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CONSERVATION INTERNATIONAL

SPECIES SURVIVAL COMMISSION

MARGOT MARSH BIODIVERSITY FOUNDATION

SEAPA
South East Asian Primatological Association

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

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Instructions to Contributors

Scope
The journal/newsletter aims to provide a basis for conservation information related to the primates of Asia. We welcome manuscripts on any aspect of primate conservation, including articles, thesis abstracts, news items, recent events, recent publications, primatological society information, etc.

Manuscript submissions
Manuscripts and all editorial correspondence should be directed to: Dr. Jatna Supriatna (jsupriatna@conservation.org), Conservation International Indonesia.
Manuscripts are to be submitted to the journal including a cover letter on the understanding that they have not been published previously and are not being considered for publication elsewhere. The corresponding contributor is responsible for ensuring that the manuscript has been seen and approved by all co-contributors. It is the responsibility of the contributor to also ensure that manuscripts emanating from a particular institution are submitted with the approval of the necessary authority. The Editors retains the right to modify the style and the length of a contribution and to decide the time of publication. Contributors should retain a copy of the paper as the Editors cannot accept responsibility for loss or damage. Electronic copies should be supplied forall figures (illustrations and maps) and tables. The full name and address for each contributor should be included. Abbreviations and acronyms can be used, but have to be explained.

Contributions
Manuscripts should be submitted in English. Manuscripts must be clearly typewritten and double-spaced. Words to be printed in italics should be underlined and accompanied by the text on electronic copies for PC compatible text-editors (MS-Word, Excel and Access). Metric measurements should always be given, or where inappropriate, the metric equivalents should be provided in parentheses. All pages including tables should be numbered. Footnotes should be avoided and bound manuscripts will not be accepted.

Articles
Each issue of ASIAN PRIMATES JOURNAL will include up to six full articles, limited to the following topics: Taxonomy, Behavior, Genetics (when relevant to systematics), Biogeography, Ecology or Conservation. Manuscripts of full articles should not exceed 30 double-spaced pages including references. Please include an abstract. Tables and Illustrations should be limited to six. Full articles will be sent out for peer-review.

Short articles
They are usually reviewed only by the editors and editorial board members. A broader range of topics is encouraged, including e.g. behavioral research, in the interests of informing on general research activities, which contribute to our understanding of Asian primates. We encourage reports on projects and conservation and research programs (who, what, where, when, why, etc.) and most particularly information on geographical distributions, locality records, and protected areas and the primates which occur in them. Texts should not exceed 20 double-spaced pages including references.

Figures and maps
Articles may include small black-and-white photographs, high-quality figures and high-quality maps. We stress the importance of providing maps, which are **publishable**.

News items
Please send us information on primate-related projects, field sites, courses, recent publications, awards, events, activities, etc.

References
Examples of house style may be found throughout this journal. Please refer to these examples when listing references:

Journal article
Bynum, E.L., Kohlhaas, A.K., and Pramono, A.H. 1999. Conservation Status of Sulawesi Macaques. *Tropical Biodiveristy* **6**: 123-144.

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

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

Thesis/Dissertation
Wallace, R.B. 1998. The behavioural ecology of black spider monkeys in north-eastern Bolivia. Doctoral thesis, University of Liverpool, Liverpool, UK.

Report
Muckenhirn, N.A., Mortensen, B.K., Vessey, S., Fraser, C.E.O., and Singh, B. 1975. Report on a primate survey in Guyana. Unpublished.

Foreword

Soon after the release of the first issue of the Asian Primates Journal, we received many congratulatory and encouraging messages from across the globe. To all, we wish to express our sincere appreciation. Kudos does not belong only to us, but to the members of the editorial board, the contributing authors, the IUCN/SSC Primate Specialist Group, the Southeast Asian Primatological Association, and the Margot Marsh Biodiversity Foundation. Dr. Ardith A. Eudey deserves a special mention, having long being a close friend to Asian primates and Asian primatologists, and one of the driving forces behind the interest in primate studies and conservation in the region.

However, despite the best of our efforts, some errors were present in the first issue. Apparently, corrections made were not visible in the printer's electronic version. Nevertheless, the editors take full responsibility for the errors and sincerely apologize to the contributing authors and readers.

One error deserving mention is with reference to the article "Rediscovery of the Critically Endangered Eastern Black Crested Gibbon *Nomascus nasutus* (Hylobatidae) in China, with Preliminary Notes on Population Size, Ecology and Conservation Status"; the abstract (lines 3 and 4) should read as "19 gibbons" instead of "19 gibbon groups".

In this issue, we publish only four of the several submitted manuscripts, to meet the publishing deadline. Given that one of our objectives is develop the capacities of Asian primatologists by encouraging manuscript submissions, therefore we have had to return a number of manuscripts for revisions and corrections.

On the business of primatology, the fifth iteration of the biennial listing of a consensus of 25 primate species considered to be amongst the most endangered worldwide and the most in need of urgent conservation measures, was held at 22nd Congress of the International Primatological Society at Edinburgh in August 2008.

The following species were added to the list: Sclater's lemur (*Eulemur flavifrons*), the northern sportive lemur (*Lepilemur septentrionalis*), the Niger Delta red colobus (*Procolobus epieni*), the Javan slow loris (*Nycticebus javanicus*), the Cao-Vit crested gibbon (*Nomascus nasutus*), and the cotton-top tamarin (*Saguinus oedipus*).

The following species on the previous list (2006-2008) were taken off the 2008-2010 list: the Sahamalaza sportive lemur (*Lepilemur sahamalazensis*), Pennant's red colobus (*Procolobus pennantii pennantii*), Miss Waldron's red colobus (*Procolobus badius waldroni*), the brown-headed spider monkey (*Ateles fusciceps*), the Horton Plains slender loris (*Loris tardigradus nycticeboides*), and the Hainan gibbon (*Nomascus hainanus*).

Although some Asian primates were added and others taken off, still eleven Asian primate species are on the list, obviously showing their dramatic situation. Asian primates are increasingly threatened from destruction of tropical forests, and illegal hunting and trade. Hence much more concerted efforts must be made to arrest and reverse this situation, and a deeper understanding of the issues that constrain the efforts is needed. To this end, the IUCN/SSC Primate Specialist Group and the Southeast Asian Primatological Association are working hard, among other things, to bridge the gap between policies and implementation.

Editors

THE POPULATION DISTRIBUTION OF PIG-TAILED MACAQUE (*Macaca nemestrina*) AND LONG-TAILED MACAQUE (*Macaca fascicularis*) IN WEST CENTRAL SUMATRA, INDONESIA

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ABSTRACT

Two macaque species, the Pig-tailed Macaque (*Macaca nemestrina*) and Long-tailed Macaque (*Macaca fascicularis*), occur sympatrically in and around the lowland and mountainous forests of the Barisan Range in the Kerinci-Seblat National Park in west-central Sumatra. We present and discuss line-transect data on the density, distribution and group size of the two macaques. *M. fascicularis* was the scarcer, found only in hill dipterocarp and lowland forests.

Keywords: *Macaca nemestrina, Macaca fascicularis*, population distribution, density, group size.

INTRODUCTION

The continuous and extensive conversion of tropical rainforests, home to the world's highest species diversity, is widely believed to be a key threat to the survival of wild populations of terrestrial and arboreal animals, including arboreal non-human primates (Eudey, 1987; Weisenseel *et al*., 1993; Laurance *et al*., 2002). It is also now believed that the local numbers of wild Pig-tailed Macaques (*Macaca nemestrina*) and Long-tailed Macaques (*Macaca fascicularis*) in Southeast Asia are continuing to decline due to habitat alteration and loss (MacKinnon, 1986). According to IUCN Red List of Threatened Species, *M. nemestrina* and *M. fascicularis* are respectively listed as Vulnerable and Least Concern (IUCN, 2008).

Both *M. nemestrina* and *M. fascicularis* have recently become seriously threatened and fragmented by human encroachment and habitat loss (from illegal and legal logging, traditional and modern crop plantations, land clearance for agriculture and new settlements/ transmigration, forest fires and droughts), as well as hunting for the illegal pet trade. Trading for export by quota for both macaque species still occurs and Sumatra is the main supply source for biomedical research (MacKinnon, 1986; Bowden & Smith, 1992). Presently, there are many cases of land conflict use between macaques and humans and, as a result, both macaque species are regarded as crop pests by farmers. Furthermore, in Sumatra, primary tropical rainforest, especially in the lowlands, have disappeared rapidly (Achard *et al*., 2002; Kinnaird *et al*., 2003; Linkie *et al*., 2004), with most of the land being converted to commercial timber concessions, or cultivated lands and human settlements (FAO, 1981; Holmes, 2001; Jepson *et al*., 2001).

To protect and manage macaque populations and their habitats effectively, the status of macaque populations in protected and unprotected areas must be evaluated continuously (Struhsaker *et al*., 1975; Wilson & Wilson, 1975a & 1975b; MacKinnon, 1986). Unfortunately, in Sumatra, there has been little effort to date to survey or census primate species, which include gibbons, langurs, macaques, slow lorises, and western tarsiers, either inside or outside of protected areas.

The Kerinci-Seblat National Park (TNKS), in the extreme west central region of Sumatra (Figure 1), is one of the Indonesian "treasure houses" of faunal and floral diversity (MacKinnon & Suwelo, 1984). It covers about 1.3 million hectares (Mha) and is the largest national park on Sumatra, and among the largest protected areas in Southeast Asia (MacKinnon, 1986). The park spans four administrative provinces: Jambi, West Sumatra, Bengkulu, and South Sumatra. Primary and secondary rainforests in the national park are occupied by *M. nemestrina* and *M. fascicularis* and five other arboreal primate

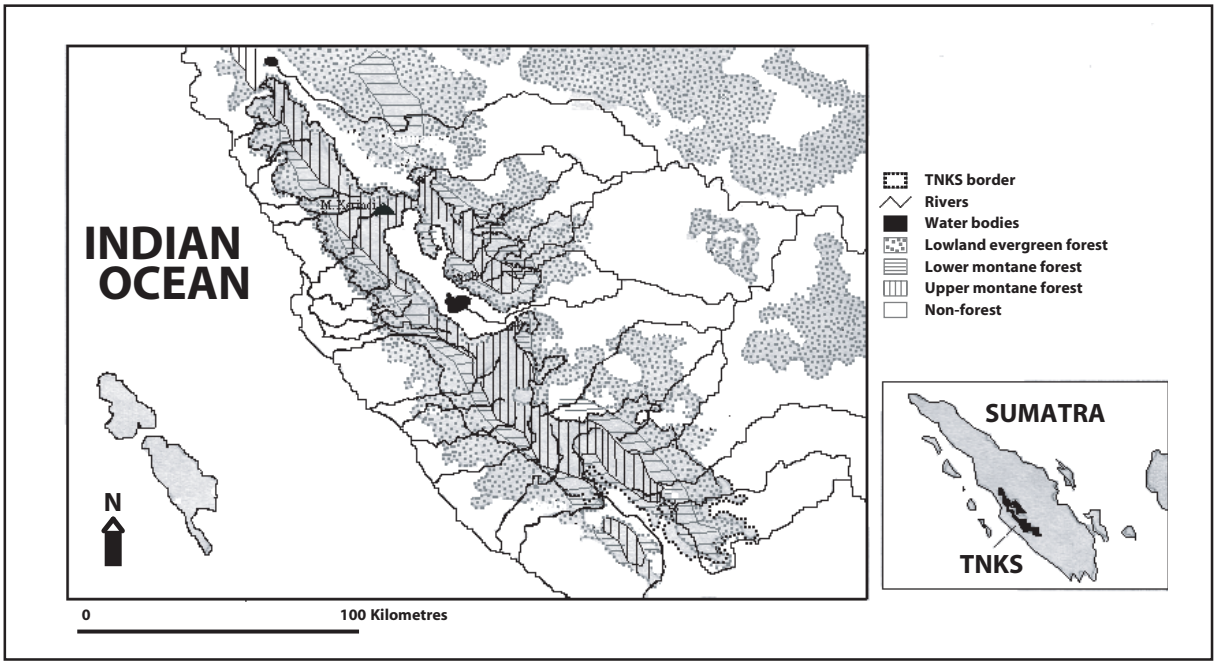

Figure 1. Map of Kerinci-Seblat National Park / Taman Nasional Kerinci-Seblat (TNKS) showing surveyed habitat types.

species (Siamang, *Symphalangus syndactylus*; Agile Gibbon, *Hylobates agilis*; Banded Langur, *Presbytis melalophos*; Silvered Langur, *Trachypithecus cristatus*; Slow Loris, *Nycticebus coucang*), in addition to being an important habitat for many other endangered species.

We examined the population status and distribution of macaques in TNKS by direct observation and line transect methods in four different habitat types (lowland, hill dipterocarp, sub-montane and montane forests), at varying elevations.

STUDY SITES AND METHODS

1. Study Sites

Survey routes were designed to cover a variety of habitat types inside and outside of TNKS. A total of 25 sites were surveyed (Figure 2, Table 1), of which most have never been visited by other researchers. Only 20% of the total area of TNKS is lowland forest <600 m above mean sea level (amsl). Nonetheless, most survey sites were within TNKS and in lowland evergreen forests, because lowland forest is currently believed to be the habitat type most seriously threatened by a variety of human activities. Several sites close to areas recently cleared for traditional and modern crop plantation as well as sites in selectively-logged forests within or near TNKS were also chosen as survey priorities.

2. Methods

We employed the line-transect method to estimate the density and population status of both macaque species through direct observation. We conducted these censuses from 1996 to 1999, while simultaneously surveying for other nonhuman primates.

We derived our methods for censusing macaques from published methods (Southwick & Cadigan, 1972; Wilson & Wilson, 1975a; Burnham *et al*., 1980; Marsh & Wilson, 1981; NRC, 1981; Peres, 1999), and adapted them to the field situation. Transects were established along existing trails on hill ridges, slopes and valleys in deep forest (85.9%) and old logged forest (8.4%) and along river banks (5.6%). Existing human or animal trails/paths were used; new trails were occasionally prepared by trimming small trees. We usually avoided steeper terrain due to difficulty in detecting animals. After the transect system was established, trail lengths were measured by pacing or using a pedometer calibrated to the observer's stride. Trails were an average of 0.5-1.0 m wide in dense forest

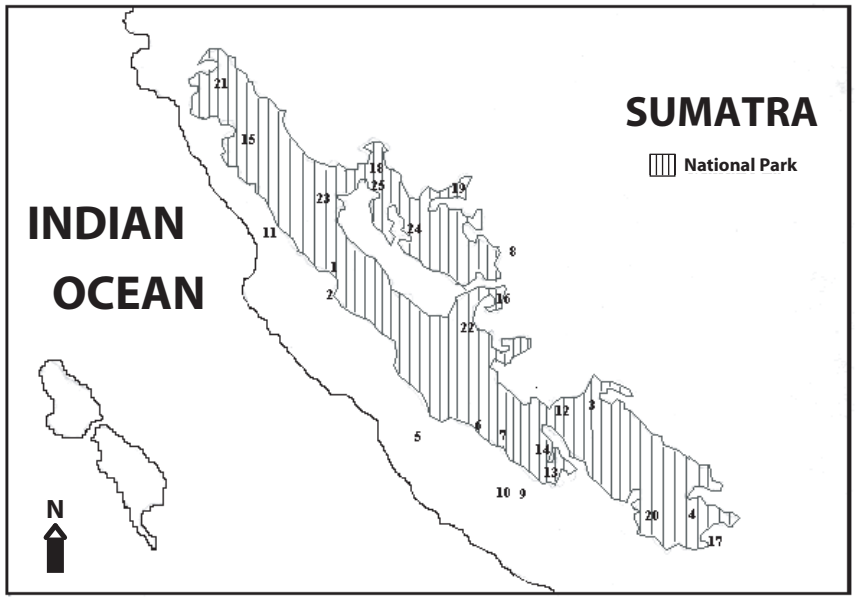

Figure 2. Map of TNKS showing survey sites.

Table 1. Site, elevation, and forest status for the 25 survey routes.

Site/habitat type	Province	Altitude (m)	Forest	Forest status
Lowland		**<450**		
Sungai Gambir	West Sumatra	250 medium	Disturbed	National Park
Sungai Melanca	West Sumatra	250 medium	Primary	Conversion
Napal Licin	South Sumatra	300 steep	Primary	National Park
Air Lakitan	South Sumatra	350 steep	Primary	National Park
Air Ikan	Bengkulu	250 medium	Disturbed	Production
Ipuh Ilau	Bengkulu	350 medium	Primary	National Park
Seblat Merah	Bengkulu	350 flat	Primary	National Park
Sungai Petekun	Jambi	250 steep	Primary	Protection
Air Santan Ketahun	Bengkulu	250 medium	Disturbed	Production
Napal Putih	Bengkulu	250 medium	Disturbed	Protection
Batang Pelangai	West Sumatra	250 medium	Disturbed	Protection
Hill		**450-900**		
B. Narso	Jambi	450 medium	Primary	Protection
Air Sulit	Bengkulu	450 steep	Primary	National Park
Air Melam	Bengkulu	450 steep	Primary	National Park
Air Langgai	West Sumatra	400 steep	Primary	National Park
Sungai Siporak	Jambi	450 medium	Primary	National Park
Bukit Kelam	South Sumatra	500 steep	Primary	National Park
B. Asam-Suir	West Sumatra	500 steep	Primary	National Park
Sungai Sebiang Bungo	Jambi	450 steep	Primary	National Park
Submontane		**900-1400**		
Air Dingin	Bengkulu	900 medium	Primary	National Park
Ngalau Gadang	West Sumatra	1100 steep	Primary	National Park
Air Hangat	Jambi	900 steep	Primary	National Park
Montane		**1400-2400**		
Betung Mudik	Jambi	1600 steep	Primary	National Park
Pelayang Gedang	Jambi	1500 steep	Primary	National Park
Danau Tujuh	Jambi	2100 steep	Primary	National Park

and 1.0-1.5 m wide in secondary forest, but trails were wider in recently logged forests as they followed old logging roads.

The average trail length surveyed on a given day was 2.6 km (range = 1.6-4.8 km). We walked slowly (average speed <1 km/h) with a local field assistant familiar with the terrain and the local wildlife. We frequently stopped for several minutes to listen for animal sounds, or when we encountered primates, to determine the group size and group spread. We started the census walk in the morning between 06:30 and 07:30 and finished by the middle of the day.

To estimate primate densities, it was first necessary to estimate the effective width of the strip surveyed (effective strip width, or ESW) (Marsh & Wilson, 1981; NRC, 1981; Peres, 1999). We estimated the maximum reliable detection distance (1/2 ESW) for density calculations for each species and habitat type using two methods: King's method, based on the "animal-to-observer", or direct distance, and Kelker's method, based on "animal-to-nearest trail", or perpendicular distance. In both methods, the maximum reliable distance is determined from the frequency-distribution curve of sightings, which generally shows an obvious plateau, followed by marked drop in frequency (Marsh & Wilson, 1981; NRC, 1981; Garcia, 1993; Brugiere & Fleury, 2000). We planned to estimate the maximum reliable detection distance as the last distance category before a drop of at least 50% in sighting frequency (NRC, 1981). Maximum reliable perpendicular, and the direct distance were then used to estimate the ESW.

RESULTS

1. Detection Distance and Effective Strip Width (ESW)

Because few sighting-distance data were collected for either macaque species, the cut-off cannot be shown in the histogram distribution of perpendicular distance (Figure 3a and b). Thus, we used the maximum distance at which they were sighted rather than maximum reliable distance to estimate ESW.

A. Maximum reliable animal-to-trail or perpendicular distance

The maximum perpendicular detection distance recorded for *M. nemestrina* was 20 m in montane forest (mean = 10.5, sd = 7.7, n = 2) thus ESW was computed as 40 m. In sub-montane (mean = 17.0, sd = 7.1, n = 2) and hill dipterocarp (mean = 13.5, sd = 8.0, n = 11) forests, the maximum distance was recorded as 30 m (Figure 3a) and the ESW was 60 m for both forest types (Table 2). In lowland forest, all groups of this species were recorded within 40 m as an effective distance and its ESW was 80 m (range = 0-45 m, mean = 15.8, sd = 8.3, n = 17). *M. fascicularis* was the scarcer species and was recorded only in hill dipterocarp and lowland forests. In both forest types, animal sightings were recorded within 35 m in hill dipterocarp forest (mean = 15.7, sd = 10.2) and lowland forest (mean = 14.9, sd = 9.0).

Table 2. Effective Strip Width (ESW) used for mean density calculations.

ESW (m)	Species	
	Pig-tailed Macaque	Long-tailed Macaque
Perpendicular distance		
Montane Forest	60	-
Sub-montane Forest	60	-
Hill Dipterocarp Forest	60	60
Lowland Forest	80	60
Direct distance		
Montane Forest	60	-
Sub-montane Forest	80	-
Hill Dipterocarp Forest	80	80
Lowland Forest	80	80

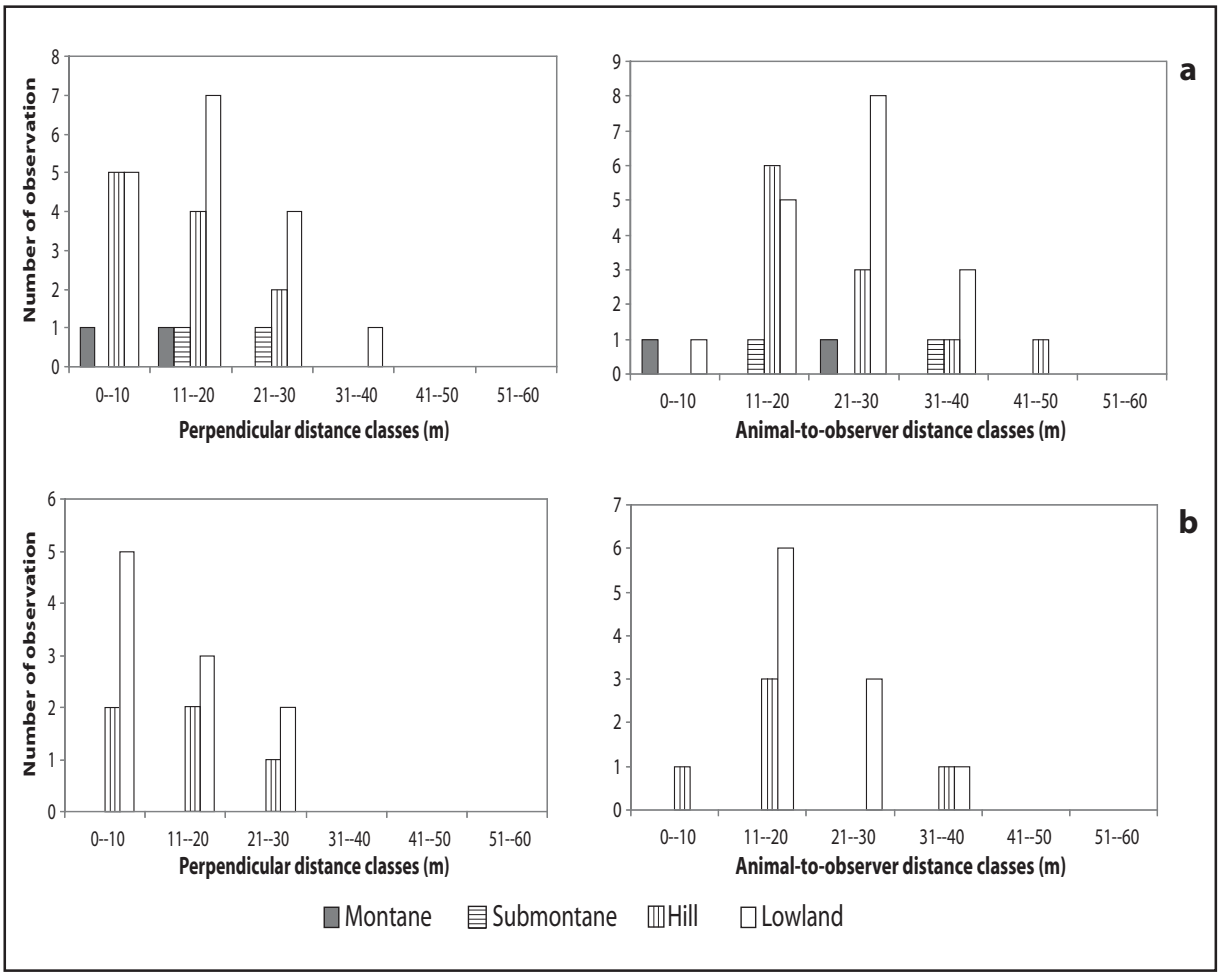

Figure 3. Observed perpendicular and animal-to-observer distance for Pig-tailed Macaque (a) and Long-tailed Macaque (b).

B. Maximum reliable animal-to-observer or direct distance

Sightings at a maximum distance of 30 m were recorded for *M. nemestrina* in montane forest (mean = 17.5, sd = 10.6). In three other forest types namely, sub-montane (mean = 22.5, sd = 10.6), hill dipterocarp (mean = 25.9, sd = 10.9), and lowland (mean = 25.6, sd = 8.1), sightings were recorded at a maximum distance within 40 m. *M. fascicularis* was recorded only in hill dipterocarp forest (mean = 19.0, sd = 9.6) and lowland forests (mean = 23.0, sd = 5.9) and had a maximum sighting of 40 m in both.

2. Pig-tailed Macaque and Long-tailed Macaque Densities

Group density estimates were calculated from data collected from a total of 311.2 km of line transects in four habitat types: lowland forests (eleven sites), hill dipterocarp forests (eight sites), sub-montane forests (three sites), and montane forests (three sites). Group densities calculated using perpendicular distance were higher than those produced using direct distance for *M. fascicularis* in lowland and for *M. nemestrina* in sub-montane and hill dipetrocarp forests (Table 3).

The estimated group densities (estimated by averaging the estimates produced using each method) for *M. nemestrina* had high densities in lowland forest (1.7 groups/km^2) and hill dipterocarp forest (1.5 groups/km^2); lower densities were found in montane (0.7 groups/km^2) and sub-montane forests (0.8 groups/km^2). *M. fascicularis* had lower densities and was found only in hill dipterocarp forests (0.5 groups/km^2) and lowland forests (1.1 groups/km^2).

3. The Distribution of Pig-tailed and Long-tailed Macaques in and around TNKS

We assessed the distribution of the two macaque species in censuses comprising 400 km of transects in 120 routes at 25 locations, ranging in altitude from 200 to 2,200 m amsl in and around TNKS forest complex. In montane forests, only *M. nemestrina* was observed. Like *S. syndactylus* and *P. melalophos*, they were observed at all elevations (from sea level to 1,900 m amsl) although seldom in montane and sub-montane forests, and most sightings in hill dipterocarp and lowland forests. The average elevation used by the Pig-tailed Macaques in and around TNKS was 477 m amsl (range = 225-1,900, n = 32), estimated from 25 survey sites.

Groups of Long-tailed Macaques were absent from montane forest and scarce at higher elevations such as sub-montane forest. In Kerinci-Seblat forest complex, groups were found only in lowland and hill dipterocarp forests (at six locations), and not above 800 m amsl. The maximum elevation for this species was at Air Hangat at 700 m amsl and its mean elevation was 382 m amsl.

4. Macaque Group Sizes

We recorded macaque group whenever they were sighted. The average group size of both macaque species was much larger than those found in *S. syndactylus*, *H. agilis* and *P. melalophos* in Kerinci-Seblat. In hill dipterocarp forest, *M. nemestrina* had an average group size of 10.5 individuals (range = 1-20 individuals, SE = 1.6, n = 11), larger than in montane, sub-montane and lowland forests (Figure 4). In montane forests, the average group size was 7 individuals (range = 6-8 individuals, SE = 10, n = 2), whilst in sub-montane forests the average group size was 9.5 individuals (SE = 0.5, n = 2). In lowland forest, the average group size of 8.5 individuals (range = 1-13, SE = 14, n = 17) being slightly smaller than in sub-montane forests and slightly larger than in the montane forests.

M. fascicularis had an average group size (9.6 individuals; range = 1-17 individuals, SE = 2.9, n= 5) that was slightly larger in the hill dipterocarp forests than in the lowland forests (9.0 individuals; range = 4-16 individuals, SE = 1.4, n = 10) (Figure 4).

DISCUSSION

Both *M. nemestrina* and *M. fascicularis* were rarely seen in any of the habitat types in and around Kerinci-Seblat National Park (TNKS) and, as a result, low densities were observed for both in this study. *M. fascicularis* is usually most abundant in swamp forest (Crocket & Wilson, 1980), and Chivers and Davies (1978) reported that this species has high densities in riverine and edge habitat in peninsular Malaysia. Furthermore, the densities of *M. nemestrina* were markedly lower in all habitats types than those reported for peninsular Malaysia (Chivers & Davies, 1978).

Table 3. Group density estimates for Pig-tailed Macaque and Long-tailed Macaque in and around Kerinci-Sablat National Park.

Habitat type	N		km² surveyed		Density ± SE (groups/km²)	
	Pig-tailed Macaque	Long-tailed Macaque	Pig-tailed Macaque	Long-tailed Macaque	Pig-tailed Macaque	Long-tailed Macaque
Reliable primate-to-trail						
Montane	2	0	2.9	0	0.7 ± 0.8	-
Submontane	2	0	2.2	0	1.0 ± 1.0	-
Hill dipterocarp	11	4	6.3	6.3	1.7 ± 0.5	0.6 ± 0.3
Lowland	17	10	9.8	7.3	1.7 ± 0.9	1.3 ± 0.4
Reliable primate-to-observer						
Montane	2	0	2.9	0	0.7 ± 0.5	-
Submontane	2	0	2.9	0	0.7 ± 0.7	-
Hill dipterocarp	11	4	8.4	8.4	1.3 ± 0.3	0.4 ± 0.2
Lowland	17	10	9.8	9.8	1.7 ± 0.5	1.0 ± 0.3

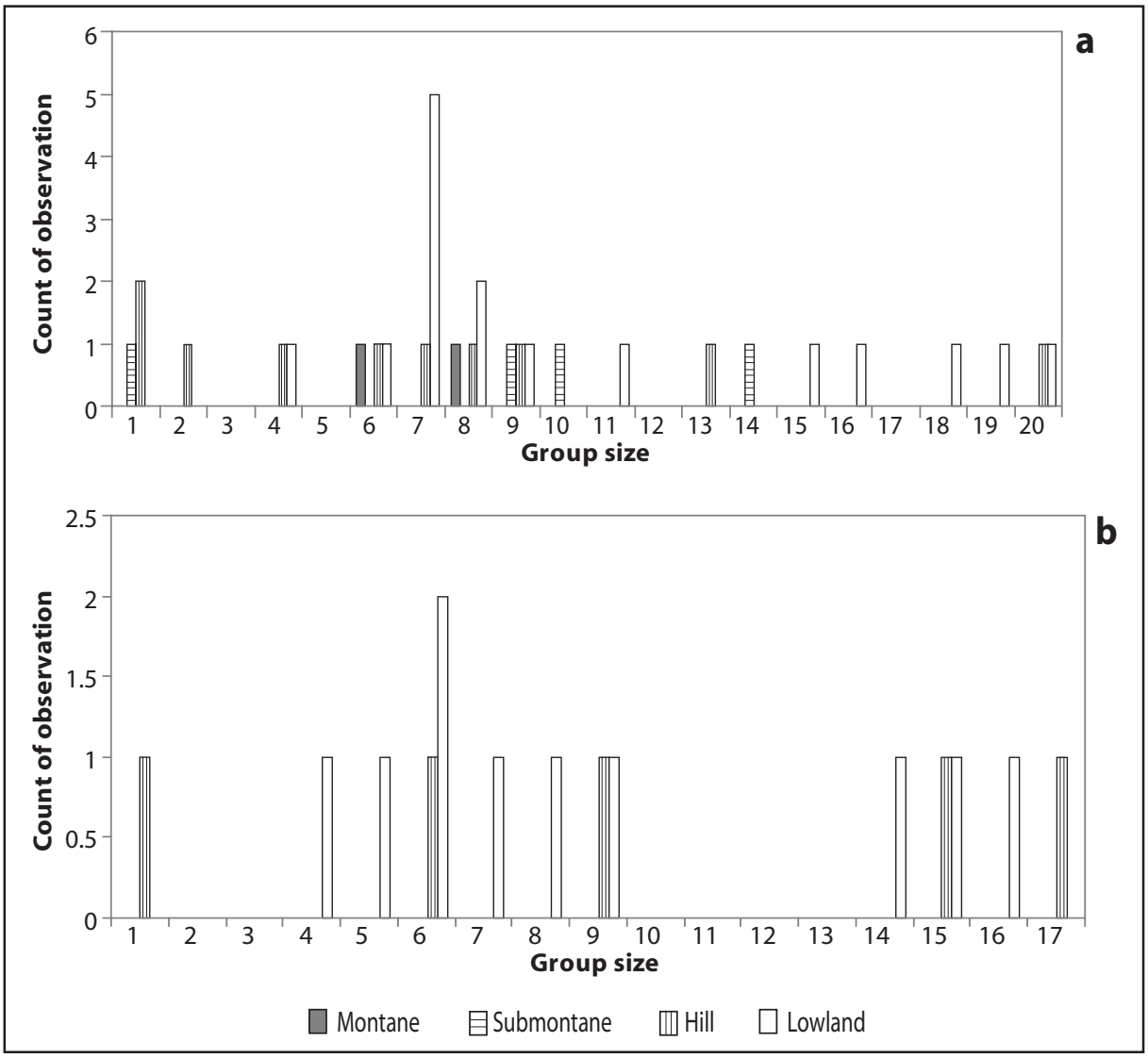

Figure 4. Group size for Pig-tailed Macaques (a) and Long-tailed Macaques (b) in montane, sub-montane, hill dipterocarp, and lowland forests.

Although semi-terrestrial, *M. nemestrina* is hard to study in the field (Marsh & Wilson, 1981; Robertson, 1986). The highest densities of this primate found at TNKS were in the lowland and hill dipterocarp forests (Table 4). The densities observed seemed less than those reported in 1970s by Rijksen (1978) at the Ketambe study area, Gunung Leuser National Park. Wilson and Wilson (1976) observed higher population densities of *M. nemestrina* throughout Sumatra than that observed in the TNKS' primary lowland forest, and at 25.5 range of group densities of *M. nemestrina* in the Krau Game Reserve in peninsular Malaysia, were similar in five different habitat types, i.e. at 0.1-0.3 groups/km^2. Meanwhile, Marsh and Wilson (1981), who also studied *M. nemestrina* in peninsular Malaysia, reported mean densities of 0.1 and 0.9 groups/km^2 in lowland and swamp forests, respectively.

Like other macaques, *M. nemestrina* lives in large groups with normally 15-40 individuals and an average 23 individuals (Caldecott, 1983; Robertson, 1986). Even larger groups were observed at Lima Belas, peninsular Malaysia (Caldecott, 1983) where the increase is associated with more immature in the group.

For *M. fascicularis* at Krau Game Reserve, the highest densities were found in riverine forest, while densities were reduced in lowland and disturbed forest (Chivers & Davies, 1978). On the other hand, Marsh and Wilson (1981) found that

mean densities of *M. fascicularis* in lowland forest were higher than previously reported by Chivers and Davies (1978), but the highest densities found in peninsular Malaysia were in freshwater swamp forest (Marsh & Wilson, 1981) (Table 4). According to Crockett and Wilson (1980), who studied ecology and abundance of *M. fascicularis* and *M. nemestrina* in various habitat types in Sumatra, found that the highest group densities of *M. fascicularis* were in *Rhizophora* mangrove forest. The next favored habitat of this macaque was secondary hill dipterocarp forests, followed by mixed mangrove forest and riverine parts of the lowland forests.

In this study, group densities of *M. fascicularis* in the lowland forests were slightly higher than reported for the same habitats at the Krau Game Reserve (Chivers & Davies, 1978), but lower than those reported by Marsh and Wilson (1981) for peninsular Malaysia or for primary lowland forest in Sumatra (Crockett & Wilson, 1980). In hill dipterocarp forest, the density of *M. fascicularis* at TNKS was 85% less than that reported by Crockett and Wilson (1980) for throughout Sumatra. Crockett and Wilson (1980) found higher densities and group sizes of *M. fascicularis*, with the largest average group sizes in secondary lowland habitats. Yet, the group size average of this species in TNKS is still lower than those reported by Southwick and Cadigan (1972) in the urban areas of peninsular Malaysia.

ACKNOWLEDGMENTS

We are extremely grateful to Fauna and Flora International (FFI) through the Project Orang Pendek (POP) and Biodiversity Assessment Project in Kerinci-Seblat National Park, Sumatra, Indonesia which gave us the inspiration to survey those animals. We thank the Indonesia Institute of Science (LIPI), and the Ministry of Forestry of Indonesia. Finally, AY would like to express his deep thanks to the Gibbon Foundation in particular to Willie T.M. Smits for the financial support during the writing of this manuscript at Cambridge, UK.

Table 4. Comparative densities and group size in Pig-tailed and Long-tailed macaques on Sumatra and in Malaysia.

Site	Density/km²				Group Size		Source
	Pig-tailed		Long-tailed		Pig-tailed	Long-tailed	
	Group	Individuals	Group	Individuals			
TNKS							
Lowland	1.7	14.7	1.3	10.7	8.5(1-13)	9.6(1-17)	this study
Hill	1.5	15.7	0.6	6.6	10.5(1-20)	9.0(4-16)	this study
Sub-montane	1.0	5.9	-*)	-	9.5	-	this study
Montane	0.7	4.8	-	-	7.0(6-8)	-	this study
KETAMBE	-	19.0	-	-	4.04	6.4	Rijksen, 1978
SUMATRA							
Lowland	2.48	36.7	1.31	24.4	18.3(16-21)	46.0	Wilson & Wilson, 1976, Crockett & Wilson, 1980
Hill	2.24	33.2	5.26	97.8	16.0	-	Crockett & Wilson, 1980
Mangrove	-	-	6.47	120.3	21.0	13.0	Crockett & Wilson, 1980
MALAYSIA							
Swamp	0.9	-	4.8	-	-	-	Chivers & Davies, 1978; Marsh & Wilson, 1981
Lowland	0.1	-	1.4	-	-	29.8(14-70)	Bernstein, 1967; Chivers & Davies, 1978; Marsh & Wilson, 1981
Urban	-	-	-	-	-	24.0(7-44)	Southwick & Cadigan, 1972
KRAU GAME RESERVE							
Disturbed	0.1	-	0.6	-	-	-	Chivers & Davies, 1978
Riverine	0.3	-	1.4	-	-	-	Chivers & Davies, 1978
Lowland	0.3	-	0.2	-	20.0	24.0	Chivers & Davies, 1978
Hill	0.2	-	-	-	-	-	Chivers & Davies, 1978
Sub-montane	0.3	-	-	-	-	-	Chivers & Davies, 1978
LIMA BELAS ESTATES	-	15-40	-	-	50.0(45-55)	-	Caldecott, 1983

***)** *data not available*

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OCCURRENCE RECORDS OF THE BENGAL SLOW LORIS (*Nycticebus bengalensis*) IN NORTHEASTERN INDIA

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ABSTRACT

The Bengal slow loris, *Nycticebus bengalensis* is a cryptic nocturnal primate whose distribution within India is known only from incidental records and few targeted surveys. We report three opportunistics sightings of the species made along nocturnal walks as well as two captive lorises in three states in northeastern India - Meghalaya, Assam and Arunachal Pradesh. We also provide photographic documentation of lorises from two of the states to document differences in pelage coloration. Slow lorises are under threat due to deforestation, hunting and the pet trade, but more information regarding their occurrence and ecology is needed to improve conservation efforts.

Keywords: Bengal slow loris, *Nycticebus bengalensis*, occurrence, northeastern India.

INTRODUCTION

The Bengal slow loris (*Nycticebus bengalensis*) is one of seven nocturnal strepsirrhine primates that occur in Asia (IUCN, 2008). The genus *Nycticebus* (Family Lorisidae) is distributed from northeastern India eastward through South and Southeast Asia into the Philippine islands, and *N. bengalensis* is a wide-ranging species that occurs in northeastern India, Bangladesh, Myanmar, Cambodia, southern China, Lao People's Democratic Republic, northern Thailand, and Vietnam (IUCN, 2008). This is the only nocturnal primate in the northeastern Indian states, and is listed in Schedule I of the Indian Wildlife (Protection) Act, 1972. Little is known about the ecology of the species across its range and it is categorized as Vulnerable in the IUCN Red List (IUCN, 2008). *N. bengalensis* is reported to occur in evergreen and semi-evergreen forests and is recorded from all seven states of Northeast India (Choudhury, 2001). However, Choudhury (2001) does not state the origin of these records, and or whether they are based on direct sightings or accounts by local residents. Targeted surveys have been conducted only in Meghalaya, Assam (Radhakrishna *et al*. 2006) and some parts of Tripura (Swapna *et al.,* 2008). Mishra *et al.* (2006) reported the presence of slow lorises in Arunachal Pradesh based on secondary information.

In this paper, we collate direct sighting records as well as other occurrence information on the Bengal slow loris, which were obtained during field studies for other projects. The records are from Assam, Meghalaya and Arunachal Pradesh and are the most recent records of direct sightings of the Bengal slow loris from these locations. The Bengal slow loris is reported to vary in color across its range (Sindhu Radhakrishna, pers. comm.), and in order to documentation this variation, we present photographs of three individuals.

METHODS

We compiled reports of lorises gleaned from incidental records in the field during nocturnal walks as well as from interactions with the local community. Fieldwork was conducted in different states in Northeast India by the three authors on separate research projects aimed at small carnivores, flying squirrels and small mammals. Trails were walked by one or more investigators and two or more field assistants shortly after dusk. Spotlights and flashlights (white light) were used to locate nocturnal mammals. Most effort was focused on the arboreal community, and different levels of the canopy were searched for eyeshine. Once an eyeshine was detected, more light and binoculars were used to identify the animal. This method has been used in various studies focusing on nocturnal, arboreal mammals (Duckworth, 1998; Rajamani, 2000). Lorises were detected this way in Assam, Meghalaya and Arunachal Pradesh.

Additionally, occurrences of lorises in Assam and Meghalaya were also documented from the local forest department offices as well as resident communities.

RESULTS

We sighted three slow lorises in the wild in Assam, Meghalaya and Arunachal Pradesh and observed two captive slow lorises (Table 1 & 2, Figure 1). Given the paucity of information on occurrences of slow lorises from the wild in India, it is important to provide detail about the sighting locations and to list the existing threats present at these individual sites.

1. Direct Sightings of Slow Lorises in the Wild from Nocturnal Walks

A. Assam

On 25th May 2007, at 18:45 h, KK and her field team detected a slow loris in the Jeypore Reserve Forest (RF) (108 km^2) at N 27.20147°, E 95.44476° (altitude ca. 150 m above sea level [asl]), 900 m west of the Kothalguri Beat Office along the Jeypore-Khonsa road. KK's field assistant Lakhindra Sonowal spotted the animal by its red eyeshine behind a large fork on a free-standing *Ficus* tree (tree not in fruit). The forest here is categorized as Assam valley tropical wet evergreen forest (category 1B/C1) (Champion & Seth, 1968), also called the Upper Assam *Dipterocarpus - Mesua* forest. It was heavily logged in the past, but now relatively undisturbed. However, there is moderate traffic on the Jeypore-Khonsa road, and occasional incidents of poaching for meat are reported by local people. The Assamese name for the slow loris is *Lajuki Bandor*.

B. Meghalaya

A Bengal slow loris was sighted (by all authors) on 12th March 2007 in Baghmara RF (43.92 km^2) after 3 hours of walk between Panda and Ampangre on the Baghmara-Maheshkola road (N 25.20121°, E 90.69569°, altitude ca. 150 m asl). The authors were walking down the road at a speed of 1 km/hour, and the animal was sighted in the forest interior approximately 20 m from the edge of the road. As soon as we spotted the animal it froze, but then subsequently moved into the foliage and onto a neighboring tree. The habitat is a tropical semi-evergreen forest and at that time, trees were devoid of mature leaves and new leaf flush and flowers were begining to appear. Figure 2 is a photograph of the loris sighted here. The slow loris is known in Meghalaya as *Gilwe*.

C. Arunachal Pradesh

On 20th November 2007, at 19:57 h, a slow loris (Figure 3) was sighted by Kalyan Varma and three other naturalists in Deban, Namdapha Tiger Reserve, in the forest off the Miao-Vijaynagar road (N 96.391207°, E 27.497210°, 339 m asl). The loris was sighted on a tree that bent over the trail (ca. 2 m from the road). The four naturalists searched the vegetation using flashlights and walked through the forest with a speed of ca. 1.5 km/hour. The forest type is low elevation tropical evergreen forest. Local

Table 1. Locations of occurrence of the Bengal slow loris (*Nycticebus bengalensis*) in Assam, Meghalaya and Arunachal Pradesh.

Record No.	State	Site	GPS Location	Altitude m amsl	Habitat type	Date
1	Assam	Jeypore Reserve Forest, Dibrugarh Division	N 27.20147°, E 95.44476°	150	Assam Valley Tropical Wet Evergreen	25 May 2007
2	Assam	Namtok, Dirok part of the Dehing-Patkai WLS, Digboi Division	N 27.26174°, E 95.60981°	100	Assam Valley Tropical Wet Evergreen	31 December 2005
3	Meghalaya	Baghmara Reserve Forest, Garo Hills Division	N 25.20121°, E 90.69569°	150	Tropical Semi-evergreen	12 March 2007
4	Meghalaya	Gongrot Aking, adjoining Balpakram NP, Garo Hills Division	N 25.263050°, E 90.730530°		*Jhum* field bordering Tropical semi-evergreen forest	April 2005
5	Arunachal Pradesh	Deban, Namdapha Tiger Reserve	N 27.497210°, E 96.391207°	339	Low Elevation Tropical Evergreen	20 November 2007

Table 2. Details of direct sightings of wild Bengal slow lorises.

Record No.	Location	Height of animal on tree (m)	Height of tree (m)	Time of sightin (hours)	Duration of walk (hours)
1	Jeypore Reserve Forest, Dibrugarh Division, Assam	7	15	18:45	2.0
3	Baghmara Reserve Forest, Garo Hills Division, Meghalaya	13	20	19:30	3.5
5	Deban, Namdapha Tiger Reserve, Arunachal Pradesh	20	approx. 25+	19:57	1.5

communities are reported to hunt wildlife, and the forest along the Miao-Vijaynagar road is disturbed by regular movement as well as extraction of timber and other resources by local tribal communities (Datta, 2006).

2. Captive Lorises

We observed two captive lorises, one in Assam and one in Meghalaya. In both cases the animals were released into the nearby forest patches.

A. Assam

A male slow loris caught by a tea estate worker from Namtok, Dirok Forest, part of the Dehing Patkai Wildlife Sanctuary (WLS), was rescued on the 31st December 2005 and handed over to Mr. Pradipta Barua, Range Forest Officer,

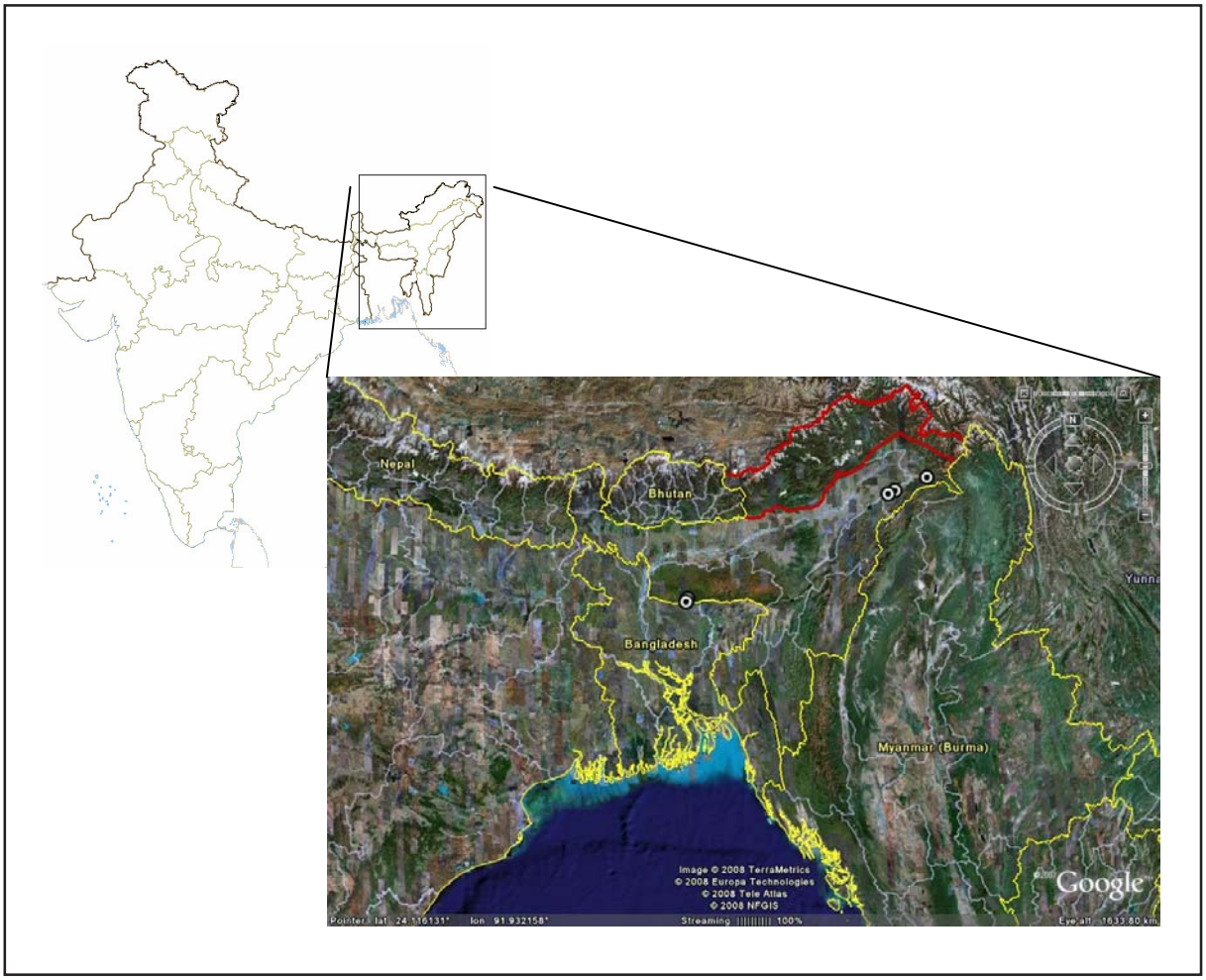

Figure 1. Map of India with focus on the Northeast. Sightings of the Bengal slow loris are plotted on the map.

Figure 2. Bengal slow loris sighted at Balpakram Reserve Forest, Meghalaya.

Figure 3. Bengal slow loris sighted at Deban, Namdapha Tiger Reserve.

Margherita West Range, Digboi Forest Division, Assam. The animal was released the next day into Dirok Forest (Beat Office location N 27.26174°, E 95.60981°, 100 m asl, 30 km²). The forest here is Assam valley tropical wet evergreen forest, previously logged and now with secondary vegetation as well as extensive tall *Dipterocarpus macrocarpus* (Hollong) plantations. Poaching is suspected to occur at this site also.

B. Meghalaya

A slow loris (Figure 4) was captured from a *jhum* field adjoining Balpakram National Park and kept in Gongrot *Aking* (unit of clan land consisting of one or more hamlets) (N 90.730530°, E 25.263050°), Rongra Block, south Garo Hills district, Meghalaya, between March and April 2005. The loris was kept as a pet in a small bamboo cage for 2-3 weeks in a household within the *Aking* (ca. 50 households). The family initially fed the animal with rice, but later with fruits and insects until it was released. Gongrot *Aking* shares a border with Balpakram National Park to its north and the loris was released into the park at night on 17th April 2005 after persuasion from NV and colleagues. Shortly before, the *jhum* fields had been burnt to be prepared for cultivation. Local people report that many wild animals come into newly burnt fields to eat the shoots that spring up, making this a good period for hunting animals. A questionnaire survey undertaken across 33 *Akings* of Rongra block to assess knowledge of 56 large mammals (including slow loris) revealed that 76% of the respondents claimed to have seen slow lorises, indicating that the animal is probably common in the region (Ved & Sangma, 2007). The forest type in the region is tropical semi-evergreen forest that is disturbed by human activities.

DISCUSSION

The Bengal slow loris, like the other species of the genus *Nycticebus*, is a cryptic nocturnal mammal whose distribution is known only from occasional accounts and a few research studies (Nekaris *et al*., 2008). As for the whole range, the occurrence of slow lorises is not well documented for northeastern India. In this study, we report the occurrence of the species in specific forest patches in three states, namely Meghalaya, Assam and Arunachal Pradesh. We do not

Figure 4. Bengal slow loris kept in captivity in Gongrot Aking, Meghalaya in April 2005.

present encounter rates based on hours spent walking or distance as these sightings were opportunistic and not part of a study aimed to estimate density or abundance of lorises. Systematic studies with repeated transect walks are required to estimate abundance or densities accurately (Buckland *et al*., 1993; Duckworth, 1998). Any encounter rates calculated from this report might not be true representations of the abundance of the loris at these sites. If calculated, our encounter rates (0.28-1.0 lorises/km) would be higher than other reported rates for the same species (0.22 lorises/km: Swapna *et al*., 2008; 0.03-0.33 lorises/km: Radhakrishna *et al*., 2006; 0.10-0.13/km: Nekaris & Nijman, 2007) as well as other species of the genus (0.05-0.74 lorises/km: Nekaris & Nijman, 2007). Given that there are no replicates for any of our walks, these rates would be inflated figures.

The distribution and population densities of the Bengal slow loris in Northeast India are known to be affected by a number of factors including habitat destruction, subsistence hunting, and trade (Radhakrishna *et al*., 2006). However, the lack of information on area of occurrence and the species ecology is a major hurdle to monitoring impacts of these factors on slow loris populations throughout their range. A number of other factors – most of them unique to this region, further complicate the matter. Anthropogenic activities are known to have resulted in widespread fragmentation of the forest cover of the northeastern states, and protected areas as well as most of their animal populations are not contiguous (Choudhury, 2001). While long-term studies on the Sunda slow loris have shown that the species does not necessarily depend on undisturbed primary forest (Wiens, 1995), the reaction of the Bengal slow loris to such habitat disturbance remains to be examined. Compounding the problem is the fact that several slow loris habitats are outside protected areas. Insurgencies affect many of the states, and the consequent security issues associated with conducting field research at night are a deterrent for researchers to take up detailed studies of nocturnal species like the loris.

In Northeast India the Bengal slow loris *Nycticebus bengalensis* is affected by trade as well as subsistence hunting (Radhakrishna *et al*., 2006). Local knowledge of lorises is often high due to such activities, as indicated by Ved and Sangma's (2007) survey. Reports of slow lorises in captivity are numerous throughout the range of these animals, including northeastern India. While slow lorises are captured to be kept as pets in many tribal communities (Duckworth *et al*., 1999), they are also captured for trade purposes (Nekaris & Nijman, 2007). After an assessment of the extent of unsustainable trade in slow lorises, the genus was moved from Appendix II to Appendix I of CITES (CITES, 2008), awarding it the highest level of protection and banning all international trade. Efforts are required to document the intensity of trade and capture of the slow loris in northeastern India in order to determine the effect of such activities on local loris populations.

The slow loris is known to vary extensively across its range, and the recent division into five species is based on genetics, morphological differences and pelage characteristics (Nekaris *et al*., 2008). The importance of documentation of pelage characteristics in *Nycticebus* was brought to light by Nekaris and Jaffe (2007), who used pelage characteristics to identify source locations of slow lorises recovered from the pet trade circuit. Recent research has shown facial markings to play a role in social communication (Bearder, 1999), and isolated populations of nocturnal mammals might have evolved different facial patterns. Given that the slow loris is a commonly traded species, it is important to document pelage variation in both color and facial markings through the range of the species to aid identification of the source of recovered animals/skins. We provide photographs of the species from two of the states, and while we do not have many replicates from each population to document individual variation, these pictures might prove useful in bulding photo libraries of animals from different sites. With the advent of powerful digital cameras, it is easier to photograph nocturnal mammals today than it was even a few years ago, and we advocate photographic documentation of populations of lorises. This resource would especially benefit scientists and conservation biologists if these were made available in the public domain.

Conservation efforts for the slow loris must be directed towards identifying the most important habitats, and not only preserving these, but also connecting them with forest corridors. The efforts of conservation-oriented organizations are vital in raising awareness in tribal communities about biodiversity and consumption of natural resources (including subsistence hunting).

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23 YEARS RESEARCH OF SICHUAN SNUB-NOSED MONKEYS (*Rhinopithecus roxellana*) IN ZHOUZHI NATIONAL NATURE RESERVE, CHINA

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ABSTRACT

The mountainous 52,931 ha Zhouzhi National Nature Reserve (ZNNR) in the Qinling Mountains of China is home to one of the world's most threatened primates, the Sichuan snub-nosed monkey (*Rhinopithecus roxellana*). Although no accurate numbers are available, a recent census in ZNNR estimated the total population at 1,100-1,200 individuals. The habitat has been severely degraded due to unsustainable exploitation of natural resources from human economic activities, especially from commercial logging, and there is rapid loss and changes in its habitat. Since the late 1980s, various ecological and behavioral studies on this China-endemic primate species have been conducted in ZNNR. In this paper, we give an overview on some key findings based on our 23-year research experience and provide some recommendations to efficiently protect the species in ZNNR.

Keywords: *Rhinopithecus roxellana*, Zhouzhi National Nature Reserve, China, ecology, behavior.

INTRODUCTION

The Zhouzhi National Nature Reserve (ZNNR) (107°33´-108°20´E, 33°33´-33°56´N) was established in 1985 to protect 52,931 ha of temperate forest on the northern slopes of the Qinling Mountains in Shaanxi province, China. ZNNR experiences a semi-humid montane climate, with spring from March to May, summer from June to August, autumn from September to November, and winter from December to February. The composition of the forest in ZNNR varies with altitude, from deciduous broadleaf forest at low elevations to mixed coniferous broadleaf forests above 2,200 m and coniferous forest above 2,600 m. The Reserve was established because it provides habitat for the China-endemic and Endangered Sichuan snub-nosed monkey (*Rhinopithecus roxellana*) (Long & Richardson, 2008). The most recent census conducted in 1998 estimated the *R. roxellana* population in ZNNR at 1,100-1,200 individuals in 12 groups (Li *et al.,* 2001), which is about 5% of the world population (Quan & Xie, 2002).

The Sichuan snub-nosed monkey of the Qinling Mountains was first reported on by Liu (1959). Studies on this species in ZNNR have been undertaken systematically since the late 1980s. Many aspects of its ecology, social organization, behavior, and protection have been reported by researchers, mainly from Northwest University of China. Information on the species is mainly based on studies undertaken by the second author and his students since 1989. The information is supplemented with personal observations and communication with local communities. However, research on the species is better known from studies at Shennongjia and Baihe Nature Reserves in the Hubei and Sichuan provinces, respectively (Kirkpatrick *et al.,* 1999; Gron, 2007). This paper attempts to review some key findings of long-term habitat surveys and behavioral observations. In addition, we discuss the conservation prospects for the Sichuan snub-nosed monkeys in ZNNR.

1. Threats to *R. roxellana* in ZNNR

Although this species has been on China's list of First-class Protected Animals since 1975, its survival status is not assured. For a long time due to unsustainable exploitation of natural resources for human economic activities, especially commercial logging, its habitat has rapidly diminished and changed dramatically (Li *et al*., 2002; Li *et al*., 2003a). According to the Institute of Forestry Research and Design of Shaanxi, about 40,000 m^3 of logs were removed from the Qinling Mountains annually in the last century. From 1996 to 1997, the habitat of one *R. roxellana* troop of Yuhuangmiao region in ZNNR was subjected to commercial logging.

Although its range still contained enough food, and the vegetation continued to provide a safe refuge from peoples and predators, the activities of the two logging companies seriously disrupted the limited surrounding habitat, threatening the troop's survival (Li *et al.,* 1999).

In ZNNR, *R. roxellana* is faced with deforestation and habitat fragmentation, caused not only by commercial logging but also by local villagers' daily activities (Li *et al*., 2001; Li *et al*., 2002; Li *et al*., 2003a). During our fieldwork, we noticed that most local villagers in ZNNR practice traditional ways to cut wood for cooking and other daily energy-related purposes. Spring is the season for local villagers to collect medicinal plants and in fact, in April, there were about 40 people per day collecting plants within the home range of our study troop. Furthermore, tourism is having an increasing negative impact, mainly due to the development of roads and other infrastructure. Hence, the key research findings are reviewed, and some suggestions for further protection of Sichuan snub-nosed monkeys in ZNNR are offered.

2. Review of Research on *R. Roxellana* in ZNNR

Below we summarize some key findings of 23 years of ecological and behavioral research on Sichuan snub-nosed monkeys in ZNNR.

A. Home range and feeding ecology

There is a seasonal change in home range of *R. roxellana* in ZNNR (Li *et al*., 1999; Li *et al*., 2000). Its home range size was 14.1 km^2 in spring, 9.5 km^2 in summer, 12.1 km^2 in autumn, and 12.3 km^2 in winter; the total area used was 22.5 km^2 (Li *et al*., 2000). The monkeys used both logged and unlogged areas (Guo *et al*., 2004) and their movement across the home range was extensive in spring and restricted in autumn (Tan *et al*., 2007). The daily path length (DPL) varied from 0.75 km to 5 km, with a mean of 2.1 km. The monkeys occupied elevations 1,500–2,600 m above sea level, with an annual mean of 2,137 m (Tan *et al*., 2007).

R. roxellana consumed 84 plant species and its overall diet consisted of 29.4% fruit/seeds, 29.0% lichens, 24.0% leaves, 11.1% bark, 4.2% buds, 1.3% twigs and 1.0% unidentified items (Guo *et al*., 2007). Once, *R. roxellana* preyed and consumed an Eurasian blackbird (*Turdus merula*) in ZNNR, and food-sharing behavior among higher-rank members occured in the one-male unit when this vertebrate prey was obtained (Zhao *et al*., 2008a). It has also been reported that *R. roxellana* in ZNNR will alter its diet rather than its home range when it is faced with a weather event that causes its main food items to become rare (Li *et al*., 2003b).

B. Social composition and hierarchy

Studies have found that the basic social and reproductive unit in *R. roxellana* is the harem or one male unit (OMU), consisting of a single resident male, and a number of adult females, sub-adult females, juveniles and infants (Zhang *et al.,* 2006). OMU size ranges from 5 to 14 individuals, with an averaging at 9.0±2.3 individuals. One OMU included only 1 adult male with 2-5 (3.3±0.9) adult females, 0-2 (1.1±0.6) sub-adult females, 1-4 (2.0±0.9) juveniles and 0-2 (1.0±0.8) infants and neonates (Zhang *et al*., 2006). Both male and female dispersal occurred (Chen *et al.,* 1983; Zhao *et al.,* 2008b). Immigration/emigration rates of adult females are higher than those of sub-adult females (Zhao *et al*., 2008b). Adult male *R. roxellana* may live with more than one unit of females during their lifetime (Zhao & Li, 2009).

Dominance index analysis showed a linear dominance ranking order existing within and between OMUs (Li *et al*., 2006; Zhang *et al*., 2008). Within an OMU, the resident male was the highest-ranking individual; followed by adult females, sub-adult females, and finally the juveniles. A female's rank within its OMU is not static, an adult female may rise in rank after she has given birth (Li *et al.,* 2006). The rank order of OMUs could change between the mating season and birth season (Li *et al.,* 2006). The dominance rank of OMUs was positively correlated with the duration of their stay in the band, and this may be attributed to the association of the resident male with adult females, rather than the fighting ability of resident males, as males do not fight seriously with each other. Subordinate units were observed to merge with dominant units resulting in an elevation of their rank (Zhang *et al.,* 2008).

C. Sexual behavior and reproductive strategy

For Sichuan snub-nosed monkeys, normal copulation behavior includes courtship, mounting, intromission and ejaculation (Li & Zhao, 2007). The intromission process can be further divided into two phases: intromission prophase and intromission anaphase (Zhao & Li, 2005). *R. roxellana* is a seasonal breeder although copulation occurs throughout the year, with the majority of copulations occurring between September and November (Li & Zhao, 2007). Females initiated 96.2% of courtship attempts, while males initiated only 3.8%. There is a skewed sexual competition with multiple females competing for a single male, which was shown in female courtship attempts and female sexual interference (Zhao, 2005; Li & Zhao, 2005 & 2007).

Habitat fragmentation has caused geographic isolation between various monkey populations. Within the social structure of the Sichuan snub-nosed monkeys, due to this habitat fragmentation, inbreeding is a strong possibility as a result of the resident male copulating with his offspring. Zaho *et al*. (2005) first reported extra-unit sexual behavior in wild *R. roxellana*, and that in such cases the female apparently prefers to choose a new resident male over a more established one. This extra-unit sexual behavior exhibited by wild *R. roxellana* appears to be a kind of genetic 'bet-hedging' strategy, which decreases the likelihood of inbreeding depression by increasing the degree of heterozygosity in their offspring.

It should be mentioned that monkeys could adopt a flexible behavioral strategy in the event of individual dispersal. For instance, after a male takeover, the new resident male and OMU females show different behavioral adjustments (Zhao *et al*., 2008c). At the same time, the members' sexual interactions are consistent with an interpretation of behavioral adjustment towards male takeover, and of inbreeding avoidance. In addition, adult female *R. roxellana* employs various reproductive strategies related to female dispersal, which may increase their reproductive success (Zhao *et al*., 2008b).

3. Past and Future Conservation Efforts

In China, some wildlife including the Sichuan snub-nosed monkey, are strictly protected by local laws and regulations, such as the "People's Republic of China Constitution", the "People's Republic of China Forest Law", the "People's Republic of China Wildlife Conservation Law", the "People's Republic of China Environment Law" and the "Management Methods for Forest and Wildlife Type Nature Reserves". Based on the these laws and regulations, Shaanxi Province has issued additional laws and regulations, namely the "Rule of Wildlife Management of Shaanxi Province", the "Lists of Shaanxi Major Protected Animals" and the "Lists of Shaanxi General Protected Animals". The Shaanxi Provincial government gazetted 52,931 ha as the Zhouzhi Nature Reserve to protect wild Sichuan snub-nosed monkeys and their forest habitat in 1985. Three years later, the Chinese central government upgraded it to a National Nature Reserve, which falls under the management of the Administrative Bureau of Zhouzhi Nature Reserve in Zhouzhi County.

Since the 1990's Northwest University researchers have carried out surveys and research on this endemic species in cooperation with the ZNNR management authorities. This research has been supported by a number of successive national and international funding agencies, and include the Natural Science Foundation of China, Chinese Key Project of Ministry of Education, Chinese Shaanxi Natural Science Foundation, Primate Conservation Inc., Nippon Life Insurance Fund of Japan, Daiko Foundation of Japan, Zoological Society of San Diego, and Cosmo Oil Eco Card Fund some of which were directed towards the protection of the species. For instance, to recover the habitat of Sichuan snub-nosed monkeys in ZNNR, 27,000 trees were planted between 2005-2007 on obsolescent logging roads with the support from Cosmo Oil Eco Card Fund.

Knowledge about the ecology and behavior of Sichuan snub-nosed monkeys is critical for their conservation. A long-term comprehensive conservation and research project is imminently required for *R. roxellana* in ZNNR. Further research

should focus on traditional forest management, status investigations in severely degraded forests, periodical population surveys, and comparative ecological studies including *R. roxellana* populations in ZNNR and those in Shennongjia Nature Reserve and Baihe Nature Reserve. With this information, detailed conservation strategies for this Chinese endemic species can be established. Meanwhile, it is urgent that increasing development of local tourism in ZNNR should be effectively managed by both national and local administrations.

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THE HOOLOCK GIBBON (*Hoolock hoolock*) IN TINSUKIA AND DIBRUGARH DISTRICTS OF ASSAM, INDIA

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ABSTRACT

The distribution, habitat, status and conservation of the hoolock gibbon *Hoolock hoolock* are described in the Tinsukia and Dibrugarh districts of eastern Assam, India, a stronghold of the species. The habitat is dominated by tropical wet evergreen rainforest. Most of the gibbons are confined to the protected areas and reserved forests. Occurrence in some village woodlands is interesting. At present, Dihing-Patkai Sanctuary and Upper Dihing (west block) reserved forest complex has the largest gibbon habitat in the area. In all, the species occurs in more than 40 fragmented populations. As poaching is insignificant, they are relatively densely distributed in some pockets. There were a minimum of 1,700 gibbons in the area in 1995-1996 with a marginally declining trend. Presently there may be fewer than 1,300 individuals. Destruction of forest by felling of trees, encroachment for agriculture including tea plantation and settlement, oil mining and exploration and open cast coal mining are major threats. Recommendations have been made for new protected areas, extension and adequate protection of existing protected areas, and stopping of new mining in key habitats.

Keywords: Hoolock gibbon, *Hoolock hoolock,* Tinsukia, Dibrugarh, Assam, Dihing-Patkai Sanctuary, Upper Dihing reserved forests.

INTRODUCTION

The hoolock gibbon *Hoolock hoolock* is the only ape of the Indian subcontinent. It occurs only in a small part of the country in the north-east where it is restricted to the south of the Brahmaputra River and east of the Dibang River (Parsons, 1941; Choudhury, 1987). Outside India, it is distributed in a small area of southern China, eastern Bangladesh and Myanmar (Burma) (Corbet & Hill, 1992). Formerly in the genus *Hylobates*, Prouty *et al*. (1983a & 1983b) argued for the placement of the hoolock gibbon in a separate subgenus, *Bunopithecus* Matthew and Granger, 1923, based on its distinct karyotype. Brandon-Jones *et al*. (2004) and Groves (2005) placed it in the genus *Bunopithecus* based on the findings of Roos and Geissmann (2001) and Takacs *et al*. (2005), while doubting the validity of the name. Eventually, Mootnick and Groves (2005) showed that *Bunopithecus* was not applicable to the species (or to gibbons at all), and named instead a new monotypic genus, *Hoolock* Mootnick and Groves, 2005. Taxonomy of gibbons as well as other primates has been reviewed by Groves (2005).

Information on the species in Assam can be found in Tilson (1979), Choudhury (1987, 1989, 1990, 1991 & 2000), Kakati (1997) and Das (2002), and in some other synoptic works on primates or wildlife in general (Pocock, 1939 & 1941; Prater, 1948; Choudhury, 1988, 1995, 1996b & 1997). Some information on the gibbons of other states of north-east India are found in McCann (1933), Alfred and Sati (1990), Misra *et al*. (1994), and Choudhury (2003 & 2006). In this article, the distribution, habitat, status, and conservation of the hoolock gibbon in the Tinsukia and Dibrugarh districts of eastern Assam, India, a stronghold of the species, are presented.

STUDY AREA AND METHODS

The districts of Tinsukia (3,790 km²) and Dibrugarh (3,381 km²) (27°05'-27°58' N, 94°32'-96°01' E) are located in the eastern part of Assam with Arunachal Pradesh on three sides of the former district. The area is plains with the floodplains of the Lohit and Brahmaputra rivers in the north and west, respectively. The foothills of Patkai Range mark the southern areas. The habitat type ranges from tropical wet evergreen rainforest, moist deciduous to Salix swamp. The climate of the area is tropical monsoon with a hot and wet summer and a cool and usually dry winter. The temperature ranges from less than 7°C to more than 36°C. Annual rainfall ranges from 2,500 to more than 3,500 mm.

Between 1987 and 1996 with brief visits continuing until May 2008, I was able to carry out field studies in the habitats of the hoolock gibbon in Tinsukia and Dibrugarh districts as part of a broader survey of primates and other wildlife. However, intensive studies were performed in 1992-1994 when I camped in Tinsukia District for more than two years. During the field study, the presence of the gibbon was ascertained by direct sighting, its distinctive call and in some areas by interviewing local forest staff and villagers. For direct observation, foot transects along existing and newly cut paths and trails, boat transects along nullahs (gullies) and rivers, and elephant-back transects (using trained elephants) along existing and newly-cut trails were made.

RESULTS AND DISCUSSION

1. Distribution and Habitat

In Tinsukia district, the hoolock gibbon occurs in all regions excluding the wide riverbeds of the Brahmaputra and Lohit (Figure 1) as is evident from the distribution pattern. Tea gardens, roads, railway and large human settlements have resulted in fragmentation. In fact, Tinsukia is an illustrative case of fragmentation (see also Table 1). In Dibrugarh, the species occurs in the north and south-east. Most of the gibbons are confined to reserved forests (RF) while some are also present in unclassified forests. Most interesting, however, is the occurrence in some village woodlands. At present, Upper Dihing (west block) RF is the

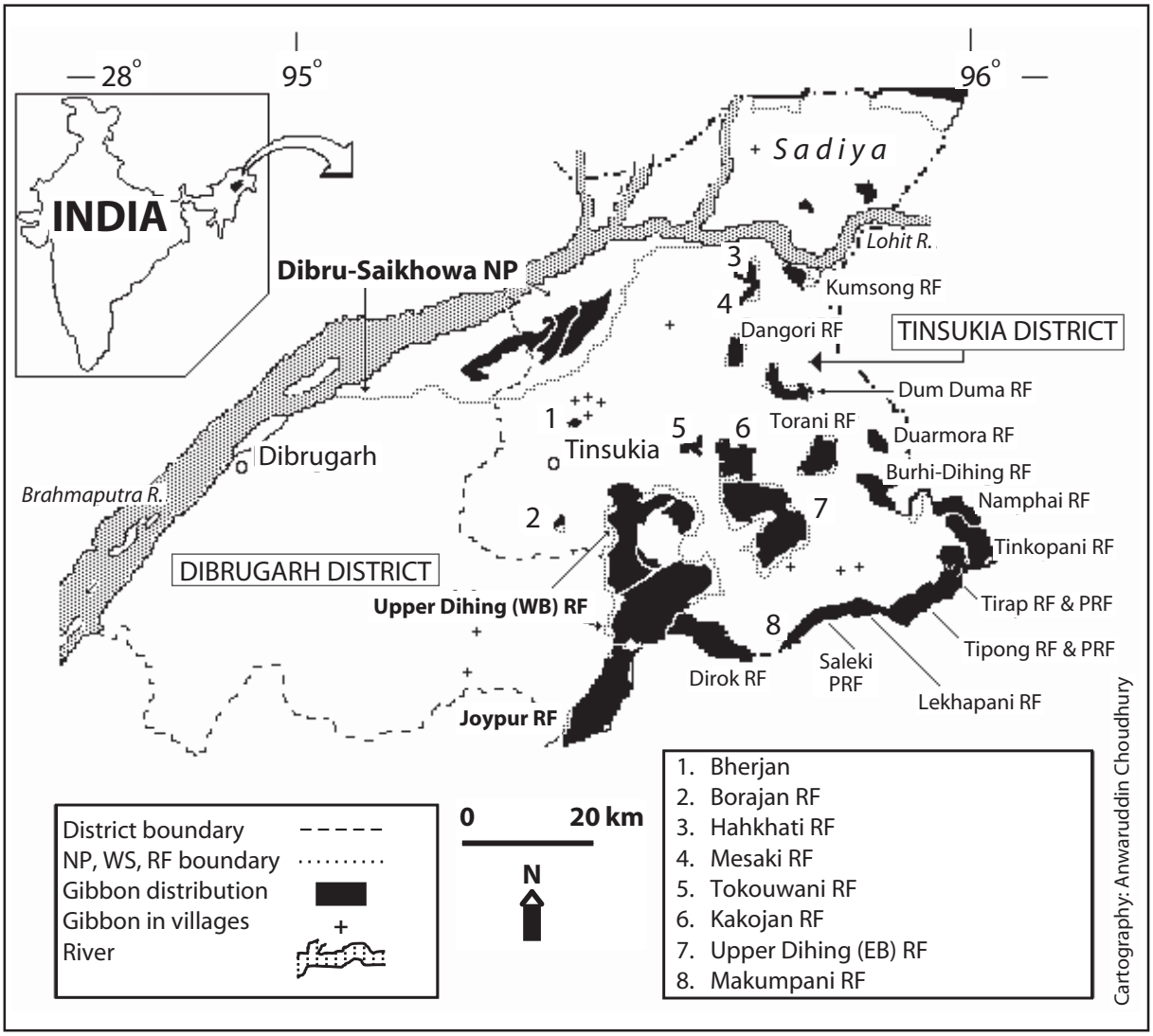

Figure 1. Gibbon distribution in Tinsukia, showing population fragmentation.

Table 1. Hoolock gibbon in Tinsukia and Dibrugarh districts.

Area Name	Area (km²)	Approx. current suitable habitat for gibbons (km²)	Population range	Remarks
Dibru-Saikhowa NP	340	50	E	Severely degraded; At least 4 fragmented populations
Tinsukia District				
Bherjan-Borajan-Podumoni WS	7.2	3	F	Three fragmented forests
Burhi-Dihing RFs	22.95	16	D	Two fragmented forests
Digboi (west block) RF	9.2	7	E	Contiguous with Upper Dihing (west block) RF
Digboi (west block) RF	11	4	F	
Dirak RF	30.4	27	D	
Duarmora RF	6.5	4	F	
Dum Duma RF	28.8	20	D	High density gibbon population inpockets
Hahkhati RF	6.7	3	F	Contiguous with Mesaki RF
Hollogaon RF	3.7	2	F	
Hollonghabi RF	5.2	1	?	Severely degraded
Kakojan RF	23.2	18	D	
Kotha RF	11.3	2	?	Severely degraded
Kumsong	22.5	9	E	Severely degraded
Kukuramora RF	3.65	2	F	Partially degraded
Kundil Kaliya RF	72.8	10	E	Severely degraded
Lekhapani RF	13.96	8	F	
Makumpani RF	4.8	3	F	Contiguous with Dirak RF
Mesaki RF	13.66	5	F	Contiguous with Hahkhati RF
Naloni RF	3.8	1.5	F	A pair in 1993; current status unknown
Namphai RF	21.2	10	E	Two fragments, one contiguous with Tinkopani RF
Phillobari RF	3.14	1.50	F	3 in 1993; current status unknown
Sadiya Station (north block) RF	23.3	8	F	Degraded
Saleki proposed RF	29.4	15	E	
Tinkopani RF	30.3	21	E	
Tipong RF	4.45	3	F	Contiguous with Tipong (1st Addn) proposed RF
Tipong (1st Addn) proposed RF	20	15	E	
Tirap RF	14.5	10	E	Contiguous with Tirap (1st Addn) proposed RF
Tirap (1st Addn) proposed RF	29.95	18	E	
Tokowani RF	4.97	3	F	
Torani RF	20.4	13	E	
Upper Dihing (west block) RF	275	179	A	At least 5 fragmented populations; still large gibbon population. A part has been included in Dihing-Patkai WS.
Upper Dihing (east block) RF	132	70	C	At least 3 fragmented populations; still large gibbon population.
Villages in Tinsukia			E	
Dibrugarh District				
Joypur RF	108.7	84	B	At least 2 fragmented populations; still has large gibbon population. A part has been included in Dihing-Patkai WS.
Villages in Dibrugarh			F	

Population size: A => 500; B = 250-500; C = 100-250; D = 50-100; E = 20-50; F =< 20
NP = National Park; **WS** = Wildlife Sanctuary; **RF** = Reserved Forest.

largest gibbon habitat in the district followed by Upper Dihing (east block) RF, Joypur RF, Dibru-Saikhowa National Park, Dum Duma RF, Dirok RF, Tinkopani RF, Kakojan RF, Tirap RF and Namphai RF.

In summary, the hoolock gibbon occurs in three protected areas, 27 reserved forests, three proposed reserved forests, and in some other areas; totaling at least 40 fragmented populations in Tinsukia, three in Dibrugarh and one falling in both. In Dibrugarh, it occurs only in one reserved forest while the single national park falls partly in both the districts (Table 1). As poaching is insignificant, they are relatively densely distributed compared to many other parts of north-east India.

In Tinsukia district, the species has become extirpated in recent years from Podumoni and Bherjan forests of Bherjan-Borajan-Podumoni Wildlife Sanctuary. In Dibrugarh district, it used to occur also in Namdang and Telpani RFs, but no further records were made in recent decades. Throughout its range in Tinsukia and Dibrugarh, the hoolock gibbon is sympatric with other primates such as the Assamese macaque (*Macaca assamensis*), northern pig-tailed macaque (*M. leonina*), rhesus macaque (*M. mulatta*), capped langur (*Trachypithecus pileatus*) and slow loris (*Nycticebus bengalensis*) and in a few areas with the stump-tailed macaque (*M. arctoides*).

The hoolock gibbon is arboreal and a dweller of dense evergreen and semi-evergreen forest in the plains, foothills and hills. It has been recorded from less than 90 m in Dibru-Saikhowa to above 500 m in Dirok and Joypur RFs. All the recorded sites were in tropical evergreen or semi-evergreen forests except in Dibru-Saikhowa where it has also been recorded in Salix swamps and deciduous woodland. The total potential habitat, i.e., good or dense or nearly dense forest (more than 40% crown density as per Forest Survey of India) is only about 850 km². Of these, the known "area of occupancy" (as per IUCN criteria; IUCN, 2008) is around 650 km² of which at least 220 km² support gibbons at relatively high density.

2. Village Gibbons

The occurrence of hoolock gibbons in some village woodlands is very interesting. The first such case came to light when I heard a gibbon call from Baghjan while surveying for White-winged Wood Ducks *Cairina scutulata* in July 1992. The call came from Motapung and Motapung-Kaesia villages. Then I located further groups in at least eight more village woodlands, namely Joigukhowa-Torajan, Borgaon, Na-Dhulijan, Pasegaon, Kambagaon and Bura-Burithan (Sadiya) in Tinsukia district, and Hukanigaon and Chopatoli in Dibrugarh district. In these 10 village woodlands, about 30 gibbons were present in 1994. A few more were reported from Enthem-Ketetong area of Tinsukia district. Details of these 'village gibbons' will be published later.

3. Status

The hoolock gibbon is a rare primate of the Indian sub-continent. It is protected under Schedule I of Wild Life (Protection) Act and is listed as 'Endangered' by IUCN (IUCN, 2008). However, in some forest pockets of Tinsukia district, it is still common and easily seen. Estimating the population of the hoolock gibbon is relatively easy compared to other primates of the region because it can be located by its call besides by direct sightings. Moreover, in these districts, it is not shy.

The population density (crude but excluding the treeless areas) could be estimated for six sampled areas, Borajan, Dum Duma (Kasijan to straight south up to the boundary), Upper Dihing (west block) between Kheto and Lakkhipathar and in Jorajan-Choraipung, Dibru-Saikhowa NP and Dangori RF. The density in 1992-1996 (1992-1994 for Borajan) was 10 gibbons/km² in Borajan (drastically reduced after 1994 due to felling of trees in a relatively small area), 8.58/km² in Dum Duma (Kasijan to straight south up to boundary), 6.05/ km² in Upper Dihing (west block) between Kheto and Lakkhipathar, 8.8/km² in Upper Dihing (west block) between Jorajan-Choraipung, 1.46/ km² in Dibru-Saikhowa NP, and 4.71/km² in Dangori RF. The very low density in Dibru-Saikhowa was due to a change in habitat type. However, as a precaution, the next-lowest density i.e., 4.71/km² (Dangori RF) may be taken as a guide for estimating overall population in the 220 km² that supports gibbons at a higher density. The figure of 1.46/km² from Dibru-Saikhowa could be used to estimate population in the remaining 480 km².

This indicates that there was a minimum of about 1,700 gibbons in Tinsukia-Dibrugarh forests in 1995-1996 (excluding the few gibbons that live in village woodlands) of which more than one-quarter were in Upper Dihing (west block) RF. In post-1996 period, besides Borajan, there was a noticeable but unknown decline in Dibru-Saikhowa due to shrinkage of potential habitat through erosion, felling of trees and encroachment by 'forest villagers'. The single old female of Bherjan was killed in 2002. In other areas, there was also an apparent decline but

that cannot be quantified unless studies are repeated in the areas. If the loss of habitat is taken as a yardstick (in the absence of poaching for meat), then there might be fewer than 1,300 animals. The largest group observed was six gibbons about 1 km west of Raja-ali Beat office in Upper Dihing (east block) RF on 19 August 1993. It contained an adult pair, another adult male which seemed to be younger than the alpha male, two sub-adults of different age groups and a juvenile.

4. Conservation Problems

A. Habitat destruction

Destruction of forest by tree felling, encroachment for agriculture and settlement, expansion of tea plantations, *jhum* or slash-and-burn shifting cultivation (in Patkai foothills), and monoculture tree plantation are major threat. These lead not only to a reduction but also to fragmentation of habitat. Encroachment is a major problem in the reserved forests and as well as in Dibru-Saikhowa National Park. In the hilly areas along the Arunachal Pradesh border including the Saleki proposed RF, *jhum* cultivation is an important factor in forest destruction. The satellite images taken in of 2007 have shown that the entire southern two-third of Borajan block of Bherjan-Borajan-Podumoni Wildlife Sanctuary has virtually lost all its trees. The ultimate cause of habitat destruction is, however, the very rapid growth in the human population, from 1.4 million in 1971 to 2.3 million in 2001 in these two districts.

B. Poaching and trade

Unlike many other parts of north-east India, poaching negligible in Tinsukia and Dibrugarh. Occasionally, people from Arunachal Pradesh poach in Joypur and other bordering areas including Dirok and Tinkopani, but it is not alarming. There is no known trade, however, young animals are sometimes kept as pets.

C. Drilling and mining

Oil drilling and exploration, and open cast coal mining are major concerns. The largest rainforest patches of the area in Upper Dihing reserved forests have been heavily exploited for oil mining for more than a hundred years. New wells are also coming up. A large area near Choraipung in Upper Dihing (west block) RF was damaged due to oil exploration by the Premier Oil Company as recently as 2004-2005.

D. Other issues

Pollution from oil fields, refineries and open cast coal mining are also conservation issues to be taken into account. In Dibru-Saikhowa National Park, the dramatic earthquake of 1950 resulted in major geomorphological changes, which included sinking of large parts of the present national park, while huge amounts of silt brought down by the Brahmaputra and the Lohit Rivers have accumulated on the riverbeds. Since then, the area started getting regularly flooded (also water logging) during the monsoon resulting in a change of vegetation type (Choudhury, 2000). Evergreen trees started to be replaced by deciduous species, while the low-lying areas were colonised by *Salix tetrasperma*. Diversion of a major channel of the Lohit river through Ananta *nullah* has resulted in further shrinkage of habitat due to erosion. The two 'forest villages', Laika and Dadhia, have illegally expanded by destroying forest areas, while many villagers are also engaged in illegal logging. This has greatly reduced the potential habitat of the gibbon in the park (only less than a sixth is suitable now). It will not be surprising if the gibbon vanishes from the park within the next 5-6 years (28 groups were confirmed and some more were reported in 1992-1994; Choudhury, 2000). Depredation in the cultivations and orchards by the hoolock gibbon has not been recorded although there were a few instances of the gibbons entering orange orchards, but without causing any damage.

CONSERVATION MEASURES TAKEN

Some of the important gibbon habitats covering parts of Upper Dihing (west block), Dirok and Joypur RFs were declared as Dihing-Patkai Wildlife Sanctuary in 2004 while Bherjan-Borajan-Podumoni Wildlife Sanctuary was notified already in 1999. Both were recommended after the studies reported here (Choudhury, 1989, 1995, & 1996a). However, the protection measures are inadequate and habitat degradation continues.

RECOMMENDATIONS

1. Important habitats for gibbons such as Dum Duma-Dangori should be declared as protected areas. Part of Upper Dihing (west block), especially areas near Choraipung and like Joypur RF should be added to Dihing-Patkai Wildlife Sanctuary and upgraded to a national park as was originally recommended (Choudhury, 1996a).
2. The existing protected areas should be provided with adequate protection.
3. The tea companies should collaborate with Bherjan-Borajan-Podumoni Wildlife Sanctuary and help to fence these small pockets. The oil industry, which has obtained greatest maximum benefit from the rainforests of Upper Dihing should support the protection work of Dihing-Patkai Wildlife Sanctuary.
4. No new oil well should be allowed in protected areas. With modern technology, drilling is also possible from distance.

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