Ruppert et al., 2018). Multiple variables, including predator avoidance, range defence, and access to food, affect the selection of sleeping sites in primates (José-Domínguez et al., 2015). The roadside Oil Palm plantation at SNP may be an important food source for *M. leonina* and food proximity might favour the selection of the plantation as a sleeping site. In Malaysia, *M. nemestrina* acts as a potential biological pest control agent in Oil Palm plantation by hunting rats (*Rattus* spp.) (Holzner et al., 2019). Feeding ecology of *M. leonina* in Oil Palm plantations has not yet been studied; therefore, whether they also act as biological pest control is still unknown. Studies on the feeding ecology of *M. leonina* at SNP are pivotal to determine how this ecologically flexible species meets its nutritional requirements in Oil Palm plantations alongside mixed evergreen forests. Further study is also needed to understand the relationship between foraging strategies and the higher individual densities of *M. leonina* at SNP when compared with other sites in and around Bangladesh (Choudhury, 2008; Feeroz, 2012).

Natural forest cover at SNP has been decreasing due to the expansion of Lemon orchards, monoculture plantations, and illegal wood harvesting (Hasan et al., 2018). Altogether 38% of dense forests were degraded in 1993–2006 and 42% in 2006–2019 (Masum & Hasan, 2020). Meanwhile, the increase in canopy gaps at SNP might negatively impact the *M. leonina* population, which is already small and isolated (Molur et al., 2003). Interviews of local people at SNP revealed that *M. leonina* travels to human settlements to forage on seasonal fruits. The people generally tolerate the macaques for their socio-cultural and religious value. However, sometimes the macaques badly damaged storage sheds in human settlements and in such cases, people repulsed the macaques using bamboo or wooden sticks. No injury to either *M. leonina* or human is known to have occurred in such conflicts throughout our study period. However, the highway that passes through the forest and the exposed power line have been responsible for primate mortality. During this study, we recorded the death of a *M. leonina* in a road accident. From 2016 to 2018, at least seven individual primates, including two *M. leonina* individuals, were killed on the road by accidents and further eleven individuals, including one *M. leonina*, were killed by electrocution (Hasan et al., 2018).

SNP becomes congested from December to February, when many visitors enter the forest, make noise, disturb animals, throw out food waste, and plastic bags and containers (Fig. 2). *Macaca leonina* usually showed aggressive behaviour in proximity to visitors and was not observed to take food directly

from them. But in February 2018, an adult male was witnessed licking a packet of potato chips thrown by visitors. Such uncontrolled visitor activity severely interrupts daily activities of diurnal mammals and could potentially spread diseases to non-human primate populations (IUCN Bangladesh, 2015).

This study did not find any evidence of ongoing hunting or trading of *M. leonina* in SNP. In Bangladesh and nearby Indian regions, trade in *M. leonina* bones for traditional medicine, meat for food, and the live monkeys as pets was reported almost 20 years ago (Molur et al., 2003), but the current situation is unknown. Monkey performers often catch monkeys, including *M. leonina*, from local forests, or buy them from villagers who catch and sell monkeys illegally (Akhter et al., 2014), yet the extent of live trade in non-human primates remains undetermined in Bangladesh (WCS, 2018). *Macaca leonina* is listed under Schedule I of Wildlife (Conservation and Security) Act, 2012 (Dey & Rabbi, 2015). Thus, it is legally protected in Bangladesh, and killing or illicit trading of the animal is a punishable offence, but law enforcement remains deficient (IUCN Bangladesh, 2015). The penalty for killing primates, except *H. Hoolock*, is also unclear (see Section 37, Wildlife Act, 2012). Therefore, we suggest a further clarification of the relevant regulations.

The existing SNP management plan (2016-2025) aims to protect, maintain, and enhance the biological significance and aesthetic value of SNP by integrating a community-based management system (BFD, 2016). Strict implementation of the SNP management plan may eradicate the conservation problems affecting *M. leonina* that have been identified. In the long term, though, threatened species, including *M. leonina*, may require specific management schemes. Population monitoring by the forest departmental staff every two years would help to reveal population trends for *M. leonina*. Over-exploitation of forest products requires systematic enforcement of regulations. Further conversion of forest for Lemon cultivation within the national park boundary and illegal encroachment should be prevented. Placing speed breakers in the accident-prone locations on the road, and replacing uninsulated power lines with insulated wires are highly advocated to minimize roadkill and electrocution. Controlling the number of visitors in winter and their activities in the forest will facilitate eco-tourism. Finally, building the capacity of forest departmental staff through training and modernized equipment is key to effective implementation of management plans and enhancing the protection of the animals and forests.

ACKNOWLEDGEMENTS

The study was funded by the Ministry of Science and Technology of Bangladesh. The field equipment was provided by IDEA WILD, USA. We acknowledge the Bangladesh Forest Department for research permission (Letter no-22.01.0000.101.23.2017.1859), and SNP staff who helped with data collection. Members of the *Tipra* community provided valuable information. We are grateful to Sabit Hasan, Shimul Nath, Sajib Biswas and Mahia Tasnim for participating in the fieldwork. We thank Prof. Monwar Hossain for allowing access to the seminar library of the Department of Zoology, Jahangirnagar University and Md. Touhidur Rahman for his assistance. We thank Prof. Farid Ahsan for sharing some articles and Mr Nathan Haislip for English edits. Finally, we acknowledge the reviewers and the editors for improving the manuscript.

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A SHORT NOTE ON THE OCCURRENCE OF CAPPED LANGUR *Trachypithecus pileatus* IN TIBET, CHINA

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The range of Capped Langur *Trachypithecus pileatus* (Blyth) includes northeast India, Bangladesh, Bhutan and northwest Myanmar (Groves, 2001; Mittermeier et al. 2013; Choudhury, 2014; Roos et al., 2014; Das et al., 2020). Hu et al. (2017) mentioned that after the upgrading of Shortridge's Langur *T. shortridgei* Wroughton to full species (Groves, 2001), *T. pileatus* (excluding *T. shortridgei*) was not known to occur in China prior to their study. However, they were not correct, as Choudhury (2014) specifically mentioned that it occurs in a small area of Tibet (defined as the Chinese province of Xizang, excluding the areas claimed by China and falling within India). This note aims to resolve its occurrence in China by describing the current knowledge of its distribution and refers to an article published by Hu et al. (2017), which requires some clarifications.

The occurrence of a langur species in the Namcha Barwa region of south-eastern Tibet was mentioned in the 1990s by Qiu & Bleisch (1996); however, they classified it as Hanuman Langur *Semnopithecus entellus* (Dufresne). Since the range of *S. entellus* is nowhere near Namcha Barwa, I responded that it should be *T. pileatus* (Choudhury, 1997). Bleisch (1997), in his reply, explained that the inferred presence of *S. entellus* was based upon local interviews and earlier reports such as Cai & Zhang (1980) and Liu (1993). Qiu (1997) did not respond directly with reference to *S. entellus* but mentioned that Capped Langur occurred on the border of northern Yunnan Province (in China) and Myanmar. However, the form of *T. pileatus* on the border of Yunnan and Myanmar has since been reclassified as *T. shortridgei* (Groves, 2001).

The question remained whether other forms of *T. pileatus* occur in Tibet. Considering the upper limit of elevation of the species and its habitat, it can cross the Great Himalaya and the Mishmi Hills only at places where the Trans-Himalayan rivers have cut these mountains. There are five such areas, from west to east as follows: Kurichu, Nyamjangchu (Manas), Subansiri, Siang (Yarlung Zangbo) and Lohit, and these have also acted as corridors to several mammal species (Choudhury, 2009) (Fig. 1). Kurichu is in Bhutan, and

here *T. pileatus* occurs up to the border with China (Choudhury, 2008), and there is subtropical habitat through which its range could extend into Tibet. Nyamjangchu is in the upper reaches of the Manas River and here, as well, the subtropical forest can facilitate the movement of the species to Tibet. Along the Subansiri River, the occurrence of the Capped Langur is not known and needs more exploration. Along the Siang River, the species occurs along the right (west) bank well inside Tibet (Choudhury, 2012), and the report of *S. entellus* (Qiu & Bleisch, 1996) in this region was probably actually referring to *T. pileatus*. After visiting the area, George Schaller (pers. comm.) sent me a photo taken in the area which showed *T. pileatus* (Appendix 5 in Choudhury, 2008; 2010). There is no *T. pileatus*, or other langur species, along the left (east) bank of the Siang River or between this river and Dibang River (Borang & Thapliyal, 1993; Choudhury, 1997). Capped Langur occurs on both sides of the Lohit River, but the range ends well before the Chinese border owing to unsuitable habitat – dominated by conifers, with *Pinus merkusii* (Jungh. & de Vriese) as the main species.

As far as subspecific identities are concerned, three have been recognised, based on hair patterns on the head and face rather than pelage colour, which is highly variable seasonally (Choudhury, 2014; 2016). They are *T. p. pileatus* (including *T. p. dura* (Wroughton), which has been synonymised), *T. p. tenebricus* (Hinton), and *T. p. brahma* (Wroughton). Of the two photos in Hu et al. (2017), Figure 2A is of *T. p. tenebricus* as correctly mentioned by the authors (also see Fig. 2). However, Figure 2B in Hu et al. (2017), which the authors hypothesised to be *T. (p.) shortridgei*, appears to be of *T. p. brahma*. My justification for identifying the langur in Figure 2B as *T. p. brahma* includes its contrasting cap and side whiskers (less conspicuous in *T. shortridgei*), creamy side whiskers (grey in *T. shortridgei*), and darker bluish-grey pelage colour (refer to photos of *T. p. brahma* in Choudhury (2014), and Fig. 3 & 4 in this article). *T. shortridgei* should not occur in Medog County in Tibet (where Figure 2B was taken) as there are zoogeographic barriers in the form of



Fig. 1. Map of North-east India, Bhutan and China showing the Trans Himalayan rivers. 1. Kurichu; 2. Nyamjangchu (Manas); 3. Subansiri; 4. Yarlung Zangbo (Brahmaputra), and 5. Lohit.



Fig. 2. Capped Langur subspecies *T. p. tenebricus* in Bhutan. Photo by Anwaruddin Choudhury



Fig. 3. Capped Langur subspecies *T. p. brahma* in Arunachal Pradesh, west of the Siang (Yarlung Zangbo) River. Photo by Anwaruddin Choudhury.



Fig. 4. Capped Langur subspecies *T. p. brahma* in Assam, west of the Siang (Yarlung Zangbo) River. Photo by Anwaruddin Choudhury

Lohit and Yarlung Zangbo rivers and the high mountain between Lohit and Salween rivers. The only possible contact zone for *T. shorridgei* with *T. pileatus* is with the nominate subspecies in northern Myanmar around the upper reaches of the Chindwin River. Meanwhile, a new population of *T. shorridgei* was found to occur in south-eastern Tibet (Wu et al., 2016); following this Jiang et al. (2015) deleted *T. pileatus* from the checklist of the mammals of Tibet (probably thinking that the langurs in Tibet were all *T. shorridgei*). Wu et al. (2016) did not provide a photo, but since figure 2B in Hu et al. (2017) is from west of Yarlung Zangbo, it is certainly *T. p. brahma* and not *T. shorridgei*. Seasonally *T. p. brahma*'s ventrum becomes reddish-orange, more prominently in the breast region. Its side whiskers are creamy to buffy, seasonally with a yellowish tinge, which are not present or not prominent in *T. shorridgei*.

Figure 2A of *T. p. tenebricus* in Hu et al. (2017) seems to be from the Nyamjangchu (Manas) corridor as it is from near Lai in Cuona County. Two areas in Tibet need exploration: the Kurichu River corridor (Louzha County) and the Subansiri River corridor (Longzi and Cuona counties). In both of these areas, *T. pileatus* is likely to occur. Both of these rivers have cut the mountains forming deep valleys with subtropical habitat, which can facilitate trans-border movement of the Capped Langur. The present note clarifies that two subspecies, *T. p. tenebricus* and *T. p. brahma*, occur in Tibet, west of the Yarlung Zangbo, with the former in western areas and the latter in eastern areas. It further shows several zoogeographic barriers between *T. p. brahma* and *T. shorridgei*, and there should not be any confusion regarding any overlapping range.

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EXTIRPATED OR IGNORED? FIRST EVIDENCE OF BENGAL SLOW LORIS *Nycticebus bengalensis* FROM MADHUPUR NATIONAL PARK, BANGLADESH

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ABSTRACT

We report the first verifiable record of globally Endangered Bengal Slow Loris *Nycticebus bengalensis* in Madhupur National Park, an old-growth natural Sal *Shorea robusta* forest in north-central Bangladesh. On 21 October 2020, we sighted a male *N. bengalensis* in Madhupur National Park by chance while recording videos on the forest's biodiversity. For three decades, *N. bengalensis* was believed to have been extirpated from the Sal forests in Bangladesh, in the absence of a specialized nocturnal survey. Given the alarming state of extreme habitat alterations due to human activities and other threats to *N. bengalensis* in Bangladesh, an assessment of its distribution and population status in Sal forests is crucial for conservation planning.

Keywords: Distribution, *Nycticebus bengalensis*, slow loris, strepsirrhine, tropical moist deciduous forest

Bengal Slow Loris *Nycticebus bengalensis* (Lacépède) is an arboreal strepsirrhine primate native to Bangladesh, north-eastern India, Bhutan, Myanmar, China, Thailand, Cambodia, Lao PDR and Viet Nam (Nekaris et al., 2020). Within its distribution range, *N. bengalensis* inhabits a variety of habitats including tropical evergreen rainforest, semi-evergreen forest, and mixed deciduous forest from sea level up to 2,400 m (Choudhury, 2001; Nekaris et al., 2020). It shows ecological flexibility, residing in secondary to degraded forests, forest edges, bamboo stands and plantations (Nekaris et al., 2020). However, there is a paucity of information on its status, distribution, ecology and behaviour (Al-Razi et al., 2020). In Bangladesh, the distribution of *N. bengalensis* is still poorly understood. IUCN Bangladesh (2015) reported that its range is confined to north-eastern and south-eastern semi-evergreen and hill forests in the country. A small number of individuals have been rescued from human habitations in the northern border areas of Bangladesh (Nekaris et al., 2020). Yet, no reports suggest *N. bengalensis* presence in the central and north-central Sal *Shorea robusta* (Gaertn) forests.

Madhupur National Park (hereafter MNP; 8,436 ha; Fig. 1) is a moist deciduous Sal forest in north-central Bangladesh. On 21 October 2020 at 11:54 h, while recording videos of the biodiversity in MNP, the second

author encountered an adult male *N. bengalensis* in a roadside bamboo *Bambusa* sp. clump near Lohoria Deer Breeding Centre at Lohoria Beat (24°41'44.7"N, 90°06'21.1"E; Fig. 2). A group of *Macaca mulatta* (Zimmermann) was foraging in the bamboo clump. The *N. bengalensis* individual was sighted about 3 m above the ground and was observed for several minutes before it moved fast to the next bamboo clump by walking on the forest floor. It walked about 8 m on the ground and then climbed up a nearby bamboo thicket before disappearing from our view. No inter-specific interaction was observed except that a sub-adult male *M. mulatta* came closer just before the *N. bengalensis* came to the ground. Conceivably, the nocturnal primate *N. bengalensis* may have been disturbed at its sleeping site by the diurnal *M. mulatta* group. The whole episode was photographed and recorded using a GPS enabled Redmi Note 9 Pro smartphone device. We did not have permission and resources to conduct surveys at night in MNP. Hence, we informally interviewed local staff of the Bangladesh Forest Department to know if *N. bengalensis* had been introduced into the area in the past. According to the interviews, there are no records of *N. bengalensis* introduction in MNP. Two staff members claimed to have witnessed *N. bengalensis* in MNP previously, including one sighting near Lohoria Deer Breeding Centre. However, they had not formally documented

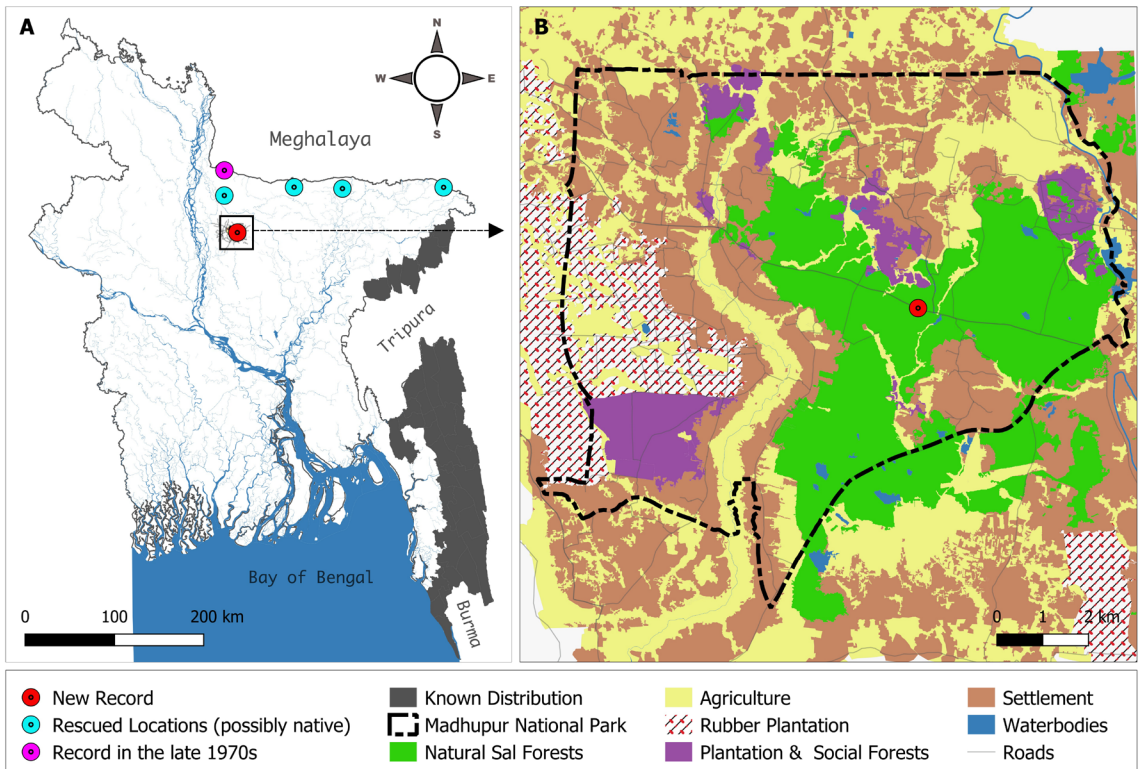


Fig. 1. Distribution of *Nycticebus bengalensis* in Bangladesh (A) and the new record in the Madhupur Sal Forest landscape (B). The national distribution of the species follows Khan (2018) and IUCN Bangladesh (2015). GPS locations of the Loris rescued locations were projected based on the information published by national newspapers. Forest data was extracted from NISHORGO site (<http://nishorgo.org/>), and the map was created using QGIS 3.8 (QGIS Development Team, 2019).

their observations (M.H. Khan, pers. comm. 2020). Hence, our sighting is the first verifiable record of *N. bengalensis* in MNP, a location over 50 km from the closest known area of occurrence in Bangladesh.

In the late 1970s, *N. bengalensis* occurred in the Sal forest of Balijhuri range of Jhinaigati Upazila, beyond the Gazni Reserve of Sherpur district, bordering Tura Hills in Meghalaya state in India (Khan & Ahsan, 1986; Fig. 1). Over the past three decades, *N. bengalensis* is believed to have been extirpated from the Sal forests in Bangladesh (Khan, 1987; IUCN Bangladesh, 2015), but this has not been tested in specialized nocturnal surveys. Khan (2018) included the northern border areas of Bangladesh, an area where a number of individuals were rescued, in the distribution range of *N. bengalensis* (Nekaris et al., 2020; Fig. 1). In fact, the northern bordering areas of Bangladesh still support a few patches of disturbed Sal forests, surrounded by human habitations (Khan, 2018; IUCN Bangladesh, 2015). *Nycticebus bengalensis* is ecologically flexible

and can live even in heavily disturbed agricultural areas and in proximity to human habitations if suitable food is available (Al-Razi et al., 2020; Nekaris et al., 2020). Hence, the rescued individuals could have been inhabitants of remaining disturbed Sal forests in the northern border area (Khan, 2018; Nekaris et al., 2020), a possibility that should be examined rigorously in nocturnal surveys of the area.

The diet of *N. bengalensis* is composed of plant exudates, nectar, fruits, bark, floral parts, tender leaves, invertebrates and avian eggs with a preponderance of exudates (Swapna et al., 2010; Das et al., 2014). One study found exudates to make 67.3% to 94.3% of the total diet (Swapna et al., 2010). MNP supports substantial plant species diversity, including many of the preferred food species of *N. bengalensis* (Swapna et al., 2010; Das et al., 2014; Rahman et al., 2017). MNP is home to *Terminalia bellirica* (Gaertn.) Roxb., *T. arjuna* (Roxb. ex DC.) Wight and Arn and *T. chebula* Retz. are important food sources; *T. bellirica* is particularly



Fig. 2. *Nycticebus bengalensis* in the roadside Bamboo clumps at Madhupur National Park, North-central Bangladesh.

important during winter periods of scarcity (Swapna et al., 2010). The species increased nectar consumption in April, concentrating on *Careya arborea* Roxb., whereas *Acacia concinna* (Willd.) DC and *A. pennata* (L.) Willd were preferred items in summer (Swapna et al., 2010). *Careya arborea*, *A. concinna* and *A. pennata* are common plants in and around MNP (Rahman et al., 2017). *Nycticebus bengalensis* also feeds on other species such as *Sterculia villosa* Roxb, *Spondias*

pinnata (L.f.) Kurz, *Lansea coromandelica* (Houtt.) Merr, *Ficus hispida* L. f., *Artocarpus chama* Hamilton, and *Dillenia indica* L., found in MNP (Swapna et al., 2010; Das et al., 2014; Rahman et al., 2017). Hence, we speculate that MNP contains adequate availability of preferred feeding plants and is a suitable habitat to support a population of *N. bengalensis* unnoticed in the past. Our sighting may indicate the possible occurrence of *N. bengalensis* in other Sal forests,

notably the Bhawal National Park and Kadigarh National Park, which were historically connected to MNP (inferred from Stanford 1991).

Both globally and in Bangladesh, *N. bengalensis* is an Endangered primate, threatened by habitat destruction, illegal pet trading, hunting for bushmeat and use in traditional medicine (Molur et al., 2003; IUCN Bangladesh, 2015; Nekaris et al., 2020). The population of *N. bengalensis* in Bangladesh is estimated to have been reduced by about 50% over the last two decades, and much of its remaining habitat occurs in small, isolated fragments and shrinking rapidly (IUCN Bangladesh, 2015). Thus, specialized nocturnal surveys are crucial to reveal the distribution and site-specific population status of *N. bengalensis* in MNP and other Sal forests in Bangladesh.

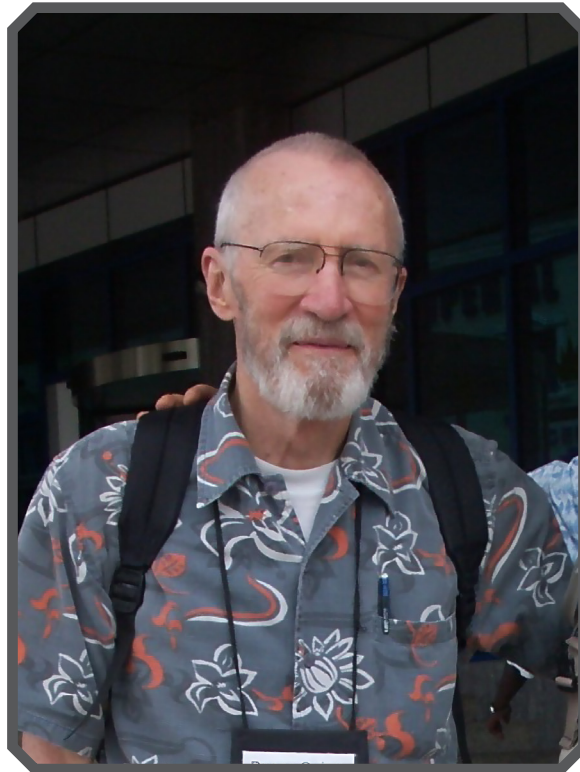
ACKNOWLEDGMENTS

We are grateful to Mr Jamal Hossain, and other government staff in Madhupur National Park for providing valuable information and to Dr Monirul H. Khan for verifying the record. We acknowledge Dr Sabir B. Muzaffar and Dr Christian Roos for commenting on an earlier draft of the manuscript. We thank Mr Sabit Hasan, Mr Selim Rana and Mr Feroze Ahmed for sharing relevant information. Finally, we are grateful to anonymous reviewers and editors for improving the manuscript.

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CELEBRATION OF A LIFE WELL LIVED



Duane D. Quiatt
(1929-2021)

Duane passed away at his home in Boulder, Colorado, on 13th June at the age of 92. He was Professor Emeritus in the Department of Anthropology, University of Colorado-Denver (UCD) where he had been a member of the faculty since 1969. Duane led a rich life, always surrounded by students and colleagues of many diverse academic interests and backgrounds. He easily made friends wherever he went around the world. Duane served in the army between 1951 and 1953 based in Japan, before attending the University of Michigan, where he obtained a Bachelor of Arts (1956) and Master of Arts (1959) in English. He moved to Colorado to teach English at UC-Boulder between 1959 and 1961, but switched early in his academic career to anthropology, first starting in archaeology. However when he returned from his first field season to find that the crates with his excavated pottery “had all been destroyed beyond recognition,” Duane, true to character, wasted no time and dived into something equally challenging. Switching to primatology, he conducted his PhD research on the social organization of rhesus macaques on Cayo Santiago (Puerto Rico), where he later returned to conduct studies on social learning and food resource access strategies, many years later.

Strongly influenced by his mentor Gordon Hewes (1917-1997), Duane had many interests and approached them all with intellectual rigour and his unique and independent style. These interests ranged from the origin of language, cognition, cultural behaviour, social learning and tool use. Duane never forgot his archaeological interests, however, and creatively blended field archaeological method and primate field studies on various occasions. The results ranged from experimental work in the famous Anasazi cliff dwellings at Mesa Verde to the study of Japanese macaque stone handling behaviour and interpretation of their residual artifacts in the wild in Japan and in a captive population in Colorado. Duane also observed gibbons in Khao Yai (Thailand) and chimpanzees in the Budongo Forest (Uganda). With a strong interest in cultural behaviour and information transfer, he collaborated on two books, one an edited volume with the primatologist Junichiro Itani of Kyoto University entitled 'Hominid Culture in Primate Perspective' and another co-authored with Oxford primatologist Vernon Reynolds entitled 'Primate behaviour: Information, social knowledge, and the evolution of culture'. These are but a few of his many and diverse activities, but with every endeavour he undertook, he mentored and had a great impact on a number of young anthropologists, many of us with whom he remained lifelong friends. Duane was also a poet, and he often talked about one day publishing his entire works. Unfortunately for us this has not yet happened.

The following are the closing lines of his first poem published as a young man in 1958.

“

*...Laugh at old men if you dare,
But I believe them when they swear
Less wet, less dry, less hot, less cold,
The weather slowly grows as we grow old.*

”

**[Quiatt D 1958. Two Poems. The Antioch Review 18(4),
The American Abroad (Winter, 1958), p. 498]**

Duane was an easy going all weather friend. He will be greatly missed, but his legacy lives on in the thoughts and work of the many he befriended and made an impact on along his journey.

(Prepared by M.A. Huffman)

TRIBUTES FROM FRIENDS AND COLLEAGUES

“ Duane was one of the finest of my colleagues in primatology, whom I counted as a dear friend. He was what he seemed – an unassuming straightforward caring guy who rode the ups and downs of life without complaint, always seeing a humorous side. I first met Duane in 1982 at the IPS conference in Atlanta, where we learned we had a lot in common, in particular that we had both started our primatological careers with a PhD on the social behaviour of rhesus monkeys. Duane was a first rate primatologist whose interests ranged widely and keenly; a poet; a co-operator without competitive or egotistical traits; empathetic and dependable as a friend. They don't make many like him and we were lucky to have known him.”

**Vernon Reynolds, Professor Emeritus
Oxford University (UK)**

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“ I remember Duane as extremely pleasant, imaginative, and having an engaging curiosity. I recall his suggestion that “household” is a term that can be applied to nonhuman primates. I was skeptical at first, but now, after many years of observations, I think that there are good reasons to justify its application to gibbon social units. They do not always consist of nuclear families, but may be highly variable, depending on how pair bonds are formed, and whether or not any relatives happen to join. Gibbon territories don't look like houses, but they are long-lasting and out-survive any of their individual occupants. And like households, territories require maintenance and individual commitments. I am grateful to Duane for his insights, his friendship and also his warm hospitality.”

**Warren Brockelman, Professor Emeritus
Mahidol University (Thailand)**

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“ He was truly the most gentle gentleman I have ever known. He was a thoughtful thinker and exceptionally generous to others; generous with his time, his brilliance, his encouragement. He nurtured little sparks in all of us and cheered us on. I will never forget the first time I met him; it was 1990. I was so filled with excitement about my dream of studying wild bonobos. A dream that absolutely everyone else had poo-pooed and dismissed. Yet he nourished, uplifted, and encouraged me from the very first. He supervised my Master's degree, and mentored me from that point forward. I was blessed to know him as a friend. Whenever I saw him, as I'm sure he did with others, his eyes would light up and sparkle, a big smile would break out across his face. He always made me feel 'seen' and valued. His guidance was always unassuming and solid.”

**Jo Thompson, President / Executive Director
Lukuru Wildlife Research Foundation (DR Congo)**

.....

“ Duane was my very first mentor in physical anthropology and evolution. I especially remember a seminar class where all the graduate and senior level undergraduate students in the Department got together to participate in a human and primate evolution seminar. Duane let us go and guided our discussions at the fringes of what was known and I know we all came out of it with a huge number of questions that had not yet been asked by the anthropology profession as a whole. Duane was one of the most insightful professors I had and we continued to keep in contact for many years. I later turned what I had learned in Duane’s seminar into a paper on the evolution of land mammal diversity. I loved listening to Duane’s lectures which always resulted in a ton of new questions for me.”

**Richard Stucky, Curator Emeritus
Denver Museum of Nature & Science, Denver, CO (USA)**

.....

“ I met Duane in 1982 when I was an undergraduate at Ft Lewis College (Durango CO), just back from Japan where I first started my training in primatology. We collaborated in Japan in 1984 on stone handling behavior, a newly innovated cultural behavior in Japanese macaques when I was a Masters student at Kyoto University (KU). We wrote two papers from that experience, and he taught me much about the process of critical thinking, writing papers and mentoring. A few years later, after finishing my PhD he arranged for me to become an adjunct research professor at UCD so I could obtain US research funding for a pilot project at Budongo while based at KU on a contract research position. Duane was always there as a trusted friend and solid colleague with good advice, a cup of tea, a plate of pie or a good hike, wherever our paths crossed around the world.

**Michael A. Huffman, Associate Professor
Primate Research Institute, Kyoto University (Japan)**

.....

“ I had the good fortune to take a course in primate behavior from Duane at UC Denver and also spent time with him in the field. He not only taught me about non-human primates but also about integrity and being true to oneself. He conducted research because it was interesting to him, not because it was a hot topic or fundable. If he didn’t have a grant for research he wanted to explore – he self-funded. In 1998, I obtained a Fulbright to study self-medicative behavior at Budongo. Duane helped prepare me for many years in the field. He encouraged me to be my best, trust my observations, and acknowledge that spending time with non-human primates was a privilege. I am grateful for the time I spent with this amazing, creative, and kind soul.”

**Paula A. Pebsworth, Scientific Coordinator
Cloudbridge Nature Reserve (Costa Rica)**

.....

“ I first met Duane when I was a very green post-grad student heading out to Budongo Forest to study chimpanzees in the late 1990s. We worked together on one of my first ever peer-reviewed publications looking at the prevalence of disabilities from snare injuries in chimpanzees throughout East Africa. Whilst the subject matter might seem a bit dark, Duane always focused on the positive aspect of how chimpanzees had been able to overcome and manage such debilitating injuries well into old-age. He gave me a lot of time in preparing that paper in my formative primatology years, and for that I’m very grateful.”

**Emma J. Stokes, Regional Director
Central Africa, Wildlife Conservation Society (Rwanda)**

.....

“ My first job after graduation was on Cayo Santiago where I had the good fortune to encounter Duane, and his daughter Sarah, his then field-assistant. In UK schooling I’d learned almost nothing but a reductionist natural science from age 14, and I was feeling the limitations. In Duane there was appreciation for empiricism but also a liberating, amused, imaginative curiosity about all things, fed by his fondness for literature. His understated insights, whether on living macaques or on extinct Anasazi, were built on an engaged intuition as much as on meticulous measurement. Scholarliness to aspire to. I’m moved to see how his qualities have been relished by others.”

**John R. Fellowes, Co-Editor
Asian Primates Journal & IUCN SSC Primates Specialist Group**

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Instructions to Contributors

Scope

This journal aims to provide information relating to conservation of the primates of Asia. We welcome manuscripts on any relevant subject, including taxonomy and genetics, biogeography and distribution, ecology and behaviour, active threats and primate-human interactions. Submissions may include full articles, short articles and book reviews.

Submissions

Manuscripts and all editorial correspondence should be directed to Dr Ramesh Boonratana (ramesh.boonratana@mahidol.edu or rboonratana@gmail.com). Manuscripts are to be submitted to the journal on the understanding that they have not been published previously and are not being considered for publication elsewhere. The corresponding author is responsible for ensuring that the submitted manuscript has been seen and approved by all co-contributors, and the covering letter accompanying it should be signed to this effect. It is also the responsibility of the contributor to ensure that manuscripts emanating from a particular institution are submitted with the approval of the necessary authority. The editors retain the right to modify the style and the length of a contribution and to decide the time of publication; they will endeavour to communicate any changes to the contributors. The full name and address of each contributor should be included. Please avoid the use of unexplained abbreviations and acronyms.

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Manuscripts should be submitted in UK English. Manuscripts must be in electronic format in MS-Word or a compatible program, double-spaced and left-justified. The first page should include a concise title, up to seven keywords not found in the title, full names and addresses of all authors, current addresses if different, email addresses, and indication to whom queries and proofs should be sent. In-text citations should use comma and ampersand and follow first chronological, then alphabetical, sequence: (Matsuzawa & MacKinnon, 1980; Marsh, 1998; Matsuzawa, 1998a, 1998b). All pages including tables should be numbered. Footnotes should be avoided.

Full articles will be sent out for peer-review and should contain significant new findings. They should not exceed about 20 pages in length (double-spaced), including references. Please include an abstract of no more than 200 words, placing the work in conservation context and summarising what it has contributed, and subheadings (e.g. Introduction, Methods, Results, Discussion, Acknowledgements, References) as appropriate.

Taxonomy

Both the common name and the scientific nomenclature should be used at the first mention of any species or subspecies. The scientific nomenclature at first mention should also include its taxonomic authority, e.g., Bornean Orangutan *Pongo pygmaeus* (Linnaeus), Sumatran Orangutan *Pongo abelii* Lesson, North-east Bornean Orangutan *Pongo pygmaeus morio* (Owen). Subsequent mention should include only the scientific nomenclature, i.e., *Pongo pygmaeus* or *Pongo pygmaeus morio* at start of a sentence, or *P. pygmaeus* or *P. p. morio* within the sentence. Authors are referred to IUCN (or more recent/authoritative sources) for up-to-date animal nomenclature and the World Flora Online (www.worldfloraonline.org) for up-to-date plant nomenclature. The up-to-date common name and the scientific nomenclature of Asian primates acceptable to the Asian Primates Journal are available at the journal's webpage (www.primates-sg.org/asian_primates_journal/).

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Measurements should always be metric, or where this is inappropriate, the metric equivalents given in parentheses. Time

should be designated in the 24-hour system (as e.g. 17:30 h) and date in the European system (e.g. 7 December 2011). Summary statistics should include measures of both central tendency and dispersion where appropriate, e.g. means and standard deviations (SD). Reports of all statistical tests should include the name of the statistical test, the name and value of the test statistic, the degrees of freedom, the probability value used to determine significance and the authors' interpretation. Probabilities should be reported as exact values if not significant, otherwise rounded off to either $p < 0.05$, 0.01 or 0.001.

Figures, maps and tables

Articles may include photographs, high-quality figures, high-quality maps and tables. Please keep these to a minimum. We stress the importance of providing maps which are publishable, with clear explanation of features shown, scale and orientation. Please number tables and figures (as Table 1, Fig. 1 etc.) and provide clear concise captions. Please submit the tables and figures as separate files.

Acknowledgements

Remember to thank those who have contributed substantially to your paper, not forgetting (in the final submission) the reviewers.

References

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Journal article

Lappan, S. 2009. Flowers are an important food for small apes in southern Sumatra. *American Journal of Primatology* **71**: 624–635.

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Asian Primates Journal

A Journal of the Southeast Asia, South Asia and China Sections of the IUCN/SSC
Primate Specialist Group

Volume 9

Number 1

2021

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