EXAMINING *RAFFLESIA KERRI* POPULATION AND THEIR CONSERVATION STATUS IN LOJING HIGHLANDS, KELANTAN

by

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DECLARATION

I declare that this thesis entitled "Examining *Rafflesia kerri* population and their conservation status 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 : ……

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Date : 28 AUGUST 2024

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"Examining *Rafflesia kerri* population and their conservation status in Lojing Highlands, Kelantan."

ABSTRACT

The aim of the study is to assess and update the populations of *Rafflesia kerri*and determine their conservation status in Lojing Highlands, Kelantan. A total of 52 clusters from 20 populations of *R. kerri* had been identified and mapped. The conservation status of populations were categorized into five classes, namely: (i) Very active, (ii) Active, (iii) Moderately active (iv) Poorly active and (v) Dormant. From 52 clusters, the findings reveal that four (8%) clusters are categorized as very active, indicating a healthy and thriving population, while six (11%) of the clusters are active, and 27 (52%) are moderately active. Meanwhile, 14 (27%) are categorized as poorly active and only 2% from the clusters are dormant. The distribution of the species highlighted that the populations are concentrated in three main areas, these are: (i) Berus-Dawai, (ii) Cebur and (iii) Cebur-1Malaysia, with elevations ranging from 930 to 1,054 meters above sea level. The study was recorded eight blooming flowers, with five being female and three are males, and also documented a total of 90 buds and 89 rotten buds. 95 rotten flowers, and 34 cupules indicating the ongoing reproductive challenges faced by the species. The study underscores the importance of specific environmental conditions such as humidity, temperature and proximity to water sources for the growth and sustainability of *R. kerri*. The study emphasizes the need for tailored conservation strategies to address the varying needs of different population groups, aiming to enhance the adaptability and long-term viability of *R. kerri* in its natural habitat. This research provides critical insights and practical recommendations for the sustainable management and conservation of *R. kerri*, contributing to the preservation of biodiversity in the Lojing Highlands.

Penilaian Populasi *Rafflesia kerri* dan Status Pemuliharaan Mereka di Tanah Tinggi Lojing, Kelantan

ABSTRAK

Tujuan kajian ini adalah untuk menilai dan mengemas kini populasi *Rafflesia kerri* serta menentukan status pemeliharaannya di Lojing Highlands, Kelantan. Sebanyak 52 kluster daripada 20 populasi *R. kerri* telah dikenalpasti dan dipetakan. Status pemuliharaan populasi telah dikategorikan kepada lima kelas, iaitu: (i) Sangat aktif, (ii) Aktif, (iii) Sederhana aktif, (iv) Kurang aktif dan (v) Dorman. Daripada 52 kluster, penemuan menunjukkan bahawa empat (8%) kluster dikategorikan sebagai sangat aktif, menunjukkan populasi yang sihat dan berkembang, manakala enam (11%) kluster adalah aktif, dan 27 (52%) adalah sederhana aktif. Sementara itu, 14 (27%) dikategorikan sebagai kurang aktif dan hanya 2% daripada kelompok tersebut adalah tidak aktif. Penyebaran spesies tersebut menekankan bahawa populasi tertumpu di tiga kawasan utama, iaitu: (i) Berus-Dawai, (ii) Cebur dan (iii) Cebur- 1Malaysia, dengan ketinggian antara 930 hingga 1,054 meter di atas paras laut. Kajian tersebut merekodkan lapan bunga yang mekar, dengan lima daripadanya adalah betina dan tiga adalah jantan, serta juga mendokumenkan sejumlah 90 tunas dan 89 tunas yang rosak. 95 bunga yang rosak, dan 34 cupule menunjukkan cabaran pembiakan yang sedang dihadapi oleh spesies tersebut. Kajian ini menekankan kepentingan keadaan persekitaran tertentu seperti kelembapan, suhu dan jarak kepada sumber air untuk pertumbuhan dan kelestarian *R. kerri*. Kajian ini menekankan keperluan untuk strategi pemuliharaan yang disesuaikan bagi menangani keperluan pelbagai kumpulan populasi yang berbeza, dengan tujuan untuk meningkatkan kebolehsuaian dan kelangsungan jangka panjang *R. kerri* di habitat semulajadinya. Penyelidikan ini memberikan pandangan penting dan cadangan praktikal untuk pengurusan dan pemuliharaan *R. kerri* yang mampan, menyumbang kepada pemeliharaan biodiversiti di Tanah Tinggi Lojing.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

One amazing genus of parasitic blooming plants with unique qualities is *Rafflesia.* Found only in tropical rainforests of Southeast Asian nations which are Thailand, Malaysia, Brunei, the Philippines and Indonesia. *Rafflesia* is notable for its enormous scale; some species produce blooms with diameters of up to one meter. These parasitic plants lack leaves, stems, and roots, relying on specific host plants, primarily *Tetrastigma* species, for water and nutrients. *Rafflesia's* reproductive strategy is equally unique, as its flowers emit a putrid odor resembling rotting flesh to attract pollinators like flies for pollination. Due to their limited distribution and distinctive features, *Rafflesia* species are often protected by conservation laws and used as flagship species to promote the preservation of tropical rainforests. There have been reported a total of 14 species of *Rafflesia* in Malaysia. Characteristics like flower size, colors, and particular host plants these species parasitize vary among them. Sabah is home to species including *Rafflesia pricei* and *R. keithii*; Peninsular Malaysia boasts species like *R. cantleyi, R. azlanii, R. kerri* and others. One finds species like *R. hasseltii* and *R. tuan-mudae* in Sarawak. The spread of these species throughout many parts of Malaysia adds to the general species variety of *Rafflesia* in the nation (Norhazlini et al., 2022).

R. kerri is an endemic species found in Peninsular Malaysia and the southern part of Thailand. It belongs to the genus *Rafflesia,* which is known for its unique

characteristics as a parasitic flowering plant. *R. kerri* is distinguished by its large, dull red flowers with perigones covered by numerous small white-pinkish warts and a wide diaphragm opening. This species grows without traditional vegetative components such as leaves, stems, or true roots, making the flower the only visible structure. The anatomical analysis of *R. kerri* revealed simple and uncomplicated structures in various components of the flower, including the perigone lobe, window, processes, and ramenta. The perigone lobes consist of an epidermal layer on the cell wall, parenchyma cells in the internal part, and undeveloped vascular bundles. In the window parts, there is an epidermal layer, parenchyma cells, vascular bundles, and trichome papillus. The processes are characterized by an epidermal layer and parenchyma cells, while the ramenta contain an epidermal layer, parenchyma cells, and mucilage cells within the ground tissues. *R. kerri* is an intriguing species due to its parasitic nature, large and distinctive flowers, and specific habitat requirements. Conservation efforts are essential to protect *R. kerri* and other Rafflesia species from extinction, as environmental changes and habitat loss pose significant threats to their survival. Understanding the anatomical characteristics and ecological requirements of R. kerri is crucial for developing effective conservation strategies and preserving these remarkable plants for future generations (Asfarina et al., 2022).

In the context of *Rafflesia* ecology, *Tetrastigma* plays a crucial role as a host plant for the parasitic *Rafflesia* species. *Tetrastigma* vines have woody stems with a thick, uneven surface and are characterized by tendrils that help them climb or hang onto other trees. The leaves of *Tetrastigma* can be hard to find, but the stems and roots are recognizable in the forest. *Tetrastigma's* ability to climb and establish on other plants provides suitable space for *Rafflesia* seeds to grow and develop. *Rafflesia* is

closely tied to its habitat and its unique parasitic nature. *Rafflesia* is a holoparasitic plant that relies entirely on its host plant for water and nutrients. The condition of the host plants, the forest environment, and the availability of water resources are crucial factors for the survival of *Rafflesia* in its natural habitat. Rafflesia is known to grow in moist forest slopes near streams, and successful blooming is often associated with locations near streams. The seasonal climate of Southeast Asia, including variations in water availability, temperature, and day length, may influence the flowering of *Rafflesia* (Farah et al., 2018).

Rafflesia is renowned for producing some of the largest flowers in the plant kingdom. These extraordinary blooms can grow up to one meter in diameter and emit a pungent odor reminiscent of decaying flesh to attract pollinators such as flies. Thriving in the lush tropical rainforests of countries like Malaysia, Indonesia, Thailand, and the Philippines, *Rafflesia* species are currently under threat due to habitat destruction and illicit harvesting. Named in honor of Sir Thomas Stamford Raffles, the genus encompasses multiple species, each characterized by unique traits and geographical distributions. *Rafflesia* flowers have become a prominent attraction for ecotourism, providing economic benefits to local communities. Dedicated efforts by scientists and conservationists are underway to study and protect these iconic plants, ensuring the preservation of their biodiversity amidst growing environmental challenges. Urgent conservation actions are imperative to safeguard these exceptional plants from the brink of extinction (Pastor et al., 2023).

In Southeast Asia, the conservation status of *Rafflesia* varies across different regions. Brunei is home to one species, *R. pricei*, found in Ulu Temburong National Park, where rigorous conservation measures are enforced under national legislation.

Malaysia, particularly in Malaysian Borneo, celebrates *Rafflesia* as an ecotourism attraction, with 14 recorded species and varying protection regulations in different states. In the Philippines, the lack of a comprehensive conservation strategy for *Rafflesia* poses a threat to the 12 classified species, with some listed as Critically Endangered, Endangered, and Vulnerable. Indonesia, on the other hand, has taken significant steps in conservation, with all Rafflesia species protected under national laws and the development of the Rafflesia Strategic Action Plan (RSAP) to guide conservation efforts. The conservation criteria in Indonesia have identified most *Rafflesia* species as Critically Endangered, emphasizing the urgent need for conservation actions to safeguard these unique plants from extinction in their natural habitats (Pastor et al., 2023).

1.2 Problem Statement

The Rafflesia species, known for its rare and striking flowers, is confronted with a multifaceted problem that threatens its survival. According to Qayyum-Nadia et al., (2023). The core issue is the species' vulnerability to extinction, which is exacerbated by a combination of anthropogenic and environmental pressures.

Firstly, conservation efforts to date have been insufficient and poorly executed. This includes the failure of ex-situ conservation, where attempts to grow Rafflesia outside its natural habitat have not yielded successful results. This lack of effective conservation measures has left the species exposed to various threats. The population of R. kerri in Lojing is in a threatened state and is decreasing due to land conversion and unsustainable tourism activities. Although 1000 acres of the Rafflesia

area have been gazetted as the Rafflesia Conservation Park, regulations are not enforced to optimally protect the Rafflesia.

Tourism, while contributing to local economies and raising awareness about the species, has become a double-edged sword. The influx of visitors to see the rare flowers can lead to the destruction of the host plants and young buds. Tourists, often in pursuit of the perfect photograph, may unknowingly cause harm by trampling on the delicate vegetation that supports the Rafflesia.

Another significant issue is the collection of Rafflesia buds and flowers by local communities. These are sometimes sold to outsiders for medicinal purposes, based on traditional beliefs rather than scientific evidence. This practice not only disrupts the natural population dynamics but also encourages the unsustainable exploitation of the species.

Urban development and agricultural expansion are additional factors that encroach on the natural habitats of Rafflesia. As cities and farms grow, they can fragment and degrade the ecosystems that Rafflesia depends on, further reducing the species' chances of survival.

The Rafflesia species, especially R. kerri, is facing a critical threat due to the unsustainable expansion of agricultural lands in the Lojing Highlands. This expansion is part of a broader issue of land use change, which is a significant concern for the conservation of biodiversity in the region. As more land is cleared for agriculture, the natural habitats of Rafflesia are being degraded, leading to a smaller and more fragmented area for the species to survive.

Fragmentation of habitats is particularly detrimental to species like Rafflesia because it can isolate populations, making it difficult for plants to reproduce and for pollinators to reach them. This can lead to a decrease in genetic diversity and increased risk of extinction. Additionally, the disturbance caused by land clearing and agricultural activities can directly harm the plants, as they are sensitive to environmental changes.

The mortality rates of Rafflesia buds are alarmingly high, with smaller buds being particularly vulnerable. This suggests that even if some mature plants survive, the next generation may not, as the buds fail to reach maturity. The study by Meijer (1958) on R. arnoldii, for example, indicates that a substantial proportion of buds do not make it to maturity, which is a clear indication of the species' struggle to reproduce and maintain viable populations.

Furthermore, the lack of a clear policy on urban development in the highlands exacerbates the problem. Without proper planning and regulation, commercial centers and agricultural lands can encroach on ecologically sensitive areas without consideration for the impact on native flora and fauna. This unchecked development can lead to the degradation of the environment and the loss of habitats that are crucial for the survival of species like Rafflesia.

The cumulative impact of these factors underscores the urgent need for a comprehensive conservation approach. This includes implementing sustainable tourism practices, educating local communities about the ecological importance of Rafflesia, and enforcing regulations to protect the species' habitats from urban and

agricultural encroachment. By addressing these challenges holistically, there is hope for the preservation of the Rafflesia species for future generations.

1.3 Objectives

The objective of this study are:

1. To determine the population's status of Rafflesia kerri in Rafflesia Conservation Park, Lojing Highlands.
2. To map the population distribution of Rafflesia kerri in the Rafflesia Conservation Park, Lojing Highlands.

1.4 Scope of Study

The study was conducted in the Rafflesia Conservation Park (RCP), Lojing Highlands, Kelantan, during the period from October 2023 to February 2024. The survey was done at three sites within the park, each designated as a habitat for Rafflesia. Evaluation of these sites involved careful determination of their individual sizes of buds. In addition, the main objective was to evaluate the population of R. kerri at each site. This was achieved through the marking of host plants and accurate recording of their coordinates using Global Positioning System (GPS). The resulting data were used to classify the population status into five different categories, namely: (i) Very active, (ii) Active, (iii) Moderately active, (iv) Poorly active and (V) Dormant. A very active population exists in several stages of Rafflesia. The stage of Rafflesia has existed a blooming flower or rotten, more than eleven off bud including rotten bud, and cupule. While a population of blooming flowers or rotten, about sixth to tenth of buds from various stages, it is considered as active status. Moderately active status means one cluster has blooming or rotten flowers and one to five buds from

various stages. Poorly active are no blooming or rotten flowers but only buds or cupules in a cluster. Cluster which has only a scar within a host plant is considered dormant status. Next, the outcome of this research is the development of a comprehensive monitoring system, using the data collected, aimed at conserving the Rafflesia species while facilitating its potential as a tourist attraction in the area.

1.5 Significant of Study

Overall, this study holds significant value for multiple stakeholders, including the country of Malaysia where tourism growth is possible. The Rafflesia Conservation Area's increased tourist attractiveness improves the national economy through the tourism and hospitality industries. Meanwhile, the conservation success story will demonstrate Malaysia's commitment to environmental protection and sustainable resource management, while national pride will highlight a unique natural wonder, potentially enhancing national identity and promoting Malaysia as an eco- tourism destination.

The conservation area in Kelantan state holds the opportunity to stimulate economic growth since tourism income supports local companies and generates job possibilities. Furthermore, environmental stewardship encourages responsible tourismand promotes awareness about conserving biodiversity throughout the st ate. Meanwhile, cultural pride highlights the significant role of the Orang Asli in conserving biodiversity and demonstrates unique regional skills.

Residents were offered opportunities for employment such as tour guiding, lodging, and other tourism-related occupations to increase their income and improve their standard of living. The community involvement in conservation builds

ownership and encourages sustainable resource management. The cultural preservation raises consciousness regarding Orang Asli traditions and knowledge, which promotes their cultural identity.

In terms of the scientific community, the progress of information adds to a better understanding of Rafflesia ecology, population dynamics, and successful conservation techniques. The data repository also contains useful information for future study on Rafflesia and other parasitic plants. Through conservation guidance, future conservation efforts for endangered species and their environments are informed.

In conclusion, the significance of this study goes beyond specific stakeholders and has profound consequences for the environment, economics, culture, and scientific knowledge.

CHAPTER 2

LITERATURE REVIEW

2.1 Rafflesia in general

Rafflesia is a genus of parasitic flowering plants native to Southeast Asia, known for the largest flower in the world. The genus is named after Sir Thomas Stamford Raffles, the leader of the expedition that discovered the first species of Rafflesia in Indonesia in the early 19th century. In Malaysia, Rafflesia is an important and iconic plant, known locally as Bunga Pakma. 14 species of Rafflesia have been recorded in Malaysia, with nine occurring in Peninsular Malaysia and five in the states of Sabah and Sarawak in Borneo (Pastor et al., 2023) and (Siti Munirah et al., 2021).

R. kerri is an endemic species to Peninsular Malaysia and Southern part of Thailand. It is a parasitic flowering plant that grows without the vegetative components such as leaves, stems, and true roots, where the only visible structure is the flower itself. It is easy to identify R. kerri by its large dull red flowers, perigones covered by numerous small white pinkish warts, and a wide diaphragm opening. The species was first described in 1984 by William Meijer, based on a holotype deposited in KEW, collected in 1929 by A.F.G. Kerr. The genus was discovered to grow in lowland and hill primary, over-logged, and old secondary forests at altitudes ranging from 300 to 1600 m a.s.l. R. kerri is noted as the second largest species after R. arnoldii (Asfarina et al., 2022).

Rafflesia is only parasitized on one genus i.e Tetrastigma spp. from the family of Vitaceae as their host plant. The host plants of Rafflesia such as T. curtisii. T.

diepenhorstii, T. glabratum, T. leucostaphylum, T. papillosum, T. rafflesiae, T. quadrangulum, T. scortechinii and T. hookeri. R. kerri host plants are T. rafflesiae and T. hookeri (Nasihah et al., 2016). This species is a climbing vine that typically thrives in the dense forests of Peninsular Malaysia. As a climbing plant, it relies on other high plants for support to reach sunlight in the forest canopy.

T. hookeri plays a crucial role as a host plant for R. kerri, providing the necessary support for the growth and development of the parasitic Rafflesia flowers (Farah et al., 2018).

2.2 The morphology of Rafflesia

The morphology of Rafflesia kerri is characterized by its large dull red flowers, perigones covered by numerous small white pinkish warts, and a wide diaphragm opening. It is a parasitic flowering plant that lacks leaves, stems, and true roots, with the flower being the sole apparent structure (Figure 2.2). The anatomical study of R. kerri has revealed that its components, including the perigone lobe, window, processes, and ramenta, have simple and uncomplicated structures. Additionally, the internal structures of R. kerri were found to be mainly composed of perigone lobes made up of an epidermal layer on the cell wall, parenchyma cells at the internal part, undeveloped vascular bundle, window parts made up of epidermal layer, parenchyma cells, vascular bundles, and trichome papillus, processes made up of epidermal layer and parenchyma cells, and ramenta made up of epidermal layer, parenchyma cells, and the presence of mucilage cell within the ground tissues. These anatomical features provide valuable insights into the biology of R. kerri and

contribute to our understanding of how this unique flower persists as a parasite (Asfarina et al., 2022).

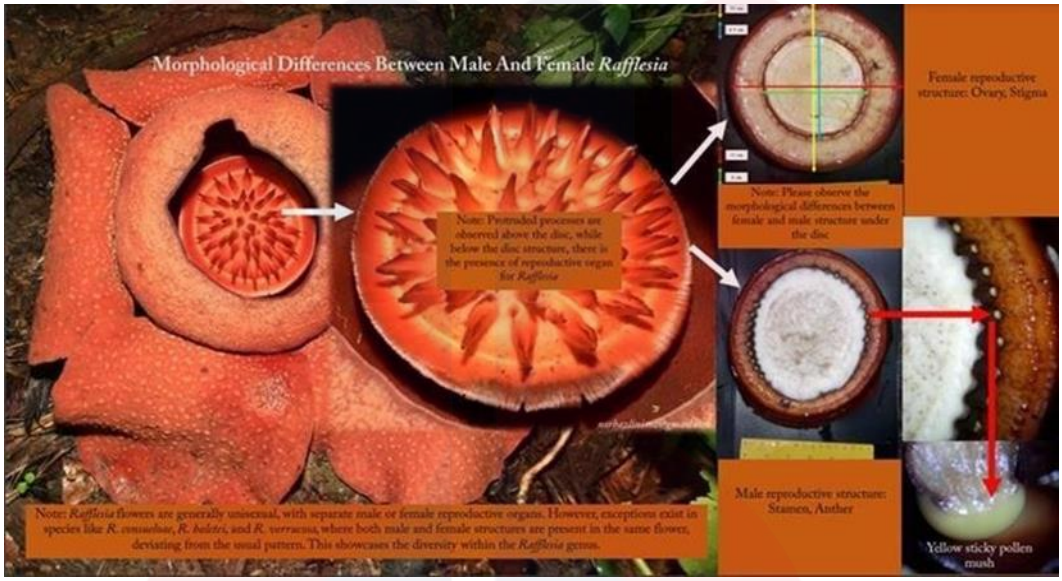


Figure 2.2: Morphological Differences Between Male and Female Flowers of Rafflesia. (Source: Illustrated by Norhazlini M.Z.)

2.3 Distribution of Rafflesia in Malaysia

Table 2.3 below shows the distributions of 14 species of *Rafflesia* in Malaysia. In general the habitats of *Rafflesia* are distributing either in secondary or primary forested areas.

Table 2.3: Distribution of *Rafflesia* species in Malaysia

No.	Year of Described	Species	Distribution
1.	1868	*R. Tuan-mudae* Beccari	Sarawak, Mt. Gading National Park (endemic), Mt. Pueh, Sematan, Mt. Rara, Mt. Penrissen.

2.	1879	*R.hassetti* Suringar	Sumatera and Borneo (WestSarawak & West Kalimantan), Sumatera, West Sumatera (Muaro Labuh, Liki, Alahan Panjang, Sijunjung & Limo Puluah Kota). Riau (Bokit Tiga Paloh National Park) & Jambi (Bangko, Sarolangun, Kerinci Sehlat National Park): Sarawak, Tanjung Data & Samunsam & hasselti Suringar
3.	1910	*R.cantleyi Solms*-Laubach	Peninsular Malaysia (Perak, Gerik, Ipoh, Kelantan. Ulm St, Kuala Koh, Kuala Betis Parang, Raub, Jerantut, Pulau Tioman Terengganu, Tasik Kenyir & Pasir Akar, Besut
4.	1984	*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.	1984	*R. pricei* Meijer	Peninsular Malaysia, Kelantan, (Mt.

			Chamah, Mt. Stong Mt. Basor, Mt. Berangkat FR. Bakit 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.
6.	1984	R. kerri Meijer	Peninsular Malaysia, Kelantan, (Mt. Chamah, Mt. Stong Mt. Basor, Mt. Berangkat FR. Bakit 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.	1989	*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.	2003	*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.	2009	*R. su-meiae* Wong, Nais & Gan	Peninsular Malaysia: Mt. Chamah, Kelantan-Perak border
10.	2013	*R.Sharifah-hapsahiae* Adam, juhari, Nik Arif & Wan	Peninsular Malaysia; Pahang, Raub, Mt. Benom FR
11.	2016	*R. Parvimaculata* sofiyanti, Mat- Salleh,Khairil, Zuhailah, Mohd-Ros & Burslem	Pahang, Lata Jarum. May occur in Perak (insufficient data).
12.	2016	*R. tuanku-halimii* Adam,Aizat-Juhari, Azilah & Wan	Perak; Gerik and Pahang, Raub (Sg. Kenau, Sg. Yel and Matau).
13.	2021	*R. tiomanensis* Siti-Munirah, Salamah & Razelan	Endemic in Pulau Tioman, Pahang, Peninsular Malaysia.
14.	2022	*R.tuanku*-azizahia	Peninsular Malaysia; Pahang, Lata Tinggi, Mt. Benom FR. Ulu Dong, Raub.

Sources: Siti Munirah et al., (2021); Susatya et al., (2017); Adam et al., (2016); Sofiyanti et al., (2016); Galindon et al., (2016); Barcelona et al., (2014); Adam et al., (2013); Balete et al., (2010); Mat-Salleh et al., (2010); Wiriadinata and Sari., (2010); Wong et al., (2009); Barcelona et al., (2009); Barcelona and Pelser (2008); Barcelona et al., (2006); Galang and Madulid., (2006); Fernando and Ong (2005); Susatya et al., (2005); Latiff and Wong., (2003); Barcelona and Fernando (2002); Nais., (2001); Mat-Salleh and Latif., (1989); Meijer., (1984); Teismann and Binnendiik., (1850).

2.4 Life cycle of Rafflesia

The development of *Rafflesia* occurs through several distinct stages, based on Figure 2.3 beginning with its growth in the host plant. Initially, *Rafflesia* exists as an endophyte within the host, forming a filamentous structure that resembles endophytes. This endophytic phase can last for an extended period, although the exact duration is not well-defined. During this time, the endophyte forms a clonal network of meristematic cells, which are separated by the host tissue. The next stage involves the development of the flower bud, which can be divided into two main phases: the emergence of the bud from the host plant and its maturation. The entire bud development phase typically takes about 12 to 16 months, although some species, such as *R. azlanii*, can develop from a newly emerged bud to a full-bloomed flower in just 40 to 50 days. Once the bud has matured, it transitions into the flowering phase, which can occur throughout the year, influenced by various genes associated with stress response and hormone signaling. After blooming, the flower eventually undergoes senescence, marking the end of its life cycle. The entire life cycle of *Rafflesia*, from seed to seed, can take three to five years, depending on the species and environmental conditions. This unique developmental process highlights the complex biology of *Rafflesia* and its adaptation to a parasitic lifestyle (Mursyidah et al., 2023).

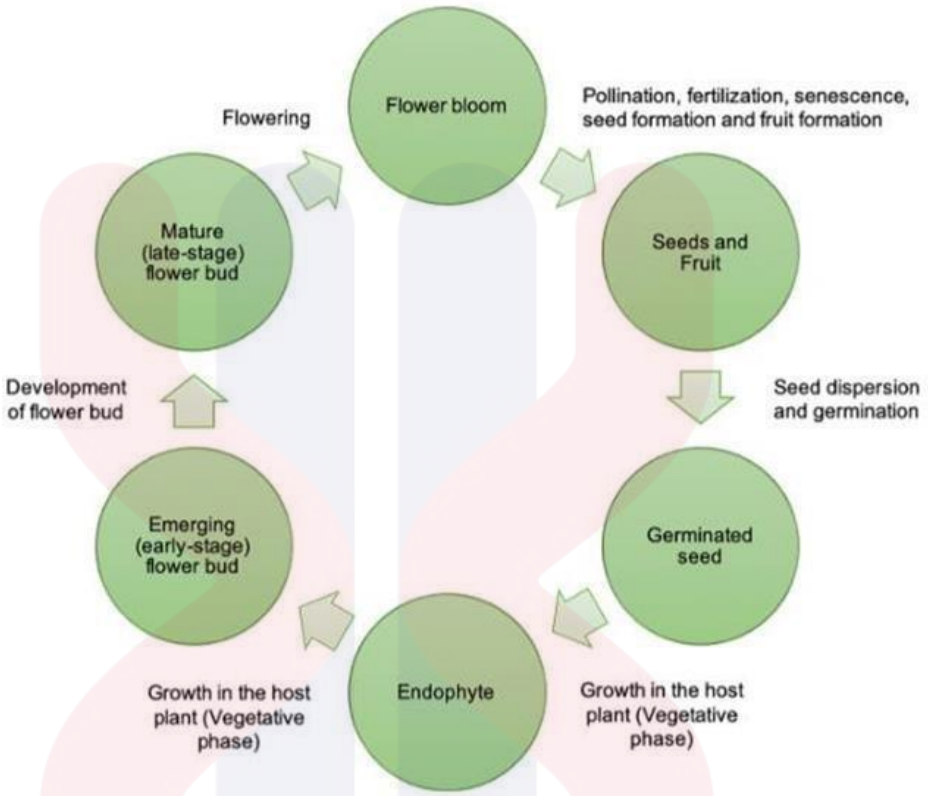


Figure 2.3: Life cycle of *Rafflesia*. (Source: Illustrated by Mursyidah et al., 2023)

The life cycle of *Rafflesia* begins with the germination of its tiny seeds, which are dispersed by animals such as tree shrews, squirrels, wild pigs, elephants, and ants. Once the seed finds a suitable host plant, it germinates and penetrates the host's stem, where it forms a network of thread-like structures called haustoria. The haustoria absorbs nutrients and water from the host plant, allowing the *Rafflesia* to grow and develop (Norhazlini et al., 2022).

After several years of growth, the *Rafflesia* plant produces a large flower that can measure up to one meter in diameter and weigh up to 10 kilograms. The flower has a strong smell like rotting meat that attracts flies and other insects, which act as pollinators. If pollination is successful, the flower will produce a fruit containing thousands of tiny seeds (Norhazlini et al., 2022).

The fruit takes several months to mature, after which it splits open and releases the seeds. The seeds then disperse and begin the cycle anew. The entire life cycle of *Rafflesia* can take up to several years to complete, and the plant spendsmost of its life as a network of haustoria inside its host plant, only emerging as a flower for a brief period of time (Norhazlini et al., 2022).

2.5 Habitat of Rafflesia

Rafflesia is found in lowland and hill primary, over-logged, and old secondary forests at altitudes ranging from 300 to 1600 meters above sea level. In Peninsular Malaysia, *R. kerri* has been discovered in various habitats, including the Lojing Highlands and the forest reserves in Kelantan and Perak. These habitats provide the necessary conditions for the growth and development of *Rafflesia* species, contributing to their unique ecological niche within the forest ecosystem (Asfarina et al., 2022).

The habitat of *Rafflesia* is typically in moist forest slopes near streams inside the forest. The availability of water resources, the condition of the host plants, and the forest environment are important factors for the survival of *Rafflesia* in their natural habitat. The seasonal climate of Southeast Asia, particularly the availability of water resources, may influence the seasonal flowering of *Rafflesi*a. For example, the study in Royal Belum State Park found that the population and distribution of *Rafflesia* decreased due to habitat interruption by human intervention and natural factors such as wildlife trampling and immature buds (Farah et al., 2018).

The habitat of *Rafflesia* can be found in tropical rainforests. The plant is known to parasitic specific host plants, woody liana species of the genus *Tetrastigma* (Vitaceae, wild grapes). *Rafflesia* grows in lowland dipterocarp forest, logged areas,

along riverbanks, and hill dipterocarp forest, among other types of tropical rainforest habitats. The tropical rainforest in Malaysia, where many species of Rafflesia are found, can be categorized into different types, including lowland dipterocarp forest, heath forest, limestone hill forest, mixed dipterocarp forest, hill dipterocarp forest, and hill mixed dipterocarp forest (Norhazlini et al., 2022).

2.6 Conservation status of Rafflesia in Malaysia

Rafflesia, often known as Bunga Pakma in Malaysia, is one of main source of income from ecotourism. In Sabah, for example, all *Rafflesia* and *Tetrastigma* species, the host plant of *Rafflesia* is categorized as Total Protected Plants under the Wildlife Conservation Enactment 1997. The Commissioner Law Review has designated all *Rafflesia* species as 'Total Protected Plants' in Sarawak under the Wildlife Protection Ordinance 1998 (Pastor et al., 2023).

Currently, there are several websites in Malaysia designed to connect visitors with those who oversee *Rafflesia* populations as part of "park management." A Facebook and iNaturalist social media initiative that seeks to raise *Rafflesia* species awareness, improve community health, and foster greater care. *Rafflesia* populations are widespread in Sabah; some are on privately owned property that local proprietors take great care to maintain as tourism attractions (Susatya et al., 2023).

The Forest Stewardship Council (FSC) created high conservation value areas (HCVAs) in 1993 to encourage responsible forest management by companies that rely on forests. According to Hally and Salem (2015), the themes of HCVAs are species diversity, ecosystem services, ecosystems and habitats, landscape level ecosystems, community needs, and cultural values. For instance, in the Lata Jarum Forest Reserve

for Rafflesia, the Pahang Forestry Department has established HCVAs (Pahang State Forestry Department, 2022). Together with the Felda Global Ventures Holdings Berhad (FGV) and the Forestry Department, the Federal Land Development Authority (FELDA) has set aside land for the construction of the Rafflesia Interpretation Centre (PPIR). An area of 50 hectares in the Lojing Highlands in Gua Musang District, for instance, has been declared by the state government as the High Conservation Value Forest (HCVF) for R. kerri in Kelantan (Fauzan et al., 2021).

The success of both in-situ and ex-situ conservation measures determines the degree to which Rafflesia species are protected (Nais, 2001). Ex-situ preservation refers to safeguarding a species outside of its native environment, whereas in-situ preservation refers to safeguarding a species within its natural habitat. In addition to Rafflesia, other plant species are also the target of this endeavor, which also makes use of laboratory techniques like tissue culture and botanical gardens and gene banks. The issue of Rafflesia species reproduction and preservation has not been resolved despite several attempts. In Sabah, initiatives for conservation have included the creation of Rafflesia reserves, information centre, and incentive programmes (Peters and Thing, 2016). The government also piqued the attention of Sabah's indigenous people in taking part in the initiative.

CHAPTER 3

MATERIAL AND METHODS

3.1 Description of the Study Area

The study area is located in Lojing Highlands, Gua Musang, Kelantan. This area is situated in the south-eastern part of Kelantan which has an altitude of 1500-6010m a.s.1. as shown in Figures 3.1.1. and 3.1.2. The forest in this area is categorized as an upper dipterocarp or lower montane forests (Adriansyah et. al., 2015). Majority of community that live at Lojing Highlands is from the Temiar ethnic group (Norliyana, 2015).

Lojing is laying between the geographical coordinates of latitude 4˚32' to 4˚47 N and longitude 101˚20' to 101˚34' E. Lojing is also located in the Titiwangsa Range, and it is believed that many species here have yet to be described due to the difficulty of accessing the area (Ibrahim, 2010). Lojing is known for housing the famed *Rafflesia kerri*, which serves as the major attraction for both local and foreign visitors.

In 2011, the Permanent Forest Reserved area in Lojing was 16,235 hectares. Approximately 8000 hectares of property in Lojing are classified as private land. In 2010, a total of 242.3 hectares of land were converted to for agricultural purposes. The vegetable farm was mostly established and managed by individuals who were not from the surrounding area. The proprietor of the agricultural estates often used the Temiar community in Lojing as workers. The primary occupation, particularly for youths belonging to the local Temiar ethnic group, is working as laborers (Zakaria et al., 2010).

Lojing is abundant in many plant species, including mosses, ferns, wild orchids, gingers, pitcher plants, wildflowers, bamboo, and ethnobotany. It is imperative to preserve the treasures of Lojing so that future generations may appreciate and see the diverse fauna. The stunning atmosphere of Lojing has great potential to attract tourists and might also serve as a suitable location for film production. The considerable morphological diversity shown by ferns makes them very suitable for cultivation as sumptuous decorative plants in forest environments (Ibrahim & Maryati, 2008).

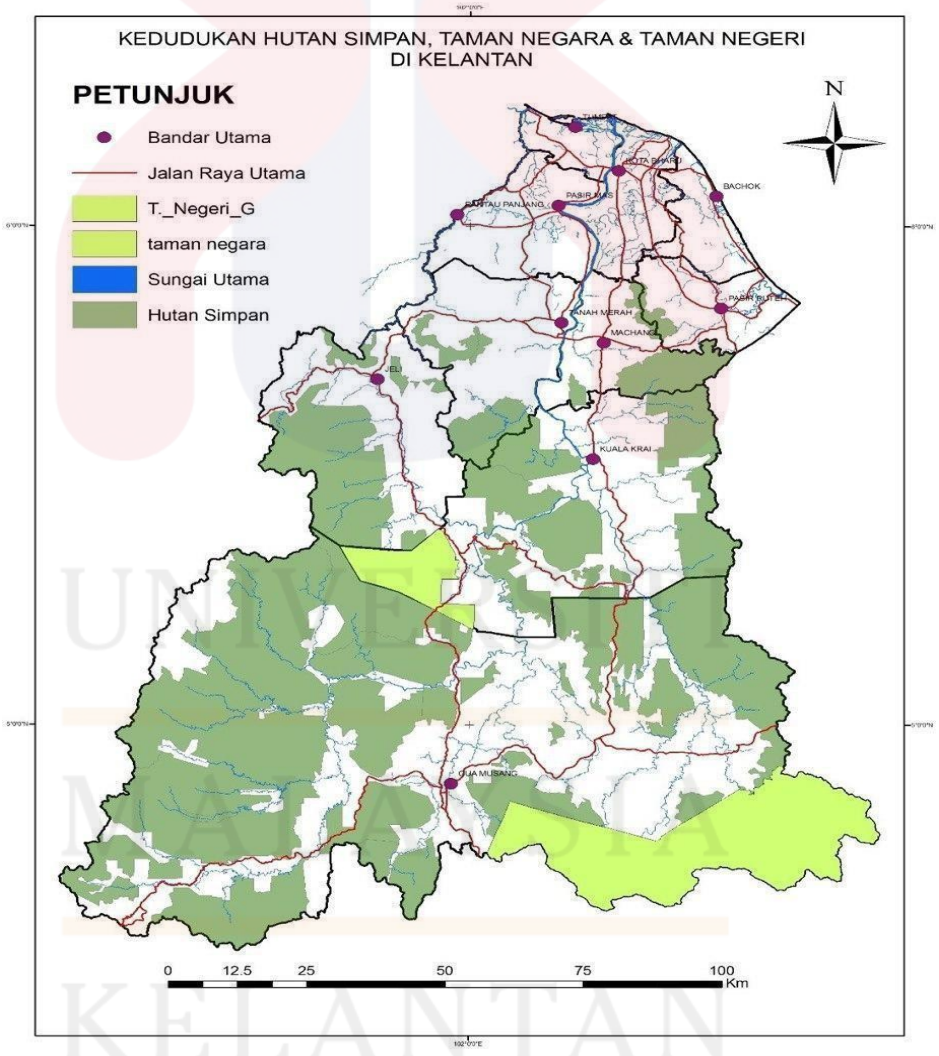


Figure 3.1.1: Locations of study area forest reserves, national park and state park in Kelantan, Malaysia. (Source: Zulhazman Hamzah., 2012).

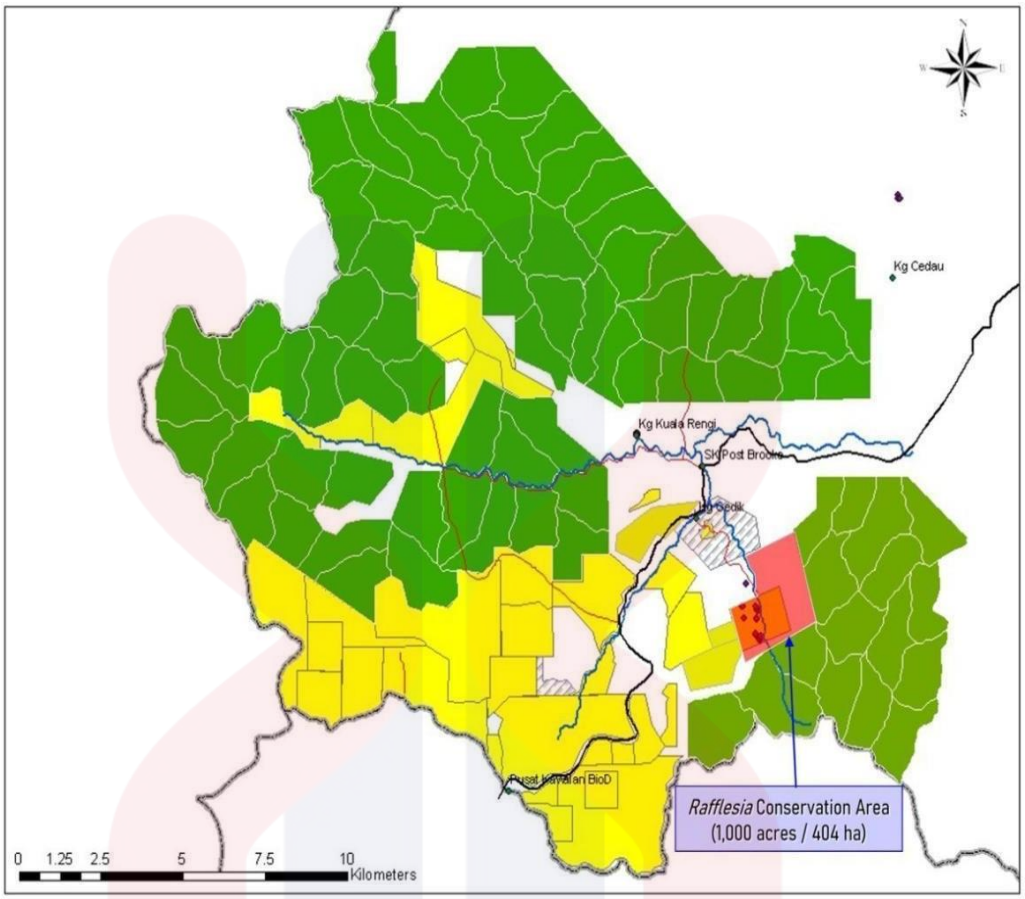


Figure 3.1.2: Close-up view of the study area; Rafflesia Conservation Area, Lojing Highlands Kelantan, Malaysia. (Source: Zulhazman Hamzah., 2012).

3.2 Material

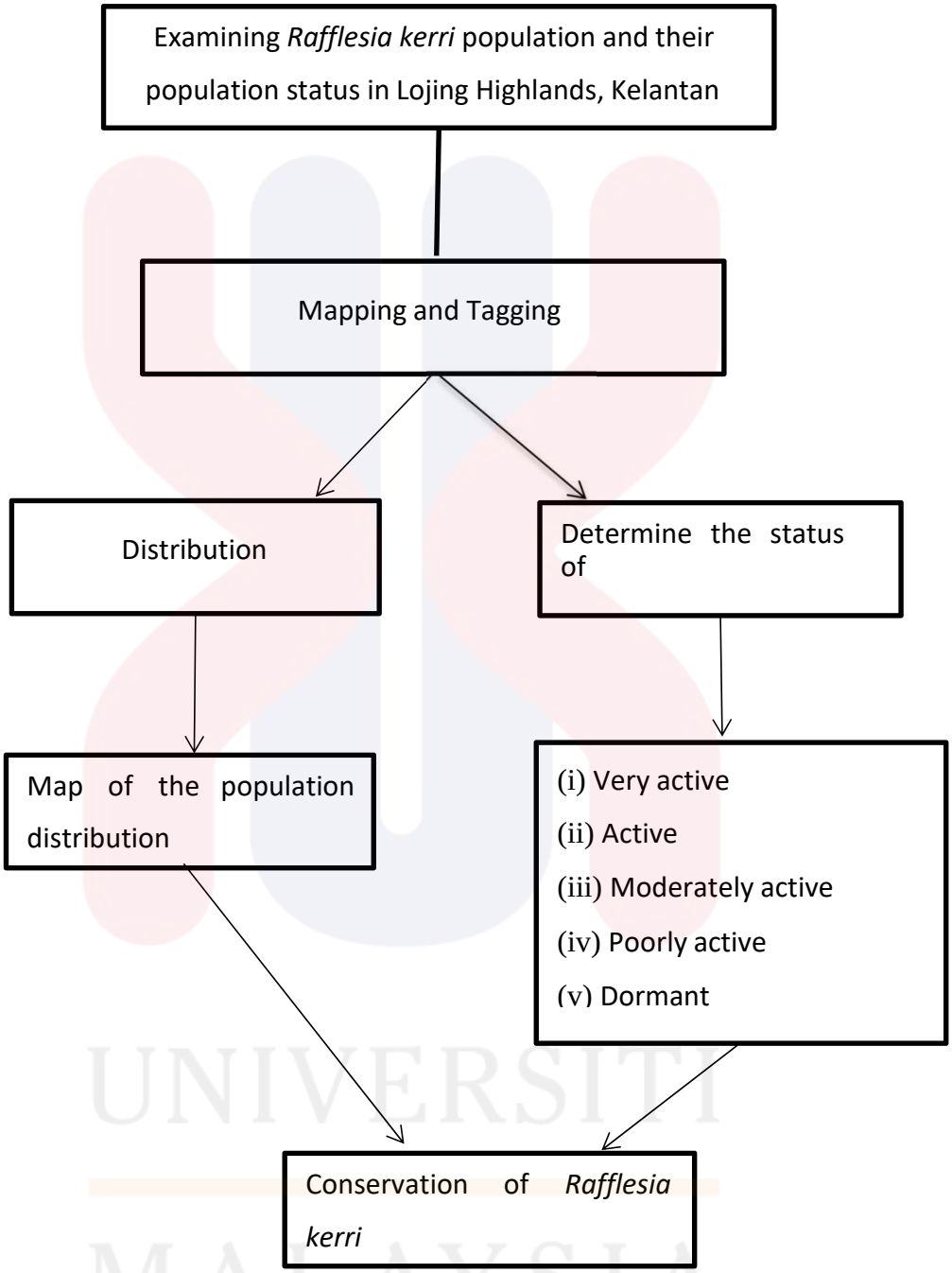
The equipment used in this study are summarized in Table 3.2 below.

Table 3.2: The equipment of the study

No.	Field sampling equipment	Functions
1.	The Global Positioning System (GPS)	GPS was used to map the location and calculate thevelocity and elevation of the study area.
2.	Measuring Tape or Diameter Tape	Measuring tape was used to measure the diameter of*Tetrastigma* (host plant), and the size of blooming flowers and buds of *R. kerri.*
3.	Laminated paper	Laminated paper was planted as a sign board of the *R.kerri.*
4.	Raffia Rope or Ribbon	Raffia rope was used to tie laminated paper to treebranches as a reference board.
5.	Permanent Marker	This type of marker does not fade easily when exposedto rain. It is used to write on laminated paper.

3.3 Method

The study's methodology was designed in accordance with research objectives, ensuring that the used techniques were deliberately selected to attain the desired objectives and provide significant outcomes. Figure 3.3 below illustrates how the study was conducted.



3.3.1 Preliminary Survey

A preliminary survey was conducted in October 2023. The purpose of the survey is to determine the site of the *Rafflesia kerri* population within the study area. During this survey, intensive groundwork was conducted to identify the location of *Rafflesia* populations to find the blooming flowers, buds, rotten flowers and scars of *Rafflesia*. The new bud (the early stage of bud development) is difficult to identify as it has very small swellings under the bark of its host plant, (*Tetrastigma* spp.). Sometimes the bud of *Rafflesia* is hidden within the dense leaf litter under the forest floor.

3.3.2 Identification of Rafflesia population

Field surveys were conducted in 20 populations of *Rafflesia* to examine their status. Each population was divided into subpopulations called clusters. The number and condition of died buds, buds and flowers were recorded and photographed. The diameter size of *Rafflesia* host plants were also measured using measuring tape. The location of each *Rafflesia* population was taken and mapped using GPS (Global Positioning System) and marked with a tag. Additionally, the ecological data of *R. kerri* was also taken.

3.3.3 Classification of Rafflesia population status

The status of each population of Rafflesia kerri were categorized into five classes, these are:

1. Very Active
2. Active
3. Moderately Active
4. Poorly Active
5. Dormant

3.3.4 Generation of Distribution Map of Rafflesia kerri

A systematic technique is used to create a detailed distribution map of Rafflesia kerri, which involves the integration of ArcGIS, GPS technology, and ExpertGPS software. At first, field surveys use GPS devices like the Garmin GPSMAP series to gather accurate coordinates (latitude and longitude) of Rafflesia populations. The data points, which are carefully documented together with relevant variables such as population names and elevation, are subsequently transmitted to a computer using software such as Garmin Basecamps to be compiled into a unified dataset.

Afterwards, the GPS data is loaded into ArcGIS, where it is combined with base maps such as topographic maps and satellite photos to offer contextual information. ArcGIS utilizes spatial analytic techniques, such as the "Add XY Data" tool, to accurately display GPS coordinates and link them with population parameters. These technologies are used to map the spread of Rafflesia populations. The resultant

maps are specifically crafted to ensure lucidity and legibility, integrating symbology, legends, scale bars, and north arrows.

ExpertGPS software is used concurrently to enable accuracy and completeness by visualizing and editing the GPS data. Population information is marked on data points, which are then exported in formats that work with ArcGIS (e.g., CSV, KML) for more investigation. To guarantee data accuracy and dependability, GIS layers integrated with GPS-collected data enable in-depth geographical analysis and validation against field observations. This theoretical framework guarantees the methodical creation of distribution maps appropriate for in-depth examination, display, and publishing.

3.3.5 Data Analysis

The data obtained from field surveys were meticulously examined to comprehend the population dynamics and geographical range of Rafflesia kerri. Initially, the data were gathered, encompassing GPS coordinates, population tallies, and the state of buds and blooms, into a centralized database. Every data entry was annotated with crucial information such as the date, location, and observer details to guarantee accuracy and traceability.

Following that, categorized the R. kerri populations into five distinct classess; (i) Very active, (ii) Active, (iii) Moderately active, (iv) Poorly active and (v) Dormant. The classification was determined by evaluating the quantity and state of buds and blooms in each cluster, employing criteria to distinguish between the various categories. Using Geographic Information System (GIS) technologies, the data was

visualized. With the GPS data plotted on digital maps, used spatial analytic methods to find trends and hotspots of population activity. We could get an extensive and clear picture of the research area by overlaying our demographic data on topographic and existing vectors data such as borders of forest reserves, forest compartments, state lands, land uses, rivers, streams, and the road network using programmed like ArcGIS and ExpertGPS.

In order to summarize the population data, next computed descriptive statistics, which included averages and measures of spread. This clarified the population's health generally. To find any changes in population dynamics over time, we also examined data from other survey periods, offering insights into the elements influencing R. kerri's conservation status.

Finally, consider the ecological and conservation requirements of R. kerri when interpreting the findings. Our results were published in thorough publications that emphasized significant discoveries, geographical patterns, and major trends. The foundation of our suggestions for conservation measures to preserve and conserve R. kerri in the Lojing Highlands was provided by these reports. Our goals in using these analytical techniques were to improve our knowledge of the population dynamics of R. kerri and offer doable, fact-based conservation suggestions.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 The population status of Rafflesia kerri

This study successfully documented a total of 20 populations divided into 52 clusters at the *Rafflesia* Conservation Park, Lojing Highlands as shown in Table 4.1 and illustrated in Figure 4.1 below.

Table 4.1: The population status of *Rafflesia kerri* in Lojing Highlands, Kelantan

No.	Class	No. of Population	No. of Cluster
1.	Very active	4	4
2.	Active	4	6
3.	Moderately active	14	27
4.	Poorly active	5	14
5.	Dormant	1	1
Total		20	52

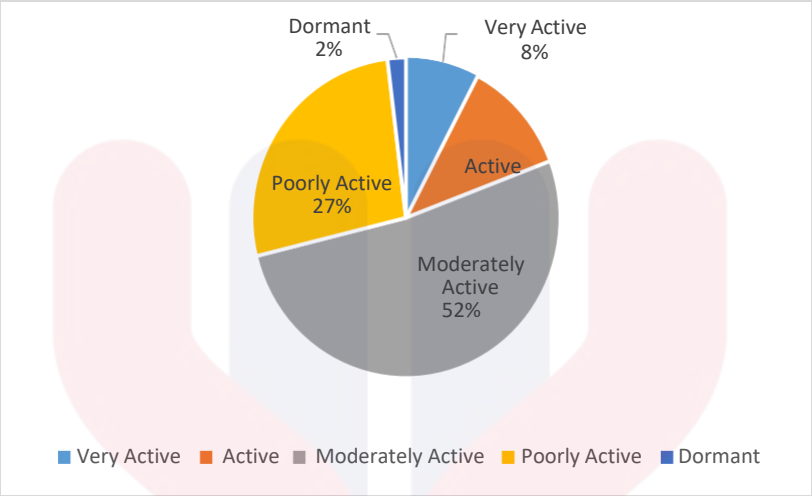


Figure 4.1.1: The percentage five classes of *Rafflesia kerri* status in Lojing Highlands, Kelantan

The data shows the overall status of Rafflesia kerri clusters, revealing that a majority of these clusters fall under the "Moderately Active" category, accounting for 52% (27 clusters) of the total population. This category includes clusters with blooming or rotting flowers and one to five buds in various stages. While the species in these clusters are still reproducing, their limited activity suggests that they are under some form of environmental stress or that conditions are not entirely conducive to their growth.

Meanwhile, 27% (14 clusters) is under the category of "Poorly Active." These clusters show no blooming or rotting flowers, only buds, indicating a severe decline in reproductive activity. The absence of blooming flowers in these clusters signals that they are struggling to thrive and may be at risk of further decline if conditions do not improve.

Clusters categorized as “Active” make up 11% (6 clusters) of the population. These clusters, characterized by blooming or rotting flowers and six to ten buds, are in a relatively healthier state compared to the “Moderately Active” and “Poorly Active” clusters. However, the fact that this category represents only a small portion of the population suggests that the majority of clusters are not reaching their full potential.

Only 8% (4 clusters) of the clusters are classified as “Very Active”, where blooming or rotting flowers are present alongside eleven or more buds in various development stages. These clusters represent the healthiest portion of the population, where reproductive activity is strong, and the plants are thriving. The small percentage of clusters in this category underscores the overall vulnerability of the species.

Lastly, 2% (1 clusters) of the clusters fall into the “Dormant” category, where there is no blooming or rotting flowers, no buds, and only scars where buds once were. This indicates that these clusters are not currently reproducing and are at significant risk of dying out if conditions do not improve.

4.2 The distribution map of Rafflesia kerri populations

A total of 52 clusters within 20 populations of Rafflesia kerri were recorded and mapped during this study at the Rafflesia Conservation Park, Lojing Highlands as shown in Figure 4.2.1. A total of nine populations were heavily disturbed by local community activities and many of host plants were chopped for no reason. The population is concentrated in three main areas which are (i) Berus-Dawai, (ii) Cebur and (iii) Cebur-1Malaysia. These areas are separated by a river or hill. There are eight

blooming flowers that were noted during the survey. The size of blooming flowers is about 80 to 90 cm. Five of them are females and only three are males. The morphological characteristics of each flower were measured and presented in Appendices. The result also shows that a total of 89 buds were recorded and 32 of them are cupules. Meanwhile, a total of 84 rotten buds and 94 rotten flowers were documented. The elevation range of the populations is from 930 to 1,054 meters above sea level (a.s.l.). The overall area calculation population including clusters is 0.0672ha.

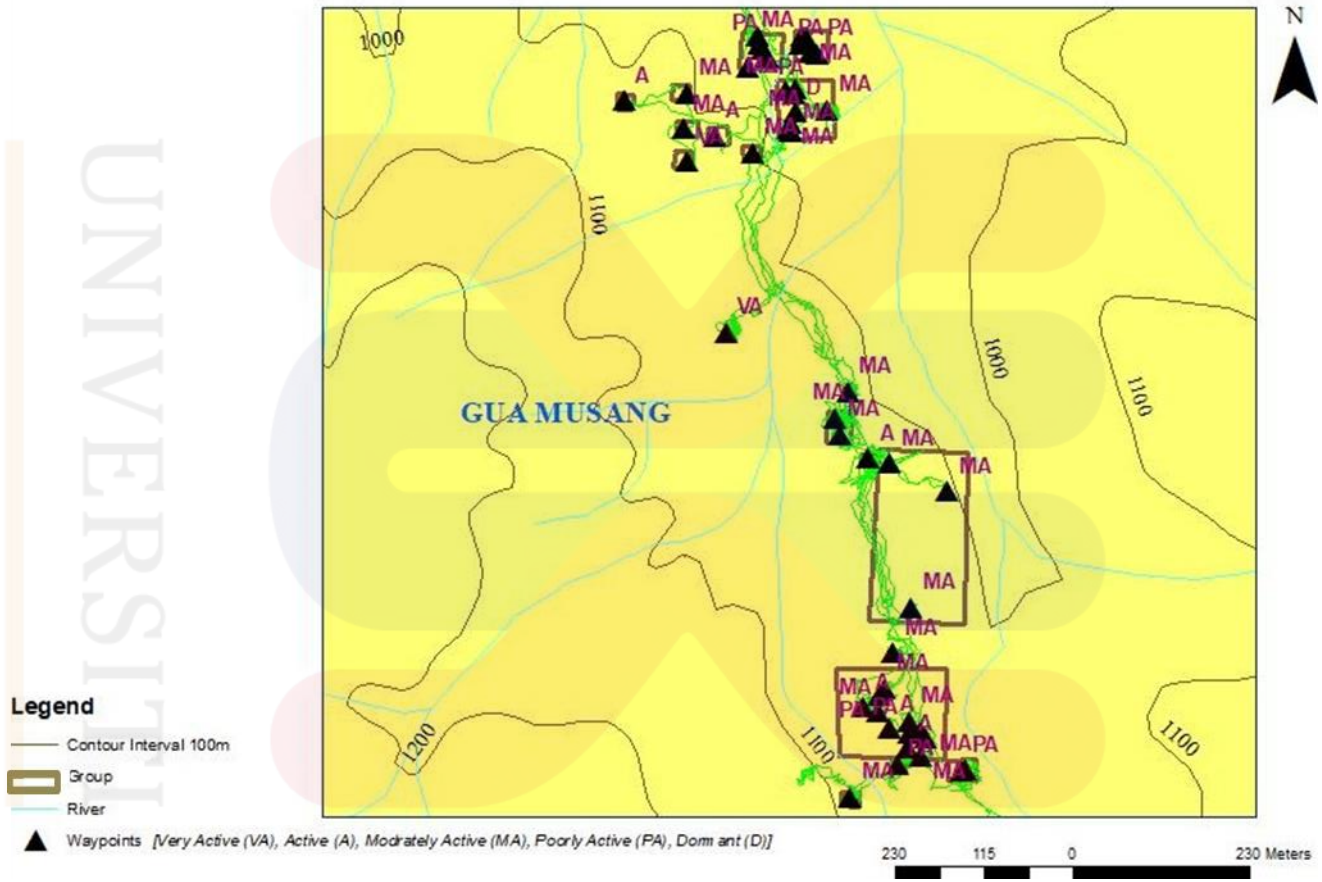


Figure 4.2.1 : Three main area of *Rafflesia kerri* populations in the *Rafflesia* Conservation Park , Lojing

In the Berus-Dawai area, a total of four blooming flowers were recorded. There are also a total of nine populations of 26 clusters as shown in Figure 4.2.3. Based on Figure 4.2.2, the overall results show that 12 clusters (46%) are moderately active, two clusters considered as active (8%), and ten clusters are poorly active (38%). This area has only one cluster in the category of dormant (4%) and one cluster is very active (4%). The four blooming flowers of R. kerri are in population no. 2 of cluster no. 7, population no. 3 cluster no. 8, population no. 7, and population no. 6. The elevation range of this area is from 930 to 997 meters above sea level (a.s.l).

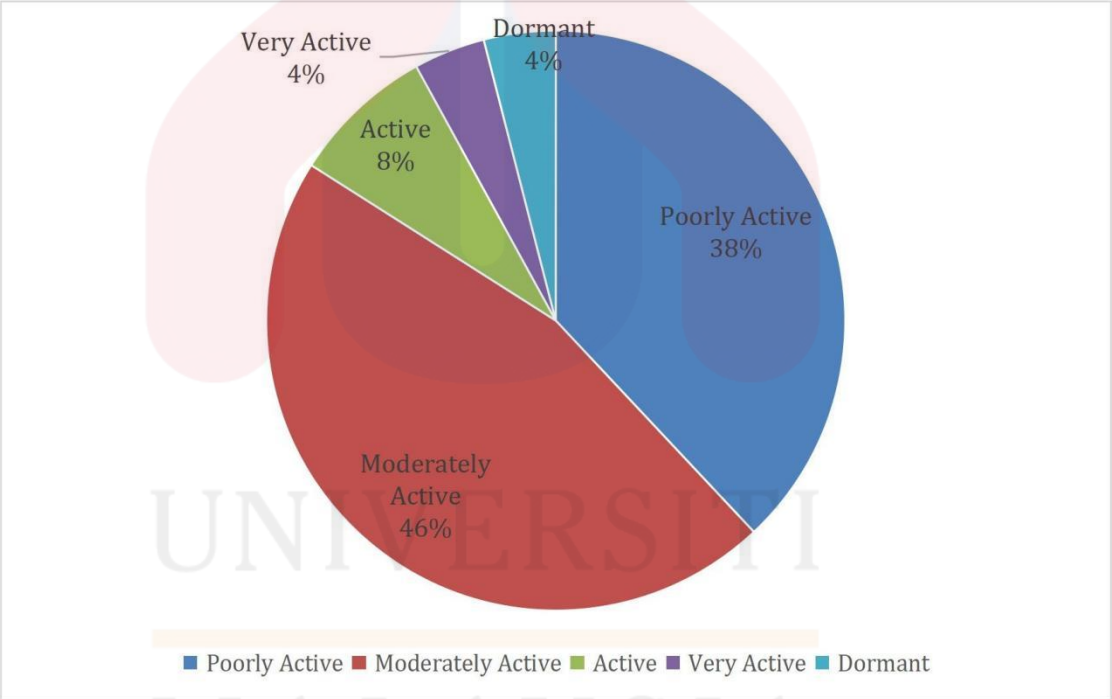


Figure 4.2.2: The percentage five classes of Rafflesia kerri status in Berus-Dawai area

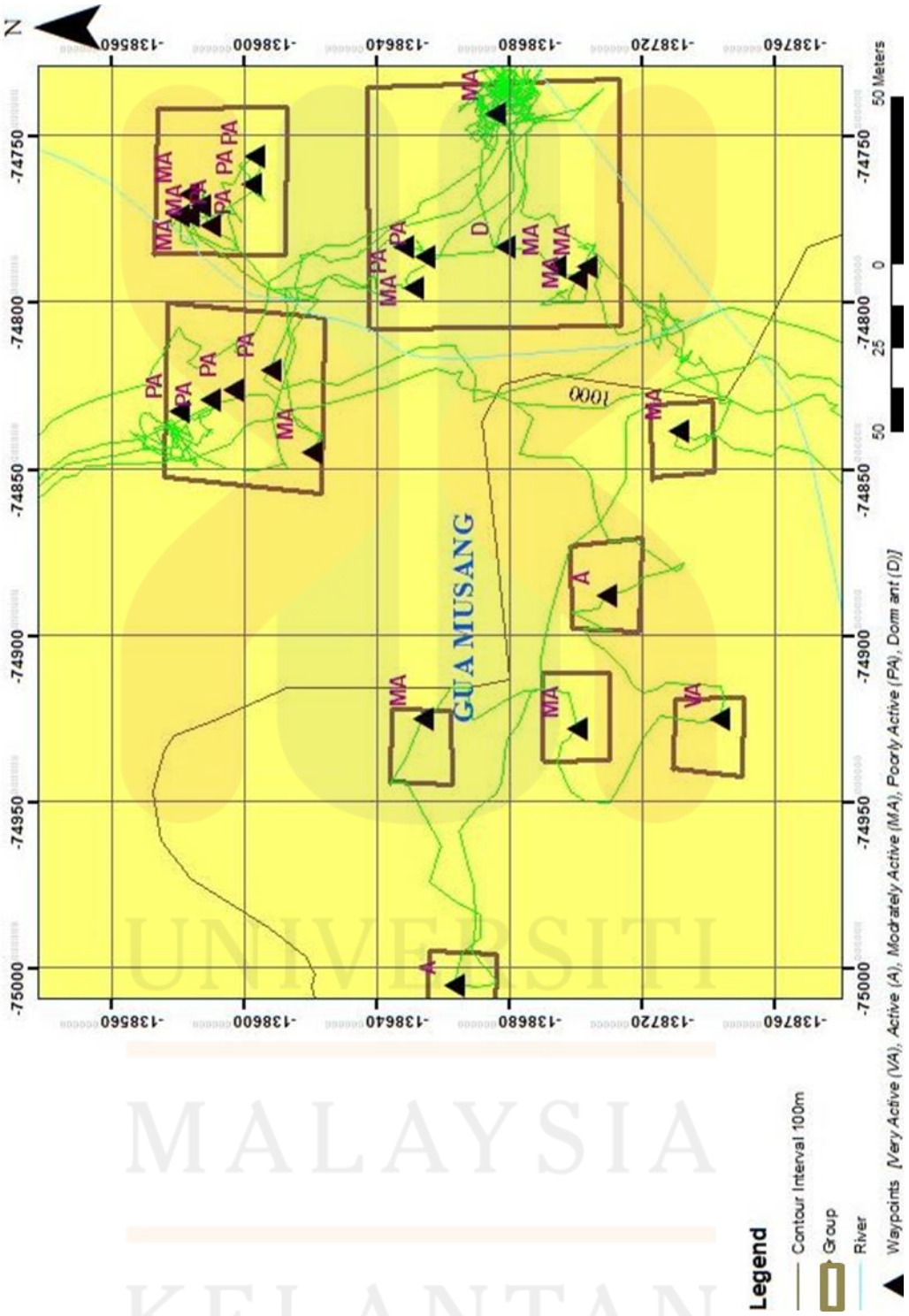


Figure 4.2.3 : Close up view Berus-Dawai area

The Cebur area has five populations divided into eight as shown in Figure 4.2.5. Based on Figure 4.2.4, there are six moderately active (75%) in this area. Both active and very active categories are 13% and 12%, respectively. This area has only three blooming flowers, each located in population no. 12 of cluster no. 1 and population no. 14 of cluster no. 2 and population no. 12 of cluster no. 1. A total of 25 rotten flowers and 16 rotten buds were recorded. While 15 buds and four cupules were also noted in this area. The range elevation of the population in this area is about 972 to 1006 meters above sea level (a.s.l)

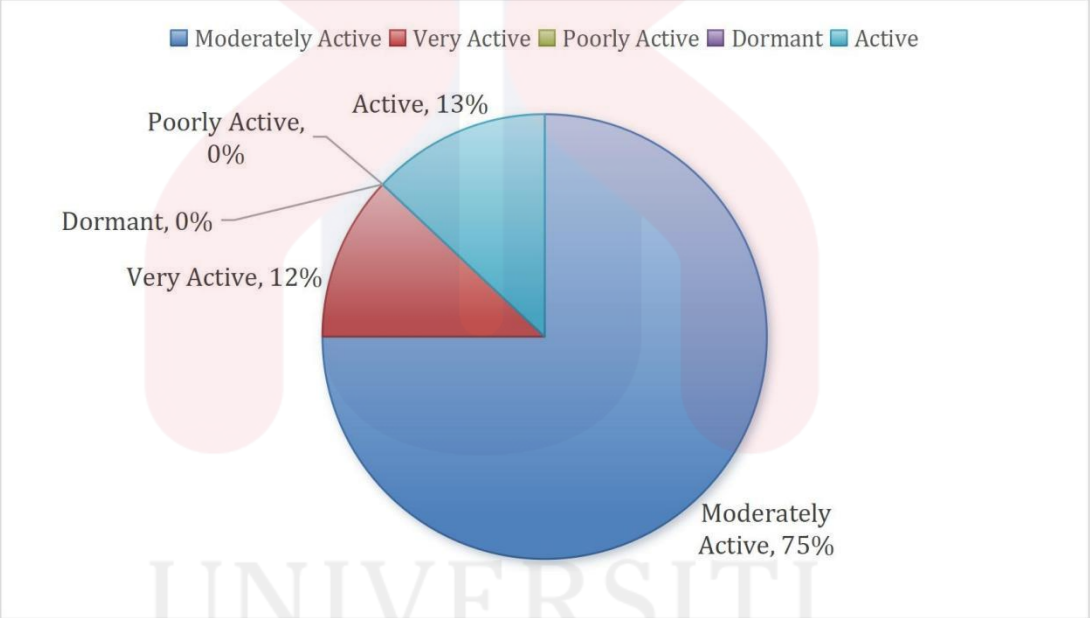


Figure 4.2.4: The percentage five classes of *Rafflesia kerri* status in Cebur area

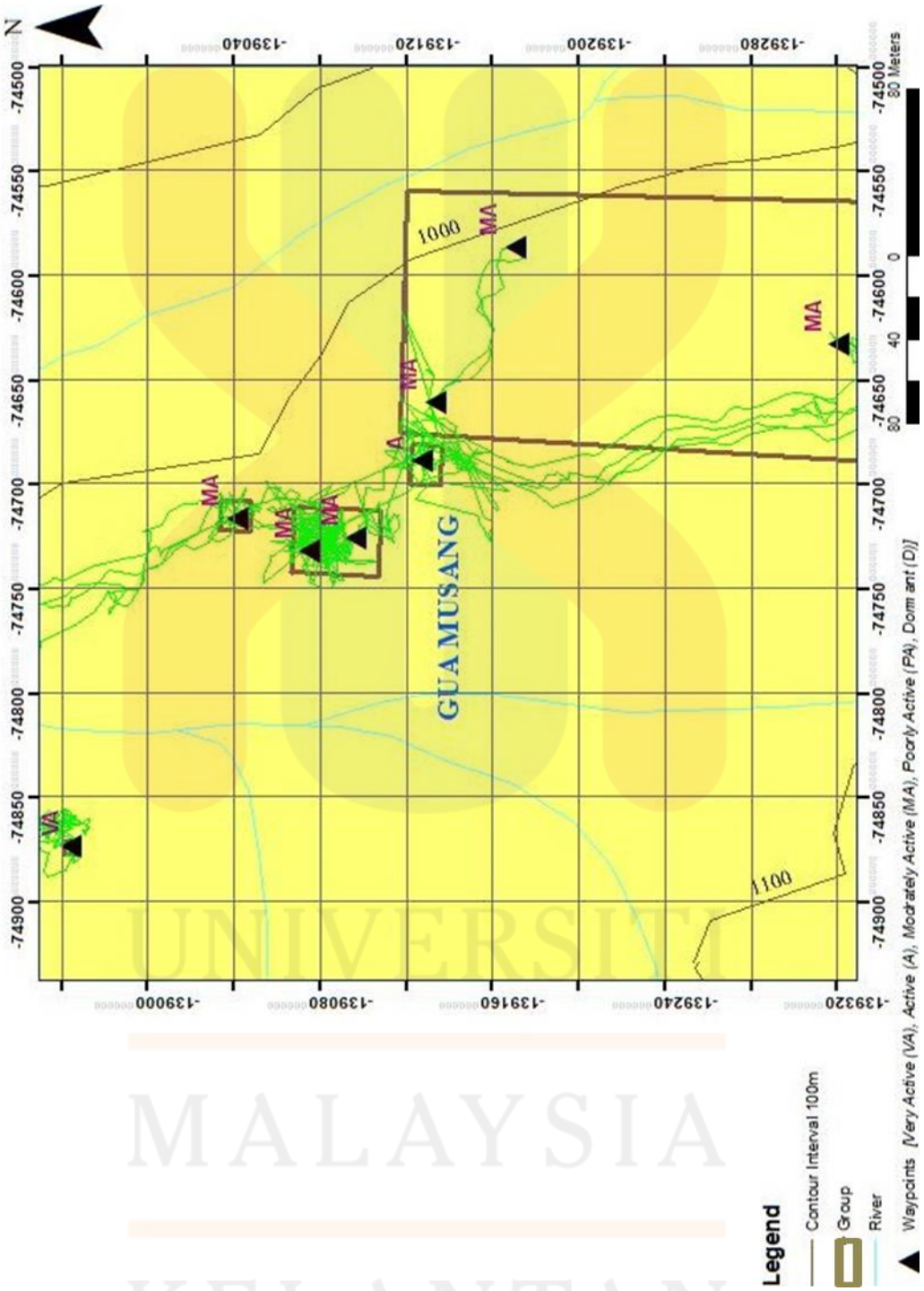


Figure 4.2.5 : Close up view of Cebur area

The Cebur-1Malaysia area has six populations comprising 18 clusters, and one blooming flower as shown in Figure 4.2.7. Based on Figure 4.2.6, the result shows that 50% (9 clusters) are moderately active; four clusters are defined as poorly active (22%) and three clusters as active (17%). While two (11%) clusters are very active categories. There are 41 buds, 16 cupules, and 49 rotten buds and 50 rotten flowers were recorded. The blooming flower was found at population no. 19 of cluster no. 1. The range elevation of the population in this circle is about 1009 to 1052 meters above sea level (a.s.l).

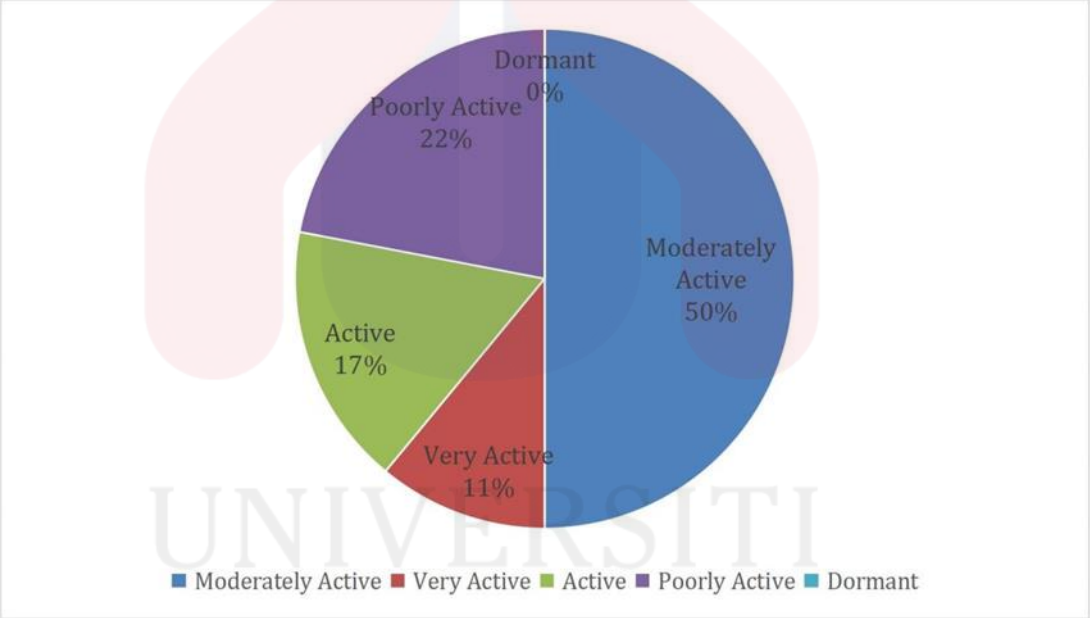


Figure 4.2.6: The percentage five classes of *Rafflesia kerri* status in Cebur-1Malaysia area

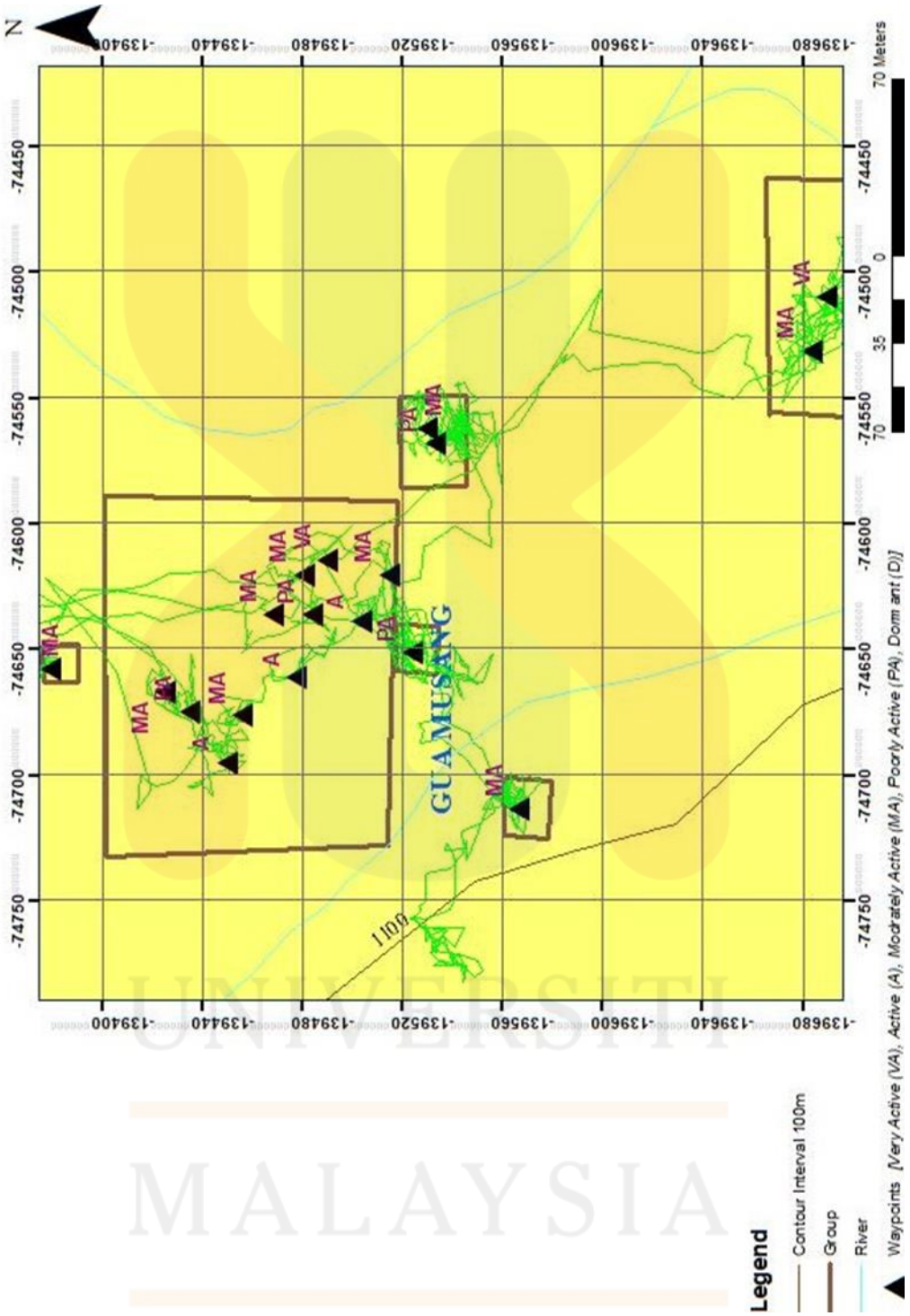


Figure 4.2.7 : Close up view of Cebur-1Malaysia area

CHAPTER 5

CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The key findings from the study are summarized below:

i. The study was successfully identified and mapped a total of 22 populations and 52 clusters of Rafflesia kerri at Lojing Highlands, Kelantan. The populations were documented as being distributing in three main aras, namely: Berus-Dawai, Cebur and Cebur-1Malaysia.

ii. The study recorded a total of eight blooming flowers, (five females and three males), 90 buds and 89 rotten buds. The average opening size of the flower is about 80 to 90 cm. There are also a total of 95 rotten flowers and 34 cupules, indicating the ongoing reproductive challenges faced by the species. The size of host plants is from the range of 3 to 12.5cm2. The elevation range of the population is from 930 to 1,054 meters above sea level (a.s.l). The overall area calculation of population including clusters is 0.0672ha.

iii. The status populations of R. kerri were categorized into five classes, namely; Very active, Active, Moderately active, Poorly active and Dormant. Most of the clusters (52%) are fall into moderately active category, meaning they are reproducing but not thriving. While (27%) are

poorly active, struggling to produce flowers, and only (8%) are in a very active and healthy categories. The presence of Dormant clusters, although small (2%), is concerning as they show no reproductive activity at all. Overall, this suggests that the population is under stress, with many clusters at risk and in need of conservation efforts to ensure their survival.

iv. Across the three area, Cebur-1Malaysia area shows more balanced distribution, with a reasonable proportion of both active and moderately active clusters, and no dormant clusters. Cebur area has a high percentage of moderately active clusters but lacks diversity in other categories, indicating a stable but not robust population. Berus-Dawai area appears to be most concerning area, with a high percentage of poorly active clusters and some dormant ones, suggesting that this site may require more immediate conservation efforts. Overall, Cebur- 1Malaysia area seems to be in the best condition, while Berus-Dawai area is the most risk.

v. A total of nine populations were heavily disturbed by local community activities and many host plants were chopped for no reason. Theres are also buds that have been chopped. Rafflesia species has belonged to their host plants for water and nutrients. When the host plants are damaged or dead, they will stop working affecting the growth of the buds. Most of host plants and buds are heavily disturbed is at Berus-Dawai area.As conclusion, 13 species from the Arecaceae family have been successfully plotted on Geographic Information System (GIS) software. These maps have shown the potential diversity and distribution of the Arecaceae family

in Gunung Stong State Park (GSSP), Dabong, Kelantan. From the results, the species of the Arecaceae family are a total of 69 individuals from 13 Arecaceae species were collected at GSSP, Kelantan. *Rhopoloblaste Singaporensis* is the most abundant species with 16 individuals. It is followed by *Pinanga pantiensis* with a total of 10 individuals. The least abundant species is *Calamus radicalis* with one individual. An educational track can be planned to conserve the existing Arecacea family. Distribution the pattern of 13 Arecaceae species was identified randomly and non-uniformly along the route. The distribution of Arecaceae species is low in diversity. However, this study area contains The Arecaceae family that benefits from the Gunung Stong State Park patch may be one of them tourist attraction because this mountain is an interesting attraction.

5.2 Recommendations

The study of population and conservation status of Rafflesia kerri can help guide future research efforts and lead to a new conservation strategy aimed at preserving these plants. Based on the information provided in this study on the conservation of R. kerri in the Lojing Highlands, here are some recommendations such as:

(i) Enhanced Research Collaboration

Effective collaboration between researchers, local people, and policymakers is crucial for collecting complete data on the populations of R. kerri, their habitat preferences, and the challenges they encounter. Through the consolidation of resources and

experience, researchers can carry out more comprehensive investigations, resulting in an enhanced comprehension of the species and the development of more knowledgeable conservation measures.

(ii) Community Involvement

It is essential to include local communities in conservation activities to guarantee the enduring safeguarding of R. kerri. By increasing public knowledge about the significance of preserving this species and engaging local communities in the process of monitoring and protecting it, stakeholders may cultivate a feeling of responsibility and guardianship among people. Communities that have been given power and authority are more inclined to embrace sustainable conservation methods and actively engage in initiatives to protect R. kerri populations.

(iii) Long-Term Monitoring Program

It is crucial to implement a comprehensive and ongoing monitoring program to accurately observe and document any changes in the populations of R. kerri and their natural environment. Conservationists may evaluate the efficacy of conservation efforts, detect new dangers, and adjust methods by conducting regular monitoring. Through systematic data collection, stakeholders may make well- informed choices to guarantee the ongoing existence of R. kerri in the Lojing Highlands.

(iv) Education and outreach Initiatives

Engaging in educational programmed and outreach projects is crucial for enhancing public knowledge about the need of conserving R. kerri. Through the dissemination of knowledge to the public, visitors, and individuals with a vested interest, stakeholders may cultivate support for conservation endeavors by highlighting the ecological significance of this species and the perils it confronts. In addition, advocating for responsible tourist practices may effectively reduce the adverse effects of human activities on the populations and habitat of R. kerri.

(v) Policy Advocacy

It is essential to advocate for policies that give priority to the conservation of R. kerri and its environment to establish effective protection measures. Through collaboration with policymakers, stakeholders may establish and enforce policies that protect this species, effectively mitigating significant risks like habitat degradation, illicit harvesting, and the impacts of climate change. Policy support is crucial in establishing a favorable environment for the conservation efforts of R. kerri and ensuring the species' enduring existence

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APPENDICES

APPENDIX A

Raw Data of population distribution and status *Rafflesia kerri*.

PLOT/ SUB-PLOT	COORDINATE	ELEVATION, m (a.s.l)	OBSERVATION	STATUS	ECOLOGY & AREA (ha/acre/km^2)
P1C1	N 04˚38’25.2’’ E 101˚30’10.0’’	930m	Bud: 1 Size of bud: 17.5cm x 17cm Host plant: 7$m2$	Poorly active	A: 0.0001 Under the Rock and Small tree, on beside the road trail, at the bush area.
P1C2	N 04˚38’24.9’’ E 101˚30’10.1’’	933m	Rotten bud: 1 Bud: 1 Size of bud: 14.5cm x 14cm Host plant: 5.5 $m2$	Poorly active	A: 0.0002 At the bush area, on beside the road trail, beside the small rock with sapling at the surroundings.
P1C3	N 04˚38’24.3’’ E 101˚30’10.4’’	936m	Bud: 2 Size of bud: 15.5cm x 14.5cm 16.5cm x 15.5cm Scar: 1 Host plant: 8$m2$	Poorly active	A: 0.0001 On beside The road trail, under the big tree, at the bush area, at the flat land.
P1C4	N 04˚38’23.9’’ E 101˚30’09.	944m	Rotten flower: 1 Bud: 3	Active	A: 0.0001 On beside the road

	6''		Size of bud: 37cm x 38cm 15cm x 15cm 14cm x 14cm Scars: 15 Host plant: 12.1$m2$		trail, under the big tree, lack of sapling at the surroundings area.
P1C5	N 04°38'25.7" E 101°30'15.4''	931m	Bud: 2 Size of bud: 14.5cm x 14cm 14cm x 13.5cm Host plants: 4.8$m2$	Poorly active	A: 0.0005 At the bush area with the sapling surrounding s, next to the rock area.
P2C1	N 04°38'24.9" E 101°30'11.8''	931m	Rotten bud: 2 Host plant: 6$m2$	Poorly active	A: 0.0001 Near the main river about 2m, at the bush area with the small and big tree surrounding
P2C2	N 04°38'25.2" E 101°30'11.9'	931m	Bud: 1 Size of bud: 14.5cm x 15cm Host plant: 4$m2$	Poorly active	A: 0.0002 At the bush area with a sapling around, about 3m from the main river.
P2C3	N 04°38'25.1" E 101°30'11.9''	931m	Rotten flower: 1 Scars: 1 Host plant: 7$m2$	Poorly active	A: 0.0001 Under the big tree, about 5m from the main river, next to the

					rock.
P2C4	N 04˚38’25.0 ” E 101˚30’12.0”	933m	Cupules: 3 Size of cupules: 6.5cm x 7cm 5.5cm x 6cm Bud: 2 Size of bud: 15cm x 15.5cm 17.5cm x 16.5cm Scars: 16 Host plant: 11.2$m2$	Active	A: 0.0002 Near the rock, about 6m from the main river, under the big tree.
P2C5	N 04˚38’25.1 ” E 101˚30’12.1”	936m	Rotten flower: 2 Scars: 5 Host plant: 3.5$m2$	Poorly active	A: 0.0003 About 9m from the main river, on the sloop area.
P2C6	N 04˚38’24.5 ” E 101˚30’12.2”	935m	Bud: 1 Size of bud: 15cm x 15cm Rotten bu bud: 1 Scars: 7 Host plant: 6.5$m2$	Poorly active	A: 0.0001 About 6m from the main river, under the big tree, at the bush area.
P2C7	N 04˚38’21.2 ” E 101˚30’11.4”	930m	Bud: 1 Size bud: 16cm x 16.5cm Blooming flower:1 Scars: 13 Host plant: 5.4$m2$	Modera tely active	A: 0.0002 About 10m from the main river, under the big tree, on the sloop area.
P3C1	N 04˚38’22.9 ”	934m	Rotten bud: 3 Scars: 5	Poorly active	A: 0010 Next to

	E 101˚30’11.2”		Host plant:5.2$m2$		the main river, near the rock, at the riverbank, near the sloop area.
P3C2	N 04˚38’23.0 ” E 101˚30’11.6”	945m	Bud: 1 Size of bud: 45.5cm x 35.5cm Scar:2 Host plant: 6$m2$	Poorly active	A: 0.0002 On top of the hill, near the sloop area, under the big
P3C3	N 04˚38’22.8 ” E 101˚30’11.5”	946m	Rotten bud: 1 Scars: 4 Host plant:5$m2$	Poorly active	A: 0.0003 Under the big tree, on the top hill, on the side of the road.
P3C4	N 04˚38’22.0 ” E 101˚30’11.6”	946m	Scars: 7 Host plant: 6$m2$	Dorma nt	A: 0.0005 At the bush area, near the sloop area, under the big tree.
P3C5	N 04˚38’21.5 ” E 101˚30’11.4”	945m	Rotten flower: 2 Scars: 3 Host plant: 7$m2$	Poorly active	A: 0.0009 At the bush area, near the slope area, next to the fallen trees with a sapling surroundin g s.
P3C6	N 04˚38’21.3 ” E 101˚30’11.3”	940m	Bud: 1 Size of bud: 20.5cm x 21.5cm	Modera t ely active	A: 0.0001 At the bush on the sloop

			Rotten flower: 2 Scars: 3 Host plant: 7.6$m2$		area, under the sapling surroundin g s, can hear the sounds of the main river from this area.
P3C7	N 04˚38’21.2 ” E 101˚30’11.4”	38m	Rotten flower: 3 Scars: 4 Host plant: 9.6$m2$	Modera tely active	A: 0.0007 On the sloop area, beside the rock, about 5m from the main river.
P3C8	N 04˚38’22.1 ” E 101˚30’12.9”	958m	Number of buds: 2 Size of bud: 17.5cm x 16cm 19.5cm x 18.5cm Cupules: 3 Size of Cupules: 5.5cm x 6cm 9cm x 8.5cm 6cm x 6.5cm Number of scars: 7 Host plant: 6$m2$ Blooming flower: 1	Active	A: 0.0002 Near the sloop area, on the top of the hill, at the bush area, the flower surroundin gs are a little bit covered by small and big trees like a canopy. Smooth soil area.
P4C1	N 04˚38’21.0 ” E 101˚30’08.2”	946m	Bud: 4 Size of Bud: 24.5cm x 21cm 26.5cm x 19.5cm 14.5cm x 12.5cm 29.5cm x	Active	A: 0.0004 Near with the small spring about 4 or 5m, on the sloop area with the

			20.5cm Cupules: 2 Size of cupules: 7cm x 6.5cm Scars: 9 Rotten Bud: 3 Host plant: 4.1$m2$		smooth soil, under the big trees.
P5C1	N 04˚38’19.9 ” E 101˚30’07.0”	965m	Bud: 3 Size of Bud: 23.5cm x 24cm 24.5cm x 23cm 10cm x 10cm Cupules: 1 Size of Cupules: 7cm x 7cm Rotten Bud: 8 Rotten Flower: 1 Number of Scars: 9 Host plant: 4.6$m2$	Active	A: 0.0167 Under the big tree, on the sloop area, near the mini waterfall, right on the hillside, smooth soil with fallen leaves covered, under it there is a big stone.
P6C1	N 04˚38’21.3’ ’ E 101˚30’6.9 ”	987m	Bud: 1 Size of Bud: 39cm x 39cm Rotten Bud: 2 Rotte n Flower: 1 Number of Scars: 4 Host plant: 4$m2$ Blooming Flower: 1	Modera t ely Active	A: 0.0014 At the bush area, near the sloop area, there a few small plants surrounde d, and the ground is covered by the fallen leaves.
P7C1	N 04˚38’22.8 ” E	972m	Bud: 2 Size of Bud: 47.5cm x	Poorly active	A: 0.0013 On the sloop area,

	101˚30’07.0”		47cm 24.5cm x 24cm Number of scars: 10 Host plant: 6.6$m2$ Blooming Flower: 1		smooth soil, under the trees, you can just hear the sound of the main river from this area. There are only a few small plants, and the land area is quite spacious.
P8C1	N 04˚38’22.5 ” E 101˚30’04.4”	997m	Bud: 5 Size of Bud: 38cm x 45cm 15cm x 15cm 24cm x 28cm 13cm x 14cm 22cm x 21cm Cupule s: 4Size of Cupule s: 12cm x 11cm 9cm x 9cm 3cm x 3cm 7cm x 7cm Rotten Flower: 1 Number of Scars: 4 Host plant: 5.3$m2$	Active	A:0.0020 Under the big tree, at the bush Area, near The sloop area, the land area is quite spacious.
P9C1	N 04˚38’20.3 ” E 101˚30’09. 8”	950m	Rotten flower: 5 Rotten bud: 4 Cupules: 1 Size of cupules:	Active	A: 0.0036 On the sloop area, next to the road trail, at the bush

			8cm x 8cm Scars: 13 Host plants: 5.5$m2$		area, a smooth soil contains a small rock.
P10C1	N 04˚38’12.7” E 101˚30’08. 7”	989m	Number of buds: 7 Size of bud: 33.5cm x 32.5cm 17cm x 16.5cm 15.5cm x 15cm 9.5cm x 8.5cm 17.5cm x 17cm 20.5cm x 19cm 22.5cm x 20.5cm Number of Cupules:2 Size of Cupules: 6cm x 5.5cm 8.5cm x 8cm Scars: 18 Rotten Bud: 3 Rotten Flower: 13 Host plant: 9.5$m2$	Active	A:0.0025 Under the big tree, a little bit clean surroundin g with small plants, the surroundin g area is slightly shaded, near the path.
P11C1	N 04˚38’10.2 ” E 101˚30’13. 8”	972m	Buds: 1 Size of bud: 13.5cm x 12.5cm Rotten Buds: 3 Rotten flower: 4 Scars: 2 Host plant: 3.5$m2$	Active	A: 0.0003 At the bush area, near with the hiking road, have many small plants are surroundin gs about 5m from

					the main trail
P12C1	N 04˚38’09.1 ” E 101˚30’13. 3”	977m	Buds: 1 Size of bud: 14.5cm x 15cm Scars: 4 Rotten Buds: 1 Rotten Flower: 3 Host plant: 4.5$m2$ Blooming Flower: 1	Active	A: 0.0004 Near the Stream River about 5 meters, at the sloop area, on the riverbank, it is quite hidden from people's view from the hiking trail.
P12C2	N 04˚38’09.1 ” E 101˚30’13. 7”	977m	Rotten Bud: 2 Rotten Flower: 3 Host plant: 4.5$m2$	Poorly active	A: 0.0001 At the bush area with small plants surroundin g, about 5m from main river.
P13C1	N 04˚38’07.4 ” E 101˚30’14. 7”	985m	Buds: 4 Size of bud: 11.5cm x 10cm 16.7cm x 15.5cm 16cm x 15cm 14.5cm x 14cm Cupules: 2 Size of Cupules: 12cm x 11.5cm 8.5cm x 9cm Rotten Buds: 2 Rotten	Active	A: 0.00021 At the bush area, about 5m from the main river, near the sloop area, have many small plants its surrounde d

			Flower: 1 Scars: 10 Host plant: 5.3$m2$		
P14C1	N 04˚38’6” E 101˚30’18”	999m	Blooming flower:1 Scars:3 Host plant:7$m2$	Poorly active	A: 0.0003 At the bush area, have small plants are surrounded, about 5m from the main river, near the sloop area, have a few small rocks its surroundings.
P14C2	N 04˚38’07.4 ” E 101˚30’14.7”	1006m	Bud:1 Size of Bud: 45.5cm x 35.5cm Scars:5 Blooming flower:1 Host plant:6.4$m2$	Moderat ely active	A: 0.0005 At the bush area, near the main river about 5m from the main river, have small plants its surrounded.
P14C3	N 04˚38’01.1 ” E 101˚30’16.5”	1004m	Buds:1 Size of bud: 7cm x 6.5cm Rotten Bud: 1 Rotten Flower: 3 Scars: 2 Host plant: 6.2$m2$	Moderately active	A: 0.0008 At the bush area, near the sloop area, have small plants are surrounded, just can hear river

					from here, smooth soil.
P15C1	N 04˚37’59.2 ” E 101˚30’15. 7”	1020m	Buds: 2 Size of bud: 24.2cm x 24.6cm 17.5cm x 18cm Rotten Flower: 3 Scars: 1 Host plant: $m2$	Modera tely active	A: 0.0036 On beside The main road, under the trees, at the bush area with a few small plants, about 5m from the main hiking trail, at the hill.
P16C1	N 04˚37’57.7 ” E 101˚30’15. 4”	1022m	Rotten Bud: 2 Rotten Flower: 1 Scars: 7 Host plant: 4.5$m2$	Poorly active	A: 0.0006 Near the second way trail, under the trees, smooth soil, at the hill, the land is slightly spacious with many fallen leaves are covering.
P16C2	N 04˚37’57.4’ ’ E 101˚30’15. 14”	1024m	Buds: 2 Size of bud: 14.5cm x 15cm 13cm x 12.5cm Cupules: 1 Size of Cupules: 9.5cm x 9cm Rotten	Poorly active	A: 0.0018 At the bush area, near the second way trail, at the hill, have many small plants

			Bud: 2 Scars: 3 Host plant: 8.5$m2$		surroundin g it, smooth soil
P16C3	N 04˚37’56.9’ ’ E 101˚30’14. 49”	1025m	Buds: 6 Size of bud: 17.5cm x 17cm 11.5cm x 10cm 25.5cm x 24cm 12.5cm x 13cm 20.9cm x 19.5cm 14.5 cm x 15cm Cupules: 3 Size of Cupules: 9.5cm x 9cm 5.5cm x 6cm	Active	A: 0.0010 Under the big trees, the land is slightly spacious with covered by many fallen leaves, near the second way trail, smooth soil, at the hill.
P16C4	N 04˚37’56.7’ ’ E 101˚3015. 09”	1024m	Buds: 1 Size of bud: 28.5cm x 27.5cm Cupules: 1 Size of Cupules: 8.5cm x 9cm Rotten Bud: 1 Rotten Flower: 4 Scars: 8 Host plant: 4$m2$	Active	A: 0.0008 Under the trees, near the second way trail, the surroundin g is slightly spacious, the land area covered by many fallen leaves, at the hill.
P16C5	N 04˚37’56.06” E 101˚30’15.	1026m	Buds: 7 Size of bud: 24cm x 22cm 22.5cm	Active	A: 0.0020 At the bush area, near

	59”		x22cm 10cm x 10cm 21.5cmx 20.5cm 13cm x 13.5cm 21cm x 20.5cm 28.7cm x 26cm Cupules: 1 Size of Cupules: 7cm x 6.5cm Rotten Bud: 2 Rotten Flower: 1 Scars: 2 Host plant: 8$m2$		The sloop area, under the big tree, have a small plant surrounde d, at the hill.
P16C6	N 04˚37’55.16” E 101˚30’16. 32”	1029m	Number of buds: 6 Size of bud: 13.4cm x 12.7cm 8.5cm x 9cm 30cm x 30.5cm 9.7cm x 10cm 23.5cm x 24cm 10cm x 9.5cm Cupules: 1 Size of Cupules: 6.5cm x 6cm Rotten bud: 3 Rotten Flower: 3 Number of scars: 3 Host plant: 6$m2$	Active	A: 0.0025 At the bush area, under the big tree, have a small plant surrounde d, the land covered by many fallen leaves, smooth soil, at the hill
P16C7	N 04˚37’54.8’ ’ E 101˚30’16.	1030m	Rotten Bud: 2 Rotten Flower: 2	Poorly active	A: 0.00013 At the

	9”		Number of scars: 6 Host plant: 8$m2$		bush area, near with the second trail, the land area quite spacious, smooth soil, the land covered by fallen leaves, at the hill.
P16C8	N 04˚37’55.6 ” E 101˚30’17.1”	1028m	Number of buds: 1 Size of bud: 19.5cm x 20cm Cuple: 1 Size of Cuple: 7cm x 7cm Rotten Bud: 9 Rotten Flower: 3 Scars: 3 Host plant: 6.4 $m2$	Active	A: 0.0006 At the bush area, near the hiking trail, have a few small plants its surroundin g, under the trees, smooth soil, at the hill.
P16C9	N 04˚37’55.9 9” E 101˚30’16.86”	1027m	Rotten Flower: 5 Number of scars: 4 Host plant: 12.6$m2$	Active	A: 0.0001 At the bush area with many small plants surrounde d, smooth soil, have a good lighting, at the hill.
P16C10	N 04˚37’56.3’ ’ E 101˚30’16.4”	1027m	Rotten Bud: 5 Rotten Flower: 8 Number of scars: 4	Active	A: 0.0002 On the side of the road, under the

			Host plant: 7.8$m2$		tree, the land area is quite spacious, at the hill.
P16C11	N 04˚37’55.81” E 101˚30’16.46”	1026m	Number of buds: 5 Size of bud: 8.5cm x 9cm 38.5cm x 38.8cm 8.5cm x 8cm 8.5cm x 8cm 16cm x 16.4cm Scars: 8 Host plant: 7.7 $m2$	Moderately active	A: 0.0012 Near the hiking trail, at the bush area with many small plant’s surroundings, smooth soil, at the hill.
P17C1	N 04˚37’54.5 ” E 101˚30’15.9”	1039m	Number of buds: 3 Size of bud: 45cm x 50cm 23cm x 22.5cm 13cm x 13.5cm Cupules: 1 Size of Cupules: 5.5cm x 6.5cm Rotten Bud: 6 Number of scars: 11 Host plant: 3.1$m2$	Poorly active	A: 0.0003 On the top of the sloop area, slightly hidden with the small plants, smooth soil,under the small trees, on the side of the road, about 5m from the main river.
P18C1	N 04˚37’53.1” E 101˚30’13.9	1030m	Cupules: 1 Size of Cupules: 7.5cm x 7cm Rotten Bud: 3 Rotten	Active	A: 0.0038 About 1km from the stream river, near the fallen tree, at the

			Flower: 6 Number of scars: 12 Host plant: 6.5 $m2$		bush area, under the big tree, the host plant is split, and the rafflesia still grows in the split
P19C1	N 04˚37’54.3” E 101˚30’18.8”	1035m	Number of scars: 2 Host plant: 4.4 $m2$ Blooming Flower: 1	Moderately active	A: 0.0024 On the top of the slope area, beside the fallen tree, smooth soil, under the big tree, there is a small spring under the slope, beside the big rocks, at the hill.
P19C2	N 04˚37’54.2 ” E 101˚30’18.6”	1054m	Buds: 4 Size of bud: 10cm x 10.5cm 38.5cm x 39cm 12.5cm x 14.5cm 17.5cm x 19.5cm Cupules: 1 Size of Cupules: 6.5cm x 7cm Rotten Bud: 2 Number of scars: 4 Host plant:	Active	A: 0.0032 Under the big tree, near the sloop area, about 2m from the spring river, and 2m from the main road, there are small plants surrounding, at the hill.

			6.3 $m2$		
P20C1	N 04˚37’49.3 ” E 101˚30’19. 8”	1053m	Number of buds: 1 Size of bud: 16cm x 15 cm Cupules: 1 Size of Cupules: 14.5cm x 14.5 cm Rotten Flower: 5 Rotten Bud: 3 Number of scars: 4 Host plant: 3.8$m2$	Active	A: 0.0010 Under the big tree, the surroundin g area is quite wide, the ground is covered with fallen leaves, near the small spring and the sloop area with a smooth soil.
P20C2	N 04˚37’49.1” E 101˚30’20. 5	1052m	Number of buds: 3 Size of bud: 39.5cm x 42.5cm 24.5cm x 19cm 16.5cm x 15.5cm Cupules: 4 Size of Cupules: 5.5cm x 6cm 6.5cm x 7cm 4 cm x 4.5cm 6.5cm x 6cm Rotten Cupules: 2 Rotten Bud: 7 Rotten Flower: 8 Scars: 11 Host plant: 5.1 $m2$	Active	A:0.0023 Near the small spring, on the sloop area, the ground is covered by the fallen leaves, near the rock and there are no trees covered.

APPENDIX B

Raw Data of blooming flowers of *Rafflesia kerri.*

POPULATION	BLOOMING FLOWER
P1C1	 Sex: Female flower Open flower diameter: 71.5cm L x 77.5cm W Perigone lobe: 5 Diaphragm: 35cm L x 36.5cm W Aperture: 15.5cm L x 20.5cm W Window: 7 rings (0.5cm L x 1cm W) Processer: 52 Ramenta: 17.5cm L x 17cm W Wart: 1cm,0.7cm,0.2cm **1st petal: L 26.7 cm; W 33.5 cm 2nd petal: L 23.5 cm; W 28.5 cm 3rd petal: L** **25.5 cm; W 32.5 cm 4th petal: L 23.5 cm; W 30.5 cm 5th petal: L 24.5 cm; W 31.5 cm**

P7C1	 Sex: Female flower Open flower diameter: 71.5cm L x 77.5cm W Perigone lobe: 5 Diaphragm: 35cm L x 36.5cm W Aperture: 15.5cm L x 20.5cm W Window: 7 rings (0.5cm L x 1cm W) Processer: 52 Ramenta: 19cm L x 18cm W Wart: 2cm,1.5cm, 0.4cm **1st petal: L 26.7 cm; W 33.5 cm 2nd petal: L 23.5 cm; W 28.5 cm 3rd petal: L 25.5 cm; W 32.5 cm 4th petal: L 23.5 cm; W 30.5 cm 5th petal: L 24.5 cm; W 31.5 cm**

P10C1	 Sex: Female flower Open flower diameter: 75.5 cm L x 80 cm W Perigone lobe: 5 Diaphragm: 35cm L x 35.5cm W Aperture: 18.5cm L x 10.5cm W Window: 8 rings (0.5cm L x 1cm W) Processer: 53 Ramenta: 19.5cm L x 19cm W Wart: 1cm,0.6cm,0.3cm **1st petal: L 22.2 cm; W 25.4 cm 2nd petal: L 19.2 cm; W 27 cm 3rd petal: L** **19.8 cm; W 30 cm 4th petal: L 18.8 cm; W 27 cm** **5th petal: L 19 cm; W 28.1 cm**

	 Sex: Female flower Open flower diameter: 84 cm L x 87 cm W Perigone lobe: 5Diaphragm: 32cm L x 35.5cm W Aperture: 14.5cm L x 15cm W Window: 9 ringsProcesser: 58 Ramenta: 19.5cm L x 19cm W Wart:1.2cm,0.9cm,0.3cm **1st petal: L 26 cm; W 25 cm 2nd petal: L27 cm; W 30 cm 3rd petal: L 28 cm; W 31 cm 4th petal: L 27 cm; W 20.5 cm 5th petal: L 29.5 cm; W 25.5 cm**

P12C3	 Sex: Male flower Open flower diameter: 73.5 cm L x 75 cm W Perigone lobe:5 Diaphragm: 15.5cm L x 14.5cm W Aperture:15.5cm L x 15cm W Window: 7 rings Processer: 61 Ramenta: 19.5cm L x 19cm WWart: 1cm,0.5cm,0.3cm **1st petal: L 23cm; W 28 cm 2nd petal: L21 cm; W 26 cm 3rd petal: L 18 cm; W 23 cm 4th petal: L 22 cm; W 24.5 cm** **5th petal: L 28 cm; W 33.5 cm**

P15C1	 Sex: Male flower Open flower diameter: 83 cm L x 77 cm W Perigone lobe: 5Diaphragm: 31cm L x 38cm W Aperture: 14cm L x 21.5cm W Window: 8 rings (0.5cm L x2cm W) Processer: 53 Ramenta: 21cm L x 18cm W Wart:2cm,1cm,0.5cm **1st petal: L 25.5 cm; W 31.0 cm** **2nd petal: L 26.5 cm; W 32 cm 3rd petal: L 30cm; W 32 cm 4th petal: L 24.5 cm; W** **32.5 cm** **5th petal: L 22 cm; W 27.5 cm**

P20C1	

	Sex: Female flower Open flower diameter: 68 cm L x 72 cm W Perigone lobe: 5 Diaphragm: 31.5cm L x 31cm W Aperture: 16cm L x 15.5cm W Window: 6 rings Processer: 51 Ramenta: 19cm L x 20cm W Wart: 1cm,0.5cm, 0.2cm **1st petal: L 21.5 cm; W 28 cm 2nd petal: L 20 cm; W 22.5 cm 3rd petal: L 20 cm; W 30 cm 4th petal: L 21.5 cm; W 25cm 5th petal: L 22 cm; W 29 cm**

P22C1	 Sex: Female flower Open flower Diameter: 81cm L x 85cm W Perigone lobe: 5 Diaphragm: 39 cm L x 34cm W Aperture: 19.7 cm L x 14.5cm W Window: 8 rings Processer: 39 Ramenta: 18cm L x 19cm W Wart: 1cm,0.5cm,0.2cm **1st petal: L 22.5 cm; W 26 cm 2nd petal: L 21.5 cm; W 30.4 cm 3rd petal: L 31 cm; W 27.5 cm 4th petal: L 27.5 cm; W 26cm 5th petal: L 24.5 cm; W 22.5 cm**

APPENDIX C

Raw Data of *Rafflesia kerri* which were distributed by local community activities.

COORDINATES	PICTURES
N 04˚38'25.0'' E 101˚30'12.0''	**POPULATION 1 CLUSTER 4**  **-1 host plant with 2 cuple**
N 04˚38'23.9'' E 101˚30'09.6''	**POPULATION 3 CLUSTER 1**  **-1 host plant**
N 04˚38'24.3'' E 101˚30'10.4''	**POPULATION 3 CLUSTER 2**  **-1 bud and host plant has been cut**

N 04˚40’28.0’’ E 101˚29’20.3’’	**POPULATION 2 CLUSTER 6** 
	
N 04˚38’09.1’’ E 101˚30’13.3’’	POPULATION 10 CLUSTER 1
	
N 04˚38’24.9’’ E 101˚30’10.1’’	POPULATION 3 CLUSTER 3  -host plant has been cut cause rotten bud

N 04˚40’28.0’’ E 101˚29’20.3’’	POPULATION 2 CLUSTER 4 
N 04˚38’12.7’’ E 101˚30’08.7’’	POPULATION 8 CLUSTER 1 (DAWAI) 
N 04˚37’55.7’’E 101˚30’17.2’’	POPULATION 13 CLUSTER 7