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**DIETARY OF DUSKY LEAF MONKEY
(*Trachypithecus obscurus*) AT TAMAN PD UTAMA,
PORT DICKSON, NEGERI SEMBILAN,
PENINSULAR MALAYSIA**

by

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DECLARATION

I declare that this thesis entitled “Dietary of Dusky Leaf Monkey (*Trachypithecus obscurus*) 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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Dietary of Dusky Leaf Monkey (*Trachypithecus obscurus*) at Taman PD Utama,
Port Dickson, Negeri Sembilan, Peninsular Malaysia

ABSTRACT

The dusky leaf monkey (*Trachypithecus obscurus*), also known as the spectacled leaf langur, is an endangered folivorous primate native to regions from Peninsular Malaysia to India. Due to urban development, especially in areas like Port Dickson, Malaysia, these arboreal monkeys face habitat loss, leading them to adapt to living in residential and urban areas. Due to human and wildlife conflict in 2021 in Port Dickson related to this animal, this study was conducted to investigate the eating habits of dusky leaf monkeys in Taman PD Utama, Port Dickson to preserve and protect this animal from decreasing. Examine the types of plants and the parts used to understand their adaptation to environmental changes and make a diet comparison between the dusky leaf monkey in the study area and other locations. Observations over a one-month period reveal that these primates rely heavily on folivores but also consume soil to their diet with essential minerals. The findings contribute to understanding the evolutionary processes enabling these primates to adapt to urban environments, highlighting the importance of preserving their natural habitats to maintain biodiversity and ensure their survival. This study provides valuable data for conservation efforts and management strategies aimed at protecting the dusky leaf monkey in urbanized areas.

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ABSTRAK

Lotong cengkong (*Trachypithecus obscurus*), atau juga dikenali sebagai Lotong bercelak adalah dikategorikan sebagai primata tempatan yang terancam, kepupusan yang boleh dijumpai dari kawasan semenanjung Malaysia hingga ke India. Disebabkan oleh pembangunan, terutama sekali di kawasan seperti Port Dickson, Malaysia, primata yang tinggal di atas pokok ini menghadapi kehilangan habitat, yang membuatkan mereka terpaksa beradaptasi dengan keadaan semasa iaitu hidup di kawasan perumahan dan kawasan bandar. Kemudian, disebabkan oleh konflik manusia dan hidupan liar pada tahun 2021 di Port Dickson yang berkaitan dengan primata ini, kajian ini dilakukan untuk mengetahui tentang pemakanan lotong bercelak ini di Taman PD Utama, Port Dickson agar dapat melakukan aktiviti pemuliharaan dan penjagaan hidupan ini daripada berkurang atau kepupusan. Kajian ini juga ingin mengetahui jenis makanan yang diambil dan bahagian tumbuhan mana yang kerap dimakan oleh primata ini berkaitan dengan pengadaptasian persekitaran yang berubah. Selain itu, perbandingan lotong bercelak dengan primata pemakan daun yang lain di lokasi yang berbeza juga dilakukan untuk mengetahui lebih mendalam tentang pemakanan primata ini. Pemerhatian yang dilakukan selama sebulan dilakukan ini menunjukkan bahawa primata ini adalah sejenis primata yang memakan daun namun tetap mengambil benda lain seperti tanah untuk mendapatkan mineral tambahan. Penemuan ini menyumbang kepada pemahaman proses evolusi yang membolehkan primata ini menyesuaikan diri dengan persekitaran bandar, menonjolkan kepentingan memelihara habitat semula jadi mereka untuk mengekalkan biodiversiti dan memastikan kelangsungan hidup mereka. Kajian ini menyediakan data berharga untuk usaha pemuliharaan dan strategi pengurusan yang bertujuan untuk melindungi lotong bercelak di kawasan bandar.

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LIST OF ABBREVIATIONS

df	Degree of Freedom
IUCN	International Union for Conservation of Nature
PD	Port Dickson

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LIST OF SYMBOL

E_i	Expected Value
χ^2	Chi-Square
Σ	Sum
%	Percentage

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The dusky leaf monkey was easy to recognize because of the white colour that surrounds their eyes like spectacles (Md-Zain & Ch'ng, 2011). There are several names refer to this species which the Spectacled Leaf Langurs, Dusky Langurs, and Spectacled Langurs. In Malaysia, the native calls, “*Cengkong*”, “*Lotong mata putih*” or “*Lotong bercelak*” because on its characteristics (Md-Zain & Ch'ng, 2010). The langurs were distributed from peninsular Malaysia to India (Karimullah, et al., 2014). The dusky leaf monkey lives primarily in trees and can be found in both lowland and hill woods. Moreover, it can be found in different settings such as parks, botanical gardens, urban, riverine, and coastal woods (Francis & Barrett, 2008; Md-Zain et al., 2010). In 2015, the IUCN Red List of Threatened Species classified this species as Endangered (Traeholt, 2015).

The primary canopy and the emergent layer of the forest are where the dusky leaf monkey likes to forage (Fleagle, 1977; Hambali et al., 2016). This species is a folivore, meaning it eats flowers, fruits (especially the ripe ones), seeds, and leaves (Francis & Barrett, 2008). The dusky leaf monkey (*Trachypithecus obscurus*) is a folivorous primate belonging to the family Cercopithecidae (old world monkey) and

under the subfamily Colobinae (which are mainly arboreal, lacks cheek pouches, have long tail and a large, sacculated stomach with many chambers) (Groves, 2001; Francis & Barrett, 2008). During the day, the langurs divided into smaller groups to survive (Rahman et al., 2020). When foraging, this species will rest on large branches while eating (Siti-Kauthar et al., 2019).

Several states were transformed into urban areas in 1990, including Kuala Lumpur, Selangor, Melaka, and Negeri Sembilan. This is due to the growing Malaysian capital's economy (Chin Siong, 2008). Port Dickson, Bangi, Seremban, and Shah Alam are all places that are currently developing (Hasan & Nair, 2014). Population figures show that 129,000 people live in Port Dickson as of 2020, which is more than the state's 2010 population estimates. The population growth in Port Dickson is indicative of the growing need for settlement. Thus, to accommodate the population and boost the nation's economic growth, many forest areas must be opened (Star Media Group, 2022). However, it will have an impact on the wildlife in the area. The desire for new homes drives the expansion of forests. Deforestation leads to habitat loss while preservation and conservation of the natural forest increase biological diversity (Bodo et al., 2021). The study area is a residential area for locals who work around Bagan Pinang Beach. There are several industrial and agricultural areas around the residential area. So, it can be said that the opening of the area was caused by the impact of urban development in Port Dickson.

1.2 Problem Statement

This species is an endangered species that has been listed by the IUCN. This is because the habitat of the species has been threatened by development in its original habitat. This species that lives arboreally that is living on trees had to move and adapt to living in very limited residential areas, parks, and cities. Due to the adaptation that occurs by this species, the type of food taken may also be different due to limited resources in limited areas. In the study area, no further studies have been done yet to understand the behavior of this species. Therefore, to conserve this primate in the area it is necessary to identify the important plant species it consumes and examine its primary food sources and dietary preferences. This knowledge will help understand how the the dusky leaf monkey selected resources in its natural habitat better. Lastly, on 21 January 2021 Port Dickson has a human-wildlife conflict which is close to the study area (Sulaiman, 2021). This is why the study area has been chosen.

1.3 Objective

- i. To determine the dietary of the dusky leaf monkey at Taman PD Utama, Port Dickson, Negeri Sembilan, Peninsular Malaysia.

1.4 Scope of Study

This study focused on the dusky leaf monkey food type and type of plants parts taken in the Taman PD Utama area, Port Dickson, Negeri Sembilan. The study area was a residential area with nearest the secondary forest and palm plantation area. This study to carried out for one month with observation methods. Within a month, only 20 days are taken to get the data. The study area was a residential area with nearest the secondary forest and palm plantation area.

1.5 Significance of Study

This study can identify the evolutionary processes that allowed these primates to take advantage of food sources and adapted to changing environmental conditions by closely examining these animals. This study can also learn more about the kinds of leaves, fruits, and other plant components that are most important to them by examining their dietary preferences. Furthermore, by examining the dusky leaf monkey's feeding habits, such as selective browsing or leaf handling, this study can comprehend the special adaptations that have allowed the species to survive in its ecological niche. The startling range of primate species present in a variety of settings is revealed by this study, which advances our understanding of primate evolution and adaptation. So, this study is useful for any party that wants to get data on these animals in the study area and for management in conserving these primates.

CHAPTER 2

LITERATURE REVIEW

2.1 Taxonomy of Dusky Leaf Monkey

The Cercopithecidae subfamily, which includes cheek-pouched monkeys, and the Colobinae subfamily, which includes leaf monkeys, are also known as cercopithecines and colobines, respectively, under the family Cercopithecidae (Napier & Napier, 1967). A species of primate, the dusky leaf monkey is a member of the subfamily colobinae and family Cercopithecidae. To support the statement, Page et al. (1999) studies said, the evolutionary relationships between 16 species in the family Cercopithecidae utilising genetic material from Old World monkeys, including *Trachypithecus obscurus*. To prove that *Presbytis* and *Trachypithecus* are indeed two separate genera, Md-Zain et al. (2005, 2008) used *T. obscurus* as a representative of *Trachypithecus*. This species belongs to family Cercopithecidae (Old World monkeys) and under subfamily Colobinae (Francis & Barrett, 2008). *T. obscurus* is a species in the subfamily Colobinae, with 11 subspecies including *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* (Brandon-Jones et al., 2004; Roos et al., 2014). Based on the website IUCN Redlist (2015), the spectacled leaf langur average lifespan was around 12 years.

2.1.1 Morphology of Dusky Leaf Monkey



Figure 2.1: Appearance of dusky leaf monkey

The distinctive features of dusky leaf monkey (*Trachypithecus obscurus*) are also known as the Spectacled leaf langurs, Dusky langurs, and Spectacled langurs. In Malaysia, the locals' calls, "Cengkong", "Lotong mata putih" or "Lotong bercelak" because on the characteristics (Md-Zain & Ch`ng, 2010). The name given was based on their characteristic such as because their diet was leaf, appearance has a white colour patch surrounding the eyes which looks like wearing a spectacle, with a greyish brown to dark grey fur depends on the subspecies. Other than white surround eyes, these species also have a white cream colour on their mouth and have a white colour on their head and stomach patch. While the young dusky leaf monkey has a pink face and is yellow to light orange in colour. The infant fur will become grey or brown in about six months. Next, Pan and Oxnard (2003)



Figure 2.2: shows infants with its mother.

Conducted a dental morphometric analysis on Asian colobines, which shed light on the perspectives around their phylogeny and functional adaptability. This statement shows that trigonid molars, small incisors, and high-crowned molars with long, short shear crests are characteristics of the colonies which, based on similarities in their oral morphology and nutritional preferences, four groups (*Rhinopithecus*, *Semnopithecus*, *Trachypithecus*, and the *Nasalis*, *Pygathrix*, and *Presbytis*) were discovered. These primates are defined as those that process leaves and related foods mostly using their posterior teeth, utilising their anterior teeth only occasionally. Nonetheless, it has long been known that leaf monkeys differ in their anterior and posterior tooth morphology (Wright & Willis, 2012). Lucas and Teaford's (1994) findings provide support for the idea that colobine's dental morphology facilitates the efficient digestion of fibrous material.

2.1.2 Anatomy of Dusky Leaf Monkey

A group of monkeys from Southeast Asia and Africa known as colobines only eat the high-fiber leaves, fruits, and seeds of trees in the wild (Nijboer et al., 2006). Colobines are medium- to large-sized monkeys (4–20 kg), separating themselves from cercopithecines by having a saccular stomach (like a cow) and larger cusps on their molars (Fleagle & Seiffert, 2017). Unlike other sympatric hindgut-fermenting primates, they can take advantage of a diet of leaves in larger quantities because their ability to metabolise food allows bacteria to detoxify defensive compounds and breakdown cellulose (Chivers, 1994).

2.2 Dietary

According to McClure (1964) and Md-Zain & Ch`ng (2010), The dusky leaf monkey is adapted to be a folivore primate. A folivore is a type of herbivore in zoology that specialises on consuming leaves. Based on Jones et al. (1994) Mature leaves contain a high proportion of hard to digest cellulose, less energy than other types of foods, and often toxic compounds. For this reason, folivorous animals tend to have long digestive tracts and slow metabolisms. Additionally, he also has observed in folivorous primates, they exhibit a strong preference for immature leaves which tend to be easier to masticate, are higher in energy and protein, and lower in fibre and poisons than more mature fibrous leaves. According to Hasson (1994), a cue is any characteristic that can be utilised to influence behaviour. This statement is supported by Williams (1992) and Maynard Smith & Harper (2003), a characteristic is considered a signal if it is adaptive for the sender and arises from natural selection-related mechanism. They also consume the fruits and flowers of many different plant species (McClure, 1964; Yap et al., 2019). The sympatric *T. o. obscurus* ate leaves

and seeds from urban and cultivated plants, but they refrained from eating the anthropogenic food sources (Ruslin et al., 2018). *T. o. obscurus* was a folivorous animal that ingested a comparatively high quantity of fruits and seeds; in particular, it was shown to ferment its foregut (Curtin, 1980). Tendency to eat fruit for longer periods of time. Colobines are thought to stay away from sugary food sources, such as ripe fruits, which can lower fermentation efficiency, produce acidosis, or even be fatal in severe circumstances (Collins & Roberts 1978; Kay & Davies 1994). According to Danish et al. (2006), ripe fruits are considered a significant source of nutrition. Nevertheless, little is currently known regarding the precise mechanism of colobine digestion in relation to the management of hazardous fermentation sugars in the forest. *T. o. obscurus* will only consume when fruit is accessible, according to a study by Ruslin et al. (2018). This shows that this species will prioritise food if available. *T. o. obscurus* ate a comparatively large quantity of ripe fruits. To support the statement, *Trachypithecus* is reported to rely more on leaves than any other Asian colobine and consumes more young leaves than mature leaves (Ruslin et al., 2018). The subjects in the study consumed not just green plant components such as invertebrates, clay soil, and tree bark of rotting wood. In order to gain nutrients like salt and protein, langurs frequently consume invertebrates that live in plants, soil, and tree bark (Rahman et al., 2015).

2.3 Habitat and Distribution

The dusky leaf monkey are arboreal primates that inhabit primary and secondary forests (Priston & McLennan, 2012; Ungar, 1995) and are adapted to a leaf-eating diet (folivore) (McClure, 1964). Furthermore, it is found in a variety of environments, including urban, riverine, coastal, and parks (Francis, 2008).

According to Chivers, (1989) that the dusky leaf monkey taking advantage because of the most available food that available there, they have an important relationship with the top rainforest layer. Primates living on the border of the forest close to nearby cities, where human-produced food is available together with naturally occurring foods from cultivated plants.

The dusky leaf monkey inhabits Peninsular Malaysia, Myanmar, Thailand, and the adjacent islands (Groves 2001; Md-Zain and Chung 2011; Roos et al. 2014). The Malaysian Peninsula is home to at least five subspecies. These are *T. o. obscurus* (Reid's dusky leaf monkey) which is the major subspecies in Peninsular Malaysia except along the north coast, *T. o. flavicauda* (Blond-tailed dusky leaf monkey) which is found in northern Peninsular Malaysia, *T. o. styx* (Perhentian dusky leaf monkey) which occurs on Perhentian Island and probably adjacent coastal areas, *T. o. halonifer* (Cantor's dusky leaf monkey) which is mostly restricted to Penang Island, and *T. o. carbo* (Tarutao dusky leaf monkey) which is found on Dayang Bunting Island and Langkawi Island (Brandonn-Jones *et al.*, 2004).

CHAPTER 3

MATERIAL AND METHODS

3.1 Study Area

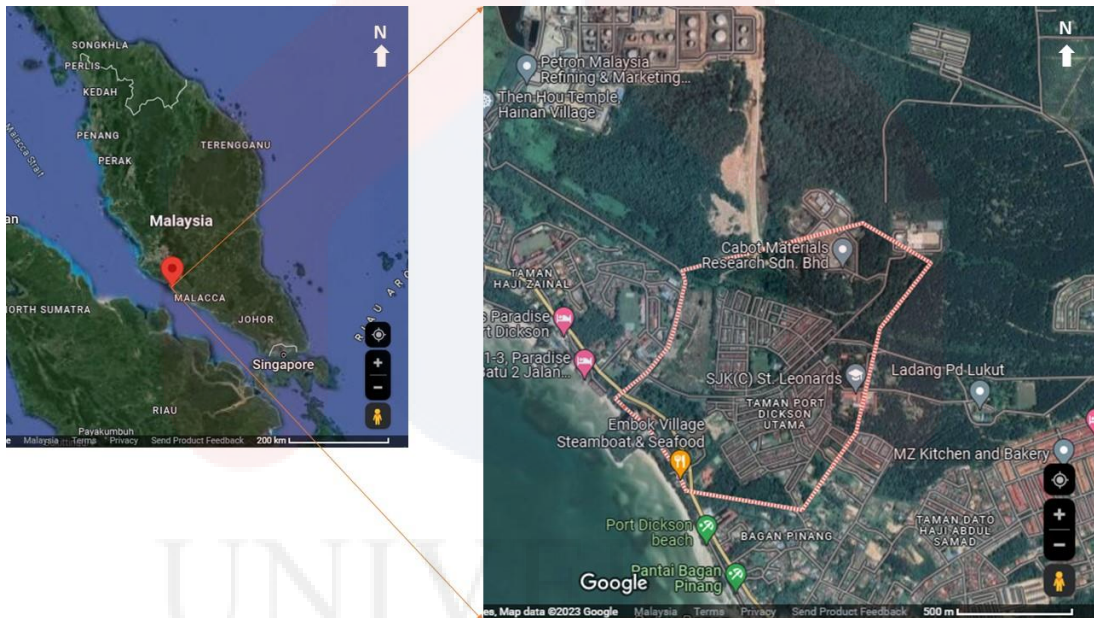


Figure 3.1: Map of study area (Source: Google Maps 2023).


The study area was located at Taman PD Utama, Port Dickson, Peninsular Malaysia ($2^{\circ}30'58.8''$ N $101^{\circ}49'49.6''$ E), which is a residential area surrounded by secondary forest (Figure 1). The secondary forest around the study area is a privately owned swamp forest. Besides that, the area also has agricultural areas which are oil palm plantations. There are several large trees around the area used as landscaping for Taman PD Utama and many plants grown by the residents. The free ranging

species of *Trachypithecus obscurus* are available in abundance in this residential area to find food from the local's crops. Besides dusky leaf monkey, there were also others primate species in the study area, known as long-tailed macaques (*Macaca fascicularis*), silvered-leaf monkeys (*Trachypithecus cristatus*), and White-thighed surili (*Presbytis siamensis*). However, this study only focused on the dusky-leaf monkeys.

3.2 Materials

These are the materials will be used to carry out the study in Taman PD Utama, Port Dickson, Negeri Sembilan to gather information on the dusky leaf monkey's foraging behaviour.

Table 3.1: List and picture of material with their amount.

Material	Picture
Binoculars	
Camera	

(sources: Google image, 2023)

3.3 Method

3.3.1 Finding the Dusky Leaf Monkey

The dusky leaf monkey was an arboreal species which can be found a group or individual of this species. The researcher focused on upper layer of the trees and the house roof in the study area where that expected were moving or resting. The weather in the study area were influenced the existence of the dusky leaf monkey either present or not. The haphazard sampling was used where the subject was selected on their convenient availability. So, the first group that be found will be the subject for this study.

3.3.2 Observing the Dusky Leaf Monkey

The material that used to observe the dusky leaf monkey was binoculars. Besides, the dusky leaf monkey known as arboreal which is animal that who spend the most of their time on the tree. So, observing the dusky leaf monkey should use binoculars because of the dusky leaf monkey stayed on the tree and hard to get closer. The camera was used to recorded when the dusky leaf monkey eating. Followed while observed this species has limitation because of the study area was nearest the private secondary forest and not allowed to enter.

3.3.3 Data Collection

The observational data by using the binocular were recorded using a standardised ethogram. The time spend was a month in September 2023 but only 20 days were used to collect the data. The food and part of the plant that consumed by that primate was identified.

3.2 Data Analysis

This test used for determining how the distribution of categorical variables differs between two or more independent groups is the Pearson's χ^2 test, named after Karl Pearson in 1900 (Hazra & Gogtay, 2016). The observed data were analysed in Microsoft Excel. Plant parts and types of food eaten will be tested using the Chi Square test. This test used for determined the significant different between each plant part that consumed by the dusky leaf monkey.

$$\chi^2 = \sum \frac{(O - E)^2}{E} \quad (\text{Equation 3.1})$$

where O : The observed count in each cell, and

E : The expected count in that cell.

Following the calculation of the Chi-square statistic, a comparison with the critical value from the Chi-square distribution table guides the decision to either reject the null hypothesis or retain it. This analytical method's objective is to investigate the differences in the plant parts that dusky leaf monkey consumed.

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CHAPTER 4

RESULT AND DISCUSSION

4.1 Types of Food Consumed.

Trachypithecus is reported to rely more on leaves than any other Asian colobine (Suarez, 2013). The dusky leaf monkey was known as a folivore primate which is a type of herbivore that were consuming leaves (Md-Zain & Ch`ng, 2010). This species also consumed other things except plants which were soil, tree bark of rotten wood, and invertebrates because of looking for some minerals like sodium and protein (Rahman et al., 2015). The observation shows the result that this species consumed several types of plant parts and soil as their diet at Taman PD Utama, Port Dickson, Negeri Sembilan, Peninsular Malaysia.

Table 4.1: The number of types of food consumed

No.	Type of food consumed	Total Consumed	Percentage (%)
1	Leaves	53	55.8
2	Flowers	8	8.4
3	Fruits	25	26.3
4	Seeds	6	6.3
5	Others	3	3.2

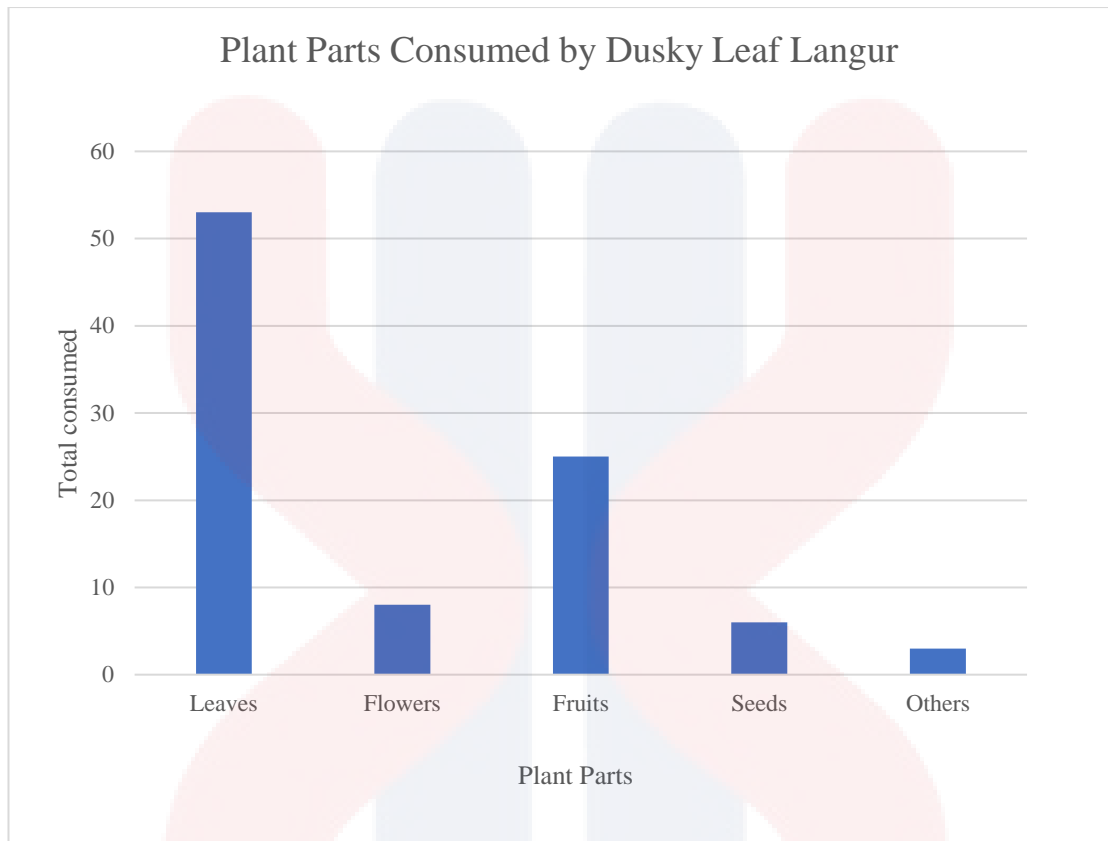


Figure 4.1: The figure shows the plant parts consumed by the dusky leaf monkey in Taman PD Utama.

Table 2 and Figure 2 show the plant parts consumed by the dusky leaf monkey in Taman PD Utama. The type of food consumed by this primate the most was leaves which is 55.8% followed by fruits 26.3%. This species also consumed flowers at 8.4% and seeds which were the lowest plant parts consumed at 6.3%. There were other things that this species takes which is soil with 3.2%. The study area was bordered by a secondary forest that was privately owned, so the results of this survey were limited to the study area that was accessible. The dusky leaf monkey fed on 26 plant species at Taman PD Utama from 21 different families which were mostly planted by the residents.

Table 4.2: Chi-square value of plant part consumed by dusky leaf monkey at Taman PD Utama.

Plant Parts	Observed	Expected	$x^2 = \frac{(O - E)^2}{E}$
Leaves	53	19	60.84210526
Flowers	8	19	6.368421053
Fruits	25	19	1.894736842
Seeds	6	19	8.894736842
Others	3	19	13.47368421
Total	95		91.47368421

The type of plant part was analyzed by using the chi-square test to determine the significant difference between the plant parts consumed by the dusky leaf monkey. Based on Table 3, The Chi-square statistic was 91.474 with 4 degrees of freedom. The two-tailed p-value was less than 0.0001, indicating that the differences in the consumption of plant parts by the dusky leaf monkey are statistically significant. The result suggests that, rather than the pattern being random, the monkeys have preferences or dislikes for plant parts. The dietary habits and ecological adaptations of the dusky leaf monkey in this area are better understood because of these data.

Table 4.3: Food plant species and plant parts consumed by a wild group of *Trachypithecus obscurus* in Taman PD Utama, Port Dickson in September 2023.

No.	Species	Family	Local Name	Consume Parts
1	<i>Acacia auriculiformis</i>	Fabaceae	(darwin blackwattle)	leaves
2	<i>Albizia saman</i>	Fabaceae	(raintree)	leaves, flowers
3	<i>Artocarpus heterophyllus</i>	Moraceae	(nangka)	leaves, flowers
4	<i>Averrhoa carambola</i>	Oxalidaceae	(belimbing)	fruits
5	<i>Bougainvillea</i>	Nyctaginaceae	(bunga kertas)	leaves
6	<i>Cetosema pubesense</i>	Fabaceae	(centro/butterfly pea)	leaves
7	<i>Cissampelos pareira L.</i>	Menispermaceae	(laghu patha)	leaves
8	<i>Comonea umbellata</i>	Euphorbiaceae	(hogrine)	leaves
9	<i>Elais guineensis</i>	Arecaceae	(pokok sawit)	fruits
10	<i>Epipremnum aureum</i>	Araceae	(devil ivy)	leaves
11	<i>Ficus microcarpa</i>	Moraceae	(malayan banyan)	leaves
12	<i>Mangifera indica</i>	Anacardiaceae	(mangga)	fruits, leaves, seeds
13	<i>Manihot esculenta</i>	Euphorbiaceae	(pokok ubi kayu)	leaves
14	<i>Melonthria pendula L.</i>	Cucurbitaceae	(creeping cucumber)	leaves, fruits
15	<i>Mikania micrantha</i>	Asteraceae	(akar lupang)	leaves
16	<i>Morinda citrifolia</i>	Rubiaceae	(indian mulberry)	leaves
17	<i>Moringa oleifera</i>	Moringaceae	(kelor/merungai)	leaves
18	<i>Naphelium lappaceum</i>	Sapindaceae	(rambutan)	fruits, leaves, seeds
19	<i>Passiflora foetida</i>	Passifloraceae	(pokok letup-letup)	fruits, leaves
20	<i>Phyllanthus acidus</i>	Phyllanthaceae	(cermai)	fruits
21	<i>Piper betle</i>	Piperaceae	(sirih)	leaves
22	<i>Pterocarpus indicus</i>	Fabaceae	(angsana/sena)	leaves
23	<i>Pyrrrosia piloselloides</i>	Polypodiaceae	(pokok duit duit)	leaves
24	<i>Terminalia catappa</i>	Combretaceae	(ketapang)	leaves
25	<i>Trema orientale</i>	Cannabaceae	(pigeon wood)	leaves
26	<i>Vitex pinnata</i>	Lamiaceae	(leban/malayan teak)	fruits, leaves



Figure 4.2: Shows the dusky leaf monkey was eating the leaf.

Taman PD Utama was the preferred environment for study area and here they forage significantly more often than at the secondary forest. Usually, the dusky leaf monkeys were spotted at the study area. Typically, langurs can be seen at the start of the observation at the end of the location Taman PD Utama. It can be assumed that they have recently emerged from the secondary forest to search for food. Because there is no competition and the place is safer from potential predators, it may be claimed that the location is one where they search for a daily food supply. Taman PD Utama's high variety of foods shows that these monkeys can adapt their diet according to the availability of food (Chaves et al., 2011). This shows how the dusky leaf monkey's diet was dependent on the environment because of the scarcity of food

sources and the requirement for nutrition for survival. Fruits and flowers are seasonal and restricted in availability (Yap et al., 2019), therefore the data acquired belongs specifically to that season's fruit and flower availability. According to Zhuo et al. (2006), adult Francois' Langurs (*Trachypithecus francoisi*) received distinct food supplies in a natural habitat at different times of the year, which altered the frequency of this species' foraging. Based on observation, dusky leaf monkeys did not eat fruit every day but only on certain days. The primate will choose the food based on the weather on the day found. Supported by Chaves et al. (2011) and Duc et al. (2009), fruits were consumed more in the rainy season than in dry season. The amount of energy required, and the available fruit will probably also influence this choice. Diverse energy-use techniques based on the demands of the moment (Rahman et al., 2015).



Figure 4.3 Shows the dusky leaf monkey was consume *Mikania micrantha* leaves.



Figure 4.4 Shows the dusky leaf monkey were consumed *N. lappaceum* fruits.



Figure 4.0.5 Shows the left-over *N. lappaceum*.

The dusky leaf monkey exhibits a diverse diet which is consuming various plant parts of different species. As shown in Table 4, there are 26 different plant species that have been identified which were consumed by the langurs. Most of the plant was consumed by the dusky leaf monkey as leaves and followed by fruits, flowers, and seeds. This dusky leaf monkey was spotted consuming other things than plant type which is soil by licking directly on the soil (Rahman et al., 2015). Occasional use of soil is recorded, indicating dietary diversity Besides feeding on green plant parts (leaves, flowers and unripe fruits), the study group also fed on the tree bark of rotten wood, clay soil and invertebrates. Based on Rahman et al. (2015), it is not uncommon for langurs to feed on invertebrates, living in plants, soil and tree bark to obtain minerals like sodium and protein.



Figure 4.6 Shows the dusky leaf monkey was licking the soil.

For instance, the species from family Fabaceae was listed the most plant by dusky leaf monkey at Taman PD Utama, Port Dickson. The Fabaceae family of flowering plants, commonly referred to as the pea or legume family, is a large and important family for agriculture (Harris, 2004; Sato et al., 2010). Besides, *Moringa oleifera*, *Albizia saman*, *Mangifera indica* and *Nephelium lappaceum* were the common plants that this species consumed at Taman PD Utama, Port Dickson. The most food consumed by this species was leaves (the mature and immature leaf was combined). It was rarely mentioned that this dusky leaf monkey drinks from open water sources. Its diet, composed mainly of young leaves or fruits, is probably where it gets its water from. This statement, supported by Jildmalm et al. (2008) shows that white-handed gibbons mostly consume fleshy fruits and young leaves to obtain their water needs. During the study period, there were several fruits available.

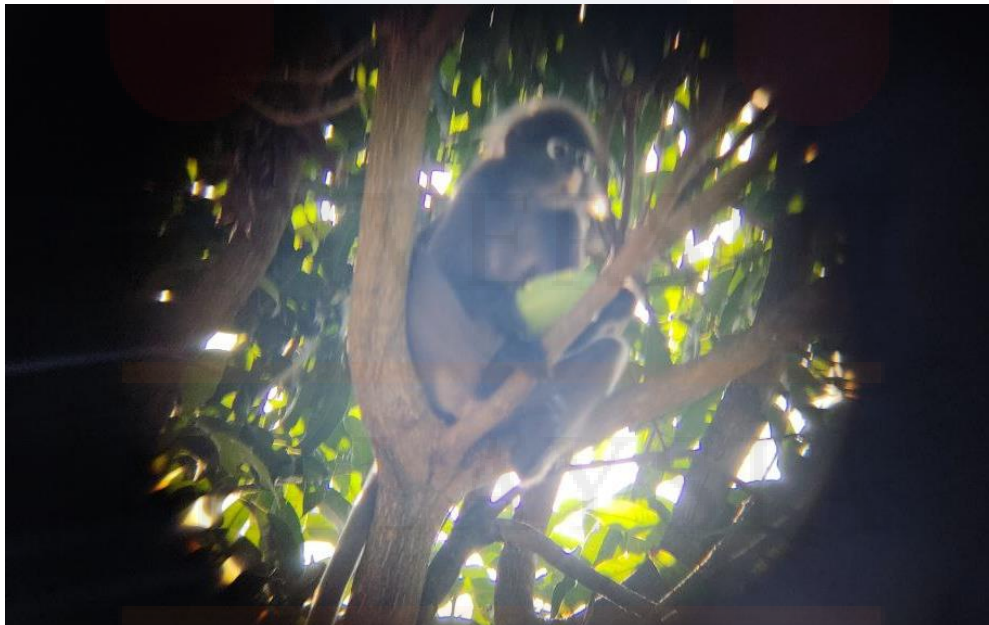


Figure 4.7 Shows the dusky leaf monkey was consumed the fruit of *Mangifera indica*.



Figure 4.8 Shows the left-over fruit of *Mangifera indica*.

However, not all fruits were consumed and among those eaten are unripe mangoes (*M. indica*) and unripe rambutans (*N. lappaceum*). The seasonal proportion of food items in langurs' diet is determined by food plant availability and phenological stages and habitat type (Solanki et al., 2008b). The dusky leaf monkey consumed seeds together with the flesh from the fruit which is from species *N. lappaceum* and *M. indica*. It seemed that the monkeys preferred fruits and seeds rich in lipids or storage carbohydrates, but not ones high in simple sugars. The choice of fruits and seeds had no influence on the amount of protein (Davies et al., 1988). *A. saman* flowers was the tree that the dusky leaf monkey consumed the most at Taman PD Utama. The tree was planted along Taman PD Utama main roads. Flowers can be an energy source for the dusky leaf monkey because flowers often contain protein

and sugary nectars, these nectars are usually dilute and produced in small quantities (Lappan, 2009).



Figure 4.9 Shows the dusky leaf monkey was carrying a bunch of *Manihot esculenta* leaves.

The growth of variety tree plants that are wide and simple to find in the area and a lot of immature leaves have lower tannin and fibre content and higher protein and water content makes the species forage on the plant parts (Takemoto, 2003; Davies et al., 1988; Jildmalm et al., 2008). *M. indica* and *N. lappaceum* was the tree where this primate chooses to rest and eat. For both plants, the langurs consumed fruits (unripe) and seeds. Mostly, the plants in the list were planted by the residents (Moore et al., 2010).

4.2 Comparison with Other Thesis

The Bangi Permanent Reserve Forest, Selangor, Malaysia was a hilly area, with a high point of 80 meters, and includes the main campus of Universiti Kebangsaan Malaysia (UKM), intercity roads, foothill oil palm cultivations, and human premises meanwhile Taman PD Utama Port Dickson in Negeri Sembilan, a residential neighbourhood close to agricultural property and a swamp secondary forest. It can be said that both locations, which are in secondary forest areas with human disturbance, have nearly similar habitat conditions. On the other hand, the observations' date was different. Except for August, observations were made between April 2014 and March 2015. Except for January and March 2015, the availability of flowers was consistently lower than that of leaves and fruits. In comparison to the previous months, the availability of fruits was generally higher from May to July 2014 and lower from January to February. The five most consumed species were *Adenantha pavovina*, *Archidendron dulce*, *Sandoricum koetjape*, *F. variegata*, and *Endospermum diadenum*. The dusky leaf monkey preferred to eat the unripe *N. lappaceum* and *Sandoricum koetjape* fruit. Meanwhile Taman PD Utama, the observation was made only in September 2023 at the starting fruit season. So, the information about food availability at these two locations could not directly be compared. However, the plants in the Taman PD Utama that the dusky leaf monkey frequently consumed were *M. oleifera*, *A. saman*, *M. indica*, *N. lappaceum*, *M. micrantha*, and *M. esculenta* were the most preferred species.

The other thesis determined that the dusky leaf monkey in Penang, Malaysia, was based on Yap et al., 2019. Dusky leaf monkeys (*Trachypithecus obscurus*) can be observed in a variety of habitats in Teluk Bahang, Penang, including secondary forests, coastal forests, and nature parks. Their diet consists mostly of young leaves,

fruits and flowers that are available according to the availability at certain conditions. Although in Taman PD Utama Port Dickson only one environment was observed, the availability of food was also the same as in Penang. However, the types of food available are also diverse due to the factors of plant cultivation by residents. Assuming an abundance of food sources and diversity in the many types of observation area, and the long-time taken to collect the data will be more variation in the variety of food available at these locations. The data was collected from March 2016 to September 2017 while the observation in Taman PD Utama Port Dickson was only done in a month. So, it can be concluded that there are significant differences in the data collected between Taman PD Utama in Port Dickson and Teluk Bahang, Penang. Most of the dusky leaf monkey diet in Penang consisted of leaves, accounting for 63.0% of all food items. This was followed by fruits (19.9%) and flowers (13.5%). Additionally, they consumed soil (3.6%), insects, tree bark, and seed pods. The findings are similar at Taman PD Utama Port Dickson as well, indicating that leaves account for up to 55.8% of the food consumed by this species of dusky leaf monkey, with fruit coming in second at 26.3%. In Taman PD Utama Port Dickson, the dusky leaf monkey consumes 8.4% flowers and 6.3% seeds, in contrast to Penang. There were no insects consumed by the primate throughout the observation period, and it was only observed licking the soil (3.2%) at the study area. In Penang, the dusky leaf monkeys ate 56 distinct species of plants from three different types of environments. Meanwhile, at Taman PD Utama Port Dickson, 26 species of plant were mainly consumed by dusky leaf monkeys. From 26 species found, there were 7 plants listed as plants that were consumed by the dusky leaf monkey in Penang. *Acacia auriculiformis*, *A saman*, *Morinda citrifolia*, *Averrhoa*

carambola, *Phyllanthus acidus*, *Terminalia catappa*, and *Vitex pinnata* were in the list.

Research conducted at Bukit Semujan, Danau Sentarum National Park, West Kalimantan, Indonesia observed three colored langurs (*Presbytis chrysomelas*) The characteristics of the monkeys were also the same as the dusky leaf monkey because they came from the same family, Cercopithecoidea. *Presbytis* is a genus of monkeys that eats both fruits and leaves, but it primarily favors the sections of leaves (Sumarni, 2016). Same as *T. obscurus*, the *Presbytis* also consumed leaves the most, followed by fruits, flowers, and seeds. It showed from the research that 27 listed plant species were consumed by the langurs, but only 9 feed species were recognized to be directly consumed by the langurs in the study area based on the observation. Gita susu (*Willughbeia coriacea*), Merepat (unidentified), and Karet (*Hevea brasiliensis*) were the feed kinds that were highly chosen (Santoso & Sutopo, 2023). There isn't a single species on the list of plants consumed that is similar to the plant species listed at Taman PD Utama. Another study in Jessore, Bangladesh shows the diet list of the northern plains sacred langur (*Semnopithecus entellus*) species, which was categorized in the same family as the dusky leaf monkey. In that study, there was a list of 53 plant species eaten by the sacred langur. *Albizia saman*, *Artocarpus heterophyllus*, *Averrhoa carambola*, *Mangifera indica*, *Phyllanthus acidus*, and *Moringa oleifera* were the same plant species eaten by dusky leaf monkeys in Taman PD Utama, Port Dickson.

Another study in Jessore, Bangladesh shows the diet list of the northern plains sacred langur (*Semnopithecus entellus*) species, which is a species in the same family as the dusky leaf monkey. The Northern Plains sacred langur in Jessore, Bangladesh, similarly has a varied diet, however there are some obvious variations

because of ecological and geographic factors. There is a higher proportion of fruits and flowers in the diet, especially during seasons. Seasonal changes significantly affect their diet, with more fruits consumed during the fruiting season and more leaves and flowers during other times. The dusky leaf monkeys of Taman PD Utama mostly eat young leaves, seeds, fruits, and flowers. Their folivores diet, which favours easily digested plant materials found in their environment, is shown in their eating habits. A range of native plant species that have adapted to Taman PD Utama Port Dickson's tropical environment are among the specific plant species that have been consumed. Compared to the rural and semi-urban areas of Jessore, PD Utama Park offers a diverse composition of plant species due to its higher urbanization and proportion of natural forests. For example, Jessore's countryside has a wide variety of native fruiting and flowering plants, but Port Dickson's urban green spaces may have more cultivated and non-native species. Even though both species of primates are folivores, the availability of food supplies and the ecological circumstances in the area affect what they eat. Developing conservation methods that are specific to each species' needs and habitats is made easier by an understanding of these differences. Based on Rahman et. al. (2015) study, there was a list of 53 plant species eaten by the sacred langur. *Albizia saman*, *Artocarpus heterophyllus*, *Averrhoa carambola*, *Mangifera indica*, *Phyllanthus acidus*, and *Moringa oleifera* were the same plant species eaten by dusky leaf monkey in Taman PD Utama Port Dickson. this indicates that this plant species is food eaten by the primate family Cercopithecidae.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study conducted on the dietary habits of the dusky leaf monkey (*Trachypithecus obscurus*) in Taman PD Utama, Port Dickson, Negeri Sembilan, provides valuable insights into their food preferences and ecological adaptations. The findings reveal that these primates predominantly consume leaves (55.8%), followed by fruits (26.3%), flowers (8.4%), seeds (6.3%), and other items like soil (3.2%). The high consumption of leaves indicates their folivorous nature, while the inclusion of fruits, flowers, and soil highlights their dietary diversity and need for various nutrients. The dusky leaf monkeys' significant preferences for specific plant parts are confirmed by the Chi-square analysis, indicating that their feeding behaviour is not random. Understanding their ecological demands and conservation requirements depends on this selective feeding. Comparative analysis with other studies from different regions, such as Bangi Permanent Reserve Forest, Selangor, Malaysia, Teluk bahang, Penang, Bukit Semujan, Danau Sentarum National Park, West Kalimantan, Indonesia and Jessore, Bangladesh, shows variations in dietary habits influenced by ecological and geographical factors. Developing focused conservation efforts is made easier by understanding the eating habits of dusky leaf monkeys in different environments. Sustainable survival of this species depends on

ensuring the availability of preferred food plants and reducing human-primate interactions in urban settings. This research improves the knowledge of primate ecology and emphasises how crucial habitat protection is to preserving biodiversity.

5.2 Recommendations

The data was collected in this study was useful to any parties. especially to conserve this primate and find out more about its diet in Taman PD Utama Port Dickson, Negeri Sembilan, Peninsular Malaysia. however, there are still many shortcomings in this study that can be improved and suggested for the future. Firstly, is sampling effort to understand the dietary patterns and food accessible during different months, further study can be conducted in different seasons or months. Longer study periods are suggested as well to collect more information about their dietary. Feeding behaviour between sex or age stage also recommended because it will be useful to understand more about food selection for this primate. Next, pest behaviour for this species also should be concern. It is because there were several neighbourhoods feels this primate make a problem at the resident area. So, the research was suggested to do at Taman PD Utama, Port Dickson or any resident area that in this primate foraging area. It can also compare between another primate such as *Macaca fascicularis*. Lastly, at Taman PD Utama, Port Dickson has an several primates such as *Macaca fascicularis*, *Presbytis siamensis*, and *Trachypithecus cristatus*. Others primate also have to take care about their population and should have an action to conserve this species in their habitat.

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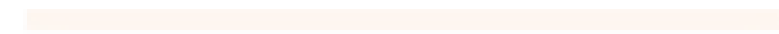
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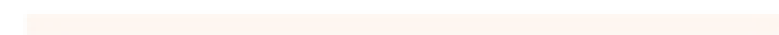
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