EVALUATING POLLINATOR SPECIES AND THEIR ACTIVITY LINKED TO FEMALE *RAFFLESIA KERRI* IN LOJING HIGHLANDS, KELANTAN

by

NOR ROZIEYANA BINTI MOHD SUPI

A report submitted in fulfillment of the requirements for the degree of Bachelor of Applied Science (Natural Resources Science) with Honours

FACULTY OF EARTH SCIENCE
UNIVERSITI MALAYSIA KELANTAN

2024

DECLARATION

I declare that this thesis entitled "Evaluating Pollinator Species and their Activity linked to Female *Rafflesia kerri* in Lojing Highlands, Kelantan" 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.

Signature :

Name : NOR ROZIEYANA BINTI MOHD SUPI

Date : 24/7/2024

ACKNOWLEDGEMENT

I am really grateful to Allah for creating the amazing *Rafflesia kerri* and for giving me the chances to study it in depth. In addition to my own efforts, my sincere gratitude to my supervisor, Associate. Professor. Dr. Zulhazman bin Hamzah, for his insightful insights and guidance during the writing of my study and degree thesis. I would like to thank to Associate. Professor. Dr. Wee Suk Ling, an entomologist from University Kebangsaan Malaysia, for providing me with advice and details regarding the identification of the insects. In addition, I want to express my gratitude to the University Malaysia Kelantan Campus Jeli laboratory staff for their support and for lending me the equipment and supplies I needed for my final year project. Norhazlini bin Mat Zain who accompanied and guided me while conducting research at the *Rafflesia* Conservation Park in the Lojing Highlands of Kelantan, I would like to thank you. Finally, I would like to express my gratitude to my family, in particular to my parents, Mohd Supi Bin Said and Salina Binti Masdar, as well as to my friends who have helped me out both financially and emotionally throughout the research project. The success of the study was greatly dependent on the advice and assistance from everyone listed above. I appreciate all of their aid and support.

A Study of Evaluating Pollinator Species and their Activity Linked to Female *Rafflesia kerri* in Lojing Highlands, Kelantan.

ABSTRACT

The genus *Rafflesia*, which is found in the family *Rafflesiaceae* in the tropical rainforests of Southeast Asia, is the largest flower in the world. *Rafflesia kerri*, found in the Lojing Highlands, is a holoparastic species that depends on the *Tetrastigma* vine for survival, protection, and nourishment, much like other species in this genus. This species differs from others in that it emits strong carrion scents from the perigone lobes and fruity scents from the central cavity. Moreover, it produces a slippery, nectar-like substance that flies can suck from the areas beneath the disc. Therefore, this type of bloom is not actually misleading. Fly pollination of sapromyophily syndrome, or the attraction of flies to the smell of carrion. Insect and visitor activity varied during the flowering stage, and a diurnal consensus was used to identify possible pollinators and non-pollinators. Blow flies belonging to the *Calliphoridae* family, primarily in the genera *Chrysomya*, *Lucilia*, and *Hypopygiopsis*, are potential pollinators. Because they have a long lifespan and are powerful flyers, flies may serve as long-distance pollinators. Meanwhile, a total of 4 genera were identified among the visitors such as *Drosophila* sp., *Paederus* sp., *Musca* sp., and *Sarcophaga* sp. The early blooming stage was marked by very active activity from pollinators. This is because the smell released at this stage is very strong. Meanwhile, late blooming has an active activity for visitors, *Drosophila* sp. because at this stage *R. kerri* is in the process of decay. It seems that a flower's aroma and vibrant appearance are crucial in luring pollinators. However, depending on the pollinator species, physiological state, blooming stage, and climatic factors, insects may use flowers at varying distances.

Kajian Menilai Spesies Pendebunga dan Aktivitinya berkaitan dengan *Rafflesia kerri* Betina di Tanah Tinggi Lojing, Kelantan.

ABSTRAK

Genus *Rafflesia*, yang terdapat dalam famili *Rafflesiaceae* di hutan hujan tropika Asia Tenggara, adalah bunga terbesar di dunia. *Rafflesia kerri*, ditemui di Tanah Tinggi Lojing, adalah spesies holoparastik yang bergantung pada pokok *Tetrastigma* untuk kelangsungan hidup, perlindungan, dan khasiat, sama seperti spesies lain dalam genus ini. Spesies ini berbeza daripada yang lain kerana ia mengeluarkan bau bangkai yang kuat dari lobus perigone dan bau buah-buahan dari rongga tengah. Selain itu, ia menghasilkan bahan licin seperti nektar yang boleh disedut lalat dari kawasan di bawah cakera. Oleh itu, jenis mekar ini sebenarnya tidak mengelirukan. Pendebungaan lalat sindrom sapromyophily, atau tarikan lalat kepada bau bangkai. Aktiviti serangga dan pelawat berbeza-beza semasa peringkat berbunga, dan konsensus diurnal digunakan untuk mengenal pasti kemungkinan pendebunga dan bukan pendebunga. Lalat kepunyaan keluarga *Calliphoridae*, terutamanya dalam genera *Chrysomya*, *Lucilia*, dan *Hypopygiopsis*, adalah potensi pendebunga. Oleh kerana ia mempunyai jangka hayat yang panjang dan merupakan penerbang yang kuat, lalat boleh berfungsi sebagai pendebunga jarak jauh. Sementara itu, sebanyak 4 genera dikenal pasti dalam kalangan pengunjung seperti *Drosophila* sp., *Paederus* sp., *Musca* sp., dan *Sarcophaga* sp. Peringkat awal berbunga ditandai dengan aktiviti yang sangat aktif daripada pendebunga. Ini kerana bau yang dikeluarkan pada peringkat ini sangat kuat. Sementara itu, peringkat akhir mekar mempunyai aktiviti aktif untuk pengunjung, Drosophila sp. kerana pada peringkat ini *R. kerri* sedang dalam proses pereputan. Nampaknya aroma bunga dan penampilan yang bersemangat adalah penting dalam memikat pendebunga. Walau bagaimanapun, bergantung pada spesies pendebunga, keadaan fisiologi, peringkat pembungaan, dan faktor iklim, serangga boleh menggunakan bunga pada jarak yang berbeza-beza.

TABLE OF CONTENTS

CHAPTER 3 MATERIALS AND METHODS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

cm	Centimetre
m	Meter

LIST OF SYMBOLS

%	Percentage
°C	Temperature (Degree Celsius)

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Rafflesia is the biggest flowers in the world (Nais, 2001). Due to their large petals, eye-catching red colour, large-hollow perigone lobe, unique scent, and parasitic nature, *Rafflesia* have drawn the attention of both domestic and foreign researchers (Abdul Hamid et al., 2021). *Rafflesia* is also parasitic plant and belonging to the family of Rafflesiacea. *Rafflesia* is exceptionally rare, with dimensions that are simply gigantic, distinguishing it from any other flower. Recognized for its uniqueness, *Rafflesia* is a well-known symbol of ecotourism and conservation for rainforests (Nais, 2001).

Rafflesia is also known as Pakma in Malaysia (Norhazlini et al., 2020). In Malaysia, there are a total of 14 species of *Rafflesia* (Siti Munirah et al., 2021). In 2002, Forest Gan and Matthew Wong made the initial discovery of the species *Rafflesia kerri* in Peninsular Malaysia, on the Main Range at the boundary between Kelantan and Perak (Hor et al., 2021). After *R. arnoldii, R. kerri* was identified as the second biggest in their species (Asfarina et al., 2022).

Rafflesia belongs to the endoparasite class, which means that it is completely confined within its host plants and only emerges from them 160 days following the germination process (Farah Khaliz et al., 2018). Only vines in the genus *Tetrastigma* are parasitized by *Rafflesia*, which are host-specific (Tobias et al., 2023).

Since insects may be drawn to *Rafflesia* by the flower's scent and appearance, it is thought that certain insect species could act as pollination agents (Yansen et al., 2022). In order to entice pollinators from the Calliphoridae family to visit the male and female flowers, the *Rafflesia* produces an offensive odour that resembles rotting meat (Norhazlini et al., 2020). Given that *Rafflesia* is a dioecious plant and that pollinators are essential to its reproductive biology, more study is required to properly comprehend pollination (Yansen et al., 2022). However, Suk et al., (2018) stated that little is known about the ecology of pollination on *Rafflesia* plants because of their rarity, remoteness, and brief flowering period.

1.2 Problem Statement

The study has filled the gaps of knowledge regarding the pollination biology of *Rafflesia*. The limited gaps on the intricate processes governing *Rafflesia* pollination underscores the gaps in knowledge about this fascinating botanical phenomenon. *Rafflesia* engages in a complex reproductive dance, one that eludes full comprehension. Within the heart of dense rainforests, where these parasitic plants thrive, their unique method of pollination remains shrouded in mystery.

The intricate interplay between the *Rafflesia* flower and its pollinators, often specific insects, reveals a delicate ecological. The lack of a comprehensive understanding impedes ability to appreciate the relationships between the plant and its environment. From the emission of alluring scents to the development of specialized structures, each facet of *Rafflesia* pollination is a testament to the plant's evolutionary adaptation.

Previous studies on *Rafflesia* pollination are very general, often only describing the types of insects that visit the flowers without detailing their specific behaviors or interactions with the plants, and this study was provided more detail on this mechanism. By overlooking the intricate relationships between the plant and its pollinators, which will lead to uncertainty on management plan on *Rafflesia* populations. Understanding the specific species involved in pollination not only enriches knowledge but also light on the balance of biodiversity within the plant's habitat.

Additionally, the study has conservation implications, as *Rafflesia* species are often indicators of ecosystem health and biodiversity. Understanding the specific pollination of *R. kerri* can inform targeted conservation strategies, especially in the unique environment of the Lojing Highlands. Besides, *Rafflesia* may develop into popular tourist destinations that support local economy (Yayan et al., 2023).

Furthermore, the research aids in comprehending the dynamics of pollination. By exploring the pollinator species and their activity linked to female *R. kerri*, the study can provide valuable information on the intricacies of the pollination process in this specific ecosystem. This study also recognizes the importance of pollinators in maintaining ecosystem services, such as plant reproduction and biodiversity. Evaluating the pollinator species associated with *R. kerri* contributes to understanding the role of these pollinators and their significance in the ecological balance of the Lojing Highlands.

1.3 Objectives

The objectives of this study are as follows:

i. To identify the pollinator species associated with female *Rafflesia kerri* in Lojing Highlands.

ii. To evaluate the pollinator activity in the blooming stages of the female *Rafflesia kerri*.

1.4 Scope of Study

The research was conducted in *Rafflesia* Conservation Park, Lojing Highlands, Kelantan, during of 14 February 2024 to 3 March 2024. This study focused on the pollination biology of *Rafflesia kerri*. This study involved in the research will initially conduct a thorough survey to accurately identify the blooming pattern of *Rafflesia*. To capture a comprehensive understanding of pollinator activity, observations were made during various stages of *Rafflesia's* blooming cycle, including the stages of fresh blooming (days 1–3), mid blooming (days 4–5), and late blooming (days 6–8). Furthermore, these observations were conducted at different times of the day, specifically in the morning (9–10 a.m.), noon (12–1 p.m.), and evening (3–4 p.m.). The observer was stayed one meter away from the flower. As part of the study, the pollinator specimens were also collected for subsequent species identification and analysis.

1.5 Significant of the Study

The following are the study's significant findings is conservation of biodiversity for understanding the pollinators of *Rafflesia* play a vital role in maintaining the diverse ecosystems. As understand, conserving biodiversity is essential to maintaining ecological equilibrium. *Rafflesia*, a plant prized for its enormous, distinctive flowers, needs pollinators to reproduce. It is crucial to comprehend these pollinators because they support the reproductive processes of plant species like *Rafflesia*, which contributes to the diverse ecosystems. Because of this interdependence, maintaining biodiversity is crucial to maintaining the complex web of life.

Next, maintaining an ecological balance is facilitated by an understanding of the relationships between plants and pollinators. Maintaining ecological balance is closely linked to comprehending the dynamic interactions between pollinators and plants. Pollinators are important for the overall biodiversity and resilience of ecosystems, as well as for the reproductive success of *Rafflesia*.

The study also will give awareness of the environment for gaining knowledge about *Rafflesia* contributes to a more profound comprehension of nature. Furthermore, unlocks the mysteries of this unusual flower while also drawing attention to the larger ecological interactions. *Rafflesia* has the complex interdependence and precarious balance of the natural world, deepening and broadening our understanding of the beauty that permeates our immediate surroundings.

CHAPTER 2

LITERATURE REVIEW

2.1 *Rafflesia* in General

The name *Rafflesia* pays homage to Sir Thomas Stamford Raffles, the head of the expedition that found a species of *Rafflesia* in 1818 during its initial visit to Bencooleen (Bengkulu), Indonesia, and Governor of the East India Company in Sumatra (Sofiyanti et al., 2016). A genus of parasitic plants known as Rafflesiaceae was only found in the low-to-mid-elevation montane forests of Southeast Asia region such as in Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines (Barcelona et al., 2009). A total of 40 species of Rafflesia were recorded worldwide, which 14 species were noted in Malaysia as shown in Table 2.1. The family Rafflesiaceae, which gives rise to the largest flowers on earth, has captured the interest of biologists for almost 200 years (Nikolov et al., 2013). *Rafflesia* flowers lack leaves, stems, and roots, making them the only visible plant organ outside of their host (Yansen et al., 2023). *Rafflesia* frequently grows on moist forest slopes close to streams within the forest; most of these plants are successful in producing full blooms when they are situated and grown close to the stream (Farah Khaliz et al., 2018).

Table 2.1. The updated of *Rafflesia* species in Malaysia.

No.	Species	Distribution
1.	*R. tuan-mudae* Beccari	Sarawak, Mt. Gading National Park (endemic), Mt Puch, Sematan, Mt. Rara, Mt. Penrissen.
2.	*R. cantleyi* Solms-Laubach	Peninsular Malaysia (Perak, Gerik, Ipoh; Kelantan; Ulu Sat, Kuala Koh, Kuala Betis; Pahang, Raub, Jerantut, Pulau Tioman; Terengganu, Tasik Kenyir & Pasir Akar, Besut.
3.	*R. hasseltii* Suringar	Sumatera and Borneo (West Sarawak & West Kalimantan). Sumatera, West Sumatera (Muaro Labuh, Liki, Alahan Panjang, Sijunjung & Limo Puluah Kota), Riau (Bukit Tiga Puluh National Park) & Jambi (Bangko, Sarolangun, Kerinci Seblat National Park); Sarawak, Tanjung Datu & Samunsam.
4.	*R. keithii* Meijer	Borneo: Sabah, Crocker Range, Keningau, Tambunan, Kimanis, Tenom, Kota Marudu (Serinsim); Kota Belud (Melangkap and Sayap), Ranau (Poring, Nalumad, Tekutan, Singgaron, Kinapulidan); Lahad Datu (Danum Hill at the Danum Conservation area. Sarawak (Mt. Hose).
5.	*R. pricei* Meijer	Borneo: Sabah, Eastern part of the Crocker Range, Mt. Alab near Sinsuran, Mt. Kinabalu, Pinosok Plateu above Kundasang; Sarawak, Schwaner Range, Mt. Bario, Kelabit Highlands; Brunei - Bukit Retak; Kalimantan.
6.	*R. kerri* Meijer	Peninsular Malaysia; Kelantan, (Mt. Chamah, Mt. Stong, Bukit Tepuh, Sg. Bells FR, Lojing Highlands; Pos Broke, Pos Hendrop, Pos Mendrop, Sg. Berok FR, Lojing FR.) and Perak (Gerik, Royal Belum State Park), Perak-Kedah border; Thailand.
7.	*R. tengku-adlinii* Mat-Salleh & Latiff	Sabah, Trus Madi Range, eastern slopes near Hulu Sinsuron; western slopes of Trus Madi Range, Maliau Basin Conservation area.
8.	*R. azlanii* Latiff & Wong	Peninsular Malaysia (Perak; Sungkai, Kinta, Sg. Halong, Temenggor; Perak - Kelantan border; Pahang, Ulu Sg. Forest Reserve, Sg. Peleting, National Park.
9.	*R. su-meiae* Wong, Nais & Gang	Peninsular Malaysia; Mt. Chamah, Kelantan-Perak border.
10.	*R. sharifah-hapsahiae* Adam, Mohamed, Juhari, Nik Ariff & Wan	Peninsular Malaysia; Pahang, Raub, Mt. Benom FR.

11.	*R. parvimaculata* Sofiyanti, Mat-Salleh, Khairil, Zuhailah, Mohd-Ros & Burslem	Pahang; Lata Jarum. May occur in Perak (insufficient data).
12.	*R. tuanku-halimii* Adam, Aizat-Juhari, Azilah & Wan	Perak; Gerik and Pahang; Raub (Sg. Kenau, Sg. Yol and Matau).
13.	*R. tiomanensis* Siti-Munirah, Salamah & Razelan	Endemic in Pulau Tioman, Pahang, Peninsular Malaysia.
14.	*R. tunku-azizahiae* Adam, Aizat-Juhari & Wan	Pahang: Hutan Simpan Gunung Benom, Ulu Dong, Raub.

Sources: Adam et al. (2022); Siti-Munirah et al. (2021); Norhazlini et al. (2021b); Ahmad Puad et al. (2020); Abdul Wahab et al. (2018); Sofiyanti et al. (2016); Adam et al. (2013); Zulhazman et al. (2010); Wong et al. (2009); Latiff & Wong (2003); Nais (2001); Meijer (1997); Mat-Salleh & Latiff (1989).

2.1.1 *Rafflesia kerri* Meijer

Puttipan (2014) stated that *Rafflesia kerri* is a member of the Rafflesiaceae family of holoparasitic flowering plants, best known for having the largest single flower in the world. *R. kerri* is parasitic flowering plants in the genus of *Tetrastigma*. This species has a diameter of 70–80 cm and a weight of roughly 10 kg (Wichantuk et al., 2018). The distribution of *R. kerri* is only restricted in the mountainous range from southern part of Thailand to the border of Kelantan, Perak and Pahang in Peninsular Malaysia (Zulhazman et al., 2011). According to Wicaksono (2017), *R. kerri* flowers frequently emerge on the younger stem of *Tetrastigma*. Thai meaning "flower bud decoction," Bua Phut is a traditional remedy used in the southern part of Thailand to help mend the female uterus after childbirth. (Tancharoen et al., 2013). In Peninsular Malaysia, the most densely populated area for *R. kerri* is Lojing Highland (Zulhazman et al., 2011). According to Abdul Hamid et al. (2021), *R. kerri* has evolved into a prominent tourist attraction in the Lojing Highland and serves as a symbol of environmental conservation.

2.2 Host plant of *Rafflesia*

Tetrastigma leucostaphyllum and *T. scariosum* are the two examples of the important holoparasite traits shared by *Rafflesia* species and these parasites grow on the root tissues of vines (Abdul Hamid et al., 2021). In Peninsular Malaysia and Peninsular Thailand, *T. rafflesiae, T. quadrangulum* and T. *hookeri.* have been identified as potential host plants for *Rafflesia kerri* (Nasihah et al., 2016). *Rafflesia* may be indicated by *Testrasigma* vines or roots (Pelser et al., 2016). *Tetrastigma* requires other plants, usually large trees, for support and sunlight because of its climbing habit (Elga et al., 2022). *Tetrastigma* grows well between 950 and 1000 meter above sea level on the undulating forest floor (Nasihah et al., 2016). Table 2.2 provides an overview of the updated host plant species that are parasitized by *Rafflesia* in Malaysia.

Table 2.2. The updated of host plant species parasitized by *Rafflesia* in Malaysia.

Host plant species	**Rafflesia species**
Tetrastigma diepenhorstii	*Rafflesia tuan-mudae*
Tetrastigma rafflesiae	*Rafflesia azlanii, R. cantleyi, R. keithii, R. kerri, R. parvimaculata, R. pricei, R. sharifahhapsahiae, R.su-meiae, R. tengku-adlinii, R. tuan mudae, R. tuanku-halimii*
Tetrastigma hookeri, T. quadrangulum	*Rafflesia kerri*
Tetrastigma papillosum	*Rafflesia pricei*

Sources: Ahmad Puad et al. (2020); Kedri et al. (2018); Wan Zakaria et al. (2016); Nasihah et al. (2016); Veldkamp (2009); Nais (2001); Latiff (1984).

2.2.1 Host Plant Relationship

Previous studies by Renjana et al. (2022), have reported attached to the shoots or roots of their host plant, the haustorium is the means by which parasitic plants, such as *Rafflesia*, obtain water and nutrients. The plants that can photosynthesize (hemiparasites) and those that cannot (holoparasites) make up these parasitic plants. *Rafflesia* are totally reliant on their host plants for water and nutrients because they do not have any leaves, chlorophyll, distinct stems, or roots of their own (Barcelona et al., 2009). Holoparasites are predominantly phloem feeders that typically retain a xylem connection and obtain all mineral nutrients, amino acids, soluble carbon, and water from the host. Hemiparasites are predominantly xylem feeders that obtain reduced carbon and nitrogen from the host (Syarifah et al., 2021). Pelser (2016) noted that when parasites are limited to a single host species, their associations with their hosts can be extremely specific, and their relationships are closely linked.

2.3 Pollination Biology of *Rafflesia*

It is thought that certain insect species help pollinate *Rafflesia*. *Rafflesia* flowers entice insects with their scent and attractive appearance. The endothermic mechanism, which may be caused by the flower's internal heat, is linked to the release of odour by flowers (Yansen et al., 2023). *Rafflesia* is a dioecious plant, meaning that fertilization requires pollinators. Strong evidence suggests that in *Rafflesia*, olfactory and visual cues are required in tandem to draw in and retain pollinators long enough for them to transport or transmit pollen (Beaman et al. 1988).

The dioecious character of the plant (separated male and female flowers on separate individuals), small populations, and the fact that most *Rafflesia* blooms encountered in the field are males as examples of limited biological factors (Adhityo et al., 2016). Pollination is the most fascinating of the many interactions between plants and insects; it is governed by floral characteristics, phenology, and the form, structure, and behaviours of the pollinators (Mohan et al., 1984).

2.3.1 Pollination Process

The process of pollinating flowers *Rafflesia* is highly intricate. This is due to the fact that for flies and other insects to help with pollination, male and female flowers must bloom at the same time. This intricate process of pollination is necessary for the flower to grow and develop. This unusual flower cannot grow outside of the host plant's tissue; instead, it will continue to multiply inside the tissue if pollination is not achieved (Asiandu, 2021).

Rafflesia fertilization requires pollinators. According to previous studies, *Rafflesia* needs both olfactory and visual cues to attract and hold on to pollinators long enough for them to carry or transfer pollen (Hidayati et al., 2016). Pollen must be transferred from the anther of male flower to the stigma of female flower by flies which was identified as pollination of *Rafflesia* (Adam et al., 2013).

2.3.2 Visitors and Pollinators

The flowers' putrid smell, which is associated with decaying flesh, draws a variety of carrion flies and blowflies belonging to the genera *Chrysomya* and *Lucilia* [Calliphoridae] (Farah Khaliz et al., 2018). According to a recent study by Hor et al. (2021), *calliphoridae* flies from the genera *Chrysomya*, *Lucilia*, and *Hypopygiopsis* are strongly believed as the pollinators for *R. kerri* in Lojing Highlands Kelantan. Meanwhile, other insect such as *Diptera* and *Hymenoptera* are served as visitors.

2.3.3 Deceptive pollination

Potential pollinators are drawn to *Rafflesia* flowers by means of deceptive pollination, which includes yellow sticky masses of pollen, brooding areas inside perigone tubes, and secondary attractants like smell and sight (Adam et al., 2013). Jurgens et al., (2015) stated that a remarkable pollination system has developed as a result of the evolution of a group of bacterial that are inextricably linked to carrion.

Flowers have acquired characteristics similar to those of decaying carcasses to attract insects that are involved in the decomposition of organic matter and aid in pollination. The smell of the rotting flesh is mimicked by the sapromyophilous *Rafflesia* flower, and the flower's colour has tricked carrion flies into thinking it is a suitable place to lay their eggs (Norhazlini et al., 2020).

2.3.4 Reproductive Success

The flowers are unisexual, and these flies serve as their pollinators. The fruit develops from the structure beneath the female flower's column after 6 to 9 months of successful pollination (Farah Khaliz et al., 2018). Successful gamete fertilization and pollination result in fruit formation on female *Rafflesia* flowers. Typically, ten days following blooming, the central column and disc harden, swell, and grow in size, while the perigone lobes and perigone tubes disintegrate (Adam et al., 2013). The thousands of tiny seeds found in *Rafflesia* fruits are thought to have been primarily distributed by small mammals like squirrels and tree shrews (Farah et al., 2018).

2.4 Conservation of *Rafflesia*

Due to conservation of natural forest to other land uses and anthropogenic factor, there is a risk of extinction for the *Rafflesia.* Ecotourism activity is one of the reasons in declining of *Rafflesia* population in Malaysia (Farah Khaliz et al., 2018). Previous study by Wicaksono et al., (2016) has reported that artificial cultivation is necessary to prevent overexploitation of *Rafflesia* species in order to maintain a balance between their ethnomedical and conservation. Using host grafting to transfer *Tetrastigma* impregnated with *Rafflesia* onto a regular *Tetrastigma* plant's stem is an effective vegetative propagation technique.

According to Malabrigo et al. (2023), community involvement could gain from small grants for sustainable development, such as training manuals for efficient local *Rafflesia* conservation and management. The majority of the local population either advertises flowering populations independently, such as by using banners on roadside signs and social media, or depends on customers from ecotourism organizations in cities and towns. It would be very beneficial to train local government officials, foresters, and expert guides in order to preserve knowledge and implement grassroots conservation of *Rafflesia*.

CHAPTER 3

MATERIAL AND METHOD

3.1 Description of the Study Area

The study area is located in the *Rafflesia* Conservation Parks, Lojing Highlands, Kelantan as shown in Figures 3.1 a. and 3.1 b. The Lojing sub-district, which is situated between 610-1500 meters above sea level, only makes up 22.4% of the Gua Musang district. The highlands experience temperatures between 18˚C and 25˚C. Betis, Hau, and Sigar are their three main areas (Dony et al., 2015). It is located between latitudes 4° 32' to 4° 47' N and longitudes 101° 20' to 101° 34' E. With a total land area of 23,435 ha, hill dipterocarp and sub-montane forests make up the majority of the natural tropical rainforest (Zulhazman et., al 2021). Sungai Dawai (N 04 38’02.8”, E 101 30’16.3”) and Sungai Dekong (N 04 38’02.8”, E 101 30’16.3”) are the two rivers that are flowing in Lojing Highland (Sharifah et al., 2014). The indigenous people of Senoi from the Temiar tribe make up the majority of the population in Lojing Highland. (Nur Azuki, 2008).

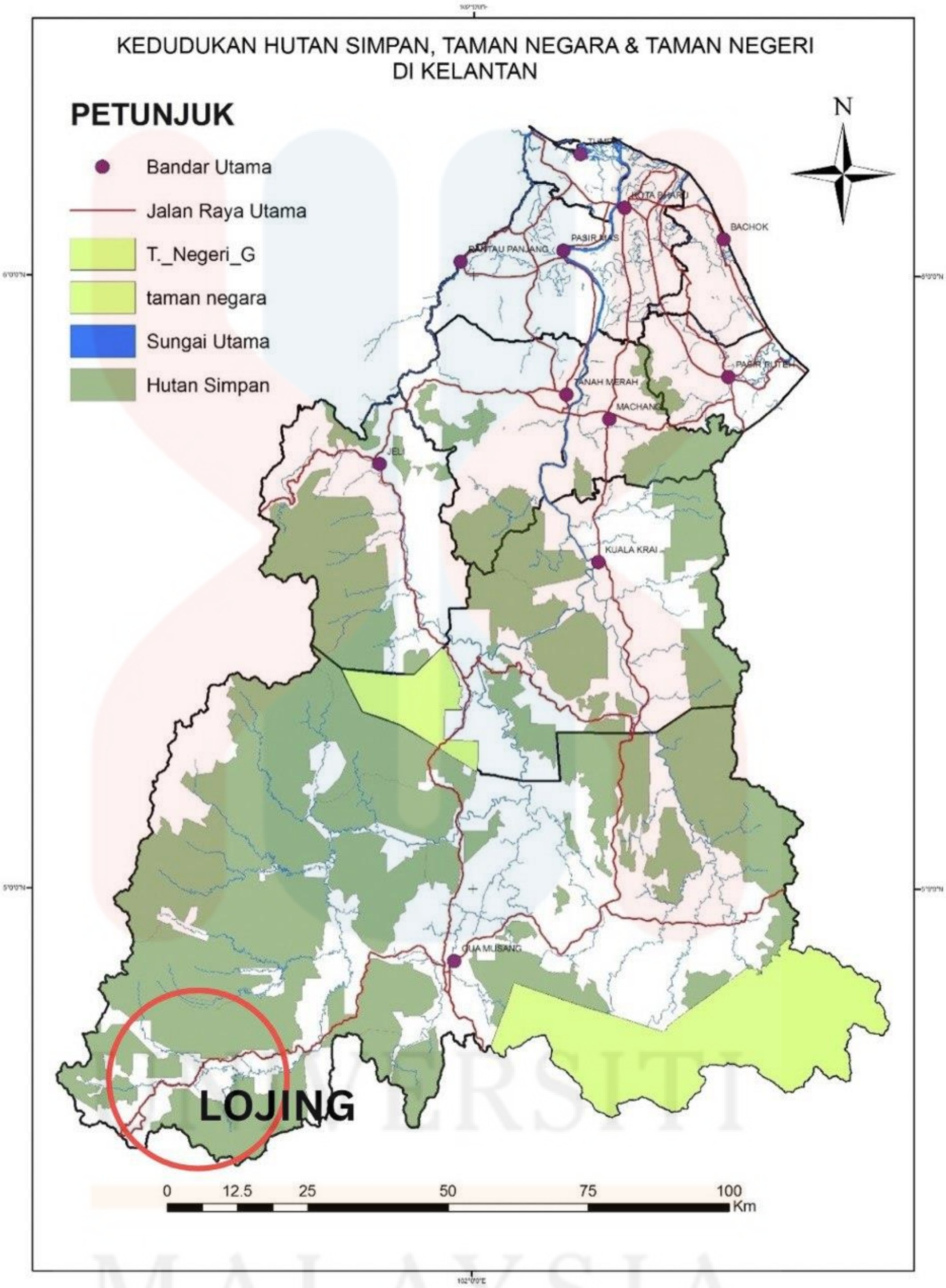


Figure 3.1 a. Locations of the study area, forest reserves, national parks, and state parks in Kelantan, Malaysia.

Sources: Zulhazman Hamzah. 2012. Assessing and mapping of *Rafflesia* distribution hotspots for nature conservation in Kelantan, Malaysia. Proceedings of the 3rd International Seminar on Regional Network on Poverty Eradication (RENPER), 15 – 17 Oct. 2012, Universitas Bengkulu, Indonesia. 9p.

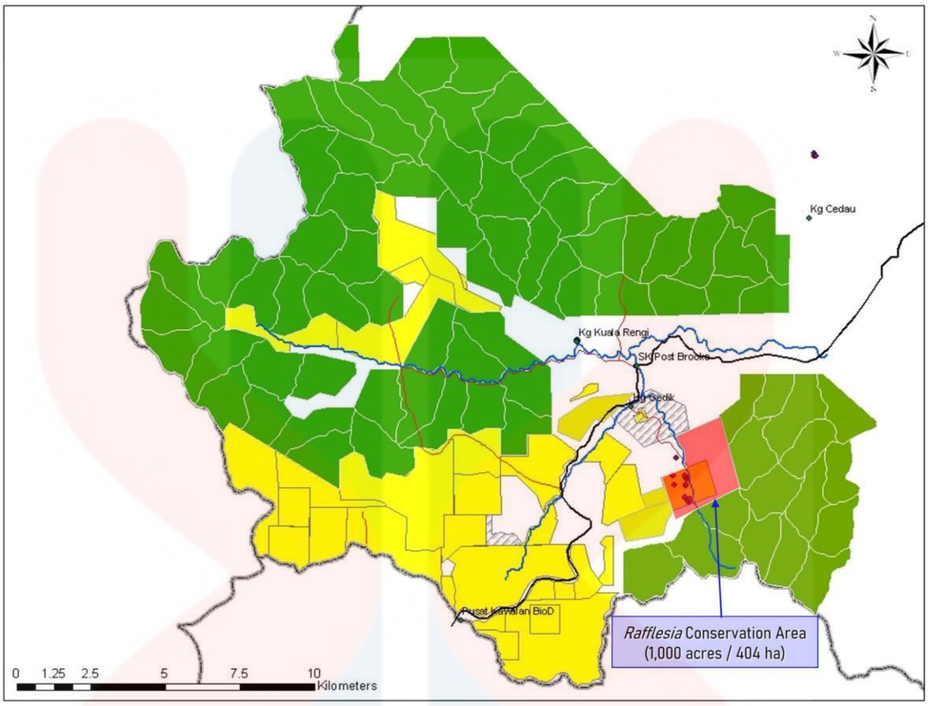


Figure 3.1 b. Close up view of the study area; *Rafflesia* Conservation Park, Lojing Highlands, Kelantan.

Sources: Zulhazman Hamzah. 2012. Assessing and mapping of *Rafflesia* distribution hotspots for nature conservation in Kelantan, Malaysia. Proceedings of the 3rd International Seminar on Regional Network on Poverty Eradication (RENPER), 15 – 17 Oct. 2012, Universitas Bengkulu, Indonesia. 9p.

3.2 Material

The materials utilized in this study are as present in Table 3.2 below.

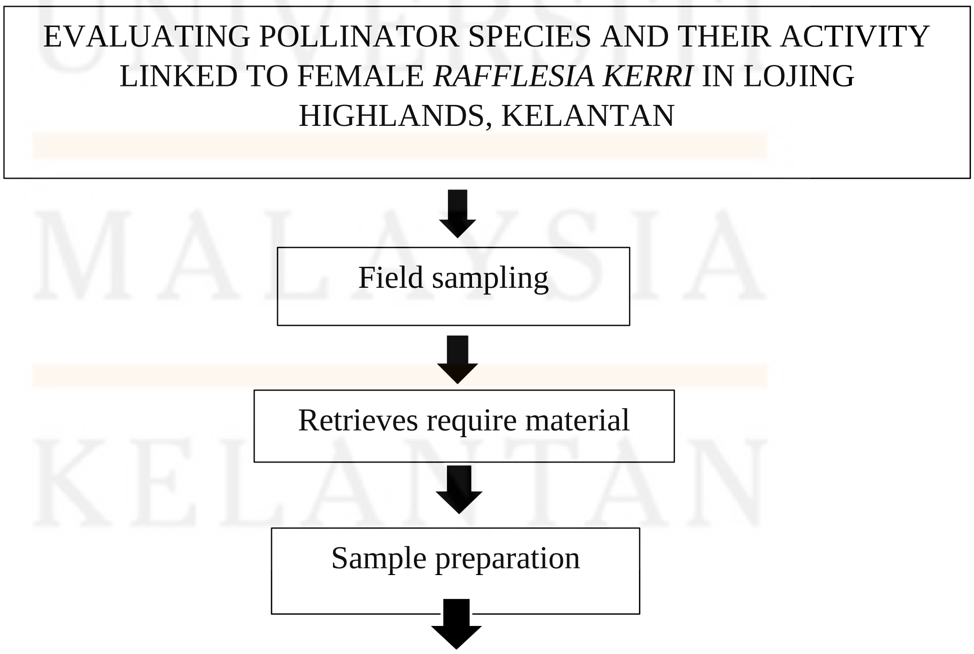
Table 3.2 The material used and their function.

NO.	MATERIAL	FUNCTION
1	Aerial net	To catch insect
2	Sweep Nets	To catch insect
3	Killing Jar	To kill insects for further investigation.
4	Insect Pin	To pin or mounting block and vials for keeping specimens.

5	Cotton Wools	Cotton wools soaked with ethyl acetate will make a release toxic gas to kill the insect instantly.
6	Digital single-lens reflex	To aid in better vision by recording and observation, such as to enlarge distanced object.
7	ThermoPro TP53 Hygrometer Humidity Levels	To measure the temperature and humidity levels.
8	Binocular Microscope	To observe the different part of the insect.
9	Digital Microscope Camera	To capture the insect images.

3.3 Method

The method used in this study was designed in line with the objectives of the study as illustrated in flowchart of the study (Figure 3.3) and collaborated section in sub-topics below.



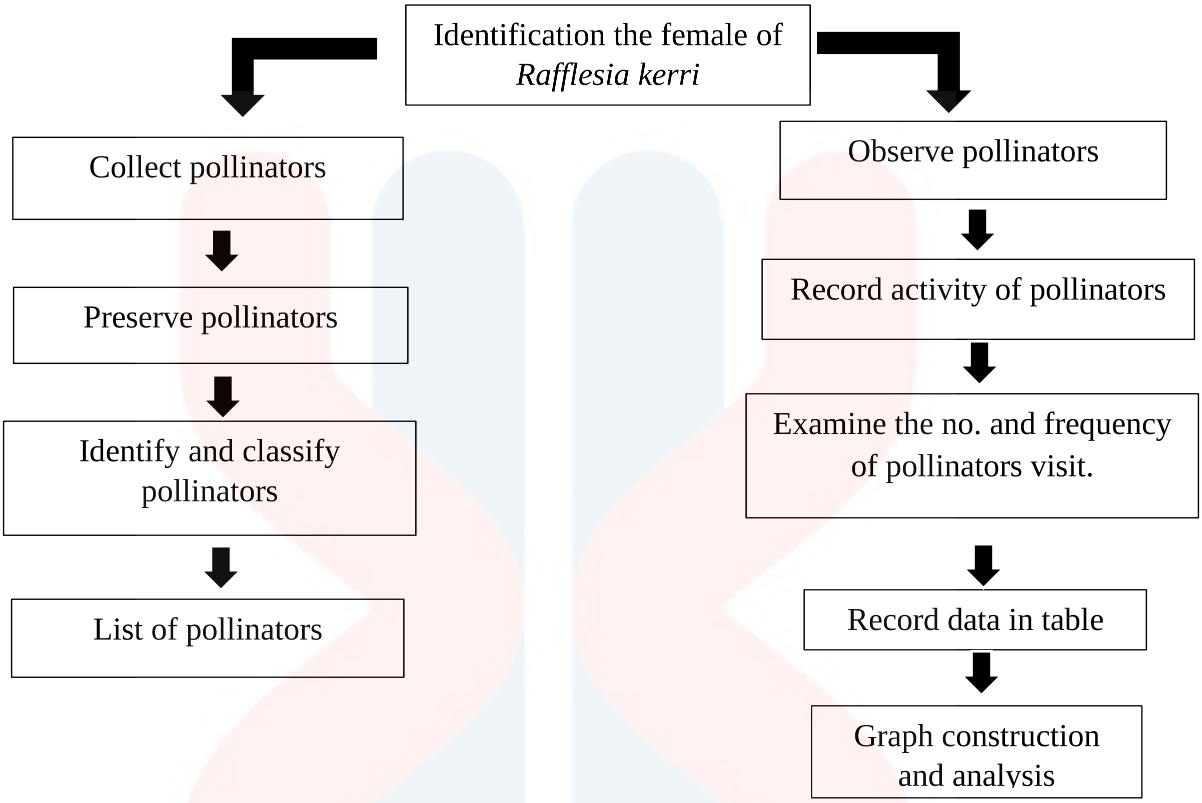


Figure 3.3. Flowchart of the study.

3.3.1 Identification of the Female *Rafflesia kerri*.

Female and male *R. kerri* can be distinguished and allow to be identified. *Rafflesia* blooms are unisexual and dioecious, meaning that only one plant can produce a female or a male. When flowers are fully open, the perigone lobes of male flowers are held more firmly than those of female flowers, which have the lobes more widely spaced (Meijer, 1997; Tran et al., 2018). Male *Rafflesia* blooms need pollinators as agents to pollinate the flower since they release a sticky yellow pollen. In order for pollen from the male flower to reach the female reproductive organ at the appropriate moment, the male and female flowers must bloom simultaneously (Beaman, 1988).

3.3.2 Identification of Pollinator Species associated with the Female *Rafflesia kerri*

The activities of insects, such as the frequency and time of insect visitation, were recorded. The observer will always remain one meter away from the flower to minimize interference with the insects' activities. By employing aerial and sweep nets, the insects were collected as specimens for subsequent species identification and analysis. The insects were categorized into two groups: pollinators and visitors. The pollinators are typically from the genus *Caliphoridae* (Hor et al., 2021). They enter the part beneath the structure of the male disc, which contains a yellow, sticky pollen mush. The adhesive pollen adheres to the thorax of pollinators. Subsequently, these pollinators approach the female *Rafflesia*, and the sticky pollen they carry adheres to the female *Rafflesia*. Insects engaging in this activity were be classified as pollinators. Meanwhile, visitors, such as mosquitoes, *Drosophilidae,* and *Sarcophagidae* (Hor et al., 2021), only visit the surface of the *Rafflesia* without entering below the disc structure. An aerial net was utilized to capture the targeted insects. Subsequently, the insects were placed in killing jars with cotton wool soaked in ethyl acetate to exterminate them. The deceased insects were then transferred to a plastic container to ensure their preservation. For identification purposes, key components of the insects, such as their wings, were carefully spread out. Insects too small to be mounted on pins were affixed to card points, while larger insects were directly mounted on pins. Pollinators were identified at the genus, morphospecies, and species levels using a binocular microscope to observe various parts of the insect. The identification process involved consulting the entomology bulletin by Kurahashi, H., Benjaphong, N. & Omar, B. 1997 and verified by the expertise from Universiti Kebangsaan Malaysia, Assoc. Prof. Dr. Wee Suk Ling.

3.3.3 Evaluation Activities of Pollinators during the Blooming Stages of the Female *Rafflesia kerri*

Observations were conducted on the three stages of blooming cycle, during the fresh blooming (days 1-3), mid-blooming (days 4-5), and late-blooming (days 6–8) phases to acquire a comprehensive understanding of pollinator activity. Additionally, these observations were conducted throughout the times: in the morning (9–10 am), in the noon (12–1 pm); and in the evening (3–4 pm). Visits at different times resulted in variations in their activities. Furthermore, each listed time had different temperatures. According to Sara et al. (2015), 84% of the variation in pollinator activity across species and sites could be explained by temperature. Given the crucial role of temperature, measuring the diversity of thermal responses within functional groups is a viable method for determining the vulnerability of ecosystems to changes in climate and land use. The total number of pollinators visiting *R. kerri* was recorded in a table along with the corresponding ambient temperature (in ºC). Temperature and humidity levels were measured using the ThermoPro TP53 hygrometer humidity gauge (Abdul Hamid et al., 2021) due to the possibility that temperature variation in the flowers indicates endothermy in *Rafflesia*. The flowers can release an odor that attracts insects as a result of this endothermic process (Yansen et al., 2023). Subsequently, an analysis of the highest frequency of pollination visits to *R. kerri* was conducted throughout its anthesis period, and the behavior of insects was also recorded as a reference.

3.3.4 Data Analysis

With careful observation and documenting combined with a methodical pollinator specimen collection, a comprehensive dataset for analysis has been produced. The primary objective of this project is to identify certain pollinator species and understand their behaviours in relation to the different blossoming situation of female *R. kerri* flowers. This will help to clarify the complex link that exists between the pollinators and the plants.

Thorough identification of pollinator specimens is necessary for the first part of the research. This study was uses field guides and entomological knowledge. Understanding patterns and variances in pollinator behaviour requires an understanding of pollinators and plants. Pollinator frequency and visitor attendance were closely observed on *R. kerri*. This can be analysed using a line graph in connection to time, the condition of the flowers, and the temperature, all of which have an effect on the frequency of pollinators and visits.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Description of the Female *Rafflesia kerri* flower

A total of two female *Rafflesia kerri* flowers were found and assessed for pollination during this study. The description of morphology characteristics and ecology were elaborated below. *R. kerri* 1 in Figure 4.1 was found in population 7 in Berus @ Beseru which is at latitude N 04 °38'22.1" and longitude E 101 °30'12.9". The distance of this place from Rnr Lojing Highland Kelantan is 3.76 km, and it has an altitude of 958m above sea level. The open flower diameter of this flower measures 71.5cm L by 77.5 cm W. This female *R. kerri* has 5 perigone lobes in the digphragm, measuring 35 cm L x 36.5 cm W. The window has 7 rings, which are equal to 0.5 cm L x 1 cm W, and has a processor 52. Next, the first petal measures L 26.7 cm; W 33.5 cm; second petal L 23.5 cm; W 28.5 cm; third petal L 25.5 cm; W 32.5 cm; fourth petal L 23.5 cm; W 30.5 cm; and the last petal, which is the fifth petal, measures L 24.5 cm; W 31.5 cm. This flower blooms on the -86° slope at the top of the hill. This *R. kerri* also grows in the bush, but the flower region is partially concealed by small trees. This flower also looks imperfect because there are two petals that has been broken. *R. kerri* is very fragile and breaks easily. This happened probably because of the tourists who came to visit this flower.

The second *R. kerri* in Figure 4.2 was located at latitude N 04°38'09.1" and longitude E 101°30'13.3". The distance between Rnr is 4.14 km, and the elevation above sea level is 977 meters. This is an open flower with a dimension of 71.5 cm L x 77.5 cm W. This flower has 5 perigone lobes, a diaphragm measuring 35cm L x 36.5cm W, an aperture measuring 15.5cm L x 20.5cm W, 7 rings equating to 0.5cm

L x 1cm W, and a processer 52. First petals measure L 26.7 cm; W 33.5 cm; second petals L 23.5 cm; W 28.5 cm; third petal L 25.5 cm; W 32.5 cm; fourth petal L 23.5 cm; W 30.5 cm; and fifth petal L 24.5 cm; W 31.5 cm. This second *R. kerri* blooms behind the bush and grows on the creeping roots of the tree. As a result, flower expansion makes it challenging for the petals to open fully. Therefore, because it is obscured by the shrub, tourists are unable to see this flower. The distance between this bloom and the water is five metres, which is rather near.

Besides that, the frequency of pollinators and visitors *R. kerri* in both Figure 4.1 and 4.2 is based on the predetermined time difference, which is between 9.00 AM-10:00 AM, 12.00 PM- 1.00 PM, and 3.00 PM-4.00 PM. In addition to the variations in blooming stages, temperature has an impact on pollinators and visitors at all times. This is claimed to be the case because *R. kerri* own scent fluctuates according to the temperature and blooming stages at different times. In table 4.1 and 4.2 summarises the flower observations in *Rafflesia* Conservation Area, Lojing Highlands Kelantan, Malaysia

Table 4.1 Summarization of *Rafflesia kerri* 1 observations.

Day of blooming stages	**Observations**
Early blooming (1-3 days)	Sunny days; flower colour bright red; smells like a rotting carcass; strong smell in the afternoon 1200-1300; a lot of pollinator and visitor activity.
Middle blooming (4-5 days)	Cloudy day; flower colour is fading; the colour changes to become darker; moist flower condition: the strong rotten smells is diminishing; pollinator activity is getting less compared to early blooming.
Late blooming (6-7 days)	Rainy day; the colour has become dark; watery and rotting flower structure; white fungus grows on each petal; the smells is less compared to the early and middle stages; the activity of *drosophila* sp. visitors is very high.

Table 4.2 Summarization of *Rafflesia kerri* 2 observations.

Day of blooming stages	**Observations**
Early blooming (1-3 days)	Sunny day; flower colour bright red; flower blooms in the bushes; flower grow under creeping tree roots; the flower smell is strong; location 5 meter from river; attract many activity pollinator and visitor.
Middle blooming (4-5 days)	Cloudy day; the flower appear dark red; unpleasant smell; flower look wet; the activity of pollinators and visitors is decreasing compared to early stages.
Late blooming (6-7 days)	Cloudy day; the colour starts to dark and bit red; the structure very fragile; flower start to crack; the smell starts to faded; the is activity breeding from visitors; flower structure start to decay because of fungus; *drosophila* sp. visitor activity is very active.

Figure 4.1: Blooming stages of *Rafflesia kerri* 1 in Lojing Highland Kelantan.

a. Early blooming, b. Middle blooming, c. Late blooming.

Figure 4.2: Blooming stages of *Rafflesia kerri* 2 in Lojing Highland Kelantan.

a. Early blooming, b. Middle blooming, c. Late blooming.

R. kerri 1 is shown in Figure 4.1.a with early blooming stage (1-3 days) was carried out and closely observed on the day of observation. The weather looked to be sunny that day. The colour bright red of the bloom gives the impression that it is still young and fresh. Following observation, it was found that *R. kerri* generates difference smells in the morning, afternoon, and evening according on the temperature. During this early blooming stage, a lot of pollinator and visitor activity. Next, *R. kerri* 1 is shown in Figure 4.1.b middle blooming stages (4-5 days) observation activity looks like a cloudy day. The colour of the flower fades off and become darker. The flower structure was very wet because of the rainy day the night before the observation day. Compared to early the blooming stages, the stench is moderately less. As a result, the reduced ability of the scent to draw pollinators and visitors results in a decrease in their activity. Additionally, it rained on the day that *R. kerri* 1 is shown in Figure 4.1.c was observed, which coincided with its late blooming stages (6-7days). The colour of the late blooming has changed to a dark, wet, and rotted structure. This is because at this late blooming stage *R. kerri* flowers will become rotten and then continue to the process of decay. On each of the petals has been grows white fungus that plays a role in the rotting of the *R. kerri*. In comparison to the early and middle periods, there are less odours. As a result, this has made *drosophila* sp. visitors more active.

Observation of *R. kerri* 2 on that sunny day in the early stages of blooming is shown in Figure 4.2. a. The colour of the flower in the early blooming stages is bright red and beautiful. This *R. kerri* blooms in the bushes and grows under creeping tree roots. As a result, the creeping tree roots on this bloom impede its ability to expand fully. The end effect is a folded petal that looks imperfect. The smell of rotting carcasses at this stage is very strong and has attracted a lot of activity from pollinators and visitors. Middle stage blooming *R. kerri* 2 observation has been completed and is shown in Figure 4.2.a. The weather that day looks like a cloudy day, and the flower looked wet. The flower appears dark red. Compared to the early blooming stage, the scent of rotting carcasses is moderately less at this point. The absence of an odour that can draw insects at this stage also decreases pollinator and visitor activity in comparison to the early blooming stage. Next, the observation for *R. kerri* 2 is shown in Figure 4.2.c has been carefully observed. On that day the weather looked like a cloudy day. The colour of the flower turns somewhat reddish-black. The flower structure also looks very fragile, and starts to crack. This is due to the rain that fell the night before the observation day. The smell also starts to fade. Besides, mosquito breeding is occurring on the diaphragm while observations are being made. This has demonstrated that, in addition to main pollinators who do pollination activities, the presence of visitors who stop by and come on *R. kerri* also perform activities such as breeding. A flower starts to decay because of fungus. At this blooming stage, the presence of *drosophila* sp. visitors is very active.

4.2 Observation of Pollinators Activity

According to Hor et al. (2021), the main pollinators of *Rafflesia kerri* in Lojing Highland Kelantan is Caliphoridae flies from genera *Chrysomya* sp., *Lucilia* sp., and *Hypopygiopsis* sp. During observation, due to the abundance of visitation. *Chrysomya* sp. visit this flower frequently and spend a significant amount of time on petals, diaphragm, and disc. In *Chrysomya* sp., the body is very stout, the head is large, and the cheeks are conspicuously hairy and yellowish with black markings (Beverley, 1991). While making critical observations to identify the genus *Chrysomya* sp., notice the back metallic blue colour and the bristle hair location on the thorax. Meanwhile, *Lucilia* sp. is the second flies that frequently visits *R. kerri*. in *Lucilia* sp., the body is slender, the head is small, and the cheeks are silvery and rather smooth (Beverley, 1991). List of pollinators and visitors as shown in Table 4.3 below.

Table 4.3: Pollinators and Visitors in Rafflesia Conservation Area, Lojing Highlands Kelantan, Malaysia.

Pollinators	Visitors
1. *Chrysomya* sp.	1. *Drosophila* sp.
2. *Lucilia*.sp	2. *Paederus* sp.
3. *Hypopygiopsis*.sp	3. *Musca* sp.
	4. *Sarcophaga* sp.

Figure 4.3 below shown the images of insect pollinators derived from this study. The main insect pollinator observed throughout the study is *Chrysomya* sp. These flies visit flowers frequently and engage in a variety of trips and activity as shown in Figure 4.4. With the frequency of many visits made by these flies, it has been proven that *Chrysomya* sp. is a main pollinator that does a lot of activities that bring *R. kerri* male pollen to *R. kerri* female for the pollination process of *R. kerri* in flowers *Rafflesia* Conservation Area, Lojing Highlands Kelantan, Malaysia.

Meanwhile, *Lucilia* sp. was identified as the second main pollinators that do a lot of activity in *R. kerri*. Three pairs of acrostichals exist in the *Lucilia* sp., whereas *Chrysomya* sp. only has one pair between the scutellum and the transverse suture of the mesonotum (Beverley, 1991).

In addition, *Hypopygiopsis* sp. was identified as the third pollinator for *R. kerri*. Throughout the observation, *Hypopygiopsis* sp. has longer hairs and more on the head, thorax, and abdomen than *Chrysomya* sp. and *Lucilia* sp.

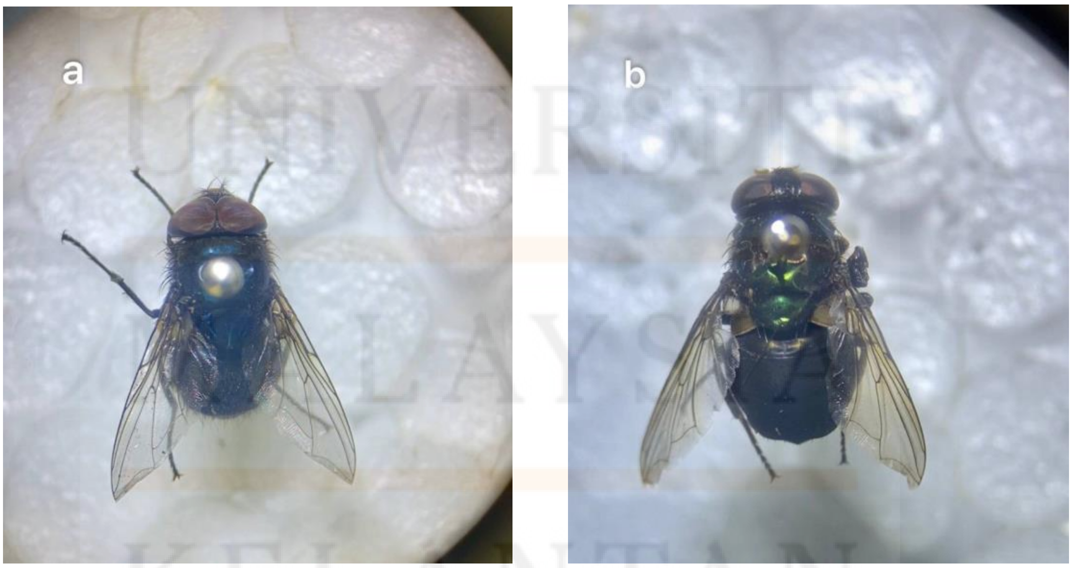


Figure 4.3: Pollinators of *Rafflesia kerri*. a. *Chrysomya* sp. (Caliphoridae), b. *Lucilia* sp. (Caliphoridae), c. *Hypopygiopsis* sp. (Caliphoridae).

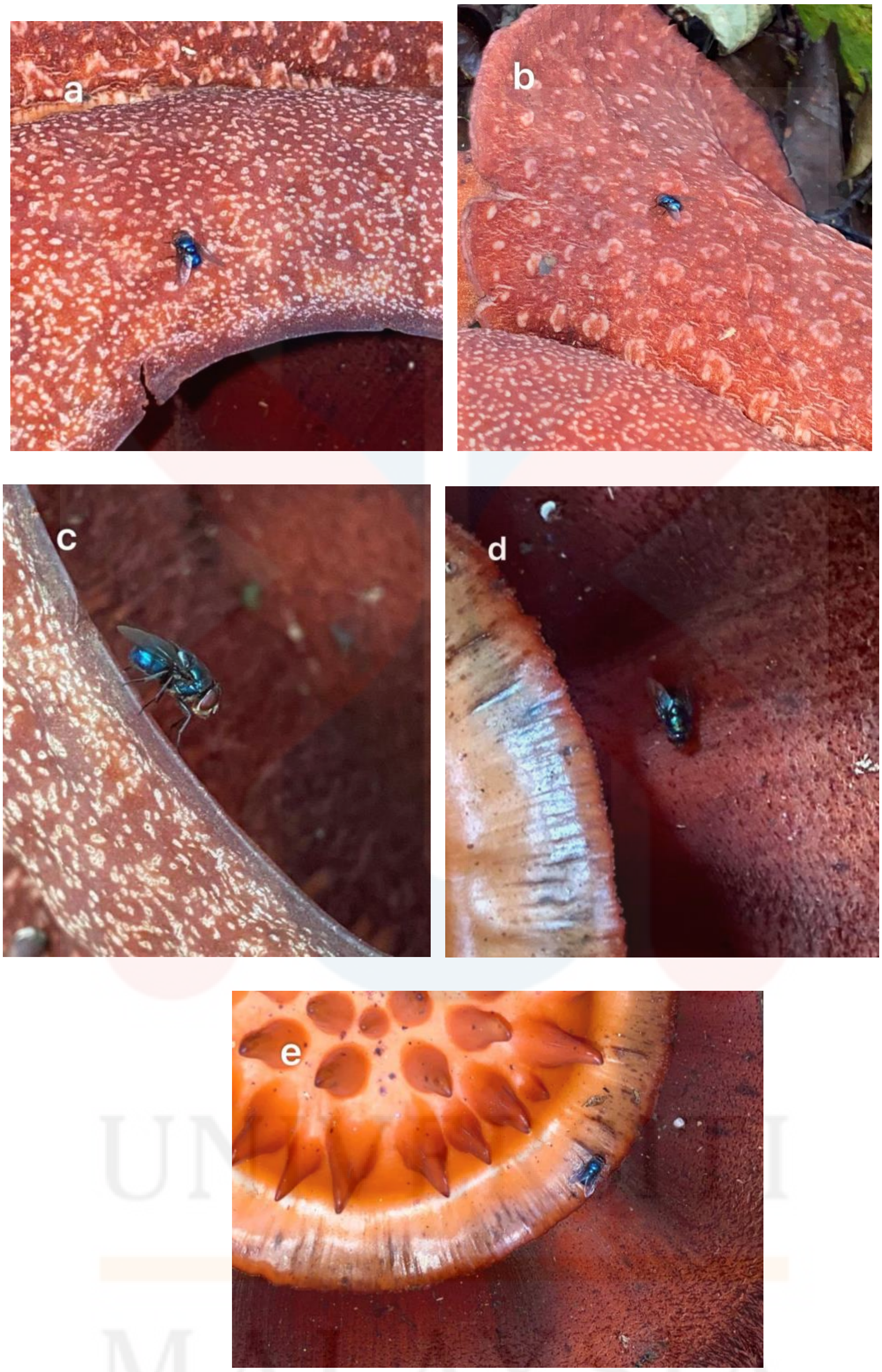


Figure 4.4: Flies behaviour on *Rafflesia kerri* a. *Chrysomya*.sp rested on diaphragm, b. *Chrysomya* sp. Rested on petal, c. *Chrysomya* sp. at the diaphragm brim, d. *Lucilia* sp. was about crawling inside the anther cavity, e. *Chrysomya* sp. rested on the disc.

During the observation, pollinators, were actively visited the flowers when flowers begin to emit odours. Therefore, the flies began to fly to land on the flowers and landed directly on each structure of *R. kerri*. As shown in Figure 4.3 a, *Chrysomya* sp. rests on the diaphragm. Next, *Chrysomya* sp. is also resting on the petals in Figure 4.3 b, and *Chrysomya* sp. is at the diaphragm brim and walks around it as shown in Figure 4.3 c. In Figure 4.3 d, *Lucilia* sp. is crawling inside the anther cavity to find a suitable place to get nutrients and lay eggs. Finally, as in Figure 4.3 e. It looks like *Chrysomya* sp. is resting on the disc and walking around the processes.

Flies are drawn to the scent of decaying waste because it indicates a food source and an appropriate location in which to lay their eggs (Francois et al., 2017). Therefore, flies are very attracted to *R. kerri* because it has a carrion-like smell. Through the observations that have been carried out, it has been found that various activities of pollinators have been recorded. They are not only looking for food but also want to find a suitable place to lay their eggs. While carrying out activities around the female *R. kerri*, they are also potentially the same pollinators that have visited the male *R. kerri*. The same pollinators visiting *R. kerri* males will bring pollen and then reach *R. kerri* female.

Figure 4.5: Visitors of *Rafflesia kerri*. a. *Sarcophaga* sp. (Diptera), b. *Paederus* sp. (Coleoptera), c. *Musca* sp. (Diptera), d. *Drosophila* sp. (Diptera).

During the observation, there are other insects that were only considered as visitors, as shown in Figure 4.5. These are several other insects that come to visit and perform activities such as resting, laying eggs, and landing on the surface of female *R. kerri*. These visitors are not the main pollinators because of several factors. Some of them are morphologically too small to carry pollen and cannot fly far enough to reach the female *R. kerri*. Additionally, some of them do not have the ability to fly long distances to complete the pollination process.

Some of the visitor's present are as shown in Figure 4.5 a. During the observation, this fly had a body colour like a soldier's shirt. *Sarcophaga* sp. flies (known as flesh flies) visiting a corpse mostly belong to the synanthropic dement of sub- tropical or even tropical origin, which constitute a part of the insect faunal succession representing actually the first and very important destruction stage responsible for the essential decomposition (Lipin et al., 2018).

Next, Figure 4.5 b., these insects are not capable of flying like flies. This insect only comes to visit around the flower because of the colour of *R. kerri*, which has attracted the insect. *Paederu*s sp. species are much more brightly coloured than most other rove beetles, with metallic blue- or green-coloured elytra and many with bright orange or red on the pronotum and the basal segments of the abdomen (Pushpa et al., 2007).

In addition, the visitors shown in Figure 4.4 c are the *Musca* sp. During the observation, *Musca* sp. came to visit each structure of female *R. kerri*. *Musca* sp. is a very large family with worldwide distribution that includes species typically associated with excrement and decaying plant matter (Adrian et al., 2018).

Lastly, the visitors shown in Figure 4.5 d. are visitors who visit a lot in the late stages of blooming. In the late stages of blooming, the flowers are rotting, infected with white fungus and have caused *Drosophila* sp. to be more attracted to the decomposition process. *Drosophila* sp., popularly known as fruit flies or vinegar flies, live in a variety of settings and feed largely on rotten fruit, rotten flower and organic debris (Muhammad, 2020).

4.3 The frequency of insects visitation and association with blooming stages.

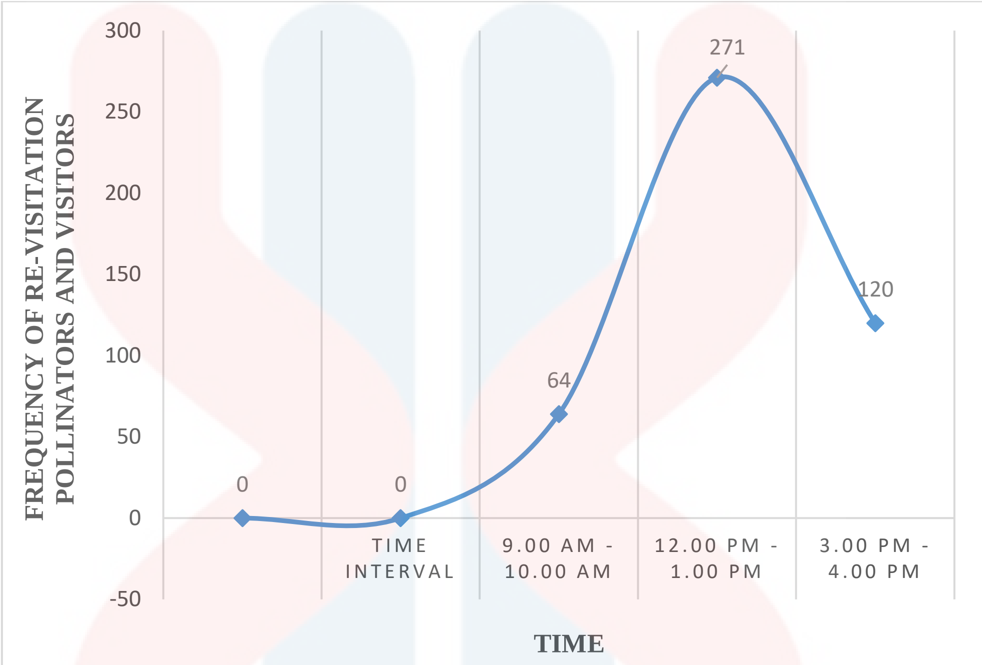


Figure 4.6: Frequency of re-visitation of insect pollinators and visitors in early blooming stage *Rafflesia kerri* 1 (Day 1 to 3)

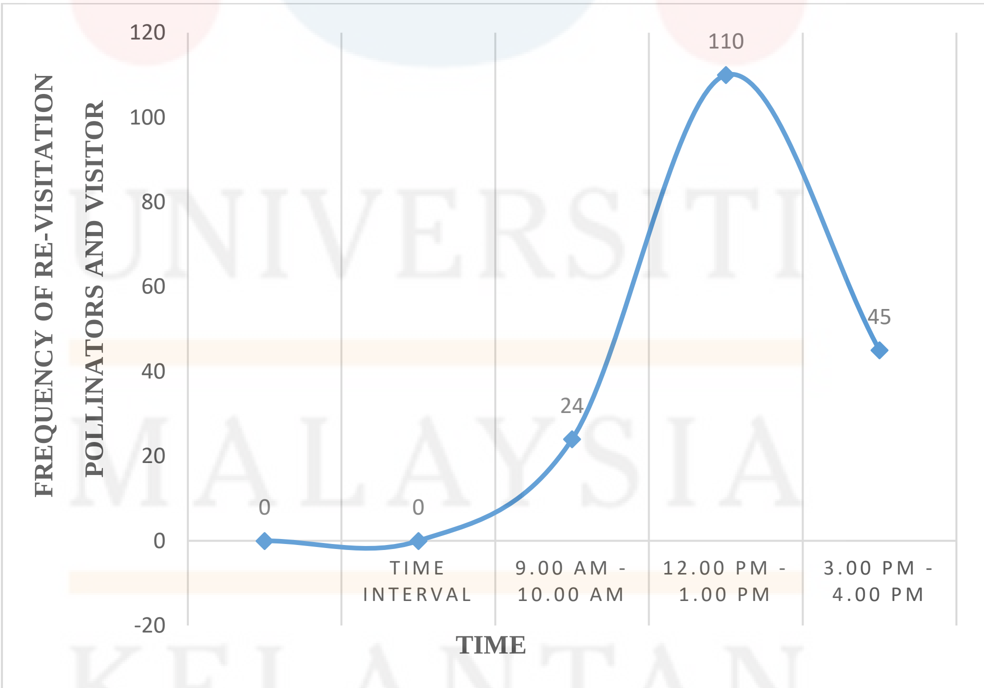


Figure 4.7: Frequency of re-visitation of insect pollinators and visitors in middle blooming stage *Rafflesia kerri* 1 (Day 4 to 5)

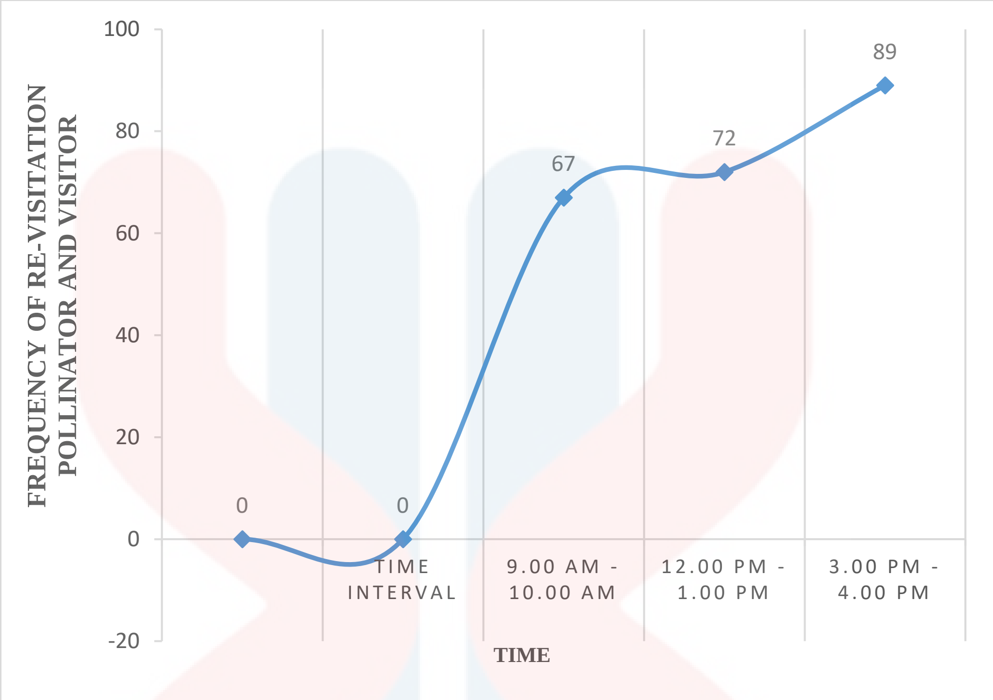


Figure 4.8: Frequency of re-visitation of insect pollinators and visitors in late blooming stage *Rafflesia kerri* 1 (Day 6 to 7)

The results of the study show a variation in the frequency of pollinator and visitor re-visitation as displayed in Figure 4.6, 4.7, and 4.8. In the early blooming stage Figure 4.6, in the morning at 9.00 am - 10.00 am, with a temperature of 23.2°C and a humidity of 67%, it had 64 visitors from pollinators and visitors. Meanwhile at 12.00 pm - 1.00 pm with a temperature of 27.5°C, humidity of 58%, and has got 271 re-visits. Then, between 3.00 pm and 4.00 pm., with a temperature of 24.5°C and humidity of 59%, pollinators and up to 120 visitors arrived. The difference between these three hours indicates that 12.00 pm - 1.00 pm has the highest temperature and humidity. As a result, temperature and humidity have a constant influence on pollinator and visitor visitation. This is because high temperatures cause female *R. kerri* to produce a strong odour.

Next, in the middle blooming stage Figure 4.7, in the morning at 9.00 am - 10.00 am with a temperature of 26.5°C, humidity 71%, and 24 visits. 110 insect arrived between 12.00 pm - 1.00 pm., with a temperature of 25.8°C and a humidity level of 58%. At 3.00 PM - 4.00 PM, with a temperature of 24.2ºC and humidity of 65%, was received 45 visits. It may also be established that there is a high rate of re-visitation between 12.00 pm and 1.00 pm because the humidity is lower during these hours, resulting in more visits by pollinators and visitors. Meanwhile, the least number of visitors arrived between 9.00 and 10:00 am. This is due to the extremely high humidity levels at the time. If the humidity is high and the temperature is low, the smell will decrease.

Furthermore, in the late blooming stage Figure 4.8, it has been shown that *drosophila* sp. is the most frequent visitor. There were 67 visitors between 9.00 and 10.00 a.m., with a temperature of 22.7 °C and a 68% humidity level. Temperature was 23.1°C, humidity was 77%, and 72 visitors visited between 12.00 and 1.00 a.m.; between 3.00 and 4.00 a.m., temperature was 24.4°C, humidity was 80%, and 89 visited. As shown in the results of the highest visitors between 12.00 pm, 1.00 pm and 3.00 pm, 4.00 pm. It can be concluded that the high presence of drosophila *sp.* is influenced by high humidity level.

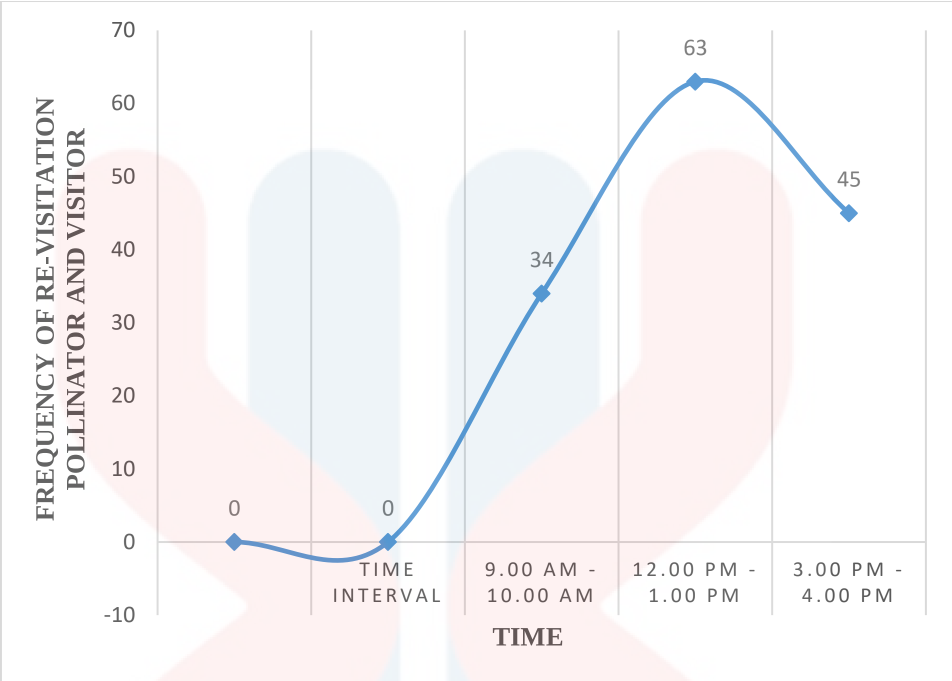


Figure 4.9: Frequency of re-visitation of insect pollinators and visitors in early blooming stage *Rafflesia kerri* 2 (Day 1 to 3)

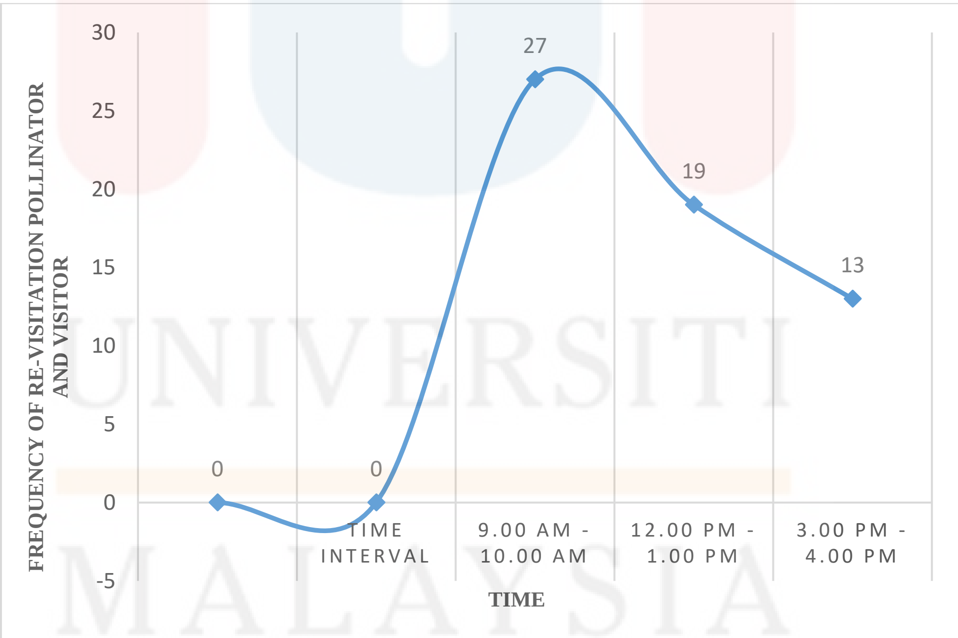


Figure 4.10: Frequency of re-visitation of insect pollinators and visitors in middle blooming stage *Rafflesia kerri* 2 (Day 4 to 5)

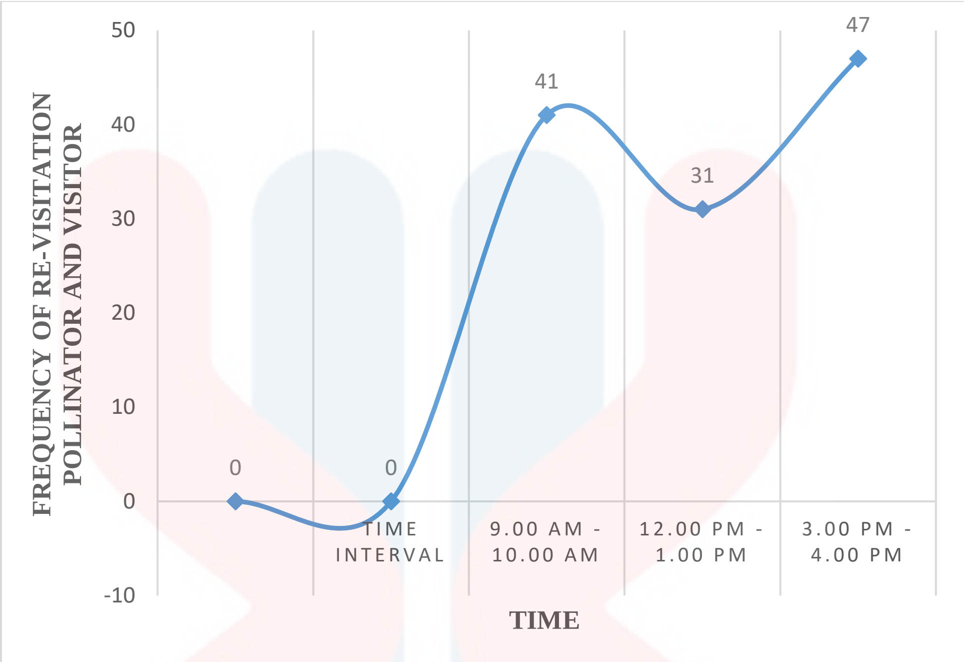


Figure 4.11: Frequency of re-visitation of insect pollinators and visitors in late blooming stage *Rafflesia kerri* 2 (Day 6 to 7)

The results of the study show a variation in the frequency of pollinator and visitor re-visitation as displayed in Figure 4.9, 4.10, and 4.11. A total of 34 visitors came in the early blooming stage Figure 4.9, at 9.00 am to 10.00 am, with a temperature of 23.1°C and a humidity of 70%. Meanwhile, from 12.00 pm to 1.00 pm, the temperature was 26.1ºC, the humidity was 60%, and there were 63 visitors. From 3.00 pm to 4.00 pm, the temperature was 24.1ºC, the humidity was 68%, and there were 45 visitors. The presence of many pollinators and visitors at 12.00 pm–1.00 pm is due to the high temperature and low humidity level compared to the three times in these early blooming stages.

Next, for the middle blooming stage Figure 4.10, at 9.00 am to 10.00 am. The temperature is 25.2 °C, the humidity is 60%, and there are a total of 27 visitors. Meanwhile, between 12.00 and 1.00 pm, with a temperature of 23.1°C and a humidity of 71%, 19 visited. Temperature was 23.7°C, humidity was 74%, and there were 13 visits between 3.00 and 4.00 pm. Pollinators and many visitors at 9.00 am to 10 am, because when observing the weather during the afternoon and evening, it looked cloudy. This can be concluded because at 9.00 am to 10.00 am, we received the lowest humidity compared to those two times.

In addition, the late blooming stage Figure 4.11, is usually only attended by *drosophila* sp. visitors. No pollinators come at this stage. This is because the smell released by female *R. kerri* has already faded off. Therefore, only *drosophila* sp. visitors come to visit because the flowers are in the process of decaying and rotting. The temperature is 21.3ºC, the humidity is 78%, and there are 41 visitors between 9.00 and 10 am. While at 12.00 pm to 1.00 pm the temperature is 22.5ºC, humidity is 71%, and visitors are a total of 32, and at 3.00 pm to 4.00 pm the temperature is 23.1°C, humidity is 82%, and there are 47 visitors. At 3.00 pm to 4.00 pm, get the highest frequency of re-visit visitors. This is because at this point it has a high humidity level of 82% compared to the two times.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Significant findings from this study have been derived and can be concluded as follows:

(i) A total of three genera, namely: *Chrysomya* sp., *Lucilia* sp., and *Hypopygiopsis* sp., were identified as insect pollinators for female *Rafflesia kerri* in Lojing Highland Kelantan.

(ii) A total of four genera were identified as insect visitors, these are: *Drosophila* sp., *Paederus* sp., *Musca* sp., and *Sarcophaga* sp.

(iii) The early blooming stage was noted to be the most active period for pollinators due to the strong scent released during this time. A total of 597 (100%) insect pollinators were observed visiting during this period, with 455 (76.2%) visiting *R. kerri* 1 and 142 (23.8%) visiting *R. kerri* 2.

(iv) The late blooming stage was identified as the most active period for visitors like *Drosophila* sp. During this period, 347 (100%) of insect visitors were recorded visiting, with 228 (65.7%) were observed visiting *R. kerri* 1, and 119 (34.3%) were observed visiting *R. kerri* 2. This is because, by this stage, *R. kerri* has begun to decay.

5.2 Recommendation

Future research initiatives and conservation plans targeted at protecting pollinator and plant ecosystems can be guided by the study of pollinators and *R. kerri* role in them. The fact that *R. kerri* is a parasitic plant that embeds its tissues within the tissues of its host plant has made research on it challenging. The male and female flowers of *R. kerri* are physically separated as different plants, making them unisexual plants. In addition, the flower has a brief flowering period. As a result, for pollination to be successful, both flowers need to be close to one another and the stigma and pollen need to be viable and responsive. Also, the population of *R. kerri* is restricted and only found in specific locations. Visible to the public, the majority of the area was gazetted as a National Park. This disrupts the environment of *R. kerri*. Increasing sample efforts is one tactic that can be considered. More field surveys including *R. kerri* are needed to expand the spatial and temporal coverage of pollinator observations among various *Rafflesia* populations and settings. In this way, variations in pollinator groups and activity patterns can be better captured.

Furthermore, a thorough investigation of each species is necessary to have a deeper understanding of the biology, behaviour, and ecological functions of each pollinator species connected to Rafflesia. This may entail examining their life cycles, preferred methods of foraging, and interactions with the *R. kerri* flowers. Potential pollinators should be thoroughly investigated in order to assess their efficacy and contribution to the pollination mechanism's success. Their appearance as pollinators can be statistically identified by observing them while the female flower of *R. kerri* blooming together with pollen adhering to their top thorax. Key pollinator habitats, which include *R. kerri* and their host plants as well as natural pollinator foraging grounds, must be protected in order to restore and safeguard the habitat of the *R. kerri*.

Improving the quality and connectedness of habitats can help maintain healthy populations of *R. kerri* and pollinators while also fostering ecosystem resilience. One way to accomplish this is through community engagement. The *R. kerri* ecosystem and habitat need to be monitored and preserved in conjunction with local communities through citizen science projects, educational initiatives, and participatory research endeavours. Enhancing local capability and encouraging stewardship can improve *R. kerri* and its pollinator conservation results.

REFERENCES

Adam, J. H., Mohamed, R., Juhari, M. A. A., Ariff, N. N. F. N. & Wan, K. L. (2013). *Rafflesia sharifah-hapsahiae* (Rafflesiaceae), a new species from Peninsular Malaysia. *Turkish Journal of Botany*, 37(6), 1038-1044.

Asfarina, I., Siti-Munirah, M. Y., Susatya, A., Norhazlini, M. Z. & Zulhazman, H. (2022, November). Examining the Anatomical Characteristics of *Rafflesia kerrii* in Lojing Highlands, Peninsular Malaysia. *In IOP Conference Series: Earth and Environmental Science* (Vol. 1102, No. 1, p. 012068). IOP Publishing.

Asiandu, A. P. (2021). Biological aspects and conservation of *Rafflesia arnoldii*: Indonesian endemic plant conservation. *Konservasi Hayati*, 17(2), 49-55.

Abdul Hamid, M. I., Nor Hizami, H., Muhamad Azahar, A. & Zulhazman, H., (2021). Modelling in-situ factors affecting bud's growth of *Rafflesia kerrii* Meijer in Lojing Highlands, Kelantan, Peninsular Malaysia. *Pertanika Journal of Science and Technology*. 29 (2), 1243-1266.

Beaman, R.S., Decker, P.J., and Beaman, J.H. (1988). Pollination of Rafflesia (Rafflesiaceae). *American Journal of Botany 75*: 1148-1162.

Barcelona, J. F., Pelser, P. B., Balete, D. S. & Co, L. L. (2009). Taxonomy, ecology, and conservation status of Philippine *Rafflesia* (Rafflesiaceae). *Blumea-Biodiversity, Evolution and Biogeography of Plants*, 54(1-2), 77-93.

Cheek, M., Etuge, M. & Williams, S. A. (2019). *Afrothismia kupensis* sp. nov.(*Thismiaceae*), Critically Endangered, with observations on its pollination and notes on the endemics of Mt Kupe, Cameroon. *Blumea-Biodiversity, Evolution and Biogeography of Plants*, 64(2), 158-164.

Dony Adriansyah, N., Nur Syazwani, M. F., Zurfarahin Zulkarnain, Sharifah Aisyah, S.O. & Mohamad Khidzir, M. I. (2014). Geological studies to support the tourism site: A case study in the *Rafflesia* Trail, near Kampung Jedip, Lojing Highlands, Kelantan, Malaysia. *International journal of Geosciences*, 5(08), 835.

Ebeling, A., Klein, A. M., Schumacher, J., Weisser,W. W. & Tscharntke, T. (2008). How does plant richness affect pollinator richness and temporal stability of flower visits?. *Oikos*, 117(12), 1808-1815.

Farah Khaliz, K., Zulhazman, H., Nur Syazwani, S., Siti Hajar, Y., Nur Kyariatul Syafinie, A. M., Nasihah, M. & Siti Fatimah, A. (2018). Distribution and Ecology of *Rafflesia* in Royal Belum State Park, Perak, Malaysia. *International Journal of Engineering & Technology*, 7(2.29), 292-296.

FSP, N. (2019). Is Rafflesia an angiosperm?. *Journal of Tropical Forest Science*, 31(3), 286-297.

Gnanaraj, P., Venugopal, V., Mozhi, M. K. & Pandurangan, C. N. (2007). An outbreak of Paederus dermatitis in a suburban hospital in South India: a report of 123 cases and review of literature. *Journal of the American Academy of Dermatology*, *57*(2), 297-300.

Hidayati, S. N. & Walck, J. L. (2016). A review of the biology of *Rafflesia*: What do we know and what's next?. *Botanic Gardens Bulletin*, 19(2), 67-78.

Hirunpetcharat, C., Wichantuk, P., Diraphat, P., Utrarachkij, F. & Tangwattanachuleeporn, M. (2018). Antibacterial activity of *Rafflesia kerrii* Meijer extracts against hospital isolates of methicillin-resistant Staphylococcus aureus (MRSA). *Interdisciplinary Research Review*, 13(1), 40-45.

Hor, P. L., Norhazlini, M. Z., Nasihah, M. & Zulhazman, H. (2021). Diurnal insect pollinators of *Rafflesia kerri* Meijer at Lojing Highlands, Kelantan, Peninsular Malaysia. *The Malaysian Forester*, 84(1), 7-15.

Kusuma, Y. W. C., Matsuo, A., Wanke, S., Suyama, Y., & Isagi, Y. (2023). How many species of Rafflesia exist in Java, Indonesia and what are the implications for conservation?. *Plants, People, Planet*.

Kuhsel, S. & Bluthgen, N. (2015). High diversity stabilizes the thermal resilience of pollinator communities in intensively managed grasslands. *Nature communications*, 6(1), 7989.

Kurahashi, H., Benjaphong, N. & Omar, B. 1997. Blow flies (Insecta: Diptera: Calliphoridae) of Malaysia and Singapore. *The Raffles Bulletin of Zoology* 45(5): 88-91.

Mohan Ram, H. Y., & Mathur, G. (1984). Flower-insect interaction in pollination. *Proceedings: Animal Sciences*, *93*, 359-363.

Meijer, W. (1997). Rafflesiaceae. *Flora Malesiana-Series 1, Spermatophyt*a, 13(1), 1-42.

Nasihah, M., Zulhazman, H., Siti Munirah, M. Y., Wan NorQayyum Nadia, W. A. & Latiff, A. (2016). *Tetrastigma hookeri* (Laws.) Planch(Vitaceae), a host plant for *Rafflesia kerri* Meijer in Peninsular Malaysia. *Malayan Nature Journal*, 68(1&2), 33-39.

Norhazlini, M. Z., Mailina, J., Shalini, M., Nor Azah, M., A. & Zulhazman, H. (2020, August). Assessing the floral volatile constituents of male and female *Rafflesia kerri* Meijer from Lojing Highlands, Peninsular Malaysia. *In IOP Conference Series: Earth and Environmental Science* (Vol. 549, No. 1, p. 012068). IOP Publishing.

Norhazlini, M. Z., Mailina, J., Shalini, M., Nor-Azah, M. A., & Zulhazman, H. (2021, August). Total phenolic content, total flavonoid content and antioxidant activity of ethanolic extract of *Rafflesia kerri* Meijer, Lojing Highlands, Peninsular Malaysia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 842, No. 1, p. 012062). IOP Publishing.

Nur Azuki, Y. (2008). A study on the acceptance of visitors by the Lojing community and the understanding of their cultural values in support of the process.

Nais, J. (2001). *Rafflesia* of The World. *Kota Kinabalu: Sabah Park in association with Natural History Publications (Borneo) Sdn. Bhd*.

Pelser, P. B., Nickrent, D. L. & Barcelona, J. F. (2016). Untangling a vine and its parasite: Host specificity of Philippine *Rafflesia* (Rafflesiaceae). *Taxon*, 65(4), 739-758.

Puttipan, R. & Okonogi, S. (2014). Antioxidant activity of *Rafflesia kerri* flower extract. *Drug Discoveries & Therapeutics*, 8(1), 18-24.

Renjana, E., Astuti, I. P., Munawaroh, E., Mursidawati, S., Witono, J. R., Fijridiyanto, I. A. & Yudaputra, A. (2022). Assessing potential habitat suitability of parasitic plant: A case study of *Rafflesia arnoldii* and its host plants. *Global Ecology and Conservation*, 34, e02063.

Rios-Carrasco, S., González-Martínez, C. A. & Vázquez-Santana, S. (2022). Floral visitors of the holoparasite Bdallophytum andrieuxii Eichler: A new report of brood-site pollination and thermogenesis for *Cytinaceae* (Malvales). *Brazilian Journal of Botany*, 45(3), 1047-1055.

Ren, L., Shang, Y., Chen, W., Meng, F., Cai, J., Zhu, G. & Guo, Y. (2018). A brief review of forensically important flesh flies (Diptera: Sarcophagidae). *Forensic sciences research*, 3(1), 16-26.

Sharifah, H. S. K., Suratman, M. N., Khamis, S., Hassan, A. N. N., & Mohammad, M. S. (2021). Host-Parasitic Relationships between Tetrastigma rafflesiae and Rafflesia azlanii and Rafflesia cantleyi in Belum-Temenggor Forest Complex, Perak, Malaysia. *Pertanika Journal of Tropical Agricultural Science*, 44(4).

Sofiyanti, N., Mat-Salleh, K., Mahmud, K., Mazlan, N. Z., Hasein, M. R. A. & Burslem, D. F. R. P. (2016). *Rafflesia parvimaculata* (Rafflesiaceae), a new species of *Rafflesia* from Peninsular Malaysia. *Phytotaxa*, 253(3), 207-213.

Pont, A. C. (2011). The Muscidae described by JW Zetterstedt (Insecta: Diptera). Zootaxa, 2852(1), 83.

Verheggen, F., Perrault, K. A., Megido, R. C., Dubois, L. M., Francis, F., Haubruge, E. & Stefanuto, P. H. (2017). The odor of death: an overview of current knowledge on characterization and applications. *Bioscience*, 67(7), 600-613.

Wicaksono, A., Mursidawati, S., Sukamto, L. A., & Teixeira da Silva, J. A. (2016). Rafflesia spp.: propagation and conservation. *Planta, 244*, 289-296.

Yansen, Y., Manik, R. J. & Senoadji, G. (2023). Insect visits and variation of floral temperatures during blossoming of *Rafflesia gradutensis*. *In E3S Web of Conferences* (Vol. 373). EDP Sciences.

Zulhazman, H., Abas, M. A., Norhazlini, M. Z., Norzielawati, S. & Boyce, P. C. (2021, August). Notes on Araceae in Lojing Highlands, Kelantan, Peninsular Malaysia. *In IOP Conference Series: Earth and Environmental Science* (Vol. 842, No. 1, p. 012076). IOP Publishing.

Zulhazman, H., Maryati, M., Peter, C. & Mahmud, M. 2011. Spatial Distribution and Conservation of Rafflesia kerri in Lojing Highlands, Kelantan. In Conservation Lojing Highlands for Sustainable Development. *Universiti Malaysia Kelantan*, Pp. 44-54.

APPENDIX – A

Raw data for the frequency of re-visitation pollinators and visitors of female Rafflesia Kerri.

***Rafflesia kerri 1* (Early Blooming 1 – 3 Days)**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
9.00 AM – 10.00 AM Temperature: 23.2 ºC; Humidity: 67%	*Chrysomya sp.*	10	19	6	**35**
	Lucilia sp.	4	6	3	**13**
	Hypopygiopsis sp.	4	4	0	**8**
	Drosophilidae	0	0	0	**0**
	Paedarus	1	0	0	**1**
	Muscidae	3	2	0	**5**
	Sachophagidae	0	2	0	**2**
	Total	**22**	**33**	**9**	**64**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
12.00 PM – 1.00 PM Temperature: 27.5 ºC; Humidity: 58%	*Chrysomya sp)*	25	36	56	**117**
	Lucilia sp.	15	30	40	**85**
	Hypopygiopsis sp.	16	15	21	**52**
	Drosophilidae	0	0	0	**0**
	Paedarus	0	1	0	**1**
	Muscidae	5	2	4	**11**
	Sachophagidae	3	0	2	**5**
	Total	**64**	**84**	**123**	**271**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
3.00 PM – 4.00 PM Temperature: 24.5 ºC, Humidity: 59%	*Chrysomya sp*	10	17	21	**48**
	Lucilia sp.	5	13	8	**26**
	Hypopygiopsis sp.	13	9	17	**39**
	Drosophilidae	0	0	0	**0**
	Paedarus	0	0	0	**0**
	Muscidae	2	2	2	**6**
	Sachophagidae	1	0	0	**1**
	Total	**31**	**41**	**48**	**120**

***Rafflesia Kerri 1* (Middle Blooming 4 – 5 Days)**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	Total
9.00 AM – 10.00 AM Temperature: 26.5 ºC; Humidity: 71%	*Chrysomya sp)*	6	3	5	**14**
	Lucilia sp.	4	3	2	**9**
	Hypopygiopsis sp.	1	0	0	**1**
	Drosophilidae	0	0	0	**0**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**11**	**6**	**7**	**24**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	Total
12.00 PM – 1.00 PM Temperature: 25.8°C Humidity: 58%	*Chrysomya sp.*	10	18	21	**49**
	Lucilia sp.	9	10	15	**34**
	Hypopygiopsis sp.	7	4	5	**16**
	Drosophilidae	0	0	0	**0**
	Paedarus	0	1	0	**1**
	Muscidae	5	2	1	**8**
	Sachophagidae	0	2	0	**2**
	Total	**31**	**37**	**42**	**110**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
3.00 PM – 4.00 PM Temperature: 24.2°C Humidity: 65%	*Chrysomya sp.*	4	2	9	**15**
	Lucilia sp.	6	3	8	**17**
	Hypopygiopsis sp.	4	4	1	**9**
	Drosophilidae	0	0	3	**3**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	1	**1**
	Sachophagidae	0	0	0	**0**
	Total	**14**	**9**	**22**	**45**

***Rafflesia kerri 1* (Late Blooming 6-7 Days)**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
9.00 AM– 10.00 AM Temperature: 22.7 ºC; Humidity: 68%	*Chrysomya sp.*	0	0	0	**0**
	Lucilia sp.	0	0	0	**0**
	Hypopygiopsis sp.	0	0	0	**0**
	Drosophilidae	12	18	37	**67**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**12**	**18**	**37**	**67**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	Total
12.00 PM – 1.00 PM Temperature: 23.1°C Humidity: 77%	*Chrysomya sp.*	0	1	1	**2**
	Lucilia sp.	0	0	0	**0**
	Hypopygiopsis sp.	0	0	0	**0**
	Drosophilidae	15	25	30	**70**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**15**	**26**	**31**	**72**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
3.00 PM – 4.00 PM Temperature: 24.4°C Humidity: 80%	*Chrysomya sp.*	0	0	0	**0**
	Lucilia sp.	0	0	0	**0**
	Hypopygiopsis sp.	0	0	0	**0**
	Drosophilidae	18	30	41	**89**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**18**	**30**	**41**	**89**

***Rafflesia kerri 2* (Early Blooming 1 – 3 Days)**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
9.00 AM – 10.00 AM Temperature: 23.1°C Humidity: 70%	*Chrysomya sp)*	4	5	8	**17**
	Lucilia sp.	2	4	6	**12**
	Hypopygiopsis sp.	1	2	2	**5**
	Drosophilidae	0	0	0	**0**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**7**	**11**	**16**	**34**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
12.00 PM – 1.00 PM Temperature: 26.1°C Humidity: 60%	*Chrysomya sp.*	9	7	15	**31**
	Lucilia sp.	2	7	12	**21**
	Hypopygiopsis sp.	1	6	4	**11**
	Drosophilidae	0	0	0	**0**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**12**	**20**	**31**	**63**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
3.00 PM – 4.00 PM Temperature: 24.1°C Humidity: 68%	*Chrysomya sp.*	5	10	13	**28**
	Lucilia sp.	2	4	7	**13**
	Hypopygiopsis sp.	1	1	2	**4**
	Drosophilidae	0	0	0	**0**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**8**	**15**	**22**	**45**

***Rafflesia kerri 2* (Middle Blooming 4-5 Days)**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
9.00 AM – 10.00 AM Temperature: 25.2 °C Humidity: 60%	*Chrysomya sp*	2	4	7	**13**
	Lucilia sp.	2	5	2	**9**
	Hypopygiopsis sp	1	2	2	**5**
	Drosophilidae	0	0	0	**0**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**5**	**11**	**11**	**27**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
12.00 PM – 1.00 PM Temperature: 23.1°C Humidity: 71 %	*Chrysomya sp.*	2	4	6	**12**
	Lucilia sp.	1	2	2	**5**
	Hypopygiopsis sp	0	0	2	**2**
	Drosophilidae	0	0	0	**0**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**3**	**6**	**10**	**19**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
3.00 PM – 4.00 PM Temperature: 23.7°C Humidity: 74%	*Chrysomya sp.*	1	2	4	**7**
	Lucilia sp.	1	2	1	**4**
	Hypopygiopsis sp	0	1	1	**2**
	Drosophilidae	0	0	0	**0**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**2**	**5**	**6**	**13**

***Rafflesia kerri* 2 (Late Blooming 6-7 Days)**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
9.00 AM – 10.00 AM Temperature: 21.3 °C Humidity: 78%	*Chrysomya sp.*	0	0	0	**0**
	Lucilia sp.	0	0	0	**0**
	Hypopygiopsis sp	0	0	0	**0**
	Drosophilidae	14	18	9	**41**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**14**	**18**	**9**	**41**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
12.00 PM – 1.00 PM Temperature: 22.5°C Humidity: 71%	*Chrysomya sp.*	0	0	0	**0**
	Lucilia sp.	0	0	0	**0**
	Hypopygiopsis sp.	0	0	0	**0**
	Drosophilidae	8	14	10	**32**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**8**	**14**	**10**	**32**

Time	Species	Frequency Re-Visitation of Pollinator and Visitor			
		On Petal	On Diaphragm	On Disc	**Total**
3.00 PM – 4.00 PM Temperature: 23.1°C Humidity: 82 %	*Chrysomya sp.*	0	0	0	**0**
	Lucilia sp.	0	0	0	**0**
	Hypopygiopsis sp.	0	0	0	**0**
	Drosophilidae	21	15	11	**47**
	Paedarus	0	0	0	**0**
	Muscidae	0	0	0	**0**
	Sachophagidae	0	0	0	**0**
	Total	**21**	**15**	**11**	**47**