

**BEHAVIORAL COMPARISON OF DUSKY LEAF MONKEY
(*PRESBYTIS OBSCURA*) ON ISLAND HABITAT AND UNDISTURBED
HABITAT OF KHLONG SAENG WILDLIFE SANCTUARY,
SURATTHANI PROVINCE**

*Sawai Wanghonsa**

A B S T R A C T

A non-human primate census was undertaken during February to March 1988 on islands in the new reservoir of the Chiew Larn Multipurpose Dam, Suratthani Province. Two census methods were utilized: a total count for islands with area less than 1 km², and the line transect method for islands greater than 1 km². Thirty-nine out of 106 small islands were occupied by primates, including 227 dusky leaf monkeys (*Presbytis obscura*), 1 banded leaf monkey (*Presbytis melalophos*), 18 white-handed gibbons (*Hylobates lar*) and 1 slow loris (*Nycticebus coucang*). The density of dusky leaf monkeys on the 6 large islands was calculated as 25.1/km² by Haynes' method, 45.5/km² by King's method and 42.6/km² by Webb's method. A total of 6 groups of white-handed gibbons was found on 3 out of the 6 large islands.

A behavioral study of dusky leaf monkey was undertaken during 0700-1800 h in May 1988 on an island and at a mainland site in Khlong Saeng Wildlife Sanctuary, using the focal sampling method. The time budgets of the two groups were found to be different. The island group spent more time sitting and feeding whereas the mainland group spent more time resting, moving, scratching, eliminating and socializing. The island group spent more time in the upper canopy layer than the mainland group. Both groups were found to prefer fruits more than young leaves.

I N T R O D U C T I O N

The dense primary tropical rain forest of Khlong Phra Saeng basin was decreed for protection as Khlong Saeng Wildlife Sanctuary in 1974, with a total area of 1155.3 km². The adjacent basin, "Khlong Phra Sok", was decreed as Khao Sok National Park in 1980, with a total area of 645.5 km². Both protected areas, in Suratthani Province, southern Thailand, have a very diverse flora and fauna, and endangered species such as Sumatran rhinoceros (*Dicerorhinus sumatraensis*), tapir (*Tapirus indicus*), serow (*Capricornus sumatraensis*) and others occur there.

In 1982 the Electricity Generating Authority of Thailand (EGAT) launched a project, the Chiew Larn Multipurpose Dam, in both protected areas. The resulting reservoir would flood a total area of lowland rain forest of 185 km² up to 95 m above

* Technical Section, Wildlife Conservation Division, Royal Forest Department, Bangkok 10900.

mean sea level. All commercial trees in the area to be inundated were logged out between 1982 and 1989.

The Wildlife Conservation Division, by order of the Cabinet through the National Socio-Economic Development Council, launched the project "A survey for forest improvement and management in Khlong Saeng Watershed Area, Chiew Larn Project in Suratthani Province," funded by EGAT, before the water was impounded. This project revealed that there were 237 wild animal species inhabiting the area, comprising 28 species of reptiles and amphibians, 47 species of mammals and 162 species of birds (NAKHASATHIEN, 1984). A "Wildlife rescue operation," funded by EGAT, was scheduled during and after water impoundment. In the project, 116 species with a total of 1,364 individuals, including 37 species of mammals, 30 species of birds and 49 species of reptiles and amphibians were rescued from doomed habitat and relocated to an area above 100 m in elevation on the mainland (NAKHASATHIEN, et al., 1987).

Seven species of non-human primates with a total of 161 individuals were rescued from the islands or the reservoir. Of these, 115 individuals were dusky leaf monkey (*Presbytis obscura*). These were apparently starving, as the average weight of rescued *P. obscura* was 5.53 kg (8 adult females and 16 adult males were weighed). LEKAGUL & MCNEELY (1977) give the weight of this species as 6-9 kg.

P. obscura has been observed to have an average group size of 17 individuals in the Krau Game Reserve at Kuala Lompat, Malaysia, by CURTIN (1980). These groups fragmented into small subgroups to feed which rendered it less necessary to travel far each day (CURTIN, 1980). They spent much more time in the upper layers of the forest (above 80 feet) (CURTIN, 1980; MACKINNON & MACKINNON, 1980) and used large firm branches for support (FLEAGLE, 1980). LEKAGUL & MCNEELY (1977) report that dusky langurs feed on about 2 kg of leaves and buds per day. CURTIN's feeding observations indicate that the diet of *P. obscura* consists of leaves (58%), fruits (32%), flowers (7%) and seeds and beans (3%). The data of MACKINNON & MACKINNON (1978) indicate slightly more frugivory: fruits (55.9%), leaves (37.9%) and flowers (6.2%). No insects have been reported in the diet, and the animals never descend to the ground to forage.

As a result of the Multipurpose Hydro-electric Project, the following activities have been continuing in the reservoir area:

1. Logging: A concession has been being permitted since 1982 and it will be valid until April of 1989.
2. Fishing: Since inundation began in April 1987, numerous fish species have been introduced by the Fisheries Department. Fishing activities are concentrated in the upper part of the reservoir.
3. Tourism: Many people visit the reservoir, mostly on weekends and in the non-monsoon season. Some travel by boat to observe the scenery.
4. Enforcement: Three ranger stations in the sanctuary and one in the national park have been established.

The main objective of this study was to compare the behavior of *P. obscura* in island habitat with that in undisturbed mainland habitat in Khlong Saeng Wildlife Sanctuary in order to evaluate the effect of the reservoir on the primate population and to produce management recommendations. Specifically, the study sought to find out the following:

- (1) the size of the population of *P. obscura* on the island;
- (2) the use of different levels of the forest canopy in both habitats;
- (3) the activity budget and diet in both island and mainland habitats.

STUDY SITE

The study was conducted at the reservoir of the Chiew Larn Multipurpose Dam, Suratthani Province, 780 km from Bangkok, situated on the boundary of Khlong Saeng Wildlife Sanctuary and Khao Sok National Park. The climate of Khlong Saeng basin is tropical monsoonal, being characterized by rather high temperature and humidity all year round and markedly seasonal distribution of abundant rainfall. It is influenced by two monsoons, namely the southwest and the northeast monsoons. The southwest monsoon, with warm and humid wind, occurs in mid-May to September, and brings cloudiness and rainfall. The northeast monsoon brings cool and dry wind in November to mid-March, and causes cloudiness and rains in a relatively narrow band along the coast of the Gulf. Aside from the monsoon, tropical storms and depressions occasionally move across the Peninsula, bringing high rainfall during October to December. Local convective rains of high intensity but short duration occasionally occur in the dry season, December to April (EGAT, 1980). The average (1983-1987) daily maximum temperature ranged from 30.5°C in April to 36.2°C in December and average (1983-1987) daily minimum temperature ranged from 22.3°C in May to 18.4°C in December. The average (1983-1987) yearly rainfall was 162 days with 1,852 mm. The average (1983-1987) monthly rainfall ranged from 17.5 mm in January to 326 mm in August. The average (1983-1987) number of rainy days ranged from 4 in February and April to 20 in May, June and October. Between April 1987 and May 1988, water was impounded up to 73.50 m msl.

The reservoir area can be sub-divided into 3 parts according to slash and burn activity. In the lower part, the entire area was deforested and burned up to an altitude 98.5 m msl. In the central part about 44% was slashed and burned up to altitude 40 m msl. The upper part has not been cut and burned (Figure 1).

METHODS

Censusing

The study was carried out from February to March 1988. Censusing was carried out during morning from 0800 to 1130 h and the afternoon from 1400 to 1700

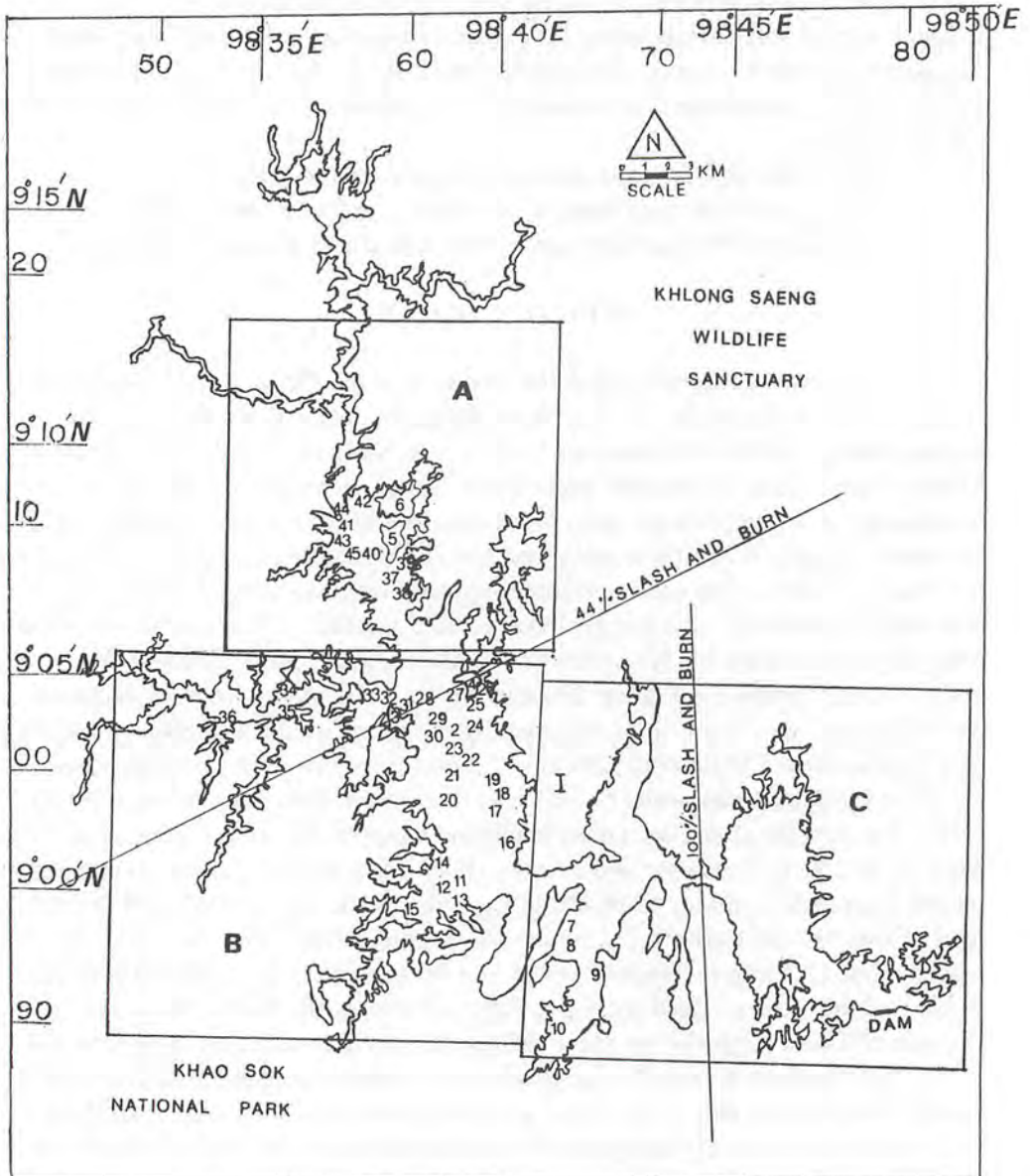


Figure 1. Map of Chiew Larn reservoir. Numbers indicate island number. I and island No.17 were behavioral study sites. The three boxed areas are shown enlarged in Figures 2–4. Figures 1–4 are redrawn from 1–RTSD, Series L 7017 1:50,000 Sheets No. 4727 II–IV and 4726 I & IV. Every 10th 1,000-m grid line and latitude and longitude are shown in upper and left margins.

h. Censusing was suspended during rain.

Two censusing methods were utilized to secure the data in this study, as follows.

Total count method. On the 106 small islands (area less than 1 km²), primates were detected and individually counted.

Line transect method. This method was used for all 6 islands with area greater than 1 km². An existing logging road or former permanent trail was selected as a transect line. Along the line, langurs were detected and the following information was recorded: distance at sighting point on the line, sighting distance, sighting angle and number of animals. A compass was employed to measure the sighting angle. Pacing was employed to estimate distances.

Likewise, a line transect was employed to census gibbons. To determine the gibbon population, it was assumed that each sighting from the line represented a group with an average of 3.4 individuals (VAN LAVIEREN, 1982)

The density of animals (D) was computed from the line transect data in several ways, as follows (n = number of observations, L = transect length, r = sighting distance, \bar{W} = mean perpendicular distance, θ = sighting angle):

(1) Haynes' method:

$$D = \frac{n}{2L \left(\frac{1}{n} \sum_{i=1}^n \frac{1}{r_i} \right)}$$

(2) King's method:

$$D = \frac{n}{2L\bar{w}}$$

(3) Webb's method:

$$D = \frac{n}{2L\bar{r} \sin \bar{\theta}}, \quad \bar{r} \sin \bar{\theta} = \left(\frac{1}{n} \sum_{i=1}^n r_i \right) \left(\frac{1}{n} \sin \sum_{i=1}^n \theta_i \right)$$

Behavior Study

Undisturbed habitat. The study was carried out from May 1, 1988, to May 12, 1988. The observation period was between 0700 and 1700 h of a group of 15 individuals including one brown infant.

Prior to observation, all behaviors were classified into the following major activity patterns:

- (1) Resting: inactivity after exertion such as sitting with eyes closed or lying down, as well as self-grooming.
- (2) Sitting: resting on the ischial callosities.
- (3) Affiliations: willingly associating with one other such as grooming, playing.

- (4) Aggression: acts of hostility or offense such as chasing, threatening.
- (5) Scratching: scraping gently with fingernail.
- (6) Eliminating: defecating and urinating.
- (7) Moving: changing place or posture such as walking, running leaping, climbing.
- (8) Feeding: putting food in mouth, chewing.
- (9) Other: activities that do not fall into the above categories such as yawning, genitalia playing, mouth cleaning.

The focal sampling method, using a 10 minute sampling period and 5 minute interval, was employed to secure the data on time spent in various activities. Using this method, a visible individual was watched through 7×50 binoculars or a 20 × telescope with tripod for 10 minutes. Five minutes then elapsed before another individual was observed. Duration of activities was noted in seconds and height above the ground was scored as 1, upper layer (above 25 m); 2, middle layer (8 – 25 m); and 3, lower layer (below 8 m). The next period was repeated with the next visible individual. The sampling was suspended when (1) the study individual disappeared from sight; (2) the observer was spotted by the animals; or (3) rain fell.

Island habitat. This part of the study was carried out from May 16 to May 27, 1988. The observation period was between 0700 and 1800 h. A group of 4 individuals (1 subadult female, 1 adult male, 1 subadult male and 1 juvenile male) was studied on island No. 17.

Prior to observation, a 110×100×150 cm blind with a small portion open on 5 sides, was set up at the center of the island 7 days before starting the observations. The focal sampling method was employed as described for the undisturbed habitat.

RESULTS

Censusing

Four non-human primate species were found inhabiting the island: dusky leaf monkey (*Presbytis obscura*), banded leaf monkey (*Presbytis melalophos*), slow loris (*Nycticebus coucang*) and white-handed gibbon (*Hylobates lar*). Only the gibbon does not swim. No primate was encountered swimming in the reservoir, but 2 species, stump-tailed macaque (*Macaca arctoides*) and crab-eating macaque (*Macaca fascicularis*) were captured when they tried to swim across the reservoir to escape from humans. Slow loris was spotted by flashlight during the behavioral study on the island.

Of the 106 small islands censused, 39 were occupied by at least one species of non-human primate, including 227 dusky leaf monkeys, 18 white-handed gibbons, 1 banded leaf monkey and 1 slow loris. Of these, 16 dusky leaf monkeys and 2 white-handed gibbons were found in flooding habitat (altitude between 60 – 80 m) (Table 1 and Figures 1 – 4).

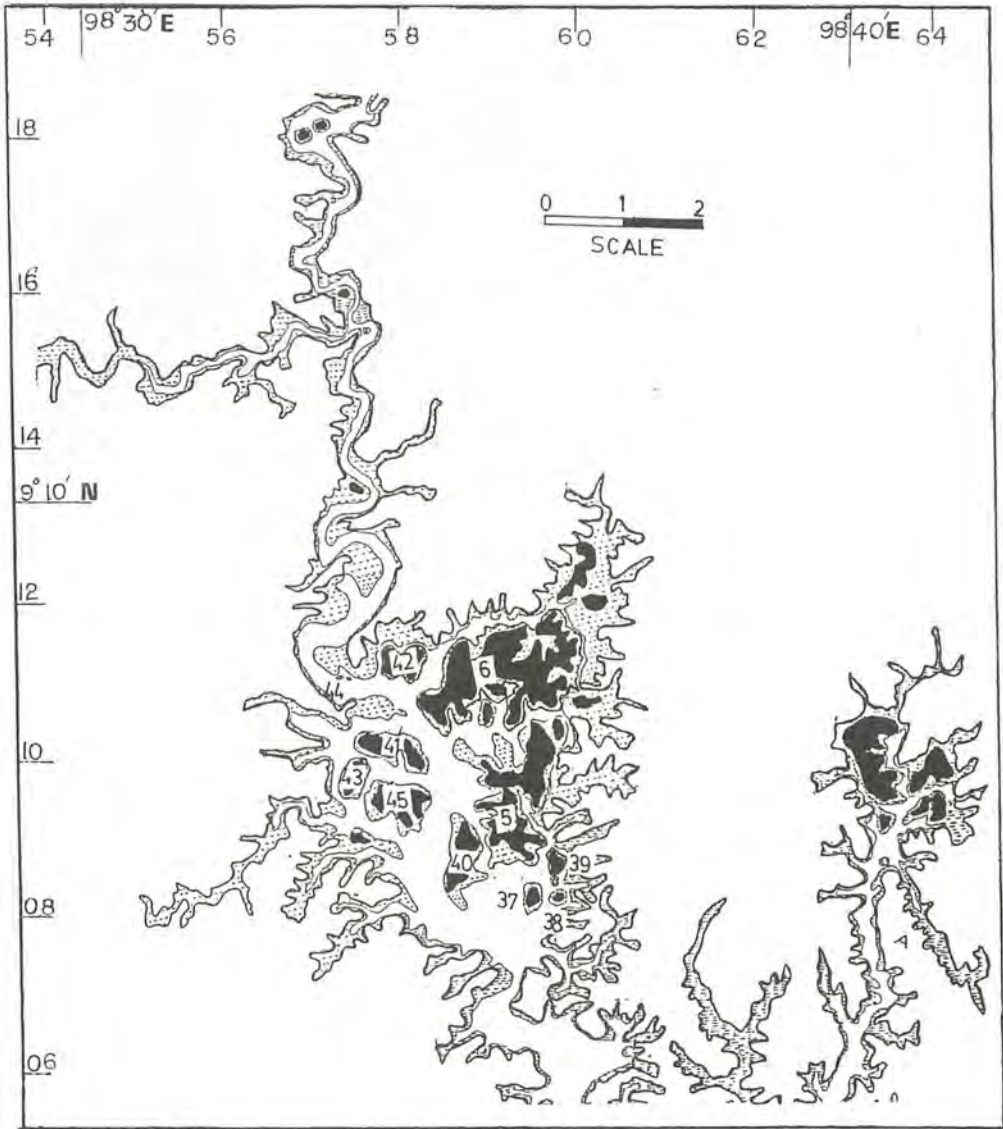


Figure 2. Enlargement area A in Figure 1. Striped areas represent portions below 95 msl flooded subsequent to the survey by rising water; darkened island areas represent final areas above 95 m.

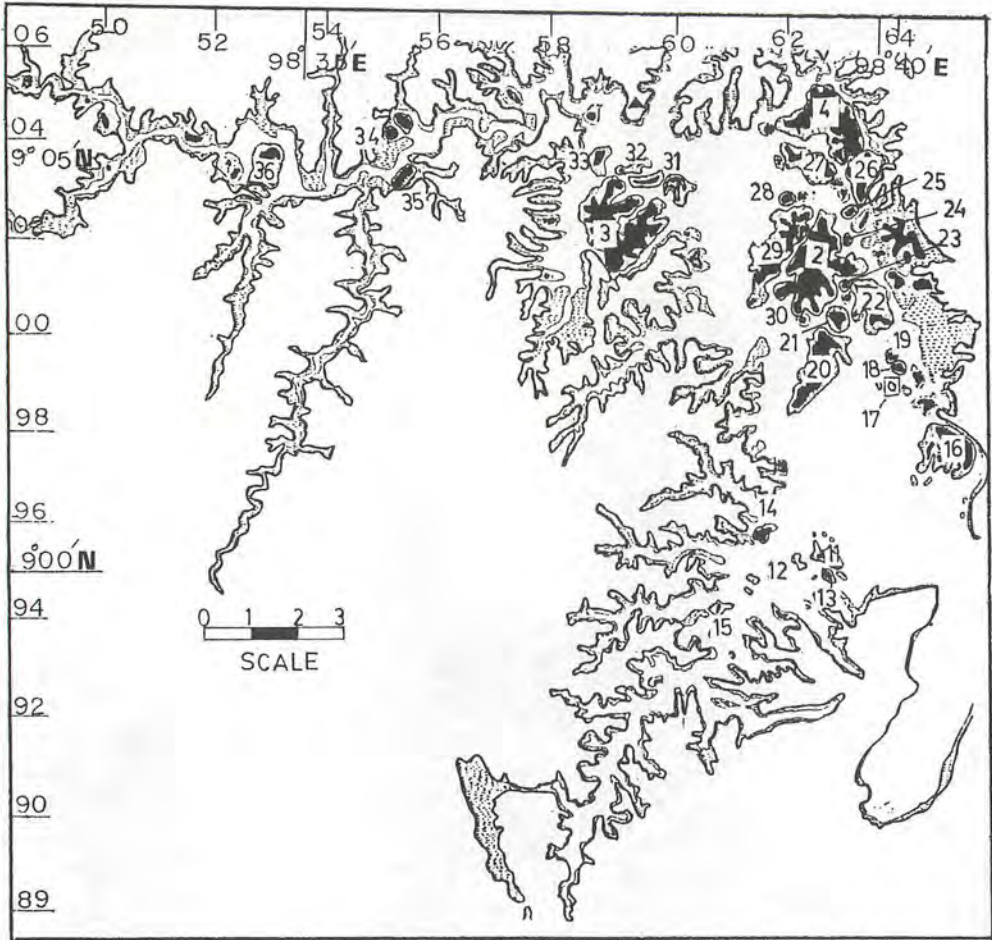


Figure 3. Enlargement of area B in Figure 1. Stripped areas represent portions below 95 msl flooded subsequent to the survey by rising water; darkened island areas represent final areas above 95 m.

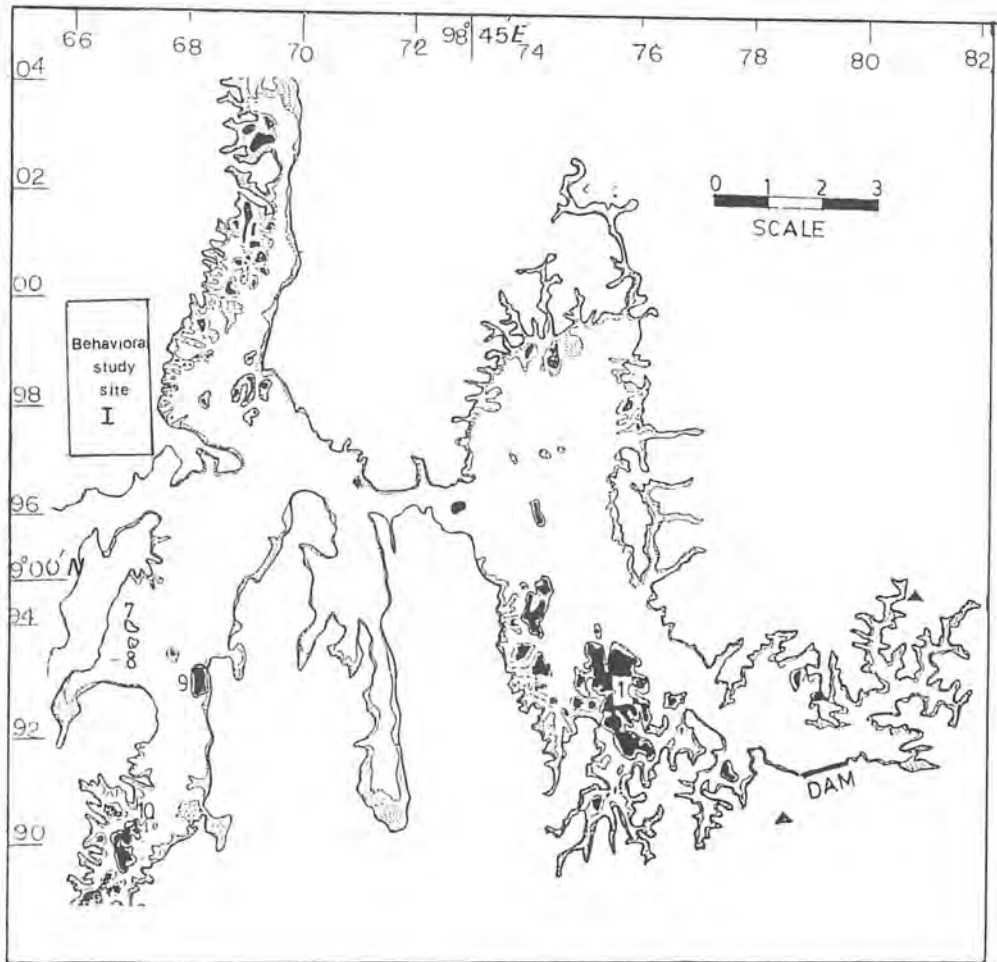


Figure 4. Enlargement of area C in Figure 1. Stripped areas represent portions below 95 m msl flooded subsequent to the survey by rising water; darkened island areas represent final areas above 95 m.

Table 1. Summary of primate observations on islands in Feb.-Mar. 1988. H = *Hylobates lar*, Po = *Presbytis obscura*, Pm = *Presbytis melalophos*.

Island No.	Area during survey (ha)	Final area (ha)	Highest elevation (msl)	Transect length (m)	Primates seen		
					H	Po	Pm
1	182.5	170.0	182	2266	2	4	
2	122.5	89.0	180-200	2848	9	8	
3	147.5	98.0	160-180	3077		3	
4	111.5	75.0	188	3108		6	
5	125.5	78.0	180-200	3482		4	
6	190.0	132.0	200-220	3031	4	2	
7	5.0	—	60-80	—		8	
8	3.75	—	60-80	—		2	
9	17.0	12.0	240-260	—		6	
10	36.75	23.75	147	—		11	
11	14.25	9.25	130	—		2	
12	4.75	—	60-80	—		4	
13	4.25	2.25	120-140	—		3	
14	9.0	3.5	100-120	—		1	
15	7.25	1.25	100-120	—		5	
16	63.0	28.0	140-160	—		13	
17	25.0	—	60-80	—		4	
18	6.0	3.0	100-120	—		7	
19	5.25	2.5	100-120	—		5	
20	79.0	40.0	173	—	2	19	
21	15.0	7.0	120-140	—		2	
22	50.0	23.0	120-140	—		10	1
23	3.75	1.5	100-120	—		2	
24	3.25	2.0	100-120	—		3	
25	6.0	2.75	100-120	—		3	
26	36.0	24.0	120-140	—		10	
27	39.0	19.0	120-140	—		6	
28	6.25	3.5	100-120	—	1	2	
29	91.0	41.0	140-160	—	7		
30	8.5	1.5	120-140	—	2	9	
31	12.25	4.5	100-120	—	4	3	
32	10.75	2.0	100-120	—		4	
33	12.75	4.75	100-120	—		7	
34	5.5	4.0	100-120	—		2	
35	10.5	6.0	140-160	—		7	
36	42.0	23.0	157	—		5	
37	9.5	4.25	100-120	—		6	
38	5.0	2.25	100-120	—		2	
39	7.0	5.75	100-120	—		5	
40	41.0	24.0	159	—		15	
41	32.5	17.0	140-160	—		8	
42	22.25	18.75	120-140	—		5	
43	16.0	6.25	100-120	—		4	
44	0.75	—	60-80	—	2		
45	43.0	21.0	125	—		17	
Total	1689.25	1036.25	—	17812	18	227	1

Six islands with area greater than 1 km² were censused by line transect. Two species, *P. obscura* and *Hylobates lar*, were found (Tables 2a and 2b). The observations for these islands were pooled and a single estimate of *P. obscura* density was made for all large islands. The dusky leaf monkey population on the 6 large islands was 25.1 individuals per km² by Haynes' method, 42.6 individuals per km² by Webb's method and 45.5 individuals per km² by King's method. The total area of the 6 islands was 8.79 km².

White-handed gibbons were found on 3 islands. Island no. 1 had one group of 4 individuals. On island No. 2 gibbons were observed four times, and 3 groups (11 individuals) were found to be present. Island No. 6 had 2 groups (7 individuals). Hence, the total white-handed gibbon population on the 6 largest islands was 22 individuals.

Behavior of *P. obscura*

Mainland habitat

P. obscura was active from dawn to dusk. The time budget over the period of study is shown in Table 3. Over an average day, time spent in various activities was 25.5% feeding, 21.9% resting, 7.7% moving, 39.8% sitting, 0.12% eliminating, 1.4% scratching, 3.5% social interaction and 0.04% other activity. Feeding behavior peaked at 0700-0800 h and 1500-1700 h; moving mostly occurred at 0700-0900 h and 1500-1700 h; resting mostly occurred at 1100-1399 h; sitting mostly occurred at 0900-1100 h and 1300-1500 h; affiliation mostly occurred at 0800-0900 h; eliminating, scratching and aggression mostly occurred at 1000-1100 h.

Feeding analysis showed that *P. obscura* preferred fruits over young leaves, 60% against 40%.

Interspecific relations. *P. obscura* shared food plants with black giant squirrels (*Ratufa bicolor*), gray-bellied squirrels (*Callosciurus caniceps*), white-handed gibbons (*Hylobates lar*) and great hornbills (*Buceros bicornis*) and feeding overlapped with the more nimble congener, banded leaf monkey (*P. melalophos*). These animals played an important role in warning one another of any unusual happening. On the other hand, the study group was chased away twice by the troop of approximately 30 stump-tailed macaques (*Macaca arctoides*) which roamed around the area.

Canopy use. They spent 85.4% of the day in the upper layer of canopy, mostly during 1200-1200 h, and 14.6% in the middle layer, mostly during 1500-1600 h. Activities in lower layers were not seen (Table 5). In the canopy the monkeys preferred boughs and large branches as supports over small branches.

Table 2. Raw Data of line transect census on 6 large islands.

(a) *Presbytis obscura*

Island No.	Obs No.	No. of animals	Perpen. distance	Sighting distance	Sighting angle	Distance on transect
1	1	3	38.97	45	60	1116
	2	1	14.77	15	80	1434
2	1	2	10.0	20	30	139
	2	3	15.64	37	25	240
	3	1	11.82	12	80	616
	4	2	29.70	42	45	1168
3	1	1	12.04	21	35	570
	2	2	12.26	16	50	919
4	1	3	16.06	28	35	830
	2	2	8.54	33	15	1124
	3	1	34.47	35	80	2546
5	1	3	4.34	25	10	2110
	2	1	21.12	50	25	3051
6	1	2	4.92	19	15	637

(b) *Hylobates lar*

Island No.	Obs. No.	No. of animals	Perpen. distance	Sighting distance	Sighting angle	Distance on transect
1	1	2	10.0	20	30	608
2	1	1	19.92	23	60	909
	2	2	10.0	20	30	1396
	3	1	5.13	15	20	1465
	4	5	7.88	8	80	2422
6	1	2	3.47	20	11	569
	2	2	28.29	40	45	862

Island habitat

The time budget over the period of study is shown in Table 4. The time budget for an entire day was 31.4% feeding, 21.7% resting, 0.74% moving, 42.9% sitting, 0.01% eliminating, 1.0% scratching, 2.0% social interaction and 0.12% other activity. Feeding behavior peaked at 0800–0900 h and 1500–1700 h; resting mostly occurred during 1000–1400 h; moving mostly occurred at 1500–1700 h; sitting mostly at 0900–1100 h and 1300–1500 h; eliminating at 1300–1400 h; scratching at 1200–1400 h and affiliating at 1100–1200 h. No aggression was observed.

Feeding proportions were fruits (94.7%), young leaves (0.1%) and mature leaves (0.2%). The group spent almost all of its time in the crown of a large *Ficus chartacea* tree in the middle of the island.

Canopy use

The animals spent 97.3% in the upper layer, 2.4% in the middle layer and 0.3% in the lower layer of the canopy (Table 5). They spent almost of all their time on small boughs and often rested in their feeding location. They were not seen on the ground during the period of study, but during the wildlife rescue operation, some *P. obscura* learned to escape detection by the team by running on the ground and hiding. On one occasion, they were seen feeding on bamboo shoots.

Comparison between habitats

Figure 6 summarizes the time budgets of both habitats. The group in the mainland habitat spent more time moving, eliminating, resting, socializing and scratching whereas the island group spent more time in feeding, sitting and other activities.

The sitting budget (Figure 7a) differed somewhat between habitats, but both habitats showed peaks during 1000–1100 h and 1300–1400 h.

The feeding budget (Figure 7b) in the two habitats is different. Feeding in the mainland group was greater than in the island group in early morning and late afternoon, whereas the island group fed more during late morning. Both mainland and island groups preferred fruits more than young leaves (Tables 3 and 4).

Figure 7c shows that the island group rested some during all hours, whereas the mainland group showed peaks of resting in morning and at mid-day, and did not rest in early morning and late afternoon.

The mainland group moved more than the island group (Figure 7d). Moving of the mainland group obviously fluctuated whereas in the island group, it was lower and more steady.

Social behavior (Figure 7e) differed between habitats. In early morning and post-noon, social activity of the mainland group was greater than the island group

Table 3. A contingency table of time budget of *P. obscura* on mainland habitat. Numbers indicate percentage of observation time in each hour devoted to each activity.

Time	Feeding		Resting	Self-groom	Moving	Sitting	Eliminating		Scratching	Social behavior		Other	Total	Frequency observation (min.)
	Fruit	Young leaves					defec	urin.		affiliation	aggression			
0700–0800	62.35	6.66	0	0	17.27	12.97	0	0	0.44	0	0.3	0	100	$N_1 = 90.03$
0800–0900	0	2.03	35.53	1.68	14.90	28.49	0	0	2.44	14.74	0.19	0	100	$N_2 = 80.98$
0900–1000	0	13.37	33.25	0	2.01	45.14	0	0.16	0.66	5.13	0.28	0	100	$N_3 = 111.27$
1000–1100	0	0	15.53	0	11.45	66.63	0	0.61	3.53	1.34	0.91	0	100	$N_4 = 90.32$
1100–1200	0	9.3	45.09	0	2.14	36.39	0	0	0.32	6.53	0	0.24	100	$N_5 = 117.97$
1200–1300	0	6.98	63.09	0	0.96	27.60	0	0	0.59	0.78	0	0	100	$N_6 = 123.58$
1300–1400	0	15.89	11.56	0	5.90	60.61	0	0	1.78	4.14	0	0.12	100	$N_7 = 115.6$
1400–1500	27.24	6.63	9.47	0	0.80	54.86	0	0.38	0.62	0	0	100	$N_8 = 74.93$	
1500–1600	0	41.37	3.78	0	10.57	41.64	0	0	2.64	0	0	100	$N_9 = 68.9$	
1600–1700	63.04	0	0	0	11.38	23.64	0	0	1.05	0	0.86	0	100	$N_{10} = 53.97$
Total	152.63	102.2	217.3	1.68	77.38	397.97	0	1.15	14.06	32.66	2.54	0.36	1000	—
percent	15.26	10.22	21.73	0.17	7.74	39.80	0	0.12	1.41	3.27	0.25	0.04	100	—

Table 4. A contingency table of time budget of *P. obscura* on island habitat. Numbers indicate percentage of observation time in each hour devoted to each activity.

Time	Feeding			Resting	Self-groom	Mov-ing	Sitting	Eliminating		Scratch-ing	Social behavior		Other	Total	Frequency observation (min.)
	Fruit	Young leaves	Mature leaves					defec.	urin.		affili-ation	aggres-sion			
0700-0800	35.26	0	0.18	20.14	0.14	0.61	42.88	0	0	0.61	0	0	0.08	100	N ₁ = 180.82
0800-0900	44.02	0	0.03	25.61	1.06	0.88	27.26	0	0	0.81	0.32	0	0.02	100	N ₂ = 156.10
0900-1000	30.83	0	0	19.43	0	0.51	46.51	0.04	0	0.73	1.86	0	0.08	100	N ₃ = 178.75
1000-1100	19.37	0	0.16	26.75	0	0.64	52.65	0	0	0.38	0	0	0.05	100	N ₄ = 158.40
1100-1200	17.78	0	0	26.52	0.96	0.92	39.26	0	0	1.39	13.05	0	0.13	100	N ₅ = 128.07
1200-1300	25.53	0.19	0	25.39	0.24	0.60	45.28	0.03	0	1.72	1.21	0	0.03	100	N ₆ = 177.68
1300-1400	11.75	0	0.03	29.80	0	0.47	56.15	0.07	0	1.57	0	0	0.16	100	N ₇ = 158.47
1400-1500	36.06	0	0	13.31	0	0.50	48.79	0	0	0.86	0.43	0	0.05	100	N ₈ = 136.33
1500-1600	48.32	0	0.20	13.82	0.31	1.12	31.41	0	0	1.37	3.26	0	0.19	100	N ₉ = 176.60
1600-1700	44.94	0	0	13.82	0	1.16	39.02	0	0	0.60	0	0	0.45	100	N ₁₀ = 165.90
1700-1800	67.78	0.19	0.31	2.49	0	1.67	24.32	0.15	0.36	1.26	0	0	0.96	100	N ₁₁ = 150.68
Total*	313.64	0.19	0.60	214.59	2.71	7.41	429.21	0.14	0	10.03	20.13	0	1.24	1000	—
Percent*	31.36	0.02	0.06	21.46	0.27	0.74	42.92	0.01	0	1.00	2.01	0	0.12	100	—

Excluded 1700-1800

Table 5. Canopy use of *P.obscura* on mainland habitat and island habitat. Numbers indicate percentage of observation time in each hour devoted to each canopy level.

Time	Mainland habitat			Island habitat		
	above 25 m	8–25 m	below 8 m	above 25 m	8–25 m	below 8 m
0700–0800	82.50	17.50	0	100	0	0
0800–0900	84.74	15.26	0	100	0	0
0900–1000	87.11	12.89	0	100	0	0
1000–1100	93.12	6.88	0	100	0	0
1100–1200	95.16	4.84	0	100	0	0
1200–1300	98.10	1.90	0	95.83	4.17	0
1300–1400	80.27	19.73	0	100	0	0
1400–1500	88.82	11.18	0	100	0	0
1500–1600	57.66	42.34	0	100	0	0
1600–1700	86.66	13.34	0	100	0	0
1700–1800	—	—	—	74.70	21.76	3.54
Total	854.14	145.86	0	1070.53	25.93	3.54
Percent	85.41	14.58	0	97.32	2.36	0.32

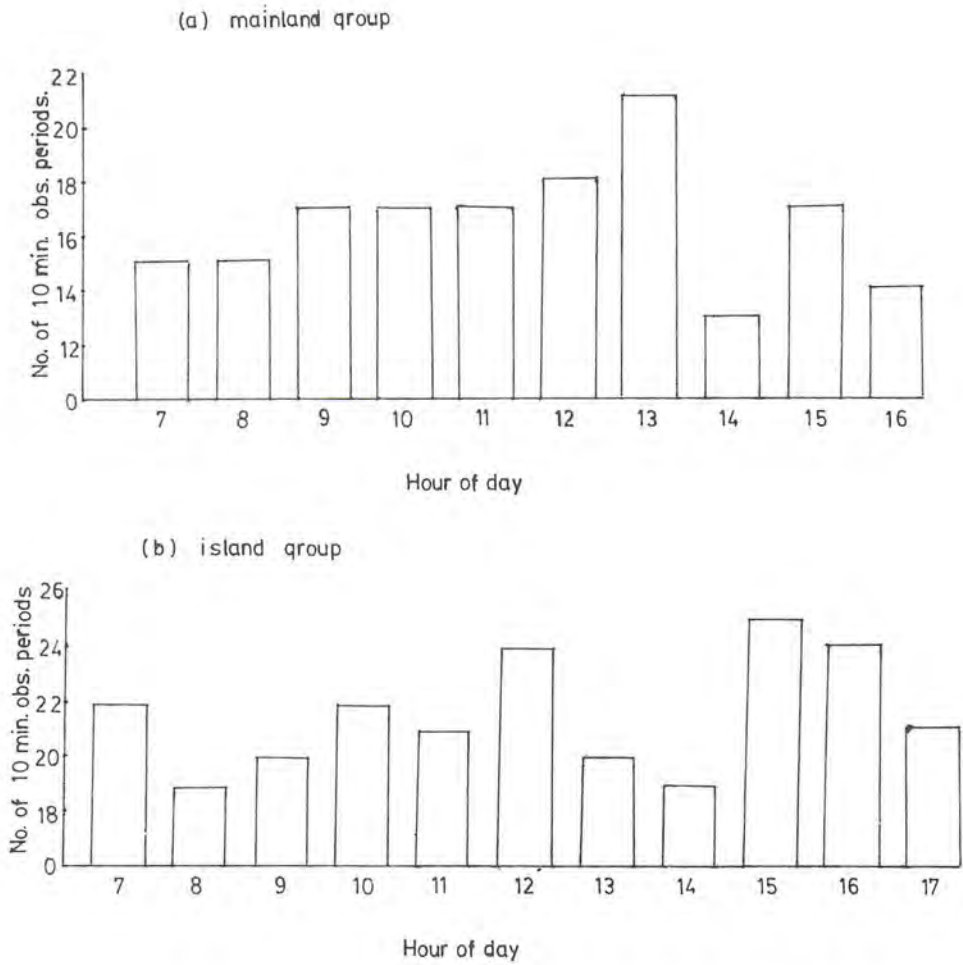


Figure 5. Total hourly number of observation periods for (a) mainland group; (b) island group.

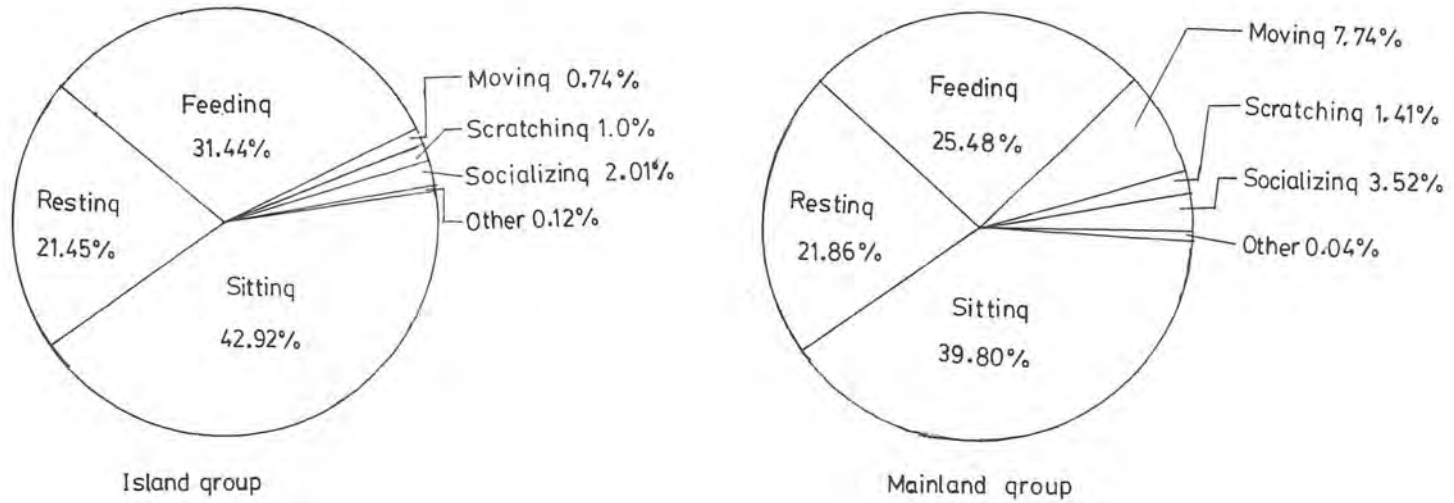


Figure 6. Comparison of time budget of *P. obscura* for island and mainland habitats.

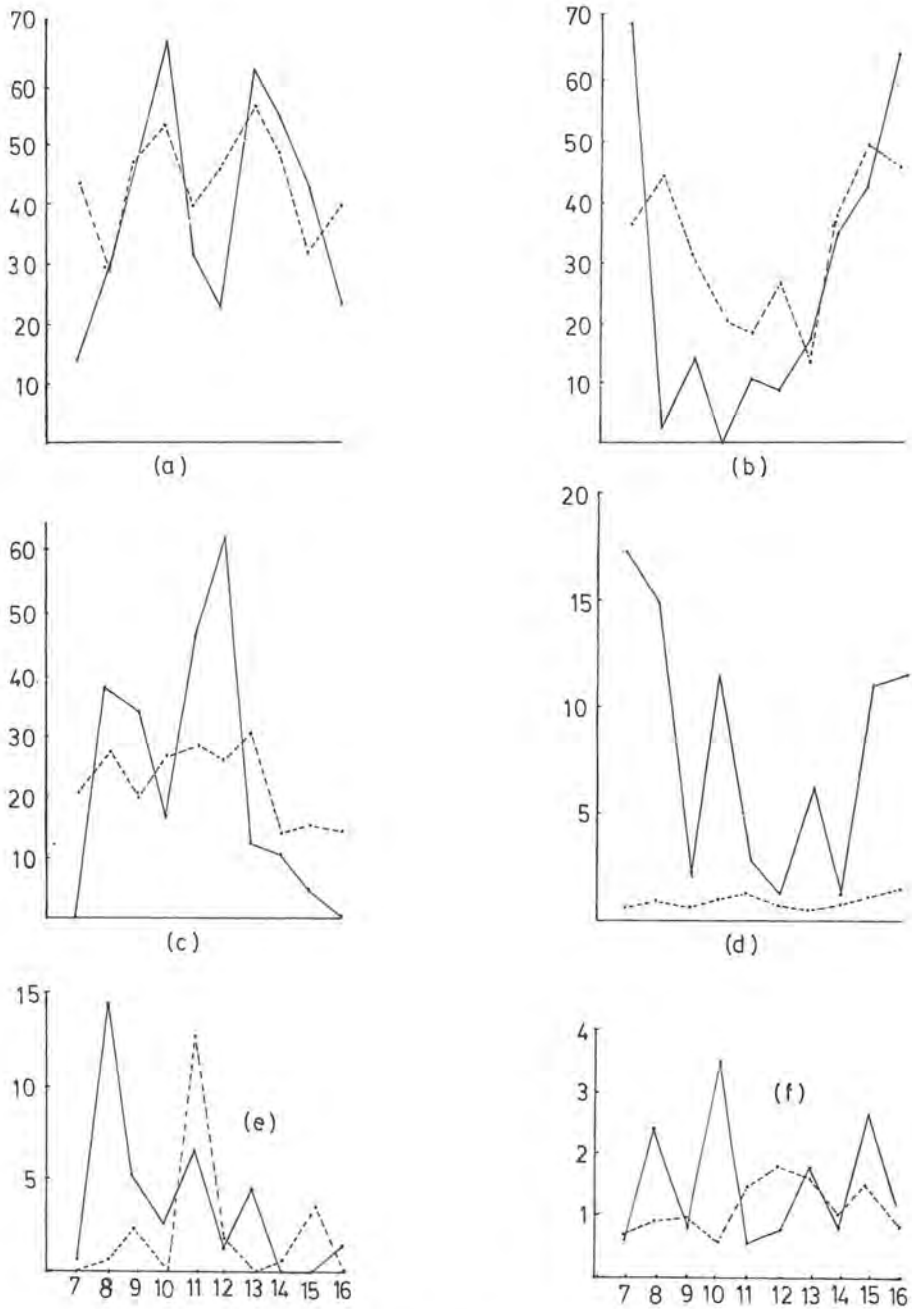


Figure 7. Percent of total activity in relation to time of day for (a) sitting, (b) feeding, (c) resting, (d) moving, (e) social behavior, (f) scratching.

—— Mainland group. - - - - - Island group.

whereas before noon and in late afternoon, the island group showed more of this activity. The peak social behavior times of mainland and island groups were 0800–0900 h and 1100–1200 h, respectively.

Scratching (Figure 7f) did not show any consistent difference, but this activity appeared to be more evenly distributed and less sporadic on the island. The peak scratching times of mainland and island groups were 1000–1100 h and 1200–1300 h, respectively.

DISCUSSION

MARSH & WILSON (1981) found that the density of *P. obscura* at Kuala Lompat, Malaysia, was 3.9 groups per km² (55 individuals per km²). Thus the island populations estimated by 3 methods in this investigation as 25 to 46 per km² on the 6 large islands may be lower. The limited area caused by rising water as well as disturbance due to previous logging and present human activities (tourism, fishing and poaching) may have resulted in low density. The animals also did not seem to go very near the edge of the islands, perhaps due to disturbance by man.

RAEMAEEKERS & CHIVERS (1980) stated that the banded leaf monkey group size in the Krau Game Reserve, Kuala Lompat, Malaysia, was 12 individuals. Only 1 banded leaf monkey was seen during my island survey. MACKINNON & MACKINNON (1980) wrote that in several competitive conflicts over feeding and sleeping positions, *Macaca fascicularis*, despite its smaller size, was able to oust the banded leaf monkey. NAKHASATHIEN (1984) noticed that *M. fascicularis* was abundant in the site during the ecological assessment prior to construction of the Khlong Saeng Hydro-power Plant, then it is possible that some *P. melalophos* groups were excluded by *M. fascicularis* during competitive conflicts between the two species. Moreover, the local people believe that *P. melalophos*' liver "liquor" serves as an aphrodisiac, because these langurs feed on a variety of leaves and fruits of medicinal plants, whose ingredients are stored in the liver. Thus poaching of banded leaf monkeys (*P. melalophos*) is high compared with other species.

Khlong Saeng Wildlife Sanctuary had moderate numbers of white-handed gibbons (NAKHASATHIEN, 1984). However, the lar gibbon was sighted on only 9 islands during the study period. Perhaps each island can be used as single group's home range, as the white-handed gibbon has been found to occupy a group range of 0.54 km² in Kuala Lompat, Malaysia (GITTINGS & RAEMAEEKERS, 1980). Usually gibbons do not survive in forests which are logged in Thailand as too few trees remain for free movement about their territories and poaching pressure is high in logging areas. As an area of approximately 185 km² was flooded due to the dam construction, it can be calculated that as many as 342 groups were eliminated or displaced.

The behavioral study showed that the activity budgets of *P. obscura* in two habitat types were different. The plant community on the island was secondary

whereas the mainland study area was primary forest. Most islands are situated in the valley between the high limestone mountain ridges, where wind is relatively strong. The island group was found to be more active in feeding, sitting and other activities, whereas the mainland group spent relatively more time in resting, moving, eliminating, scratching and socializing.

Groups in both habitats had feeding peaks in early morning and late afternoon. However, the mainland group had higher peaks in early morning and late afternoon, whereas the island group fed more evenly throughout the day. CHAUDHURI (1968) stated that the higher proportion of minerals and protein in the diet, the greater is the excretion of water in the form of urine. The mainland group was seen only urinating, whereas defecating was seen only in the island group. It is possible that nutrients in the island group's diet are less than in the mainland diet; consequently, the island group spent relatively more time feeding than the mainland group.

P. obscura in both habitats spent more time in feeding on fruits than on leaves. This is not in agreement with MACKINNON & MACKINNON (1978) and CURTIN (1980) who found that *P. obscura* consumed mostly leaves. Perhaps my observations were made during the season when fruits were most available and consumed with greater frequency.

Time spent in locomotion was obviously abnormally low on the island in comparison with the more natural mainland group. MACKINNON & MACKINNON (1980) found that *P. obscura* spent 20% or more of the day travelling. The mainland group in the study moved about 8% of the time and the island group about 1%. Both CURTIN (1980) and MACKINNON & MACKINNON (1980) found *P. obscura* to be highly dependent on upper canopy trees for feeding and the upper and middle canopy for travelling.

The social behavior turned out to be significantly different between habitats. Under natural conditions, mainland group members interacted more with each other than did the monkeys on the restricted island. The degree of interaction is also influenced by group size and composition and ecological factors. It should be noted that the island group was smaller than the mainland group, and may have been fragmented by the logging during dam construction. This would certainly affect their social interactions. The mainland area contained more appropriate ecological conditions and had less disturbance, and thus permitted more freedom of movement and easier foraging. The island group appeared to be confined to a canopy level above 25 m, whereas the mainland group was more active in the middle canopy and never reached the ground. This was due to the structure of the plant community on the island, which had secondary forest lacking a middle canopy but with a single emergent fig tree. Present human activities around the island scare the animals frequently and cause them to sit down and remain calm more than the mainland group.

CONCLUSIONS

1. Thirty-nine out of 106 islands surveyed with areas less than 1 km² were found to be inhabited by 227 dusky leaf monkeys, 18 white-handed gibbons, 1 slow loris and 1 banded leaf monkey.

2. Six islands with areas greater than 1 km² (total area 8.79 km²) were inhabited by dusky leaf monkeys, with an overall density estimated as 25.1/km² by Haynes' method, 45.5/km² by King's method and 42.6/km² by Webb's method.

3. Three out of 8 large islands were inhabited by an estimated 6 groups of white-handed gibbons with a total estimated number of 22 individuals.

4. A detailed study of the diet and activity budgets was made of the dusky leaf monkey (*P. obscura*) in the island and on the mainland. The island group was restricted by the available area and relatively reduced forest structure. The island group spent more time in feeding, sitting and other activities whereas the mainland group spent more time in resting, moving, scratching, eliminating and socializing.

5. The island group was more disturbed by human activities such as fishing, logging, tourism and poaching, and a lack of middle canopy forced them to spend much more time in an upper canopy (above 25 m) of a few large trees, *Ficus spp*, in the center of the island. The island group spent 97.3%, 2.4% and 0.3% of its time in upper, middle and lower layers, respectively, whereas the mainland group spent 85.4% and 14.6% in upper and middle layers, respectively.

6. The dietary proportions of the mainland group were 60.8% reproductive plant parts and 40.1% vegetative parts. Meanwhile, the island group consumed 99.7% reproductive parts and 0.3% vegetative parts.

RECOMMENDATIONS

1. Access to the site by villagers should be strictly limited and all activities other than fishing should be banned.

2. The fishermen should be required to camp in a given controlled area and the number should be recorded.

3. The quality and regularity of surveillance by Royal Forest Department officials should be increased.

4. Animals in the flooding island area should be translocated.

5. The 6 islands should be completely surveyed and censused for all animals in order to evaluate and manage their future lives. Specifically, the following recommendations are made:

(1) Animals having a home range greater than 1 or 2 km² should be translocated from the islands.

(2) Carnivores such as wild cats and pythons should be controlled by translocation to the mainland.

(3) An artificial salt lick should be introduced. SEIDENSTICKER & MCNEELY

(1975) stated that aside from ungulates, long-tailed macaques (*Macaca fascicularis*) and Phayre's langur (*Presbytis phayrei*) at Huai Kha Khaeng Wildlife Sanctuary used the salt licks.

(4) Further study should be encouraged to monitor the survival and inter- and intra-specific relations of the animals.

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