THE DIURNAL PRIMATE COMMUNITY IN A DRY EVERGREEN FOREST IN PHU KHIEO WILDLIFE SANCTUARY, NORTHEAST THAILAND

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ABSTRACT

Primate densities were studied in a dry evergreen forest of Phu Khieo Wildlife Sanctuary (Chaiyaphum Province, Northeast Thailand) between December 2000 and September 2001 by means of line transect sampling. A 4-km transect was walked on four consecutive days in the middle of each month resulting in 160 km of transect walks. Six of the seven diurnal species reported for the sanctuary were encountered. Phayre's langurs were most abundant (3.4 groups/km^2), white-handed gibbons were the second most common species (2.6 groups/km^2), while macaques had much lower group densities (rhesus 0.6, Assamese 0.5, pig-tailed 0.3, and stump-tailed probably below 0.1 groups/km^2). We did not encounter silvered langurs. The estimated number of individuals/km^2 is highest for Phayre's langurs (23–38), moderate for white-handed gibbons (10–12), and moderate to low for macaques (3–17). The number of observers (one versus two) had no influence on detection probabilities. Cumulative density calculations indicate robust values for Phayre's langurs and white-handed gibbons. Overall, the results concur with reports for the same species at other sites. In order to assess more reliably the status of macaques and silvered langurs in the sanctuary, further data are needed, particularly for additional habitat types.

Key words: primate group density, primate group size, population density, *Hylobates lar*, *Macaca* spp., *Trachypithecus phayrei*.

INTRODUCTION

Assessing the diversity, density, and distribution of the flora and fauna is an important task for natural history research. Such data reveal the current status of a community and form the baseline for future comparisons that help to document the progress of conservation efforts. The more data become available, the easier it will be to describe the status of a certain region and to direct future management decisions.

Long-lived and sensitive mammals have proven to be valuable indicators of habitat quality and this holds particularly true for primates (EMMONS, 1999). Typically, mammalian species richness increases with primate richness on the different continents, with the only exception being Asia. However, it is not clear whether this lack of correlation is indeed a consequence of particular circumstances in Asia or, simply the result of a lack of quantitative

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data. Therefore, it is desirable to have more data from different localities and habitats available throughout Asia.

As part of our research on the behavioral ecology of macaque and langur monkeys, we began to assess the status of one diurnal primate community in Thailand. Our major aim was to assess the role of the study species relative to the overall primate community, and to gather preliminary hints on the degree of sympatry, competition pattern, and possible niche differentiation. Furthermore, we aim to test and subsequently improve our sampling methods with our initial data.

The most comprehensive data on primate abundance in Thailand are available for Khao Yai National Park where a detailed study on the gibbon community has been ongoing for more than two decades (BROCKELMAN *ET AL.*, 1998). However, with only three diurnal primate species Khao Yai National Park appears to be exceptional. Other areas such as Huai Kha Khaeng Wildlife Sanctuary have more complex primate communities, but extensive data on abundance are not available (e.g., EUDEY, 1991). Hence, more data from other areas are clearly desirable.

In this paper we will present preliminary data on the diurnal primate community in a lesser-studied habitat in Northeast Thailand, Phu Khieo Wildlife Sanctuary. The primate diversity of the sanctuary is already well known and encompasses the following eight species: white-handed gibbon (*Hylobates lar*), Phayre's leaf monkey (*Trachypithecus phayrei*), silvered langur (*Trachypithecus cristatus*), rhesus macaque (*Macaca mulatta*), Assamese macaque (*Macaca assamensis*), pig-tailed macaque (*Macaca nemestrina*), stump-tailed macaque (*Macaca arctoides*) and one nocturnal primate, slow loris (*Nycticebus coucang*) (KUMSUK *ET AL.*, 1999). Three of these species are classified as vulnerable, two as lower risk, and for the remaining species the data available do not allow for a classification (HILTON-TAYLER, 2000). We determined the abundance of all diurnal primate species in an area of Phu Khieo Wildlife Sanctuary where dry evergreen forest predominates. We describe the methods as well as the analysis in some detail to facilitate and encourage repetition in other parts of Thailand.

STUDY AREA

Phu Khieo Wildlife Sanctuary is located in Northeast Thailand (16°5'–35'N, 101°20'–55'E) in Chaiyaphum Province at an elevation of 500 to 1300 m above sea level. The sanctuary covers an area of about 1560 km^2 and is connected to eight other wildlife sanctuaries and national parks, together forming the Western Isaan Forest Complex (total area about 4800 km^2). The vegetation consists of 54.0% hill evergreen forest, 20.5% dry evergreen forest, 16.9% dry dipterocarp and mixed pine-dipterocarp forest, 4.2% bamboo forest, 2.9% meadows, and 1.4% forest plantations. Water reservoirs cover about 0.1 % of the area (Khon Kaen University & Phu Khieo Wildlife Sanctuary, 1995).

The study site (Mai Sot Yai, 16°27'N, 101°38'E; Fig. 1) is located at 600–800 m above sea level and comprises an area of about 3000–4000 ha of dry evergreen forest interspersed with patches of dry dipterocarp forest. The borders are set by the river Phrom to the east, a plateau mountain (Phu Khieo Noi) to the south and a rugged mountainous area to the west and north. The areas to the south, west, and north are dominated by hill evergreen forest. The area east of the river Phrom consists of dry evergreen forest, but due to earlier

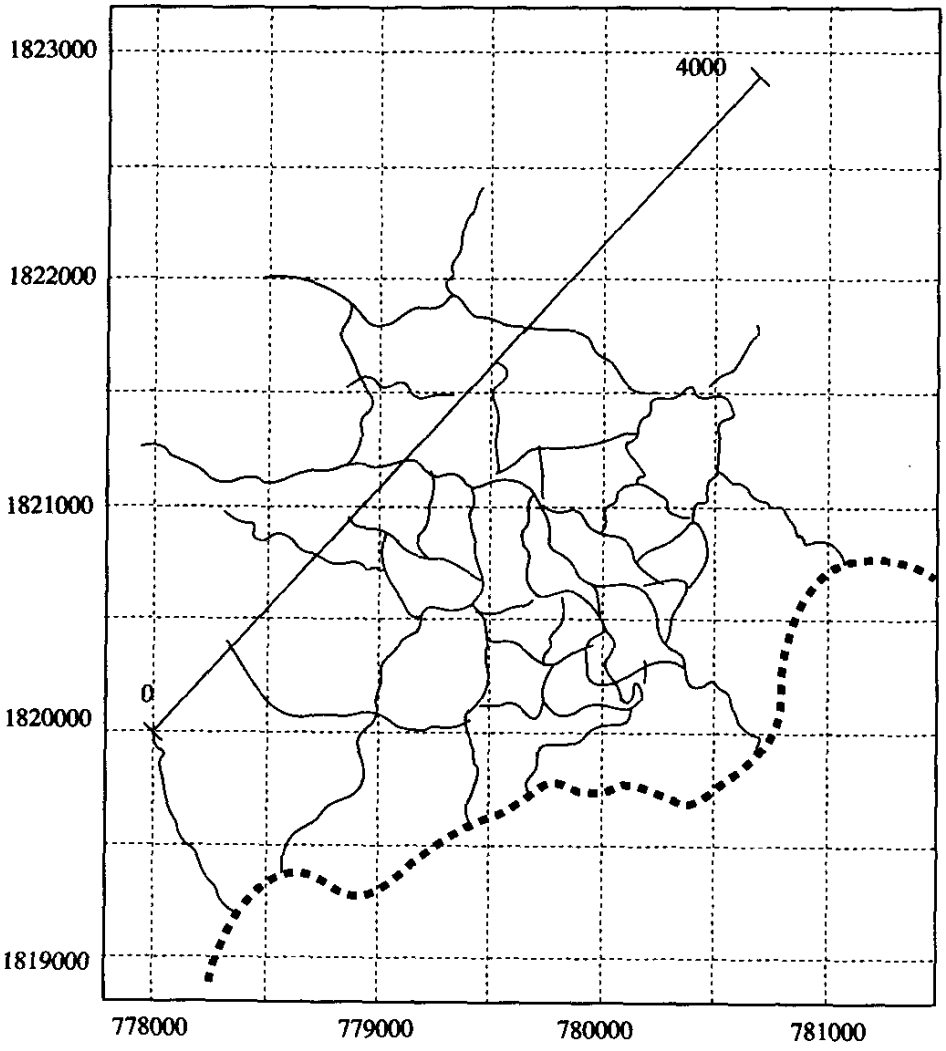

Figure 1. Map of Mai Sot Yai area within the Phu Khieo Wildlife Sanctuary indicating the position of the transect (bold line) in relation to the main study area (as of March 2002; lines represent trails) and the road (dotted line). X- and Y-axes give UTM coordinates (zone 47Q).

use, it is mainly a regenerating forest of low canopy height (less than 10 m) with islands of primary forest stands. The whole area is bisected (northeast to southwest) by a road that ends at the headquarters in the center of the sanctuary (RTSD, 1992; KHON KAEN UNIVERSITY & PHU KHIEO WILDLIFE SANCTUARY, 1995).

METHODS

Transect

A transect was established at Mai Sot Yai on November 07, 2000 (Fig. 1). For a number of reasons the placement of the transect was not entirely random. Given a recommended length of 4–5 km for transects (PERES, 1999), only some parts could become starting and ending points in the rather confined area covered by dry evergreen forest. The main road constrained the placement further, because it bisects the area in half. Finally, the character of the dry evergreen forest south of the road differs from the north. Therefore, we decided to place one transect north of the road with the option to later establish a second transect south of the road. The transect originates at Universal Transmercator coordinates (UTM; zone 47Q) 778000/1820000 about 1 km to the north of the road. It runs for 4 km in an angle of about 45° until approximately UTM 780730/1822900. The starting point of the transect is reached by a small 1-km path from the southeast (Fig. 1).

The length of the transect was horizontally determined by a measuring tape. Every 50 m the distance covered from the beginning of the transect was indicated by flagging the nearest tree and more permanently by cuts and paint. Assisted by several RFD staff from the sanctuary, the transect path was established in November 2000 at a width of about 0.5 m. It was cleared of leaf litter and branches up to 2 m high to allow for observers to move quietly. The path was again cleared in July 2001.

Data Collection

From December 2000 through September 2001, the transect was walked 40 times from southwest to northeast resulting in 160 km of transect walks. Usually we walked on four consecutive days in the middle of the month (between the 12th and 18th) with two exceptions: (i) due to heavy rainfall in June 2001, consecutive walks were once interrupted by a day, and (ii) due to schedule problems the walks in September 2001 were conducted at the beginning of the month.

Transect walks began at first daylight, if not prevented by wind, rainfall, fog, or the presence of large mammals (e.g., elephants). Typically we started around 0700 h (range 0615–0805 h) and reached the end of the transect around 1145 h (range 1035–1335 h) resulting in a mean duration of 4.75 h (range 4.09–7.25 h) which included all contact times and times out (see below). We moved at a slow speed and as quietly as possible, stopping frequently to listen. The general velocity was monitored by means of a stopwatch (3 min per 50 m, mean 1.00 km/h, range 0.96–1.02). While on the transect, we tried not to move backwards and did not leave it (cf. also PERES, 1999).

During walks, our attention was directed forward and to either side, scanning from the canopy to the ground. However, 14% of the 118 primate sightings occurred only after we

had already passed the animals. These encounters were included in the analysis. If an animal was heard or seen, we stopped and remained for up to 10 min on average (range 2–23 min). If at least one individual was actually seen the encounter rated as a primate contact. For instance, a gibbon identified and located via singing or branch movements only was not included. The mean number of primate sightings was 3.0 (range 0–6) per transect walk and the overall time period spent in contact with primates averaged 29.7 min (range 0–71) per walk. We took time out and stopped during transect walks (mean 15.9 min per walk, range 0–158): (i) if animals other than primates were observed or had to be avoided, or (ii) if rain, fog, or wind prevented us from continuing.

For each contact with primates the following data were noted (e.g., NRC US, 1981; BROCKELMAN & ALI, 1987; KREBS, 1999; PERES, 1999): species, mode of detection, time when contact started, and the location on the transect. With the exception of a presumed solitary pig-tailed macaque, all primate species encountered could unequivocally be identified. For the first individual sighted we noted: the distance (horizontal), compass bearing, height, and activity at the moment of detection. Once the center of the group was assessed, its distance and compass bearing were taken and the group spread estimated. We counted all individuals detected (i.e., all animals seen plus movements or sounds heard simultaneously at other locations) and conservatively estimated the additional number of primates present. This method results in a minimum number of individuals (i.e., all detected, see above) and a maximum number per group (i.e., the minimum number plus the highest number of additional individuals estimated). Whenever possible, distances were measured by means of an optical rangefinder. Otherwise distances and heights were estimated to the nearest meter. Estimates were checked monthly as was the inter-observer reliability also for species identifications. Data consistency was further enhanced by the fact that during all 40 walks at least one of the authors was present. Exactly half of the walks were performed by a single observer, the other half by two observers providing additional opportunities for comparison.

Data Analysis

Group and population density were assessed using the equation

$$D = n / 2 L a$$

where D = density of animals or groups per unit area, n = number of animals or groups seen along the transect, L = total length of the transect, and a = half the effective strip width.

The factor a is a constant and estimates the area under the detection function. There are various ways to estimate the detection function for a calculation of population or group densities such as Hayne Estimator, Fourier Series Estimator, etc. (KREBS, 1999). In our sample, however, the number of groups seen per species was not large enough to employ any of these estimators (cf. BUCKLAND *ET AL.*, 1993). Therefore, we chose the "maximum reliable transect-to-animal perpendicular distance" method to estimate half the effective strip width (see discussion in NRC US, 1981). In order to use this method, we calculated the perpendicular distance of the first individual encountered in all primate encounters as follows. The orientation of the transect was known (45º) and considered constant. This bearing was subtracted from the compass reading for the first individual resulting in the

detection angle φ. For animals encountered after they had already been passed the resulting angle was subtracted from 180º to correct for direction. The perpendicular distance p was determined as $p = d \sin \varphi$ where d = detection distance and φ = detection angle.

For each primate species the distribution of perpendicular distances was analyzed separately (in blocks of 10 m) to determine the detection cut-off points, which provided half the effective strip width for the species. For instance, a cut-off point at 30 m resulted in a transect width of 2 x 30 m. Together with an L of 160 km, an overall area of 9.6 km^2 was covered during all 40 walks for this particular species. The cut-off point (i.e., the maximum reliable perpendicular distance) determines the zone next to the transect where the detection probability is assumed to be 1. Consequently in our analysis, all sightings up to the cut-off point were included in the analysis, but sightings beyond the cut-off point were excluded.

Group densities were determined by dividing the number of group sightings (within the cut-off point of the perpendicular distance) by the area sampled for the species. To crosscheck the reliability of the resulting density estimates, cumulative group densities were calculated for the two most common species separately. We began by determining the mean value for December 2000. This value was added to the January 2001 data and a combined mean value was calculated for these two months. Then the February 2001 data were added and so forth.

Population densities are given as ranges referring to the mean number of individuals per species encountered (minimum and maximum values) plus the density of solitary individuals.

To calculate mean group sizes the mean minimum number of individuals per group was taken as the lower limit and the maximum number (see above) as the upper limit. Single individuals were not considered.

Possible differences in the detection probability in relation to the number of observers (one versus two) performing the transect walk were tested with the G-test of independence with William's correction (SOKAL & ROHLF, 1995).

RESULTS

Of the seven diurnal and one nocturnal primate species reported for Phu Khieo Wildlife Sanctuary (KUMSUK *ET AL.*, 1999) we encountered six species. Most frequently we saw Phayre's langurs and white-handed gibbons, less frequently rhesus, Assamese, and pig-tailed macaques, and rarely stump-tailed macaques. Silvered langurs have not been sighted, nor the nocturnal slow loris.

Maximum Reliable Perpendicular Distances

The distribution of detection distances is given in Figure 2 for species frequently encountered and in Table 1 for less frequent species (i.e., macaques). Groups of Phayre's langurs have been encountered 41 times and seem to have been reliably detected up to a distance of 30 m but not beyond (Fig. 2). Thus, only sightings up to 30 m (excluding all distances ≥ 30.1 m) were considered. White-handed gibbon groups were sighted 40 times and detected at a rather constant rate up to 40 m but not beyond. Note that solitary white-

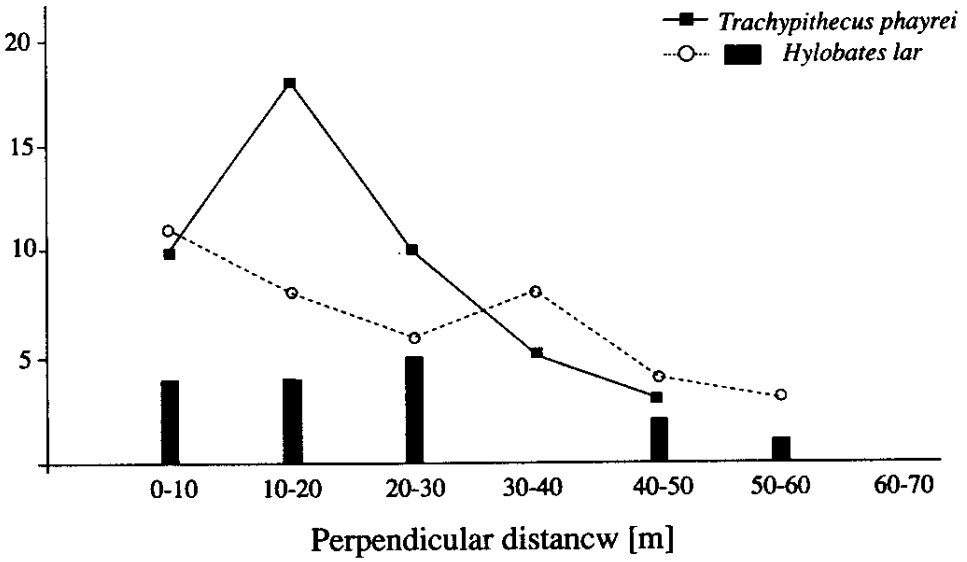

Figure 2. Perpendicular distances for groups of Phayre's langurs and white-handed gibbons, calculated for the first individual encountered. Solitary gibbons are given as columns.

Table 1: Perpendicular distances for macaque groups calculated for the first individual encountered during each contact. Sightings of solitary individuals in parentheses.

Species	Perpendicular distance [m]						
	10	20	30	40	50	60	70
Macaca assamensis	2	2	1	1			2
Macaca mulatta	2	2	2				
Macaca nemestrina	2 (1)	1					
Macaca arctoides	(1)						
Total (solitaries excluded)	6	5	3	1	0	0	2

handed gibbons (encountered 16 times; cf. columns in Figure 2) are not considered here. The one solitary Phayre's langur encountered is also not included. Generally, sightings of macaques were comparatively rare (Table 1). Thus, we combined all data to determine the cut-off point for the perpendicular distance beyond 30 m.

The number of primate sightings was almost identical for single and for two-observer walks (60 vs. 58). More importantly, the number of far distance sightings (12 vs. 9), as well as sightings of groups (41 vs. 39) and solitary animals (7 vs. 10) prior to the cut-off point, revealed only minor differences, which were not statistically significant (G_{adj} = $0.952 < \chi^2.05[2] = 5.991$). Thus, the detection probability was not affected by the number of observers performing the transect walk.

Primate Densities and Group Sizes

In the study area, Phayre's langurs were the most abundant diurnal primate (3.4 groups/km^2, Table 2). White-handed gibbons were second with 2.6 groups/km^2. All macaque species had much lower group densities, especially stump-tailed macaques (Table 2). Due to the overall low densities for macaques and the resulting small sample sizes, these figures are only rough approximations. The results for Phayre's langurs and white-handed gibbons, however, seem to be robust as indicated by the cumulative group densities leveling off after three months for white-handed gibbons and after six months for Phayre's langurs (Fig. 3).

With more than 20 individuals, macaque groups seem to be about twice as large as langur groups, which had an estimated mean maximum group size of 10.8 individuals (Table 2). Gibbon groups were smaller (3.8 individuals). Since macaques probably have a much larger group spread (estimated mean: 75 m) than Phayre's langurs (35 m) or white-handed gibbons (25 m), it is likely that a higher percentage of macaque group members has not been counted, so that group size differences between the genera might even be larger than depicted.

DISCUSSION

The results reported here should be considered preliminary. Clearly the data collected for the two most abundant species, Phayre's langurs and white-handed gibbons, are the most reliable and cumulative group density analysis suggests robust results. However, twice as much transect distance would be required for each of the two species to obtain more satisfactory results as defined by KREBS (1999), and to allow for a comprehensive statistical analysis (BUCKLAND *ET AL.*, 1993). Similarly, results for macaques should be viewed with caution. These results have a wide range and just give a first approximation. From the data obtained so far, at least another 320 km of transect walks would be necessary to obtain results with a confidence range of ± 10 % (KREBS, 1999). In contrast to earlier statements (e.g., PERES, 1999), data collection was not affected by observer number.

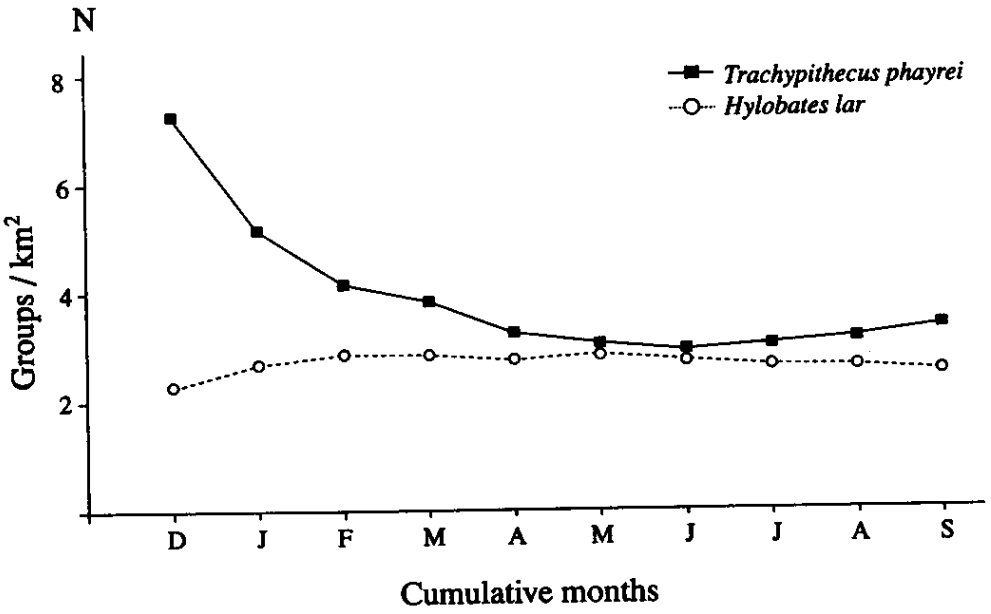

Figure 3. Cumulative group density for Phayre's langurs and white-handed gibbons (December 2000–September 2001).

Table 2: Densities and group size of the six primate species encountered (in descending density); * solitary individuals included

Species	Group density (groups/km^2)	Mean group size	Solitary animals (individuals/km^2)	Population density* (individuals/km^2)
Trachypithecus phayrei	3.4	6.7–10.8	0.1	23.2–37.5
Hylobates lar	2.6	3.1–3.8	1.0	9.9–11.9
Macaca mulatta	0.6	12.5–26.5		7.8–16.6
Macaca assamensis	0.5	9.4–18.8	0.1	5.1–10.0
Macaca nemestrina	0.3	7.7–22.7	0.1	2.6–7.3
(*Macaca arctoides*)	(0.1)			
Macaca spp.	1.5	9.8–21.6	0.2	15.5–33.9
Total diurnal primates	7.5		1.3	48.6–83.3

Primate Diversity

Our data confirm earlier reports on the diurnal primate diversity of Phu Khieo Wildlife Sanctuary (KUMSUK *ET AL.*, 1999). Besides Phayre's langurs and white-handed gibbons, rhesus macaques, Assamese macaques and pig-tailed macaques were encountered regularly. Stump-tailed macaques seem to be the least abundant. Silvered langurs were not encountered and we have only unconfirmed sightings from 1999 about 5 km northeast of the transect. Hence, currently it cannot be determined whether silvered langurs actually inhabit the dry evergreen forest type investigated. This species has also not been encountered during surveys in recent years (KUMSUK *ET AL.*, 1999) and might inhabit only remote areas of the sanctuary that are difficult to access. Thus, with a total of six confirmed and one likely but unseen species (the nocturnal slow loris) the Mai Sot Yai area investigated here falls into the upper range of primate diversity reported so far for Asia (range 3–10 species; REED, 1999).

White-handed Gibbons

With 10 to 12 individuals per km^2 the density of white-handed gibbons at Mai Sot Yai lies within the range found for the same species at other sites in southeast Asia (6.1 MACKINNON & MACKINNON, 1980; 4.4–11.2 calculated from MARSH & WILSON, 1981; 15.9 Reichard, unpublished manuscript). The mean group size is estimated to range between 3 to 4 individuals at Mai Sot Yai. Given our conservative data collection and analyses (cf. Methods), mean group size might in fact be slightly higher, exceeding 4 animals per group. This estimate is in good agreement with reports for other sites: 3.3–4.4 (GITTINS & RAEMAEKERS, 1980); 3.3–3.5 (LEIGHTON, 1987); 3.6 (BHUMPAKPHAN, 1988); 4.0 (Reichard, unpublished). The gibbon group density is moderate (2.6 groups/km^2) compared to other sites (1.2–3.7 MARSH & WILSON, 1981; 3.3–3.5 LEIGHTON, 1987; 5.0 BROCKELMAN *ET AL.*, 1998; 4.0 Reichard, unpublished) which might be due to the diverse primate community resulting in a lower carrying capacity per species. It might also mirror the distribution and seasonal pattern of abundance for key food resources. Further research into the possible causes is clearly desirable.

Phayre's Langurs

In contrast to the white-handed gibbon, little information is currently available for Phayre's langur. Thus, for a comparison we will in part rely on data for a closely related species, the spectacled langur (*Trachypithecus obscurus*). These two species are so similar in appearance that their taxonomic relationship is still disputed and they are sometimes treated as subspecies rather than as distinct species (DAVIES & OATES, 1994).

Within the Mai Sot Yai primate community, the Phayre's langur is probably the most abundant species (23–38 individuals/km^2). Early reports for Thailand suggested densities ranging from 2–7 individuals/km^2 (FOODEN, 1971) up to 65 individuals/km^2 (UICHAROENSAK, 1993). An even higher density, (117 individuals/km^2; GUPTA & KUMAR, 1994) was found at Tripura, northeast India. These extremes might in part be due to differences in sampling methods and emphasize the importance of standardizing methods. Likewise, spectacled langurs are reported to occur at varying densities between 31 individuals

(MACKINNON & MACKINNON, 1980) and about 80/km^2 (CURTIN & CHIVERS, 1978). The mean group size for Phayre's langurs at Mai Sot Yai is about 6.7–10.8 individuals conforming to earlier reports for Thailand (12.9 FOODEN, 1971; 13 UICHAROENSAK, 1993) although a mean of 20 individuals was determined for Huai Kha Khaeng Wildlife Sanctuary (BHUMPAKPHAN, 1988). The Phayre's langur groups observed at Tripura had an intermediate group size (15.4 individuals, range 12–18; GUPTA & KUMAR, 1994). Spectacled langur groups have a reported size of 10.3 (MACKINNON & MACKINNON, 1978), 14.0 (range 10–17; RAEMAEKERS & CHIVERS, 1980) and 17.0 individuals (CURTIN, 1980), a range matching the estimates for Mai Sot Yai. The same holds true for group density. It is 3.4 groups/km^2 at our site and 3 or 4 for spectacled langurs (MACKINNON & MACKINNON, 1978; RAEMAEKERS & CHIVERS, 1980). Only the Phayre's langurs in the secondary forest at Tripura had a group density that was twice as high (7.6 groups/km^2; GUPTA & KUMAR, 1994). Overall, the data for spectacled langurs in primary forests closely fit the conditions found at Mai Sot Yai. In contrast, for reasons still unclear the conditions are strikingly different in secondary habitats indicating that this species seems to be able to reoccupy disturbed habitats quickly and to reach an astounding density (GUPTA & CHIVERS, 1999).

Macaques

The results for macaques at Mai Sot Yai are only preliminary and for none of the four species are extensive data for wild, un-provisioned groups available. For pig-tailed macaques in a primary forest in Malaysia population density across habitats is estimated to be 17.9 individuals/km^2 (CROCKETT & WILSON, 1980). It is very likely that their density in the dry evergreen forest of Phu Khieo Wildlife Sanctuary is much lower. Generally, pig-tailed macaques have been difficult study animals, shy and almost impossible to habituate, which is probably why the data available for mean group sizes range from 18.3 (CROCKETT & WILSON, 1980) to 24 (CALDECOTT *ET AL.*, 1996) or 42–47 (BERNSTEIN, 1967) or up to 68 (OI, 1996). Groups at Mai Sot Yai are probably smaller (7.7–22.7 individuals) but apart from transect walks, large groups of up to 100 individuals have been encountered. However, these might have been large aggregations containing several distinct social groups, a pattern previously described for pig-tailed macaques (CALDECOTT *ET AL.*, 1996).

Rhesus macaques have rarely been observed in undisturbed areas probably because they are reported to prefer disturbed habitats and the plant species associated with those sites (GOLDSTEIN & RICHARD, 1989). In an extremely arid area within the vicinity of human settlements, SOUTHWICK *ET AL.* (1996) found a population density of 7.2 rhesus/km^2. Mean group sizes for wild groups range from 28 to 50 individuals (CALDECOTT, 1986; see also MELNICK & PEARL, 1987) which is markedly larger than the values estimated for Mai Sot Yai (12.5–26.5).

Almost no data are available for wild Assamese and stump-tailed macaques although FOODEN (1971) reports a mean group size of 21.8 individuals for Assamese macaques in western Thailand. This figure fits the conditions assumed for Mai Sot Yai. Future research is needed to assess the basic population characteristics of all four macaque species.

Solitary Individuals

Solitary individuals were regularly encountered only in one primate species, the white-handed gibbon (Table 2). Because we might have overlooked additional conspecifics the number of actual solitary animals might in fact be smaller and consequently the number of groups slightly higher. As it stands, there seem to be one extra-group individual/km^2 and thus per 2.6 groups. Unfortunately, it is rather difficult to determine the sex of white-handed gibbons and even more so during the brief contacts on the transect. Thus, it is not clear whether these solitary animals are mainly males or females. Only one solitary Phayre's langur was encountered and no all-male bands (i.e. groups composed only of males). This conforms to reports for spectacled langurs (CURTIN, 1980), although it is not yet clear whether or not this species forms all-male bands.

The Primate Community

For Thailand we know of only one investigation encompassing several macaque species conducted at Huai Kha Khaeng Wildlife Sanctuary. Species abundance is ranked with Assamese macaques as most abundant followed by rhesus macaques, pig-tailed macaques and stump-tailed macaques (EUDEY, 1980). A later analysis specifies pig-tailed macaques as most abundant then Assamese macaques and lastly rhesus and stump-tailed macaques (EUDEY, 1991). Interestingly, pig-tailed macaques are generally believed to be the most abundant macaque species at the Phu Khieo Wildlife Sanctuary as well, followed by rhesus, stump-tailed and Assamese macaques (KUMSUK *ET AL.*, 1999). Our present analysis indicates a higher density of rhesus macaques and Assamese macaques (Table 2) but it is confined to the dry evergreen forest and might not be representative of other habitat types. In general, within a primate community species densities will depend on habitat type, human impact, seasonality (especially of precipitation), resource density, and resource abundance (MARSH & WILSON, 1981; BENNETT & DAVIES, 1994). Most of these factors still have to be investigated at Phu Khieo Wildlife Sanctuary.

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