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## **The Activity Patterns of a Group of Cantor's Dusky Leaf Monkeys (*Trachypithecus obscurus halonifer*)**

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### **ABSTRACT**

This study describes the activity budget of a group of Cantor's dusky leaf monkeys (*Trachypithecus obscurus*) in Penang Botanical Garden, Malaysia. The main objective is to investigate the daily activity budget of *T. obscurus* in the field. Scanning sampling was employed as the observation method from June 2006 to December 2006. Behavioral observation of 18 individuals were conducted for 8 hours per day, from 0700 h to 1630 h. On average, *T. obscurus* spent most of their time on feeding (40.02%), followed by the resting (23.96%), moving (22.51%), autogrooming (6.52%), vocalization (3.89%), allogrooming (1.33%), allomothering (0.97%) and the least in playing (0.80%). Chi-square test showed that there is a significant difference among every behavior category of Cantor's dusky leaf monkeys. The habitat and canopy used of Cantor's dusky leaf monkeys in Penang Botanical Garden were also described.

**Key words:** *Trachypithecus obscurus*, dusky leaf monkeys, colobine monkeys, activity pattern, daily activity budget

### **INTRODUCTION**

*Trachypithecus obscurus* is a member of subfamily Colobinae (Groves, 2001, 2005) which constitutes of eleven subspecies (Brandon-Jones *et al.*, 2004): *T. o. obscurus*, *T. o. corax*, *T. o. flavicauda*, *T. o. halonifer*, *T. o. carbo*, *T. o. styx*, *T. o. phayrei*, *T. o. shanicus*, *T. o. smithi*, *T. o. seimundi* and *T. o. sanctorum*. Geographical distribution of *T. obscurus* ranges from Peninsular Malaysia to India (Brandon-Jones *et al.*, 2004). *T. obscurus* is commonly called as dusky leaf monkey or spectacled leaf monkey due to its dietary habit and white mascara patch over the eye respectively. In Malaysia, it is locally called as cengkong, lotong mata puteh or lotong berceklak regarding to its unique physical characters (Marsh and Wilson, 1981). *T. o. obscurus* (Reid's dusky leaf monkey) is the major subspecies that exists in Peninsular Malaysia, covering from the north part of Malaysia up until Thailand (Brandon-Jones *et al.*, 2004). *T. o. styx* (Perhentian dusky leaf monkey) occurs in Perhentian Island and probably the adjacent coast (Brandon-Jones *et al.*, 2004). *T. o. halonifer* (Cantor's dusky leaf monkey) is another subspecies that can be traced in Dayang Bunting Island, Langkawi Island and Penang Island (Brandon-Jones *et al.*, 2004).

Previous primate research in Malaysia mostly involved molecular aspects for both human primate (Shahrom *et al.*, 2005; Lim *et al.*, 2010) and non-human primates (Jalil *et al.*, 2008; Md-Zain *et al.*, 2008a; 2010). In addition, molecular systematic studies on Malaysian primates were also focused at the genus *Trachypithecus* of both *T. obscurus* and *T. cristatus* (Ernie *et al.*, 2005;

Md-Zain *et al.*, 2005; 2008a). Other molecular studies from neighbouring country (Thailand) also incorporated samples of *T. obscurus* (Chaveerach *et al.*, 2007; Tanee *et al.*, 2009). Recently, many primatologists have concentrated on primate ecology and behavior both in the field (Ampeng and Md-Zain, 2007) and captivity (Arnold and Barton, 2001; Md-Zain *et al.*, 2008b) with little emphasis put on dusky leaf monkeys. The field observation of dusky leaf monkey is relatively scarce due to their shyness, less predictable habits, greater stealth and tendency to disperse (Chivers, 1980). In this study, the field observation of Cantor's dusky leaf monkeys was carried out quantitatively to identify their daily activity patterns. It is hoped that this study can add more information as the other previous behavioral studies had done especially in understanding the behavior of the Malaysian primates (Alonso-Spilsbury *et al.*, 2006; Siddique, 2008; Zainudin *et al.*, 2009; Zakaria *et al.*, 2009).

## MATERIALS AND METHODS

This research was conducted in 2006 at Penang Botanical Garden, Malaysia (Fig. 1). The study site is a historical public botanical garden established in 1884 by Charles Curtis, who enthused to bear the seeds of exotic plants from distant lands. Penang Botanical Garden occupied an area of 30 hectares is inhabiting by fine collection of exotic flora and fauna, especially the long-tailed macaques (*Macaca fascicularis*) and Cantor's dusky leaf langurs. The habituated long-tailed macaque of the garden has earned it another name as the Monkey Garden.

Dusky leaf monkeys are found to exist and forage at seven different sites where five of the sites are located within the garden while another two are at the adjacent areas (Fig. 1). The study group of dusky leaf monkeys at Penang Botanical Garden is composed by 18 individuals that comprises

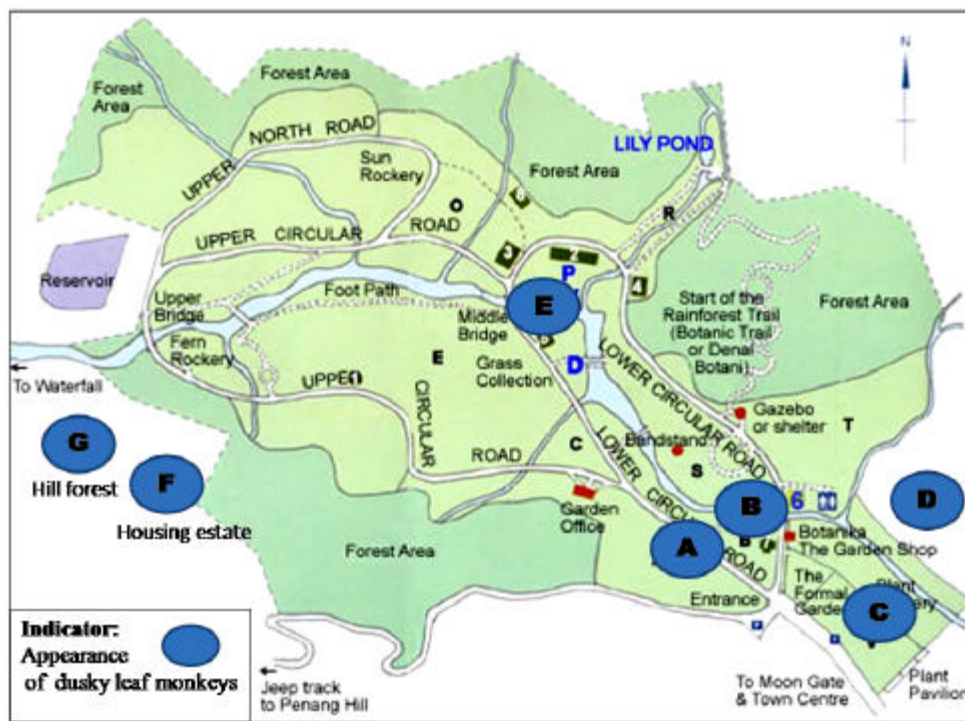


Fig. 1: Map of Penang Botanical Garden indicating the appearance sites of dusky leaf monkeys

Table 1: Categories and description of study subjects

Category	Description	No. of individual
Male adult	Largest size and foraged individually	1
Female adult	Relatively larger body size than juveniles	5
Female juvenile	Relatively smaller size to adults and moves actively	11
Infant	Clings ventrally to the mother	1
Total		18

of an adult male, five adult females, 11 sub-adult females and one infant (Table 1). This subject group is considered as habituated in the term of not running away or accustomed to the presence of the observer (Curtin, 1980).

Preliminary observation was conducted in order to be familiar with subjects and to determine types of activity patterns of the subjects (Altmann, 1974; Martin and Bateson, 1993). Preliminary observation was conducted for four days from June 16-21 2006. Scanning sampling was employed in the intensive observation for 18 days from June 2006 to December 2006. The sample session was scheduled from 0700 to 1630 h, 8 h per day excluding an hour and 30 min break. Every sampling sub-session was 15 min with 10 min confined to scan sampling while another 5 min was used to describe and make brief conclusion of each sub-session. Chi-square test was applied to analyze the conducted behavior data set. This nonparametric test is suitable to analysis the significance of activity budget which does not follow the normal distribution (Martin and Bateson, 1993).

## RESULTS AND DISCUSSION

**Profiles on activity pattern:** Cantor's Dusky leaf monkey is known as a social primate. They had been conducting their daily activity within a social group. Nevertheless, they seldom get involve in social interaction with other members during observation, where they foraged and fed individually within the group. The greatest proportion of activity budget of Cantors dusky leaf monkey was devoted to feeding (40.02%), followed by resting (23.96%) and moving (22.51%). The indirect social behaviors, autogrooming (6.52%) and vocalization (3.89%) contributed to a relatively large portion of time compared to the other social behaviors, allogrooming (1.33%), allomothering (0.97%) and playing (0.80%) (Fig. 2). Every daily activity of the dusky leaf monkey has significant different ( $\chi^2 = 39380.37$ ;  $df = 7$ ,  $p = 0.05$ ) meaning that there were differences occurred during the daily activity (Table 2). The same behavior patterns shown by Geoffroy's marmoset indicated that more time in feeding and foraging than to social behavior (Passamani, 1998). Present results however contradict with these previous studies which found out that many colobines spend most of their time in resting rather than feeding: *T. leucocephalus* (Li and Rogers, 2004), *T. francoisi* (Zhou *et al.*, 2007), *Colobus guereza* (Fashing, 2001) and *C. vellerosus* (Teichroeb *et al.*, 2003). However, our results are in line (Zhou *et al.*, 2007) as they found out that François' langurs spent little time on social activities (grooming and playing). Leaf monkeys will adjust their activity budgets in response to the change of ecological conditions particularly when food resources are scarce (Zhou *et al.*, 2007). Thus, in this study, we found that Cantor's dusky leaf monkeys increased their feeding time may due to maintain a certain daily energy intake.

The daily activity pattern of this study has been recalculated as an average daily percentage allocated to each activity. As the observation was conducted during two different periods (June 2006 and December 2006), the daily behavior allocation was presumed to be affected by some ecological settings or life span. Feeding behavior was the major behavior of the daily activity

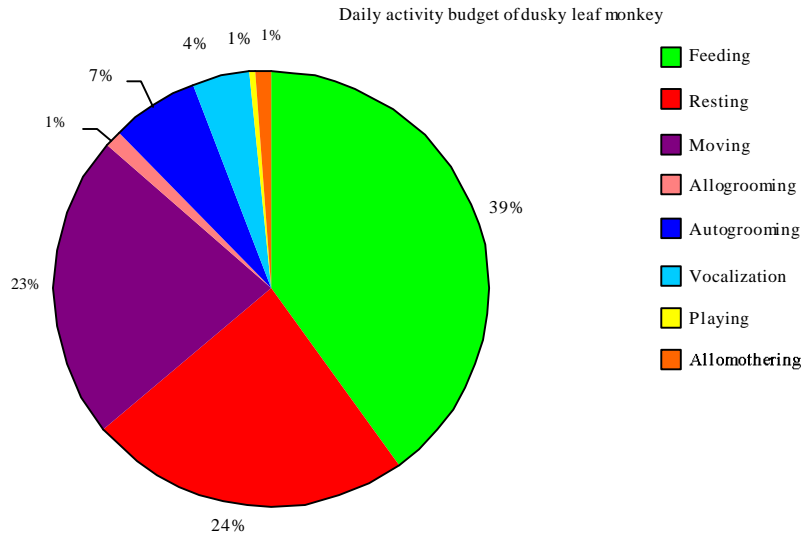


Fig. 2: Percentage of daily activity budget of dusky leaf monkeys

Table 2: Percentage and Chi-square value of dusky leaf monkey's activity budget at penang botanical garden

Activity	Percentage	Observed frequency	Expected frequency	$\chi^2$
Feeding	40.02	13192	4120	19976.02
Resting	23.96	7897	4120	3462.56
Locomotion	22.51	7418	4120	2640.00
Allogrooming	1.33	439	4120	3288.78
Autogrooming	6.52	2149	4120	942.92
Vocalization	3.89	1281	4120	1956.29
Playing	0.8	263	4120	3610.79
Allomothering	0.97	321	4120	3503.01
Total	100.00	32960	32960	39380.37

$\chi^2$ : 39380.37;  $p < 0.05$ ; degrees of freedom = 7

budget, by occupying more than 30% of the daily observation time. As no nutrition test has been conducted on the food items consumed by the langurs, there is no significant evidence showing that either the highest feeding activity was contributed by the poor nutrient (Li and Rogers, 2004) or the abundance of the food (Passamani, 1998). The feeding allocation was relatively higher from 12 to 16 December as young shoot of rain tree (food source) was sprouting within that period. The feeding time of *Rhinopithecus bieti* has changed parallel with the seasonality (Ding and Zhao, 2004). Yet, there was no obvious seasonality change at Penang Botanical Garden. Dusky leaf monkeys were seen to consume food more on leaves as many Asian colobines (Dela, 2007; Solanki *et al.*, 2008; Zhou *et al.*, 2009).

The abundant and spatial patterning of food resources affect the ranging and activity budgets of Old World Monkeys (Kinnaird and O'Brien, 2000; Fashing *et al.*, 2007). In this study, the percentage of resting behavior was recorded to be lower when the other motion-based behavior increased. The most obvious negative correlation was between feeding and resting behavior (Kurup and Kumar, 1993) and between playing and resting (Li and Rogers, 2004). However, it has still employed the second largest portion of the activity budget because food resources of dusky leaf

monkeys in Penang Botanical Garden are abundance. Results showed that frequency of movement was distributed evenly during the whole observation period with 20% per day. In daily percentage allocation, movement has no correlation with feeding behavior. It could be explained that the langurs' movements were not restricted in foraging or resource directed but has been contributed by other non-foraged movements, such as traveling (Kramer, 2001). Fashing *et al.* (2007) found out that *C. angolensis* spent markedly less time resting, spent more time feeding and moving and travelled much longer distances that is due to substantial energetic costs to living in large groups.

In this study, Cantor's dusky leaf monkeys allocated less time on social activities (grooming, playing and allomothering). Allogrooming indicated the negative correlation with the feeding behavior from 12 to 16 December 2006. The langurs have reduced their social interaction when they were active in feeding. Autogrooming and vocalization have shown no trend in daily activity allocation. Autogrooming is presumed to be a non-functional behavior in this study as it did not show hygiene (Hutchins and Barash, 1976) or mutualistic social interaction (Goosen, 1974) during the observation. Somehow, it was recorded to be in higher frequency during rainy day. Vocalization has a relatively higher frequency during playing session. Playing behavior was also distributed evenly with an extremely low percentage. However, it has recorded relatively larger fraction (>2%) for 2 days of observation. Apparently, allomothering was affected by the age and development of the infant. Its percentage only increased during observation in December 2006, when the infant has grown up and is capable to wander around with its mother. It was a contrast from the previous study which indicated that the allomothering will decrease or cease with the growth of the infant (Eimerl and DeVore, 1980). Overall, every behavior category showed its unique daily trend during the whole observation. The fluctuation of the dusky leaf monkey daily behavior was not obvious.

**Habitat use:** The habitat used was evaluated by the amount of times visited by the Cantor's dusky leaf monkeys. The same method was used by Kaplin (2001) to determine the habitat use of guenons. Habitat quality may be a factor causing different activity budget between populations of same species (Li and Rogers, 2004). Behavior could be affected by the different habitat use, such as dispersal of resources and habitat-related adaptations (Singh and Vinathe, 1990). A more widely ranging or diverse pattern would allow the group to monitor the environment for resource availability (Garber, 1993).

Site A is the entrance of the Penang Botanical Garden which planted with a rain tree (Fig. 1). Throughout the observation, site A was visited most frequently by langurs (Table 3). The prominent big tree is the favorite food source of dusky leaf monkeys. This situation relates to previous finding in Blue monkey group that was recorded to visit habitats with abundant favourite

Table 3: Frequency of appearance of dusky leaf monkey at different sites within penang botanical garden

Site	Frequency
A	14
B	7
C	8
D	3
E	9
F	1
G	3
Total	45

food (Kaplin, 2001). Their ranging behavior and distance are the response to the availability of specific resources and dietary diversity (Kaplin, 2001). Young shoot or leaves with high nutrient have attracted langurs to visit early in the morning (Ding and Zhao, 2004). *Cercopithecus aethiops* were found to practice optimal foraging theory by spending longer duration of feeding bouts in higher-quality patches (Whitten, 1998). However, Cantor's dusky leaf monkeys did not totally practiced the optimal foraging theory because their foraging area has occupied a large patch of garden. They need to employ more energy to forage in such a large area. This is true as the temporal and spatial distribution of food resources may be the most important determinant of leaf monkey ranging behaviour (Tan *et al.*, 2007).

Cantor's dusky leaf monkeys seem to exhibit the same ranging habit. Site B and F are occupied with medium-sized trees with adjacent buildings. A souvenir shop and rural housing area are located at the central of site B and F, respectively. However, langur only visited once at the housing area during the observation (Table 3). Overall, the langur group did not utilize many sites in Penang Botanical Garden evenly, but had been visiting certain site regularly with certain essential factor. *Presbytis potenziani* has occasionally utilized the gardens and secondary forest besides the predominant primary forest. It is a common trend in Mentawai primates that exists among the forest communities, human settlements and commercial logging areas (Fuentes, 1996).

**Canopy use:** Southeast Asian *Presbytis* and *Trachypithecus* tend to use the middle and upper strata of the primary or tall forests (with canopy > 20 m) (Curtin, 1980; Bennett and Davies, 1994). The same observation was found at Penang Botanical Garden while most of the activities of dusky leaf monkeys were concentrated at higher strata of canopy (site A, C, E and G). These sites are filled with the highest layer of canopy by tall and broad canopy. The feeding pattern is an indicator of the abundance and the distribution of the food (Passamani, 1998). Indeed, most of the langur's food sources comes from this layer, such as rain tree (site A), nutmeg (site C), bamboo (site E) and hill forest (site G). Normally, dusky leaf monkeys were fed on the tree-crowns of tall trees, such as figs which have many seeds especially during the fruit scarcity period (Stevenson, 2004).

Cantor's dusky leaf monkeys were observed to utilize every layers of canopy in range as long as there are supporting substrates ready for them. This finding supports previous finding by Ampeng (2006) on *Presbytis melalophos chrysomelas* which utilized every part of canopy layer in Samunsam Wildlife Sanctuary, Sarawak. The incomplete habituation of *P. potenziani* has restricted them from using the primary supports at <15-10 m at dipterocarps forest (Fuentes, 1996). Apparently, Cantor's dusky leaf monkeys group at Penang Botanical Garden has no limitation in utilizing any layer of canopy. They even found out to the range at the housing area (site F) and cross the electricity cable to site G. From this point, the subjects are assumed to be habituated to the activity's sites.

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