



# Journal of Biological Sciences

ISSN 1727-3048

**science**  
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## A Comprehensive Population Survey and Daily Activity Budget on Long-tailed Macaques of Universiti Kebangsaan Malaysia

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**Abstract:** Variation in socioecological characteristic such as activity pattern is an example of how primates adapted to their local environment. In this study, daily activity budget of long-tailed macaque (*Macaca fascicularis*) was described that confined in Universiti Kebangsaan Malaysia main campus. A comprehensive population survey of the long-tailed macaque was also conducted to determine the population count and group size. Between June 2002 and May 2010, several long-tailed macaque groups were observed via group focal sampling and the behavior continuously recorded. Population surveys indicated that there were nine groups of long-tailed macaques with 600 most individuals located around student residential colleges. Present results indicate that all long-tailed macaque groups spent most of their time in locomotion (18.00-31.36%). Resting (16.13-20.26%) and feeding (16.29-24.02%) accounted as the most activities after moving. However, long tailed-macaques were less engaged in social activities such as playing, vocalization, agonistic, grooming and sexual behaviors. Chi-square test demonstrated that daily activity budget differed significantly among behaviors.

**Key words:** *Macaca fascicularis*, long-tailed macaque, activity pattern, daily activity budget, campus monkey

### INTRODUCTION

*Macaca fascicularis* (long-tailed macaque) is one of the most geographically widespread and abundant non-human primate species in the world. This primate is widely distributed in the Southeast Asian region (Thailand, Indonesia, Singapore, Brunei, Malaysia, Philippines, Vietnam and Laos, Brandon-Jones *et al.*, 2004). They have also been introduced by humans to the islands of Mauritius (Lawler *et al.*, 1995), Ngeuar Island, Republic of Palau (Wheatley *et al.*, 2002) and Hong Kong (Wong and Ni, 2000). Due to its wide distribution, this species varies in their behavior, social organisation, habitat consumption, morphology and genetic variation (Brent and Viera, 2002; Hamada *et al.*, 2008).

Time is a limited resource for all animals and its partitioning is influenced by sociality (Pollard and Blumstein, 2008). An understanding of how primates divide up their activities throughout a day and a year is important to understand their lifestyles and to generally indicate how primates interact with their environment and invest energy and time for survival and reproduction (Defler, 1995). The allocation of time for multiple activities has significant effects on the survival of primates

(Jaman and Huffman, 2008). Time allocation may also be a critical factor that influences the evolution of group size (Pollard and Blumstein, 2008). Numerous field studies have demonstrated that activity budgets vary according to a number of environmental factors, including diet, distribution and abundance of food sources (Peres, 1993; Passamani, 1998).

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 (Md-Zain *et al.*, 2008a, 2010). In addition, primate ecology and behavior studies also involved leaf monkeys (Ampeng and Md-Zain, 2007; Md-Zain and Ch'ng, 2011). Long-tail macaques have been the focus of numerous local studies, specifically study on ecology and behavior of *M. fascicularis* in Universiti Malaya campus (Osman, 1998). This research focused on population survey and daily behavior of *M. fascicularis* at Universiti Kebangsaan Malaysia main campus. This primate can be easily found at the study area since, it usually inhabits the residential colleges' area. They exhibit a variety of different behaviors making it a species unique and attractive to study. This study will increase our understanding of *M. fascicularis* that live in the

human area. Clearly understanding the daily activity budgets of macaques leads to the effective management of its species (Jaman and Huffman, 2008).

## MATERIALS AND METHODS

**Study site:** Universiti Kebangsaan Malaysia (UKM) is located in Selangor, Malaysia and covers approximately 1, 100 ha, was chosen as the study location for this research. UKM is located 35 km south of Kuala Lumpur with ten residential colleges found in the UKM main campus. Among them are Burhanuddin Helmi Residential College (KBH), Ibrahim Yaakob Residential College (KIY), Ungku Omar Residential College (KUO), Pendeta Zaaba Residential College (KPZ), Aminuddin Baki Residential College (KAB), Dato' Onn Residential College (KDO), Tun Hussein Onn Residential College (KTHO), Rahim Kajai Residential College (KRK), Ibu Zain Residential College (KIZ) and Keris Mas Residential College (KKM). In addition, the surrounding areas also include staff housing area (Perumahan Bukit Puteri, PBP), administration buildings, faculties, club house, health centre, rest house and stadium. Few primate species can be found in UKM, namely *M. fascicularis*, *M. nemestrina*, *Trachypithecus obscurus*, *Presbytis melalophos siamensis* and *Nycticebus coucang*. This study focused

on groups of wild *M. fascicularis* at UKM main campus with representatives from sexes and different ages.

**Population survey:** Survey of *M. fascicularis* population was conducted by using census walks in order to locate and count individuals and group of macaques. The study sites were surveyed by direct sighting, movements or vocalization in order to locate macaques (Fig. 1). Once a group of macaques were found, data was collected by using the *ad libitum* sampling method. Group size and age-sex class of each individual according to Fittinghoff (1972) were observed. The macaque groups were classified according to the unique characteristics of each individual, the alpha-male and the ranging area (Hamada *et al.*, 2005). In order to obtain accurate data this procedure was repeated until exact group position, number of groups and individuals were ensured.

**Behavioral sampling method:** This research was conducted from June 2002 until May 2010. Preliminary non formal observation was carried to determine and define the behavior categories of the subjects (Md-Zain *et al.*, 2008b). Preliminary observation is critical for observer to be familiar with the subjects and their behaviour, thus enabling them to choose the right measures and recording methods (Martin and Bateson, 1993). Scanning sampling



Fig. 1: Location of study sites indicating the appearance sites of *M. fascicularis* 1: Law Faculty (LF), 2: Burhanuddin Helmi Residential College (KBH), 3: Ibrahim Yaakob Residential College (KIY), 4: Aminuddin Baki Residential College (KAB), 5: Rahim Kajai Residential College (KRK), 6: Ibu Zain Residential College (KIZ), 7: Keris Mas Residential College (KKM), 8: Perumahan Bukit Puteri (PBP), 9: Ungku Omar Residential College

method was used for intensive observation. All subjects were randomly observed for a same brief period of time in order to reduce bias (Altmann, 1974). Observation was carried out by scanning on all individuals for 10 min followed by 5 min break to describe and make brief notes. Observations were particularly difficult to conduct under rainy conditions as subjects were usually partially obscured or moved completely out of sight. Observations were also stopped when the subjects were not visible at the study sites. Behavior of daily activity budgets was taken based on previous studies by Brent and Viera (2002). Behavior categories were modified to accommodate the behavioral activity of *M. fascicularis* at the study sites. Chi-square test was applied to analyze the behavior data set obtained. This nonparametric test is suitable to analyze the significance of activity budgets that did not follow the normal distribution.

## RESULTS AND DISCUSSION

**Population survey:** Based on the survey conducted, nine groups of *M. fascicularis* were found in the UKM main campus with a total number of nearly 600 (Table 1). Each group had different group sizes ranging from 20 to 101 individuals. These groups were mostly found in student residential college areas, roads and the forest fringe, except two groups that were located in the staff housing area and law faculty. PBP and KBH group had the highest number of macaques (nearly 101 individuals) while the KUO group had the least number of individuals (20-30 individuals). These groups were observed to have their own home range, with some overlapping each other, such as the KBH, KUO and KIY groups. A pig tailed macaque was found near the KBH group trying to obtain food at the same territory which sometimes leads to conflict with

the long-tailed macaque group. The KIZ group was seen together with dusky leaf monkeys (*T. obscurus*).

**Daily activity budget:** Eight behavior categories of daily activity budgets were observed in all study groups (Table 2). An observation period of 921 h was allocated to study locomotion, feeding, resting and other social activities such as playing, agonistic, grooming, vocalization and sexual behavior of long-tailed macaques. Variations among activities were observed among groups of the long-tailed macaques in the study sites. Findings indicated that all groups spent most of their activity in locomotion (18.00-31.36%). This was followed by resting (16.13-20.26%) and feeding (16.29-24.02%). Long-tailed macaques spent less time engaging in social activities. *Macaca fascicularis* engaged more in playing (5.93-17.95%) and vocalization (1.29-15.29%) as compared to agonistic (2.45-9.70%) and grooming (2.31-13.00%).  $\chi^2$  values indicated significant differences among daily activities in all studied groups.

The total population of all nine groups of long-tailed macaques found in this research is nearly 600. This number is three times higher than that recorded by Fuentes (2006) wherein 200 long tailed macaques were found at the Padangtegal Monkey Forest, Bali. Meanwhile, Osman (1998) determined four groups of *M. fascicularis* found at the Universiti Malaya campus. In human settlement areas of Kampung Pantai Dalam, Kuala Lumpur, only 2 groups were found (Osman, 1998). Sha *et al.* (2009) recorded high group numbers (71-112 groups) of *M. fascicularis* in Singapore. In natural environment such as in the tropical rain forest, the number of group may exceed 14 whereas the group size of long tailed macaques ranged from 6 to 42 individuals (van Schaik and van Noordwijk 1985).

Table 1: Individual counts of *M. fascicularis* in the main campus Universiti Kebangsaan Malaysia

Groups	Site	Census year	Adult male	Adult female	Sub-adult male	Sub-adult female	Juvenile	Infant	Total
1	LF	2007	6	8	10-15	10-13	15-17	6	55-65
2	KBH	2009	11-16	15-16	12-13	19-20	25-26	8-10	90-101
		2007	3	4	6-9	8-9	10-12	5	36-42
3	KIY	2009	5-10	8-9	8-9	11-12	12-13	2-3	46-56
		2007	4	4	5-10	6-8	9-12	4	32-42
4	KAB	2009	3-5	6-7	4-7	5-9	6-8	2-3	26-39
		2007	3	4	4-5	5-6	6-8	1	18-27
5	KRK	2007	3	5	6-7	3-6	7-10	2	48-56
6	KIZ	2010	6	7	3	4	10	3	33
		2009	5-8	9-10	8-9	11-13	10-13	2-3	46-56
		2007	4	6	9-12	9-11	15-18	5	26-33
7	KKM	2009	5	6-8	8-11	7-12	14-17	7	47-52
		2007	6-9	9-10	9-11	12-13	9-10	2-3	47-56
8	PBP	2009							100
9	KUO	2009	4	5-6	4-6	8-9	3-4	1	20-30

Group 1: Law Faculty (LF), Group 2: Burhanuddin Helmi Residential College (KBH), Group 3: Ibrahim Yaakob Residential College (KIY), Group 4: Aminuddin Baki Residential College (KAB), Group 5: Rahim Kajai Residential College (KKR), Group 6: Ibu Zain Residential College (KIZ), Group 7: Keris Mas Residential College (KKM), Group 8: Perumahan Bukit Puteri (PBP), Group 9: Ungku Omar Residential College (KUO). Individual Count of Other Survey. KIY: 20-30 (Zuraidah, 2003); KIZ: 20-30 (Sia, 2004)

Table 2: Percentage and frequency of daily activity budget of long-tailed macaques

Behaviour	Study period							
	Jan-May 2010		March-July 2009		Aug 2008-April 2009		Aug-Nov 2007	June-Oct 2003
	KIZ	KBH	KUO	KKM	KAB	KBH	KIZ	KIY
Locomotion	18.76 (578)	21.20 (248)	22.34 (262)	26.41 (220)	31.36 (201)	29.98 (232)	23.60 (212)	18.00 (158)
Resting	16.13 (497)	20.26 (237)	13.64 (160)	18.97 (158)	16.69 (107)	18.09 (140)	17.00 (152)	15.50 (136)
Feeding	16.29 (502)	18.72 (219)	19.27 (226)	16.93 (141)	24.02 (154)	20.54 (159)	16.80 (151)	17.10 (150)
Playing	12.59 (388)	17.95 (210)	15.35 (180)	12.00 (100)	5.93 (38)	16.41 (127)	13.30 (119)	12.50 (104)
Vocalization	15.29 (471)	9.40 (110)	10.40 (122)	9.12 (76)	5.30 (34)	1.29 (10)	6.80 (61)	10.90 (96)
Agonistic	5.09 (157)	7.68 (90)	8.01 (94)	2.88 (24)	5.62 (36)	2.45 (19)	5.90 (53)	9.70 (85)
Grooming	10.22 (315)	2.31 (27)	5.37 (63)	11.64 (97)	6.24 (40)	9.43 (73)	12.50 (111)	13.00 (114)
Sexual	5.62 (173)	2.48 (29)	5.63 (66)	2.04 (17)	4.84 (31)	1.81	4.10 (37)	3.40 (30)
Total	100.00 (3081)	100.00 (1170)	100.00 (1173)	100.00 (833)	100.00 (641)	100.00 (774)	100.00 (897)	100.00 (873)
$\chi^2$ values	448.46	412.93	257.62	312.69	391.89	474.78	12.88	12.26
df	7	7	7	7	7	7	7	7
Observation hours	100	211	195	130	60	105	60	60

Different group sizes varied in the study sites. This is because some macaque groups are located to the forest fringe that close to food resources while others are ranged in lower habitat quality. This finding supports Menard (2004) that showed obvious intra-specific variations in group size depending on the habitat occupied or the history of the group. According to Van Schaik and van Noordwijk (1985) the long-tailed macaques tend to live in smaller groups when predators were absent. Group at KBH, KUO and KIY overlapped each other. This is not surprising because Simonds (1974) explained that the ranges of various macaques' species usually overlap considerably with those of neighbouring groups of the same species. The number of individuals in the groups studied was not fixed as some individuals disperse into other groups from time to time. According to Oi (1990), inter-group migration by males is routine in macaques. This is important to avoid inbreeding for their reproductive success. Competition for food resources sometimes also influences the dispersal of individuals from their main group's spread (Koenig, 2002). Based on a study of a wild population of long-tailed macaques done by Van Schaik and van Noordwijk (1985), 52 male migrations from six groups to six other groups were observed.

Eight behavior categories were recorded with variation in activities performed in each study group. The variation of activities among groups of long-tailed macaques was observed in the differences of percentages of their behaviors. This variation supports findings by Brent and Viera (2002) wherein variations in behavior and physiology events among different populations of the same macaque species were due to gross habitat differences. In this study differences occurred in individuals with different sex and age for particular behavior; infant and adult long-tailed macaques show differences in time spent for playing. This finding supports those obtained by Jaman and Huffman (2008),

who found daily activity budgets to be varied across age-sex class in captive *M. fasciata*.

A large portion of daily activity budget for all study groups was locomotion. This supports studies conducted by Suhailan (2004) and Sia (2004) that showed locomotion to have the highest portion of daily activity budget for long-tailed macaques in local residence areas. Menard (2004) and Wheatley (1980) also found that the long-tailed macaques are primates with the most moving time because this species is mainly frugivorous and spends most of their time moving in order to search for fruits. Most long-tailed macaques engage in locomotion in order to find food and to occupy more space. It was also observed that the long-tailed macaques move out from their home range when there was a shortage of food sources. This is true as locomotion pattern is greatly influenced by food sources distribution (O'Brien and Kinnaird, 1997). Human activities such as building construction in the UKM campus has shrunk and damaged the habitat of *M. fascicularis* thus affecting their food sources. Student residential colleges in UKM were seen to contain abundant food sources. As macaques adapt to the modified habitat and live commensally with humans, they are seen moving from the secondary forest to the near student residential colleges to search for food. Thus, the environment significantly influences time budgets of macaques. The lower habitat quality due to decreasing natural environment causes long-tailed macaques to spend most of their time moving. Long-tailed macaques in the UKM campus spent most of their time moving as their natural habitat quality is decreasing.

In this study, the long-tailed macaques spent less time feeding compared to locomotion. Feeding behavior was recorded as the second highest activity in many study groups (KIZ, KUO, KAB and KIY groups). This is similar to studies conducted by Suhailan (2004) and Tuan-Zaubidah (2003). However, feeding was the third most common activity in the KKM group. During the

observation, long-tailed macaques were seen to have spent more time feeding when food was available. The long-tailed macaques in the study area consumed food such as leaves, fruits, bread, rice, carbonated drinks, ice cream and junk food usually obtained from the garbage can in the hostel area. This situation littered the hostel surrounding. The long-tailed macaques, naturally are frugivorous (Wheatley, 1980), however they may also be omnivorous. Feeding sometimes causes conflicts among the individuals as subjects were seen competing for food. It was observed that gathering of food was mostly dominated by higher ranking long-tailed macaques. Thus, the long-tailed macaques need a strategy in order to avoid such conflicts. The lower ranking macaques usually eat after the higher ranking ones leave the food area. This supports previous findings by Koenig (2002) wherein lower ranking females wait until higher ranking females leave the feeding site and then eat left-over food in order to avoid aggressive contact. Meanwhile, Dubuc and Chapais (2007) reported that lower ranking females arrived in the feeding area before alpha males and alpha females as their tactic to obtain foods.

Resting behavior and feeding activities took the same amount of time for macaques in many study groups. However, this finding was in contrast with other macaques species. For example, wild lion-tailed macaques in the highlands of southern India (Kurup and Kumar, 1993) and captive Japanese macaques (*M. fuscata*) (Jaman and Huffman, 2008) were found to spend the highest proportion of time resting. An increase in one behavior causes a decrease in other behaviors (Jaman and Huffman, 2008). Time spent for feeding is inversely related to resting (Kurup and Kumar, 1993). Groups from KUO, KAB and KIY were observed to have spent less time resting because they spent much time feeding. It was also seen that resting period comes after feeding. Most resting behavior occurs when food sources were limited. During resting time, the long-tailed macaques usually sleep, lie down and sit without doing anything. The long-tailed macaques usually rest on tree branches, terrestrial areas, cars and building roofs in the colleges or near the forest fringe area.

Playing is among the most frequent social activities recorded among sub-juveniles, juveniles and infants. The juveniles exhibit the most playing activity. This is because playing behavior may form social competition and juveniles are in an active age period of learning the ways of social relationship (Kipper and Todt, 2002). Generally, males were seen to play more than females of the same age. Mothers were also seen playing with their infants. Some playing behavior exhibited by long-tailed macaques were chasing, biting without causing harm, wrestling,

swinging on tree branches and playing with objects (such as flowers and plastic). Tail-pulling was also another major playing activity among the long-tailed macaques observed in study groups.

Subjects were seen to produce vocal sounds while eating. The same situation was also observed in a study of long-tailed macaques done by Tuan-Zaubidah (2003) at Bukit Lagi, Kangar. The vocalization was also produced after and during mating. This is due to the fact that females produce vocal during copulation which is a hormonal effect (Engelhardt *et al.*, 2005). In addition, vocalization was produced as warning for predator existence, during agonistic interaction and food competition. Long-tailed macaques also produced sound while playing. This is similar to a study by Kipper and Todt (2002) that found a variety of sounds were produced by macaques while playing.

Time allocated for grooming varies between study groups. The highest percentage of time for grooming was recorded in the KIZ group. Most subjects usually engaged in grooming after feeding and while resting. This activity was usually done either on trees or on the ground. Mothers were usually found grooming their infants. Mothers continue to groom their offspring until their move out or emigrate from the group (Maestriperi, 2004). Grooming activity usually occurred between females. This proved the fact that male macaques do not often groom each other in the wild (Brent and Viera, 2002). Females were also seen grooming the males after mating. This finding was similar to those obtained by Anaya-Huertas and Mondragon-Ceballos (1998), who found that adult males were usually groomed by their mates and other individuals in their group. Females grooming their mating males help for them to obtain protection while fighting and those mates may be willing to share food (Lazaro-Perea *et al.*, 2004). It was also found that young females usually groomed the adult females. Gumert (2007) found the same situation wherein higher ranking adult females of long-tailed macaques received more grooms by other subordinate females. This situation exists because the ranking of females in groups determine the frequency of receiving grooms (Gumert, 2007).

In this study, agonistic behavior occurred when subjects were struggling for food and were trying to gain mates. Sussman *et al.* (2003) also found that aggressive behavior occurred while gaining food and mates. Subjects were seen chasing and sometimes biting other individuals; this appeared more in males similar to findings by Brent and Viera (2002) who found that male long-tailed macaques exhibited more threatening behavior. Higher ranking males usually show their aggressiveness to the lower ranking males and females. Aggressive

behavior observed from the subjects included showing their canine tooth to others, chasing and biting. Agonistic behavior sometimes occurred between groups of the long-tailed macaques in the study sites when they try to dominate an area that contains abundant and quality food sources. Cooper *et al.* (2004) also found that aggression occurred between groups of *M. radiata* in order to defend food sources. This situation was seen for the KIY and KUO groups.

Sexual behavior comprised only a small portion of daily activity. This finding was similar to those obtained by Sia (2005), Suhailan (2004) and Tuan-Zaubidah (2003). Males in the study area usually exhibited more sexual behavior and when mating occurred and male was seen perched on the back of the female body. This finding also supported Brent and Viera (2002) who claimed that male long-tailed macaques exhibited more sexual behavior than females. During observation, it was found that females mostly preferred to mate with dominant males. Van Noordwijk and Van Schaik (1999) also found that female primates which live in multi-male group focused on copulating with dominant males. In addition, De Ruiter *et al.* (1994) claimed that dominant males were the father of most of the offspring in the long-tailed macaques group.

#### ACKNOWLEDGMENTS

We specifically thank Zuraidah Bukhari, Sia Wee Hock, Aminah Puyong, Mohd Hashim Abu, Ahmad Ampeng, Salsela Saidin, Aainaa Syazwani Hamzah and Kamarul Ariffin Hambali for sharing their time during the surveys. We are also extremely grateful to the student residential colleges especially the college masters of UKM. We wish to thank Farhana Shukor, Sri Harminda Hartantyo and anonymous reviewers for their comments on the manuscript. We also thank the Faculty of Science and Technology, Universiti Kebangsaan Malaysia and Department of Wildlife and National Park (DWNP) for granting us permission to conduct this research. The project was supported by Grant ST-019-2002, IRPA 0802020019- EA301, UKM-GUP-KRIB-16/2008 and UKM-OUP-PLW-10-43/2010.

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