



**RANGING BEHAVIOUR OF LONG-
TAILED MACAQUE (*Macaca fascicularis*) AT
TAMAN PD UTAMA, PORT DICKSON,
NEGERI SEMBILAN, PENINSULAR
MALAYSIA**

by

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of Bachelor of Applied Science (Natural Resource Science) with
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DECLARATION

I declare that this thesis entitled “Ranging Behaviour of Long-Tailed Macaque (*Macaca fascicularis*) At Taman Pd Utama, Port Dickson, Negeri Sembilan, Peninsular Malaysia” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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**RANGING BEHAVIOUR OF LONG-TAILED MACAQUE
(*Macaca fascicularis*) AT TAMAN PD UTAMA, PORT
DICKSON, NEGERI SEMBILAN PENINSULAR MALAYSIA**

ABSTRACT

This study reports on the ranging behaviour of a group of long-tailed macaques (*Macaca fascicularis*) in Taman Pd Utama, Port Dickson, Negeri Sembilan. Data on ranging behaviour were collected daily for 20 days and were performed 6 days a week. Observations focused on distance movement and canopy level use by groups of long-tailed macaques. They often travel between 100 and 400 m per day. They use areas close to human settlements because of the high availability of food. The results of the study found that the long-tailed macaques do not seem to move far from their residential area. The forest canopy layer most frequently used by the research group is ground level (32.94%), followed by lower layer canopy (28.34%), middle canopy (20.71%), upper canopy (14.40%), and the lowest is the emergence (3.62%). Overall, the ranging behavior of the study group is influenced by food distribution and is also influenced by other factors. Therefore, this study shows the importance of understanding the canopy level used and the movement distance used by long-tailed macaques.

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**TINGKAH LAKU JULAT KERA EKOR PANJANG
(*Macaca Fascicularis*) DI TAMAN PD UTAMA,
PORT DICKSON, SEMBILAN NEGERI
SEMENANJUNG MALAYSIA**

ABSTRAK

Kajian ini melaporkan kelakuan julat sekumpulan kera ekor panjang (*Macaca fascicularis*) di Taman Pd Utama, Port Dickson, Negeri Sembilan. Data tentang tingkah laku julat dikumpul setiap hari selama 20 hari dan telah dilakukan selama 6 hari seminggu. Pemerhatian tertumpu kepada pergerakan jarak dan penggunaan aras kanopi oleh kumpulan kera ekor panjang. Mereka sering melakukan perjalanan antara 100 dan 400 m setiap hari. Mereka menggunakan kawasan berhampiran dengan penempatan manusia kerana ketersediaan makanan yang tinggi. Hasil kajian mendapati kera ekor panjang itu kelihatan tidak bergerak jauh dari kawasan kediaman mereka. Lapisan kanopi hutan yang paling kerap digunakan oleh kumpulan penyelidik ialah paras tanah (32.94%), diikuti oleh kanopi lapisan bawah (28.34%), kanopi tengah (20.71%), kanopi atas (14.40%), dan yang terendah ialah kanopi emergent. (3.62%). Secara keseluruhannya, tingkah laku julat kumpulan kajian dipengaruhi oleh pengagihan makanan dan juga dipengaruhi oleh factor lain. Oleh itu, kajian ini menunjukkan kepentingan untuk memahami aras kanopi yang digunakan dan jarak pergerakan yang digunakan oleh kera ekor panjang.

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LIST OF ABBREVIATIONS

cm	Centimeter
df	Degree of Freedom
DWNP	Department of Wildlife and National Parks
EM	Emergence
E	East
GPS	Global Positioning System
GL	Ground Level
IUCN	International Union for Conservation of Nature
Kg	Kilogram
LC	Lower Canopy
M	Meter
MC	Middle Canopy
N	North
O	Observation
Pd	Port Dickson
UC	Upper Canopy

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LIST OF SYMBOLS

E^i	Expected Value
Km^2	Kilometer Square
p	P Value
P_i	Observe Value
χ^2	Chi-Square
Σ	Sum
%	Percentage

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Macaca fascicularis, often known as the long-tailed macaque, exhibits a geographically fragmented distribution in various regions of Southeast Asia (Eudey, 2008; Gumert, 2011). Nevertheless, it is classified as a relatively diminutive primate and derives its name from possessing a lengthy tail that nearly matches the combined length of its body and head. The long-tailed macaque is classified within the taxonomic family Cercopithecidae and the genus *Macaca*. The subject in question belongs to the *fascicularis* species group within its genus. This group encompasses various macaque species, including the crab-eating macaque (*Macaca mulatta*). Long-tailed macaques are primates of moderate size that possess a unique physical appearance. The species under consideration exhibits a sturdy physique, characterized by a lengthy tail that frequently surpasses the length of its body. Additionally, it possesses a distinct facial structure, with a concise snout. The fur color of these animals exhibits a range of shades, spanning from brown to grey, with a tendency towards a lighter complexion on their facial region. In general, adult males exhibit a higher physical stature compared to females, sometimes characterized by the presence of prominent canine teeth. The distribution of these macaques encompasses various countries in Southeast Asia, including Malaysia, Thailand, Vietnam, Indonesia, and the Philippines. They occupy a diverse range of habitats, encompassing densely wooded areas as well as coastal zones. Long-tailed macaques exhibit a remarkable ability to adapt to various environments,

encompassing both unmodified natural habitats and those that have been significantly influenced by human activities, such as urban settings.

Macaca fascicularis, also known as the long-tailed macaque, is a primate species characterized by its substantial population and wide distribution across several habitats. This species typically occupies regions impacted by human occupation and agricultural activities, in addition to locations near natural forested regions. Long-tailed macaques exhibit the ability to endure a wide range of altitudes, spanning from sea level to elevations beyond 2,000 meters. According to the International Union for Conservation of Nature (IUCN, 2016), long-tailed macaques can be observed in many countries including Bangladesh, Brunei, Cambodia, India, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, and Vietnam. The species is commonly encountered in several ecological settings, displaying a remarkable ability to use available resources as an omnivorous mammalian organism. The diet of these organisms consists of a variety of food sources including fruits, seeds, leaves, insects, buds, and tiny mammals. Moreover, long-tailed macaques exhibit a high degree of ecological diversity. Based on the findings of Bonadio's (2019) study, it is evident that long-tailed macaques have a wide distribution throughout several habitats, encompassing primary forests, disturbed forests, secondary forests, riparian, and coastal forests, as well as mangrove forests in peninsular Malaysia. Long-tailed macaques can be readily observed in urban environments, including locations such as Kuala Lumpur Templer Recreation Forest, Penang Botanical Garden, Kuala Selangor Malawati Hill, Taping Lake Park, and Kuala Selangor Nature Park (PERHILITAN, 2006).

Taman Pd Utama is located near a forest area, making it an ideal residential park for the long-tailed macaque species, as it provides excellent conditions for residence and foraging activities. This area is often the main area of interest for macaques to find sustenance and rest, due to the abundance of fruits, insects, and foliage that are important components of their nutritional needs.

1.2 Problem Statement

There is not much information about determining the ranging behaviour of the long-tailed macaque (*Macaca fascicularis*) in Taman Pd Utama, Port Dickson, Negeri Sembilan. This study was conducted to find out the movement and use of the canopy level used by long-tailed macaques. This species is usually found in primary rainforest but due to development, data is needed to determine the long-tailed macaque's ranging behaviour in this area. In this study, long-tailed macaques (*Macaca fascicularis*) are rare in the study area because the remaining food options for this species may be unavailable or reduced. This causes a species of long-tailed macaques to invade residential areas to find food scraps in garbage cans. The findings of this study contributed to a better understanding of the ranging behaviour of long-tailed macaque at Taman PD Utama, Port Dickson, Negeri Sembilan.

1.3 Objective

The objective of this study is to determine the ranging behaviour of long-tailed macaque (*Macaca fascicularis*) at Taman Pd Utama, Port Dickson, Negeri Sembilan.

1.4 Scope of Study

The primary focus of this study is to determine the ranging behaviour of the long-tailed macaque. This study used observational methods by observing the horizontal and vertical movements of long-tailed macaques. The data obtained was recorded using an ethogram and the study site was concentrated in residential areas. To evaluate the data and bolster the study data, data analysis techniques such as Chi-Square (χ^2) were used.

1.5 Significant of Study

This study is important in providing information on the ranging behaviour of long-tailed macaque (*Macaca fascicularis*). The study can also provide insights into the movement and use of the canopy level used by long-tailed macaques. Besides, the findings of this study can provide important insights for both immediate conservation action and long-term planning. This information is important for the sustainable management of the ranging behaviour of macaques.

CHAPTER 2

LITERATURE REVIEW

2.1 Long-tailed Macaque

The long-tailed macaque, scientifically known as *Macaca fascicularis*, is a primate species classified within the family Cercopithecidae. It is categorized as an 'old world primate' species. The term "*Macaca*" originates from the Portuguese word "*Macaco*," which in turn derives from "*Makaku*," a word of Fiot (West African) origin. It is worth noting that "Kaku" in Fiot refers to the concept of a monkey. The Latin term "*fascicularis*" denotes a little strip or band. The scientific nomenclature of the animal was bestowed on it by Sir Thomas Raffles in 1821, although he did not provide an elucidation of its signification. In the regions of Indonesia and Malaysia, *Macaca fascicularis* and other macaque species are commonly referred to as macaques due to their distinctive vocalizations characterized by high-pitched cries. The crab-eating macaque is known by multiple appellations. The long-tailed macaque derives its nomenclature from the characteristic wherein its tail frequently surpasses the length of its body. The crab-eating monkey derives its nomenclature from its regular presence on the shoreline in search of crustaceans. *Macaca fascicularis*, commonly referred to as cynomolgus monkey, is an alternative nomenclature for this species. The term "cynomolgus" originates from the Greek words "kynos" and "molgus," which respectively translate to "dog" and "skin" or "hide." This designation is frequently employed within scientific contexts. The species *Macaca fascicularis* possesses a buccal pouch that functions as a repository for food over a specific duration (Chalmers, 1979; Napier, 1985; Rowe, 1996).

The long-tailed macaques exhibit a reddish-brown or grey-brown coloration, accompanied by a distinctive white fur pattern encircling their facial region. Typically, the fur coloration in this specific region of the macaque's anatomy exhibits a higher degree of brightness compared to other regions. In Borneo, it is observed that individuals possess facial hair in the form of mustaches, cheek hair, and beards. According to Sussman and Tattersall (1981), the fur color in the Philippines is seen to be darker compared to that in Thailand. The fur color of long-tailed macaques residing in woodland habitats exhibits a greater degree of darkness compared to their counterparts inhabiting coastal regions. Hence, the variation in long-tailed macaque fur color is contingent upon factors such as age, seasonal variations, and the specific habitat in which they reside. The differentiation of gender and age can be observed through variations in the intensity of fur color.

The long-tailed macaque is often recognized because of its distinctive elongated tail. The tail of this macaque specimen surpasses both its head and body in length, measuring over 90 inches (Fooden, 1997). Furthermore, the tail of this primate species functions to maintain equilibrium during arboreal locomotion, facilitating seamless transitions between adjacent trees. The long-tailed macaque exhibits quadrupedal locomotion and exhibits a preference for terrestrial activities (Rodman, 1991). Furthermore, the research conducted by Kurland (1973) and Schultz (1969) demonstrated that male long-tailed macaques exhibit greater body weight compared to their female counterparts, with a weight ratio of 100:64. The weight range of male macaques is from 3.5 kg to 8.3 kg, but female macaques typically weigh between 2.5 kg and 5.7 kg. The length of male macaques, inclusive of the tail, ranges from 14.0 cm to 65.5 cm, but for female macaques, it falls within the range of 38.5 cm to 54.5 cm (Chiarelli, 1972; Aldrich-Blake, 1980; Payne et al., 1985).

2.2 Canopy Strata of Long-tailed Macaque

The long-tailed macaque, scientifically known as *Macaca fascicularis*, is a species of primate that exhibits both arboreal and terrestrial behaviors, utilising both the canopy and ground levels in its quest for sustenance. The formation of the canopy, which consists of a dense arrangement of leaves and branches, is mostly attributed to the closely positioned trees within a forest. The uppermost layer of the canopy is estimated to extend between 100 and 130 feet above the forest floor. The lower stratum refers to the vegetative layer consisting of foliage and branches that develop underneath the uppermost layer of the forest canopy. The stratum known as the shrub layer is positioned at an elevation of 5-20 feet (1.5-6 meters) above the earth's surface and is primarily composed of shrubs and young trees. The distinct attributes of each stratum can be attributed to variations in water composition, solar exposure, and air circulation patterns. While the layers of the system are distinct, they exhibit interconnections wherein the activities and organisms inside one layer exert an influence on the others.

The term "canopy strata" pertains to the several vertical layers inside the forest canopy. It is crucial to comprehend the canopy strata of various species, such as the long-tailed macaque (*Macaca fascicularis*), as it facilitates comprehension of their habitat utilization, feeding patterns, and overall ecological dynamics. The long-tailed macaque species is recognized for its remarkable capacity to thrive in diverse ecological settings, which is exemplified by their utilization of the canopy strata as a demonstration of their adaptability. The utilization of the stage canopy by *Macaca fascicularis* is significantly influenced by the structural characteristics and compositional attributes of the surrounding forest environment.

Furthermore, the study revealed that long-tailed macaques exhibit a preference for utilizing the ground level. The predominant activity seen in *Macaca fascicularis* individuals within Taman Pd Utama is movement behaviour. The long-tailed macaques residing within the designated study region exhibit a propensity for engaging in vertical motions. Vertical movement inside the tree canopy can be achieved through the utilization of a climbing mechanism, allowing individuals to transition from one level of the canopy to another by means of jumping. The long-tailed macaque's habitat plays a significant role in determining its circumstances. The content and structure of the forest in a given area are determining factors for the stage canopy utilized by these primates. According to Ungar (1996), primates can vertically traverse various tree heights, enabling them to access a wide range of food sources.

Certain species within the studied population exhibit a substantial amount of temporal investment in lower canopy levels, specifically with alternative levels within the canopy structure. The dispersion of food sources, namely the presence of scattered food items on the ground and beneath the tree canopy, contributes to the foraging behaviour of long-tailed macaques. Consequently, these individuals exhibit collective behaviour and their locomotion is confined within proximity to the designated research site.

2.3 Distribution of Long-tailed Macaque

Macaca fascicularis is a crab-eating or long-tailed macaque found throughout the tropical mainland and Southeast Asia (Fooden 1995). This species' native range extends south and east from India (the southernmost three Nicobar Islands) to southernmost Bangladesh, where populations have been completely devastated by prawn farming and shipbuilding and southern Myanmar. In a global

context, the distribution of the genus *Macaca* extends from Gibraltar (the only area where the genus *Macaca* is found in Europe) and northern Africa across Asia, including Afghanistan, India, Tibet, Sri Lanka, and further east, including the small islands in the surrounding area, all the way to Japan.

The long-tailed macaque is the most successful primate species because it has a wide geographic distribution. The species is most common in lowland locations, where it favors coastal and mangrove forests, riverbanks, and swamp forests (Fooden, 1995), all of which are threatened by global warming. The long-tailed macaque lives in Southeast Asia near latitude 20°N 10°S and longitude 92°E 120°W. Its range also includes from the southern part of Indochina which is Thailand, Cambodia, Laos, and Vietnam, south of 17°N to the Malay Peninsula (Singapore), Sumatra, Borneo, Java, and the Lesser Sunda Islands (Bali and Timor), and the Philippines. Therefore, long-tailed macaques are found in various human-inhabited islands, including Langkawi Island, Penang Island, Pemanggil Island, Aur Island, Tinggi Island, and Redang Island.

2.4 Habitat of Long-tailed Macaque

Long-tailed macaques are known to occupy many habitats, encompassing forested regions near urban centers, public parks, waste disposal sites, religious sites, and residential zones. They exhibit a preference for habitats near water sources and disturbed forests, displaying a greater inclination towards such locations as opposed to densely forested regions. The macaque species can be found inhabiting various environments, including logging sites, agricultural fields, and gardens. Based on the findings of Fooden, (1995), the species exhibit characteristics of generalism and opportunism, enabling them to successfully inhabit diverse environments such as woods, beaches, hills, and mountains.

Long-tailed macaques often inhabit regions near bodies of water and wetlands, predominantly found inside rainforests, bamboo forests, and mangrove forests. Throughout most of the day, these organisms primarily inhabit arboreal environments and solely descend from their elevated positions to forage for sustenance. This phenomenon is predominantly observed within mangrove forests and wetlands, particularly in riverine environments. Nevertheless, it is frequently observed in anthropogenically modified environments, such as temples, roadsides, agricultural regions, and rural/urban towns (Gumert, 2011).

CHAPTER 3

MATERIALS AND METHOD

3.1 Study Area

This study was conducted in the Taman Pd Utama ($2^{\circ}30'58.8''\text{N}$ $101^{\circ}49'49.6''\text{E}$), which is in the Port Dickson district, this area is located between the forest and the beach, which is an area suitable for use as a habitat for long-tailed macaques (Figure 3.1). The topography of this area is flat and slightly hilly. Not only that, long-tailed macaques often use electric poles and cables to move from one place to another. They are more likely to go through that road where they move to Taman Pd Utama to find food.



Figure 3.1: The location of the study area. (Source: Google Maps 2023)

3.2 Materials

These are the materials that have been used in this study to obtain data about the ranging behaviour of long-tailed macaques in Taman Pd Utama, Port Dickson, Negeri Sembilan. Binoculars were used to confirm the identification of long-tailed macaques. The latitude and longitude coordinates of the point counts were then recorded using the Global Positioning System (GPS). Cameras are also used to capture images that were used as evidence in research. The materials are presented in Table 3.2

Table 3.2 Field equipment used for data collection.

Material	Picture
Binocular	
Global Positioning System (GPS)	
Camera	

(Photo source: Google Image)

3.3 Method

3.3.1 Finding the location of long-tailed macaque

Researchers walked throughout the study area to locate groups of long-tailed macaques and where they are often found. This study uses observational methods by observing the horizontal and vertical movements of long-tailed macaques. This observation was carried out for 20 days and was done for 6 days a week between the hours of 0800 a.m to 1200 p.m and 1500 p.m to 1900 p.m. The data obtained was recorded using an ethogram at 10-minute intervals. This research also focuses on forest areas and their natural food supply. The distance between the residential area and the long-tailed macaque habitat is only a few meters. In this study, this species constantly waits for food from humans either directly or indirectly by placing food scraps within their reach such as in trash cans. Bad weather conditions can affect the search for long-tailed macaques because the species will not go out looking for food when it's raining and hot. This is because they spend more time resting, playing, grooming, feeding, mating, and moving.

3.3.2 Observing the long-tailed macaque

To observe the ranging of behaviour of these long-tailed macaques, binoculars were used to determine the canopy level and distances used by the long-tailed macaques. Cameras are used to capture pictures and record videos of their ranging of behaviour. This item helps provide a better and clearer view of the observation of the species. This is because it maintains a safe observation distance of at least 4 meters.

3.3.3 Ranging data collection

The Instantaneous Scan Sampling Method was used to collect data on ranging behaviour, as suggested by Altmann (1974), Lehner (1979), and Martin and Bateson (1986). The data provided relates to the horizontal and vertical displacement of the study group, which consistently positioned itself along the road throughout the morning and evening hours. In this research effort, researchers used binoculars to conduct observations of the ranging behaviour of long-tailed macaques, while at the same time using cameras to document their ranging behaviour patterns. They used binoculars to see the movement of the group because they could not see the group of monkeys from close range. When researchers look from a distance, they can escape from being threatened by the species. The monkey's attention is attracted by their distinctive and individualistic approach. This methodology allows researchers to effectively observe the behaviour and movement of primates as they traverse the uppermost layers of the forest. The researchers also used the same instantaneous scan sampling method to document the vertical movement of groups of monkeys in each territory they traversed. During the initial observations, they recorded daily the vertical movements used by the group. According to the data provided, the height records are categorized into five different forest canopy strata, as documented by Whitemore (1993). Hence, this approach facilitates the researchers' ability to effectively ascertain or gather data on the ranging behaviour exhibited by macaques in Taman Pd Utama.

Table 1. Classification of tree height according to forest canopy strata
(Whitemore, 1993)

Canopy Strata	Code	Height (m)	Description
Emergent	EM	> 36	The crown of the forest is formed by a number of tall trees.
Upper Canopy	UC	26-35	The highest forest strata are formed loosely by interconnected tall tree crowns.
Middle Canopy	MC	16-25	Middle forest strata are formed by tightly enclosed tree crowns of medium-sized trees.
Lower Canopy	LC	6-15	Lower forest strata are formed loosely by sparsely distributed small tree crowns.
Ground Level	GL	0-5	Ground level including stream and riverbanks and understory vegetation consists of herbaceous trees and bushes.

3.3.4 Data analysis

The Chi-Square (χ^2) test was used to determine the ranging behaviour of long-tailed macaques. This makes it easier to identify the canopy level and distance used by *Macaca fascicularis*. The data collected was also analyzed using Excel.

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

χ^2 = Chi-Squared test statistic

O^i = Observed frequency in each category

E^i = Expected frequency in each category

The sum is taken over all categories.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 General Results of Observation

Table 4.1 Percentage and frequency of the daily distance by *Macaca fascicularis*

Distance (m)	Observation	Percentage (%)	$\frac{(O-E)^2}{E}$
100	483	38.30	89.263
200	399	31.64	22.249
300	281	22.28	3.721
400	98	7.77	149.715
Total	1261	100%	264.948

The Chi-Square test results indicate a significant difference in the distribution of distances traveled by long-tailed macaques, with the majority of movements within 100 meters. The study notes specific times of day when macaques are most active, correlating with temperature and comfort. The proximity to human settlements and the availability of anthropogenic food appear to influence the macaques' ranging behaviour. Figure 4.1 effectively visualizes the daily distances traveled by macaques, reinforcing the data presented in Table 4.1.

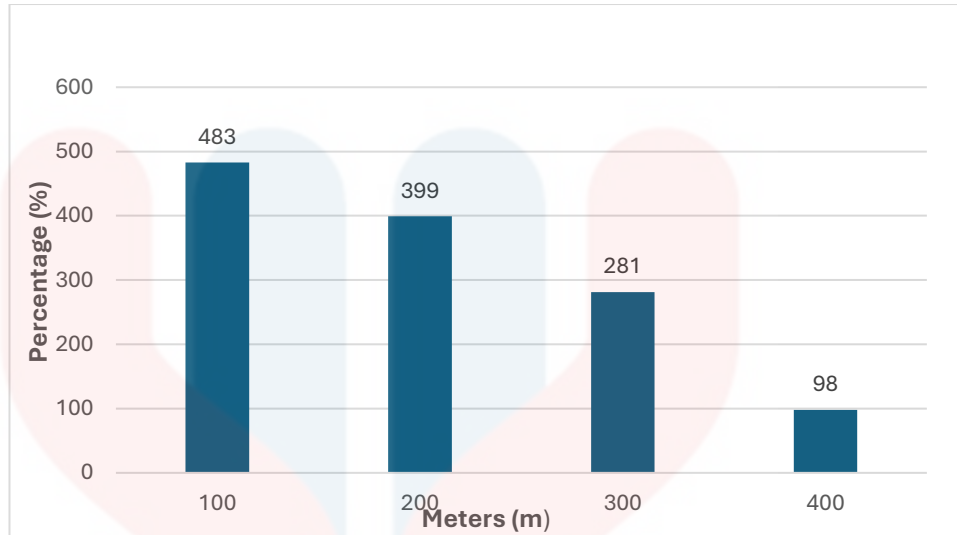


Figure 4.1: The graph shows the daily distance used by *Macaca fascicularis*

Long-tailed macaques are social animals that travel in groups. This is to ensure that group members can easily hear vocal warnings if there are predators in the environment (Hambali et al., 2012). Movement is the most important daily activity performed by long-tailed macaques compared to other activities throughout the day (Sia, 2004; Suhailan, 2004; Md Zain et al., 2010; Hambali et al., 2012). The movement of long-tailed macaques in the study location is divided into two types, namely vertically and horizontally. Following the study group for days has provided detailed information about their daily journeys in the study area. Table 4.1 shows the percentage and frequency of the daily distance used by *Macaca fascicularis*. In this study area, the amount for this sampling is for 20 days where the daily movement of the study group varies from time to time.

In this study conducted in Taman PD Utama, the study found that long-tailed macaques mainly travel within a distance of 100 to 400 meters on a regular basis. A Chi-square test revealed statistically significant variation in the distribution of these distances was significantly different ($\chi^2 = 264.948$, $df = 3$, $p < 0.0001$). At

0820a.m., the long-tailed macaques start coming out of the forest to wander in search of food while at 1100a.m., they will return to the forest again to rest from wandering. Then, they will go out again to continue traveling at 1600p.m. and they will also stop traveling at 1700p.m. This is because long-tailed macaques prefer to travel in the morning. After all, the temperature is more comfortable. Where, the movement distance used at 100 meters is (38.30%), followed by 200 meters (31.64%), 300 meters (22.28%), and 400 meters (7.77%). In addition, long-tailed macaques often travel within a range of 100 meters which is as many as 483 times, 200 meters as many as 399 times, and 300 meters as many as 281 times in a day. This is said to be so because, this pattern shows that long-tailed macaques prefer to travel shorter distances covered each day, which may be influenced by the presence of abundant food supplies close to human populations. Then, the distance of 400 meters is the least used distance which is 98 times. This is because the area has limited food resources causing the long-tailed macaque to travel further to find food. The pattern of movement and horizontal use of resource space by the study group is shown in graph 4.1. The availability of anthropogenic food reduces the need to forage long distances, limiting their daily movements to more predictable locations and abundant resources (Altmann, 1974).

Macaques use strategic areas close to human activity, frequenting locations such as nearby residential areas. Macaques have adapted to human-dominated environments, often interacting with humans and utilizing anthropogenic structures. This adaptation can lead to changes in their behaviour, such as reduced social interaction when human traffic is high. This behaviour is consistent with previous studies that suggest long-tailed macaques adjust their movement patterns in response to food availability and human presence (Hambali et al., 2012; Sha &

Hanya, 2013). The tendency to live close to human settlements, where food is easily accessible, shows their opportunistic approach to finding food, as seen in previous research (Aldrich-Blake, 1980).

Table 4.2 Percentage and frequency of the usage of trees canopy level by the study group

Canopy Strata	Observation (O)	Percentage (%)	$\frac{(O-E)^2}{E}$
Ground Level (GR)	501	32.94	127.318
Lower Canopy (LC)	431	28.34	52.854
Middle Canopy (MC)	315	20.71	0.383
Upper Canopy (UC)	219	14.40	23.863
Emergence (EM)	55	3.62	204.144
Total	1521	100%	408.563

*Showed significant ($p < 0.0001$) by using the Chi-square test (χ^2), 408.563 with 4 degrees of freedom.

The long-tailed macaque is an arboreal animal that moves vertically using the tree canopy. Consequently, in addition to horizontal mobility, they require vertical movement to use each level of the tree canopy to eat, rest, sleep, shelter, and protect themselves from predators. Primates can explore diverse food sources at tree heights that vary by vertical movement (Ungar, 1996). The use of the stage canopy by long-tailed macaques is highly dependent on the structure and composition of the forest in an area. This is also comparable to the way primates use terrestrial space, where they must adapt and be careful with every movement or action toward their environment. Table 4.1 shows the total frequency of the canopy level used by the long-tailed macaque which is 1521 times.

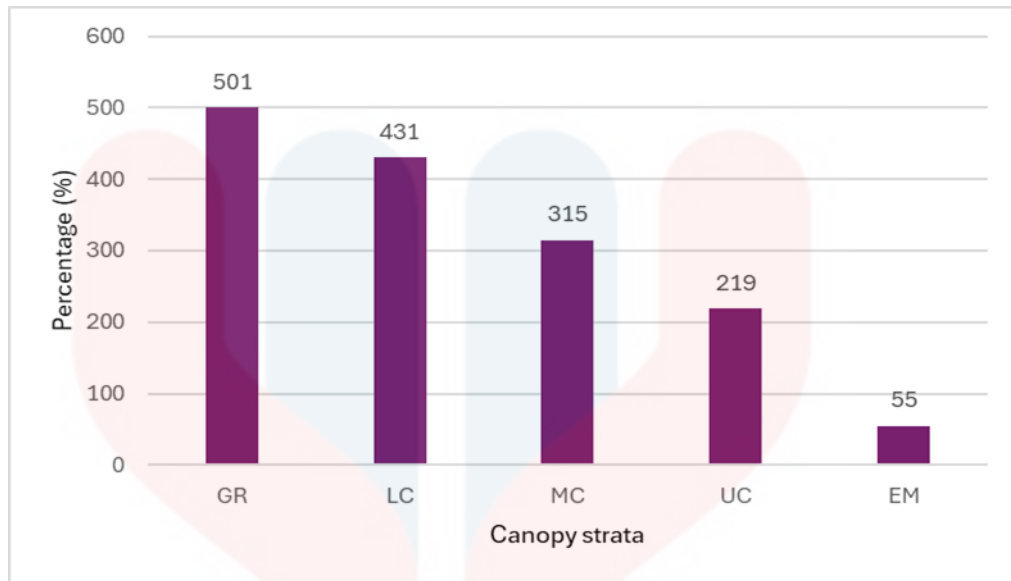


Figure 4.2 Pattern of canopy use by *Macaca fascicularis*.

In the study conducted, it was found that the long-tailed macaque spends most of its time on the ground, lower canopy, and middle canopy compared to other canopy levels. Records of canopy use by *Macaca fascicularis* are shown in figure 4.2. It was found that the study group mostly prefers to use ground level followed by the lower canopy, middle canopy, upper canopy, and least of all emerging trees. Monkeys are the most common in the ground level (32.94%), lower canopy (28.34%), and middle canopy (20.71%), while they are less common in the upper canopy and emergence level (14.40% and 3.62%), respectively. The stratification in canopy use observed in these organisms is a result of their ability to adapt to both terrestrial and arboreal environments. This adaptation allows them to effectively exploit diverse food sources and avoid predators. Vertical movement patterns of macaques suggest a preference for the ground level, followed by the lower and middle canopy. A Chi-Square test resulted in a statistically significant difference in the use of various canopy levels ($\chi^2 = 408.563$, $p < 0.0001$), $df = 4$. The desire for lower strata can be related to greater food availability and the need for a fast way to

avoid potential danger.

Table 4.2 shows that from 0820a.m to 1030a.m, they are on the ground and lower canopy to search for food. This is because they are more likely to find food in the morning. Body temperature regulation is also an important reason for apes choosing to sit on the ground and lower canopy. The soil can provide a cooler or warmer place depending on the weather conditions. On a hot day, the shaded ground provides a more comfortable place to relax and avoid overheating. While in the cold morning, sitting on the warm ground can help monkeys regulate their body temperature. The lower canopy also often has a more stable and comfortable temperature than the upper canopy which is more open to direct sunlight. At 1200p.m to 1600p.m hours, the long-tailed macaque prefers a high canopy to rest in search of food. A high canopy level provides better and safer protection from other predators. Living on trees makes monkeys more difficult for predators to reach. Researchers found that the long-tailed macaques frequented their ground level and lower canopy in the same way during the morning and evening sessions.

Furthermore, long-tailed macaques often travel from one location to another in search of food from various sources. When looking for food, long-tailed macaques use special techniques to avoid competition. Because long-tailed macaques have a large number of group members, they were separated into small groups when searching for food, which is the most successful approach to avoid conflicts between group members. Another tactic that can be observed is that the long-tailed macaques in the lower hierarchy approach the food first before the higher-hierarchy macaques take over the feeding location and force the lower-hierarchy monkeys away. There are also situations where monkeys from higher canopy levels have obtained food first before leaving surplus food for the monkeys

of a lower hierarchy to eat.



Figure 4.3 shows a group of *Macaca fascicularis* at ground level



Figure 4.4 shows the *Macaca fascicularis* at lower canopy and middle canopy



Figure 4.5 shows that *Macaca fascicularis* resting

Then, the long-tailed macaques rest for a while in the afternoon, when the weather is very hot. Long-tailed macaques were choosing areas suitable for resting and sheltering, such as tree branches and under trees. Long-tailed macaques are said to rest in the middle canopy, upper canopy, and emergent. A long-tailed monkey that does not rest was seized the opportunity to find food. Long-tailed macaques usually do not rest for long periods during the day as they are constantly searching for food and filling their stomachs to survive the night. As a result, they are referred to as diurnal animals, meaning they are active during the day and passive at night. However, the time spent in each region differed significantly between the morning and evening sessions, with the highest canopy-level sites being preferred at night. Overall, monkeys spend most of their time at the lowest levels, namely ground level and the lower canopy.

The study suggests that macaques adapt their ranging behaviour based on food availability and human presence. The Chi-Square test confirms significant differences in canopy level usage, with a preference for ground and lower canopy

levels. The study highlights the importance of vertical movement for accessing diverse food sources and avoiding predators. The figures provide clear visual evidence of the macaques' use of different canopy levels and interactions with human environments. The resting patterns of macaques, particularly their preference for higher canopy levels during hotter parts of the day, are well-documented. The study provides valuable insights into the daily movement and behaviour of long-tailed macaques in a human-dominated environment. Understanding the ranging behaviour of macaques is crucial for developing effective conservation and management strategies.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Studies on the ranging behaviour of long-tailed macaques (*Macaca fascicularis*) in Taman Pd utama provide valuable insights into their movement patterns and canopy use. The results show that these primates mainly travel within a distance of 100 to 400 meters and the majority of their time is spent on the ground level, lower canopy, middle canopy, upper canopy, and emergence. Movement patterns are influenced by factors such as food availability, human presence, and temperature regulation, which are important for their survival in the environment. The study found that there was a significant difference in the distribution of the daily distances traveled by the monkeys, with the most frequent distances being 100 meters (38.30%), 200 meters (31.64%), and 300 meters (22.28%). The least used distance is 400 meters (7.77%). This suggests that macaques prefer shorter journeys, which may be influenced by the presence of abundant food supplies close to human populations. Macaques also exhibited a preference for using ground level (32.94%), lower canopy (28.34%), and middle canopy (20.71%), with ground level being the most frequently used (32.94%). This may be due to food availability and the need to regulate body temperature. The lower canopy provides a more stable and comfortable temperature than the upper canopy, which is more open to direct sunlight. In conclusion, this study provides a comprehensive understanding of long-tailed macaque ranging behaviour, including movement patterns and canopy use.

5.2 Recommendations

A detailed study of *Macaca fascicularis* at Taman Pd Utama, Port Dickson revealed several crucial observations and discoveries that highlight the primate's broad ranging of behaviour. The data collected in this study can be utilized as a baseline for future research, particularly in estimating the ranging behaviour of long-tailed macaques throughout the day. The data obtained in this study could be used as a baseline for future and further study, especially to understand the ranging behaviour of long-tailed macaques. The study also highlights the need for effective conservation and management strategies to protect long-tailed macaque populations and their habitats. For example, the identification of vertical and horizontal movements.

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