ASSESSING THE STATUS OF RAFFLESIA'S BUD (*RAFFLESIA KERRI)* IN LOJING HIGHLANDS, KELANTAN

by

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

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DECLARATION

I declare that this thesis entitled "Assessing the Status of Rafflesia's Bud (*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.

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APPROVAL

"I hereby declare that I have read this thesis and in our opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Natural Resources Science) with Honors"

Signature : _____

Name of Supervisor : _____

Date : _____

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Assessing the Status of Rafflesia's Bud (*Rafflesia kerri*) in Lojing Highlands, Kelantan

ABSTRACT

Rafflesia flower is one of the unique and endangered species in the world. It is belonged to the family of Rafflesiaceae. The distribution of *Rafflesia kerri* species can be found in Peninsular Malaysia especially in Kelantan State and Thailand. In Kelantan, Lojing Highlands is the hot spot area to trail *R. kerri* species by tourist and researcher. In Lojing Highlands, this species is being threatened due to the agriculture activity. The objectives of this study were to identify the *Rafflesia*'s bud status, to examine the bud stages of *R. kerri* and to determine the population density of *R. kerri* bud. A study on 3 ha plot had conducted in Lojing Highlands to assess the status of *Rafflesia*'s bud The data of the bud was obtained by plot setting up and surveying in the 3 ha plot. There were 34 *Rafflesia's* buds found in the study site. The status of the buds found is six of it was dead and 28 buds were alive. Many of the *Rafflesia*'s bud found in the study site were in stage II (bract stage) with 18 buds in total. The population density of the buds in the 3 ha plot is 9 buds/ha. It shows a high population of bud density because it is nearly to have 10 buds/ha in the study site.

Menilai Status Kudup Rafflesia (*Rafflesia kerri*) di Tanah Tinggi Lojing, Kelantan

ABSTRAK

Bunga *Rafflesia* merupakan salah satu spesies yang unik dan terancam di dunia. *Rafflesia* tergolong dalam keluarga Rafflesiaceae. Pengagihan spesies *Rafflesia kerri* boleh dijumpai di Semenanjung Malaysia terutamanya di Negeri Kelantan dan Thailand. Di Kelantan, Tanah Tinggi Lojing merupakan kawasan terkenal untuk menjejak *R. kerri* spesies oleh pelancong dan penyelidik. Di Tanah Tinggi Lojing, spesies ini terancam kerana aktiviti pertanian. Plot seluas 3 hektar telah dijalankan di Tanah Tinggi Lojing Kelantan untuk menilai status kudup *R. kerri.* Objektif kajian ini adalah untuk mengenalpasti status kudup *Rafflesia*, untuk memeriksa peringkat kudup *R. kerri* dan untuk menentukan kepadatan kudup *Rafflesia*. Data kudup *Rafflesia* diperolehi dengan memasang plot dan mengukur dalam 3 hektar plot. Terdapat 34 kudup *Rafflesia* telah ditemui di dalam kawasan kajian. Status kudup yang dijumpai adalah enam daripadanya telah mati dan terdapat 28 kudup yang masih hidup Banyak kudup *Rafflesia* yang ditemui di kawasan kaian berada di peringkat II (peringkat bract) dengan jumlah keseluruhan 18 kudup. Kepadatan kudup di 3 hektar plot adalah sebanyak 9 kudup/hektar. Ia menunjukkan kepadatan kudup yang tinggi kerana ianya menghampiri 10 kudup/hektar di kawasan kajian.

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LIST OF ABBREVIATION & SYMBOLS

a.s.l.	Above Sea Level
A	Area
B	Bud
cm	Centimeter
C	Circumference of a circle
d	Diameter of a circle
GIS	Geographical Information System
ha	Hectare
HSK	Hutan Simpan Kekal (Permenant Reserved Forest)
IUCN	International Union for Conservation of Nature
m	Meter
mm	Millimeter
sq km	Square kilometer
UMK	Universiti Malaysia Kelantan
˚C	Degree celcius
π	Constant value (3.14)

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Malaysia is one of the tropical countries that have the richest biodiversity of flora and fauna. There are thousands of species of flora and fauna that can be found in Malaysia. Malaysia has the latitude of 2˚ to 7˚ N and longitude of 100˚ to 119˚ E which is near to the equator. The tropical rainforest is covered in Malaysia in about 70% with a variety of species of flora and fauna. Meanwhile, the lowland forest on Sabah and Sarawak had about 400 species of dipterocarps (Ashraff, 2012) .

Rafflesia is an endemic flower and can be found in the Southeast Asia countries like Malaysia, Indonesia for specific at Java and Sumatra, Thailand and Philippine (Sofiyanti & Yen, 2012). In Malaysia, it can be found on Peninsular Malaysia which located at Kelantan, Perak, Kedah, Pahang, Terengganu and also on the Borneo Island (Sabah and Sarawak) (Nor Azilah *et al*., 2017). The distributions of the *Rafflesia* species are as shown in table 1.1. This flower is one of the tourism attractions in Malaysia. The largest one that had been found was located at Royal Belum Grik, Perak with the total number of 10 petals bloom and 46cm in diameter (Ashraff, 2012).

Rafflesia has an unpleasant pungent smell like a rotten meat that's why the local name of this flower as a corpse flower (Patiño*et al*., 2002). The rotten smell will attract pollinator that is flies. *Rafflesia* also is a plant that has no leaves, true roots or stems and

does not has chlorophyll. It is a holoparasitic plant (Farah Khaliz *et al*., 2018). *Rafflesia* grows on the tissues of the *Tetrastigma* vine root. It totally depends on the vine for food supply. The conservation status of this species is endangered or threatened (Akhriadi *et al.*, 2010).

Table 1.1: The distribution of *Rafflesia* species (Nor Azilah *et al*., 2017) and (Akhriadi *et al.*, 2010).

Distribution	***Rafflesia* Species**
Peninsular Malaysia	*R. cantleyi* *R. kerri* *R.hasseltii* *R.azlanii* *R. parvimaculata* *R. su-meiae* *R. tuanku-halimii* *R. sharifah-hapsahiae*
Borneo	*R. pricei* *R. tuan-mudae* *R. kethii* *R. tengku-adlini* *R. arnoldii* *R. witkampii* *R. ciliata* *R.borneensis*
Thailand	*R. kerri*
Philippines	*R. leonardi*

	R. baletei
	R. lobata
	R. mira
	R. speciosa
	R. panchoana
	R. banahowensis
	R. banahao
	R. manillana
	R. scandenbergiana
Java	*R. rochussenii*
	R. patma
	R. zollingeriana
Sumatera	*R. patma*
	R. bengkuluensis
	R. hasseltii
	R. gadutensis
	R. patma
	R. microphylora
	R. rochussenii
	R. lawangensis

Lojing Highlands is located in the south-eastern part of Kelantan. It has an altitude of 1 500 – 6 010m a.s.l., which categorized as an upper dipterocarp forest which is a lower montane forest. Next, Lojing Highland is prosperous with flora and fauna and is famous for its biodiversity (Dony Adriansyah *et al.*, 2015). It is well conserved natural jungles and hills which are a popular eco-tourism attraction (Dony Adriansyah *et al*., 2015). There are so many many species of great quality tropical hardwood such as mahogany, teak, meranti and chengal can be found there .

Most people that live at Lojing Highlands are Indigenous Orang Asli tribes. Other than that, Lojing Highlands also is a conservation area for *Rafflesia* with the total conservation area equal to 404 hectares. Nowadays, the problem that had occurred at Lojing Highlands is the human development and deforestation which is uncontrollable and will lead to the habitats destruction of flora and fauna in that area especially *Rafflesia* flower (Norliyana, 2015).

1.2 Problem Statement

Generally, the *Rafflesia* flower only can be found at a certain location in Peninsular Malaysia, Sabah, and Sarawak. Nowadays, *Rafflesia* flower is a threatened species due to deforestation and rapid development of the country that will destroy their natural habitat.

The outsiders believed that *Rafflesia'*s bud has medicinal value and willing to pay the Orang Asli to collect the buds. Next, tourism activity also is one of the factors that can lead to the extinction of this flower. If the number of tourists coming to the area is not well controlled, it can be the cause the flower to die. Among the reasons is it is likely that the *Rafflesia* young buds or the host plant are accidentally trapped or stepped by tourist when they tried to get closed or approached the flower to take pictures of it. Another reason is there are some *Rafflesia* buds that grow on the ground and it is difficult to see with raw eyes because the colour of the bud is quite similar with the soil colour.

Lojing Highlands now is exposed to deforestation due to the development of agriculturural activity. This factor can effect and decrease their natural habitat which can

further cause the decreasing *R. kerri*'s population. Landslide's can also be seen at Lojing Highlands due to deforestation activity. This problem also affects rate the survival of *Rafflesia*. Majlis Dareah Gua Musang should take precaution steps to protect the forest from being intruded by outsiders.

1.3 Objectives

This study is proposed to assess the status of *Rafflesia*'s bud in 3 hectare plot in Lojing Highlands, Kelantan. The objectives of the study are as follows:

i. To identify the *Rafflesia's* bud status.

ii. To examine the bud stages of *Rafflesia kerri*.

iii. To determine the population density of *Rafflesia kerri* bud.

1.4 Scope of Study

The study was conducted at Lojiing Highlands which is considered as one of the famous spots of *Rafflesia* in Kelantan. A 3 ha plot was setup in the area near to Kg. Jedip called "Legup Cebur" by the local Temiar people.

Two bud parameters were measured, namely bud stages and bud (plant) population density. Bud development consists of three stages, namely cupule stage (stage I), bract stage (stage II), and perigone stage (stage III). The stages were determined by the bud's diameter measurement. Population density formula was used to determine the *Rafflesia*'s bud population density. The status of the *Rafflesia*'s bud was also examined in the 3 ha plot.

CHAPTER 2

LITERATURE REVIEW

2.1 Description of Study Area

The study area was located at Lojing Highlands, Gua Musang, Kelantan. Lojing Highlands is one of the areas known for the development of agricultural activity and tourism (Wan *et al.*, 2015) and (Ibrahim & Zulhazman, 2010). This area is also a hotspot for *R. kerri* Meijer. Lojing Highlands is a place that is covered with upper dipterocarp forests (lower montane forest) and well provided with a diversity of flora and fauna (Dony Adriansyah *et al*., 2014)

According to Dony Adriansyah *et al*. (2014) this study area is just near the settlement of aboriginal people of the Temiar community and is located within Sungai Beruk Reserve Forest. The study area also is located near to Perak-Kelantan border in the west and Pahang-Kelantan in the south.

Lai (2013) stated that the head of the Malaysian Nature Conservation Association mentioned that Lojing Highlands was under the jurisdiction of the Gua Musang Land Office, which is located more than 80 kilometers away. The distant location factor causes the lack of monitoring from the authorities about the problem's happening there. A lot of land clearing activities that occurred at Lojing Highlands are carried out without the proper permits and applications (Lai, 2013).

Due to this problem, where the agriculture activities are taking place without the knowledge of the authorities, it disrupts the peaceful life of local residents especially the aboriginal people (Rahim, 2010). A study by a group of researchers from Universiti Malaysia Kelantan (UMK) is being conducted at Lojing Highlands to protect the *Rafflesia* flower from being disturbed by agriculture activity (Zulhazman *et al.*, 2010). Many stakeholders such as the Government State Agencies, researchers from University, and District Office should take a role in addressing this problem to protect this increasingly threatened species from extinction (Mokhtar, 2016).

2.2 *Rafflesia kerri* Meijer

Rafflesia is from the family of Rafflesiaceae (Nikolov *et al*., 2014). Nikolov *et al.*, (2014) stated that *Rafflesia* is a holoparasitic plant family. According to Essays (2013), *R. kerri* Meijer got his name from Thailand's first Botanist (Government Botanist). His name is A.F.G Kerr. Then in 1984, this unique flower was then interpreted by William Meijer. *Rafflesia* displays the highest modification of vegetative body part in flowering plants (Nikolov *et al*., 2014).

When *R. kerri*'s flower buds start to bloom, the dimension opening of the flower is in the range of 50 to 70 cm in diameter. The perigone lobes length is about 13 to 20 cm and around 19 to 24 cm wide. Next, the petal of *R. kerri* is dull red with brownish tinge color and have abundant of warts with a 3 mm to 4 mm slot among them (Essays, 2013).

Essays (2013) also stated that *R. kerri* has the smallest wart among the *Rafflesia* family. Other than that, the diaphragm's opening of the flower is about 12 to 17 cm across and the upper face of the flower is 3 to 4 concentric rings of white spots surrounded by a dark red margin.

Figure 2.1 shows the *R. kerri* flower found in Lojing Highlands. This species is one of the endangered species in Lojing Highlands (Asfarina, 2015) The other characteristics of *R. kerri* Meijer flower are the mature bud that is about 16 to 25 cm in diameter. The ramenta of the flower are often unbranched and with a little bulgy at the apex. The upper type that is close to the diaphragm is about 10 mm long, while the lower type that is close to the flower tube is about 5 mm long. The total number of anthers of *R. kerri* is approximately 26 to 31 (Essays, 2013).

Figure 2.1: Bloom *R. kerri* Meijer in Lojing Highlands, Kelantan.

Nais (2001) stated that the phenology of this *Rafflesia* flower is said to be seasonal, where the flowering took place during the driest and hottest time of the year. *R. kerri*'s distribution is encircling in Peninsular Malaysia and Thailand. The typical habitats for this species is at lowland forest and hill dipterocarp forest. In Malaysia, it can be found at Perak-Kelantan border, Kedah, and Pahang. In Peninsular Thailand, it can be found at Ranong, Surat Thani, Khao Sok Nature Reserve, Khao Pawta Luang Keo, and Panta Chongdong. The altitude where these species is usually found is about 500 m to 1000 m a.s.l. (Nais, 2001).

According to Nais (2001), the common pollinators for this flower are *Hypopygiopsis tumrasvini* Kurahashi, *Chrysomya villencuvei* Patton, *Lucilia porphyrina* (Walker), and *C. rufifacies* (Macquart). This species is said to be a native species to Thailand. However, in 1935 the flower was accumulated on the Kelantan-Thailand border at Tepuh Hill. The first time this species being witnessed was believed at Gunung Chamah near the Perak-Kelantan border in 1992 by Forest Gan. Later in late 1992, it was found at by Thomas Wong, Matthew Wong, and Adam Abu Bakar at other sites of the location which is at Pengkalan Hulu in Keroh, Perak. According to (Latiff & Wong, 2003) in (Tan *et al*., 2010), IUCN stated that *R. kerri* is vulnerable.

In 2002, Matthew Wong and Forest Gan carried out a research on this species and have identified the population of *R. kerri* around five populations in Lojing Highlands, Kelantan. A Scientific Expedition in 2008, was held in Lojing Highlands and was organized by UMK, the expedition was led by Zulhazman Hamzah with his team from Universiti Malaysia Sabah and found about 26 areas of *R. kerri* population in a different location at Kg. Cedau, Kg. kuala Rengi, and Kg. Jedip (Qayyum Nadia, 2015).

2.3 Life Cycle of *Rafflesia*

The life cycle is the series of changes or development emergence to anthesis on organisms or living things such as plant, animal, and people. The cycle is including reproduction, fertilization, death of the organism and the replacement of new organism (Nais, 2001).

Next, as shown in the 2.2, the time required for *Rafflesia* flower to complete its life cycle is taking a very long time to finish aproximately 2 years. But the life cycle depends on the *Rafflesia* species (types). For example, as for *Rafflesia pricei* it takes about 10 to 15 months and *Rafflesia tengku-adlinii* takes about 9 to 13month to complete its life cycle. Meanwhile, *Rafflesia patma* ca. only takes 7.5 months to complete its cycle. For *Rafflesia kethii*, it takes about 12 to 16 months to complete its life cycle, and the longest one is *Rafflesia arnoldii* where it takes about 18 to 21 months to complete its life cycle (Nais, 2001). According to Meijer (1997) in (Hidayati & Walck, 2016), the life cycle of *Rafflesia* estimated to be 3 until 4.5 years to complete. Due to this prolonged nature of bud development and low incidence of flowering the study of the life cycle of *Rafflesia* is difficult.

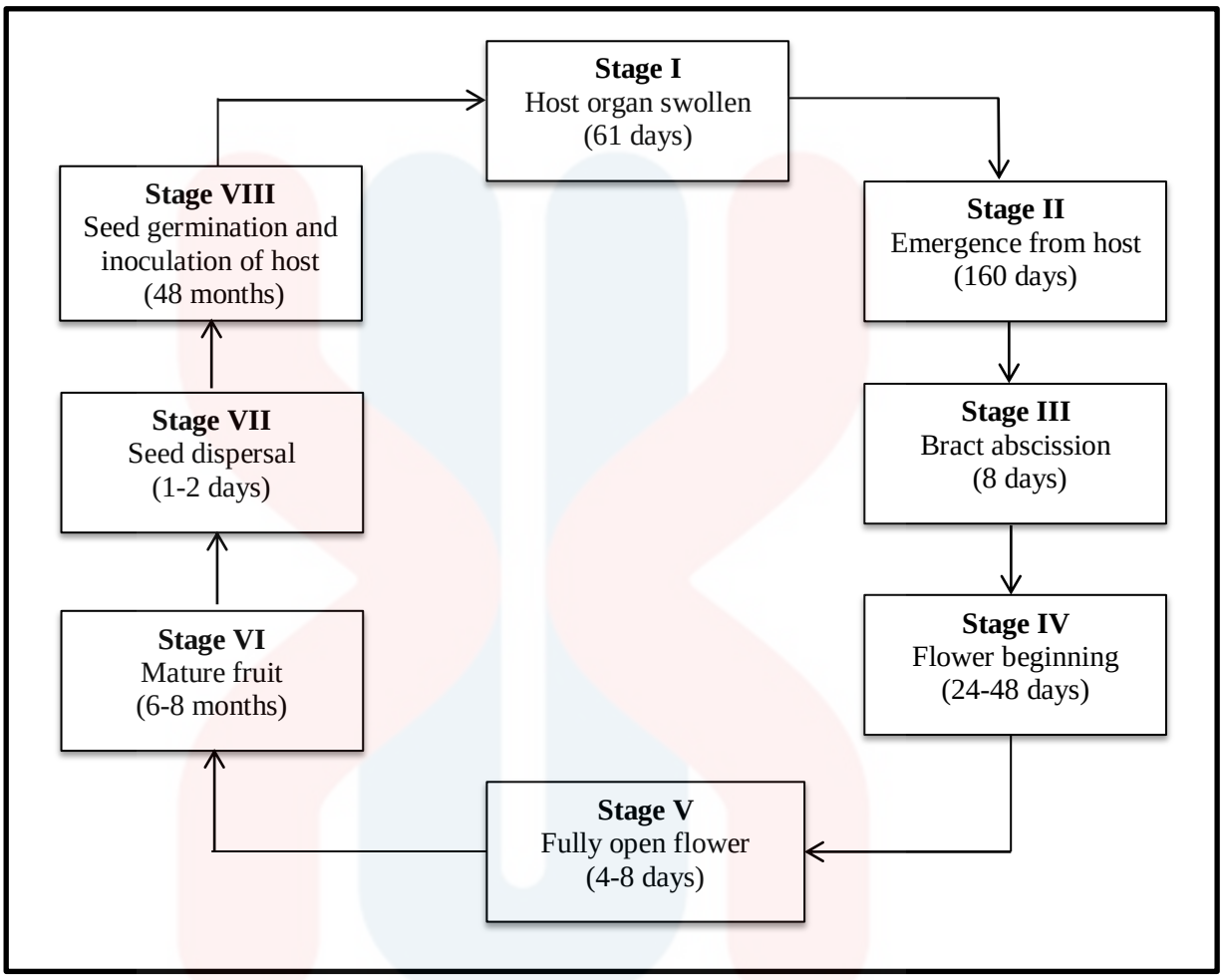

Figure 2.2 : Life cycle of *Rafflesia* (Nais, 2004).

Figure 2.2 shows the life cycle taken by *Rafflesia* flower to complete. The cycle takes 8 stages to complete the life cycle. The stage starts from the host organ swollen until the flower fully open in stage 5. Then the cycle is continues for the mature fruits from stage 6 to the stage 8 where the seed germinates and inoculates in the host plant. The complete process of a *Rafflesia* life cycle takes about two years to finish (Nais, 2004).

2.3.1 Development of *Rafflesia'*s Bud

According to Nais (2001), the development of *Rafflesia* bud takes several stages before its blooming as a flower. The development can be divided into three stages, which is Stage I, Stage II, and Stage III. Where Stage I is the post-emergence stage or waiting stage (cupule), Stage II is middle development stage (bract) and Stage III is a pre-bloom stage or rapid growth stage (perigone stage). The brief description of bud stages can be seen in Table 2.1.

Table 2.1: The brief description of the stage of *Rafflesia*'s bud (Qayyum Nadia, 2015).

Stage	Brief Description
Stage I	• In cupule stage. • Size range between 1 cm – 4 cm in diameter.
Stage II	• In bract stage, has moderate growth. • Size range between 5 cm – 10 cm in diameter. • Blackish brown color.
Stage III	• In perigone stage. • Size range between 11 cm and above in diameter.

Hidayati *et al.* in (Nais, 2001) had identified four stages of development for *R. patma* in Java. The stages are; Stage I where the bud had 2 to 4 cm in diameter and the bud is covered by the husk of the host plant. Next, Stage II is where the bud with diameter about 4 cm appear at the husk of the host plant and the bracts that covered the buds are in whitish color then change to dark brown at the ends of this stages. Next is

Stage III, at this stage, the husk will detach and the underside of the perigone lobes was exposed and the diameter of the buds is approximately around 13 cm. For the last stage, which is stage IV, the perigone lobes finally unfold and exposing its diaphragm and disk (Nais, 2001).

The bud of *Rafflesia*, which is the small one with a diameter about 4 to 8 cm will crop out in December, then bloom around January to March. However according to Meijer & Elliott (1990) in Nais (2001), the *Rafflesia* bloom can continue until June and July and starting from July until November, there will no presence of bud or flower of *Rafflesia*.

2.4 *Rafflesia*'s Host Plant

The *Tetrastigma* (liana or vine) species is the host plant of *Rafflesia*, which are limited in tropical and subtropical Asia (Barcelona, Cajano & Hadsall, 2006) and (Hor, 2015). Next, the main host plant for various *Rafflesia* species is *Tetrastigma leucostaphylum* (Dennst.). This species of host plant is the common types and distributed mostly. There are only two species of this host plants that are parasitized by *Rafflesia* in Sabah (Nais, 2001).

The characteristic of this plant are the stem is woody, long, and thick. They also climbing on the other trees to get sunlight. This plant is often found at the forest edges or at the river banks. The common place to find this tree is at the higher altitudes. It is a dioecious plant. Next, the dispertion of the fruits which are like pulpy berries are by birds. There are some species of *Tetrastigma* that have vegetative reproduction,

Tetrastigma quadrangulum is one of the example that is stated by Banzinger (1991) in (Nais, 2001) .

According to Nasihah *et al.* (2016) there are two possible *Rafflesia*'s host-plant were identified. The host species are *Tetrastigma hookeri* (Laws.) Planch. and *Tetrastigma rafflesiae* (Miq.) Planch in Peninsular Malaysia. Next, the *Rafflesia* species that inhabit the host-plant are *R. cantleyi* and *R. azlanii* (*Tetrastigma rafflesiae*)and the host-plant for *R. kerri* with *R. sumeiae* is *Tetrastigma hookeri* (Nasihah *et al*., 2016).

2.4.1 Host-Plant Relationship

The relationships between *Rafflesia* and its host plant can be from three hierarchical levels; internal (individual level), microevolutionary scale (population level) and, macroevolutionary scale (species level) including host-parasite co-evolution. According to Nais (2001), the first level which is the internal relationship is related to the troops of the internal tissue of the parasite flower (*Rafflesia*) and the host is included on how the tissues are twisted around, and the nutrients can be tapped. To studying this relationship, an anatomical sectioning tecchniques are used. But this method has not been fully studied yet. *Tetrastigma* and *Rafflesia* are connected over the haustorium. Haustoria may emerge or develop from the roots, achorage, storage, and absorption. The fragment of this haustoria is called endophyte (Nais, 2001).

Nais (2001) also mentioned that population level of Host-plant relationship is the next level of the relationship. This level is related to the allocation of the level population and the relation of *Rafflesia*'s bud with its host plant. The factors like bud

abortion, set of the flower, the growth rate, and the flower size can be identified within the population. The pattern of the distribution of this host plant is randomly distributed Meanwhile, for the host-parasite co-evolution, this may caused by the evolution of thee flower on other species of host plant. This co-evolution between parasite and the host plant may be resolved by molecular technique.

2.5 Conservation of *Rafflesia*

The tropical rainforest is the main habitat of *Rafflesia* species. But nowadays the tropical rainforest in Malaysia is being explored uncontrollably. This will give a negative impact to this species in the future. *Rafflesia* is a species that has a high mortality of bud, low level of pollination success, low level of fruit set, need specific host plant, has a large sex imbalance, and is limited in distribution. That is why this flower needs vigorous conservation effort from the authority (Hidayati & Walck, 2016).

According to Nais (2001), human disturbance is the greatest threat of loss of its natural habitats and species. An example is deforestation agricultural activities. The International Union for Conservation of Nature, IUCN (1984, 1988, 1997) has established five main categories to highlight the conservation status of species; i) extinction, ii) endangered, iii) vulnerable, iv) rare, and v) insufficiently known.

Nais (2001) stated that the conservation status of *Rafflesia* can only be evaluated by obataining and analyzing extensive field data of each species. These data include the distribution and the characteristics of sites, rarity and reproductive ecology.

There are two ways to protect or conserve the *Rafflesia* species, namely by *in-Situ* conservation and *ex-Situ* conservation. In situ conservation is conservation in its natural environment or habitat, where the species is being conserved in its most natural environment while ex situ conservation is a conservation outside or off-site where the species will be planted away from its natural habitat or environment (Nais, 2001). This approach includes conserving the whole plant or part of the plant in botanical gardens and gene banks, as well as using laboratory techniques such as tissue culture for their propagation and preservation. But there are many unsuccessful attempts of tissue culture method on the *Rafflesia* species (Nais, 2001).

Sabah Parks (2011) in (Peters & Ting, 2016) mentioned that there are three conservation efforts of *Rafflesia* in Sabah such as setting up conservation incentive scheme, establishment of information centre, and formation of a *Rafflesia* reserve. The government is also taking part in the establishment of *Rafflesia* Conservation Incentive Scheme to attracting indigenous people (Dusun people) to participate in the programme (Peters & Ting, 2016).

CHAPTER 3

MATERIALS AND METHODS

3.1 Study Area

The study area is shown in Figure 3.1. It is located near the Kg. Jedip in Lojing Highlands, Kelantan (Dony Adriansyah *et al.*, 2015). According to (Amal Najihah *et al*., 2018), the surrounding of Kg. Jedip is exposed to logging activity. The Temiar tribes that living in Lojing Highlands is known to have knowledge about medicinal plant usage (Rao *et al*., 2016). There are two rivers located in Lojing Highlands namely Sungai Dekong (N 04 38' 02.8", E 101 30' 16.3") and Sungai Dawai (N 04 38' 02.8", E 101 30' 16.3") (Sharifah Aisyah *et al*., 2014).

Lojing Highlands situated in the south western corner of the state of Kelantan with an area size of 1 817 sq km. The altitude of this highland is about 610 – 1 500 m a.s.l. with the temperature range 18˚C to 25˚C (Dony Adriansyah *et al*., 2014). The latitude of the study area is 4˚32' to 4˚47' N and with longitude 101˚20' to 101˚34' E (Qayyum Nadia, 2015) and (Nasihah *et al*., 2013).

Lojing Highlands is a natural hilly forest with beautiful views that ranging from 1 000 and 2 300 meters a.s.l. The location of the area is at Cameron Highland, Pahang border. There are several forest tracts at Lojing Highlands that were cleared for agriculture activities purposes. The land is within the boundaries of permanent forest

reserves, such as Permanent Reserved Forest (HSK) Lojing and HSK Sg. Berok (Dony Adriansyah *et al*., 2014).

One of the rare species of flora that can be found at Lojing Highlands, Kelantan is *Rafflesia kerri* (Dony Adriansyah *et al.*, 2015). *Rafflesia* distribution can only be found in Thailand and Peninsular Malaysia and has an altitudinal distribution of about 500 - 1 000 m. It can be found in lowland and hill dipterocarp forest (Nais, 2001).

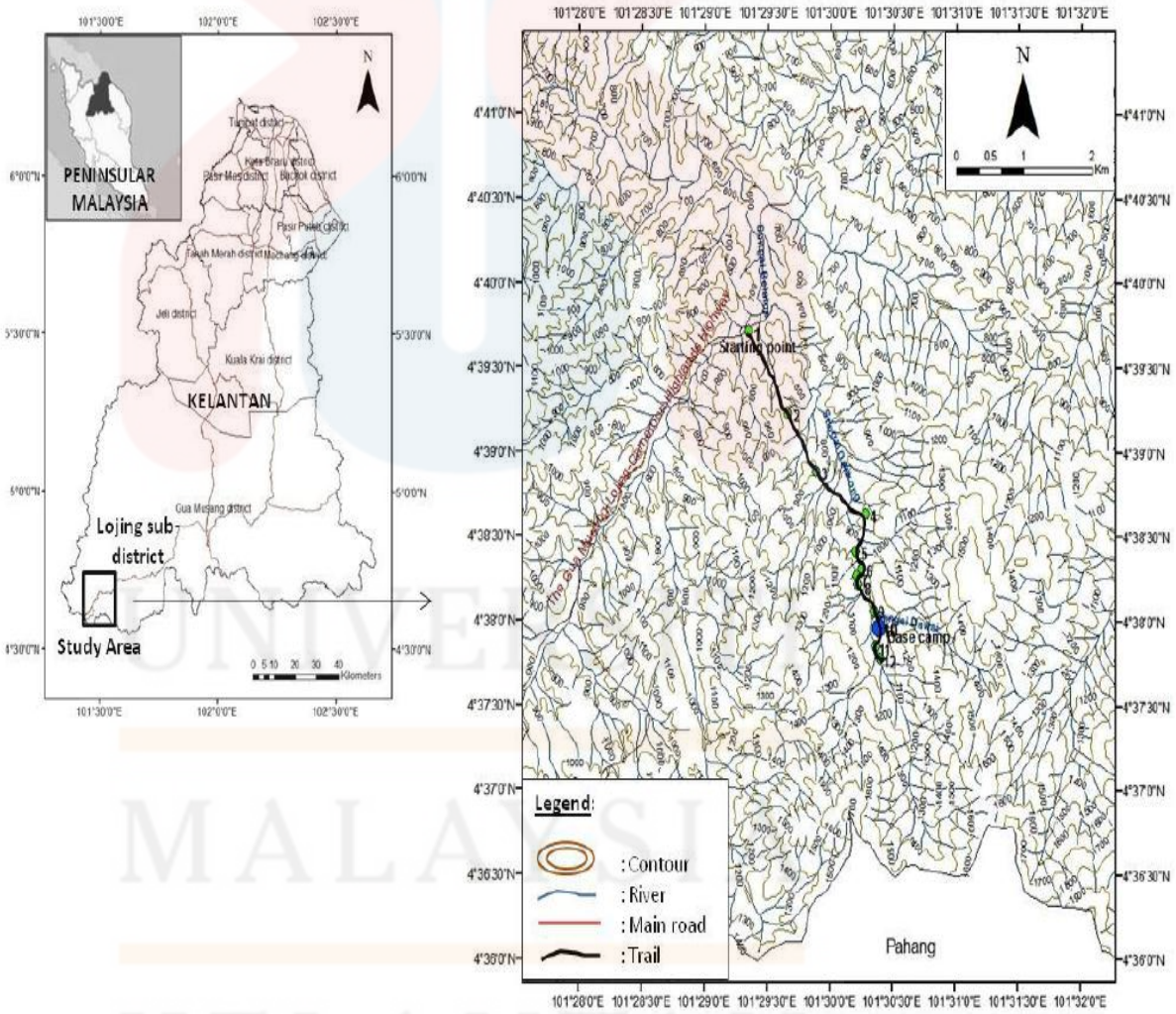

Figure 3.1: Map of study area (Dony Adriansyah *et al*., 2015).

3.2 Materials

3.2.1 Global Positioning System (GPS)

A handheld GPS as shown in Figure 3.2 was needed to take the location of where the bud is found. Every location where the *Rafflesia*'s bud was found was recorded in the GPS data. The locational coordinates were then recorded in the data sheet. Extra batteries were brought along as a spare.

Figure 3.2: A handheld GPS used.

3.2.2 Tagging

A tagging by using masking tape with tooth pick was used to mark the location where the bud is found. A specific code was used to identify each *Rafflesia*'s bud found. As an example, B_1 code was used where 'B' represents the *Rafflesia*'s bud and '$_1$' represents the number of bud that found at the study site.

3.2.3 Others Equipment

Other equipment used for this study was a measuring tape. Measuring tape was used to obtain data of the diameter of the bud. A digital camera (Nikon G12) and a smartphone were used to take a picture of *Rafflesia*'s bud for data collection. Another equipment that was used during the visit to study site was permanent marker, pens, pencil, a note book, a data collection sheet, a waterproof bag to keep all things safe, and an emergency kit was brought along during doing data collection at Lojing Highlands.

3.3 Methods

3.3.1 Plot Setting Up

A 3 ha plot was set up in Legup Cebur, Lojing Highlands. The plot was setting up by using a measuring tape and a rope. A sampling in 3 ha plot by using random method was used during this study. Random method was used because it can covered the large area in short time (Anonymous, n.d). In the 3 ha plot, a survey was done to calculate the number of *Rafflesia*'s bud found in the study site.

Next, after the plot setting up was done, a survey in the 3 ha plot was conducted to find the *Rafflesia*'s bud. When the *Rafflesia*'s bud was found, a masking tape tagging was marked at the ground near the bud. Next, the coordinates and elevation of each bud found in the study site were taken and recorded.

3.3.2 Data Collection

Each diameter of *Rafflesia*'s was measured and recorded in a data sheet. The diameter reading of the bud was taken twice to obtain an average. The location and elevation of the *Rafflesia*'s bud found in the 3 ha plot was also taken for reference. A masking tape tagging using tooth pick was made to identify the bud on the ground. The status (condition) of the bud was then recorded in the data sheet.

3.4 Data Analysis

3.4.1 Bud Measurement

3.4.1.1 Circumference of Rafflesia's Bud

The measurement of the *Rafflesia*'s bud was taken by using measuring tape. The diameter of each bud was taken and recorded in data sheet form. The reading for each bud is taken approximately two times for more accurate reading (Qayyum Nadia, 2015).

The mathematical formula (equation 3.1) was used to calculate the circumference of *Rafflesia*'s bud. The formula is correlated to find the circumference in cm of the bud.

$$C = \pi d \qquad (3.1)$$

Where;

C = Circumference of a circle

π = 3.14 (constant value)

d = Diameter of a circle

3.4.2 Bud Population Density Determination

Population density is the measurement to determine the size of the population size over its unit area (Farmer, 2011). The population density of the *Rafflesia*'s bud can be determined by using the following mathematical formula equation (3.2).

$$D_p = \frac{N}{A} \quad (3.2)$$

Where;

D_p = Population density

N = Population size or number of the organisms

A = Area of the land

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 General

Table 4.1: Shown table of *Rafflesia*'s bud condition (status) and the total number of bud found in Lojing Highlands.

***Rafflesia*'s Bud Condition (Status)**	**Total**
Healthy/Alive	28
Dead	6
Total	34

The total number of *R. kerri* bud that can be found in the 3 hectare plot is shown in Table 4.1. From the 34 *Rafflesia*'s buds found and recorded, six of them were a dead buds and 28 were healthy buds.

The highest elevation where the *Rafflesia*'s buds were found was at 1 054 m a.s.l. and the lowest elevation was at 1 026 m a.s.l.. One of the *Rafflesia*'s buds that found at the highest elevation was dead in Stage II. Four buds were found at elevation of 1 045 m and 1 041 m respectively. At elevation 1 028 m and 1 054 m, there were three *Rafflesia*'s buds found at that elevation. Lastly, the least number of *Rafflesia*'s buds found was at elevation 1 026 m, 1 036 m, 1 037 m and 1 048 m.

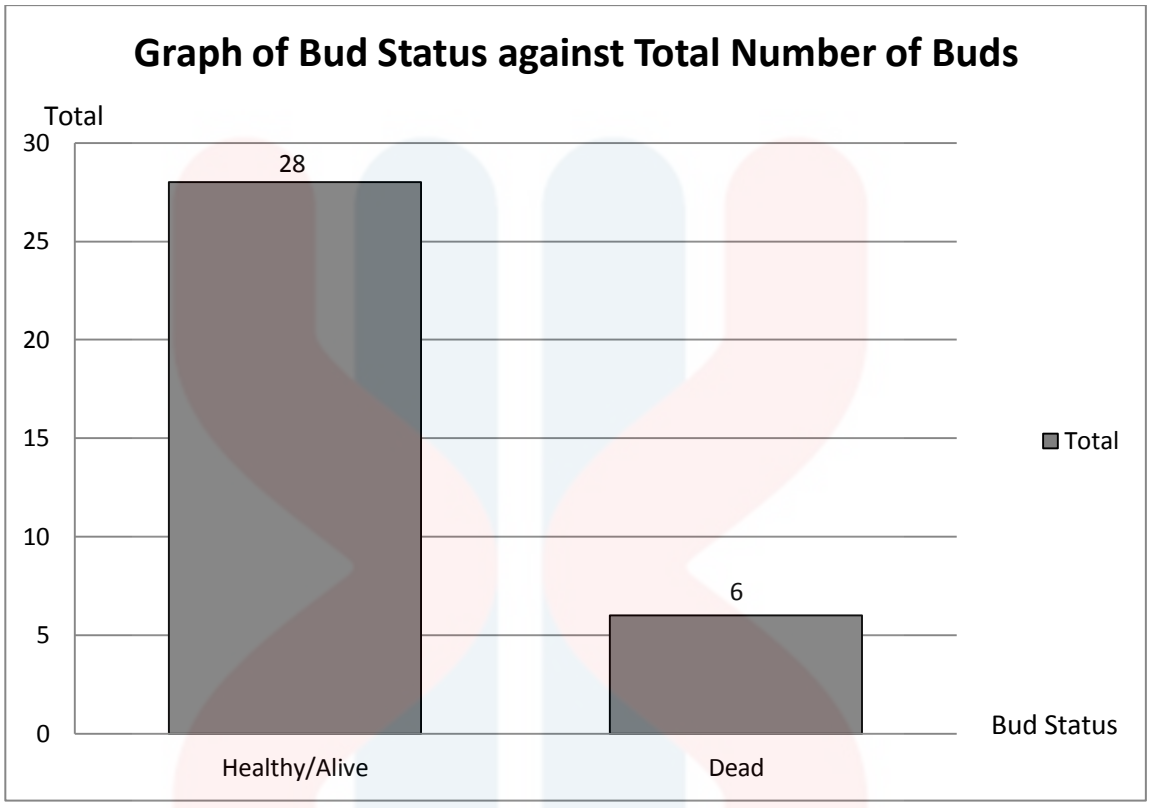

Figure 4.2: The bud Status and total number of *R. kerri* bud found Lojing Highlands.

As shown in the Figure 4.2, from the total number of bud found which are 34 buds, six from it were found dead or damage and another 28 buds were alive or in healthy condition. There are several factors that can cause the mortality to the bud. As mention from Nais (2001), it can be caused by the lack of nutrient because this species is relying on its host plant for food supply. Another factor which leads to bud mortality is being trampled by animals and visitors entering these area. Figure 4.3 and Figure 4.4 shows the dead bud and healthy bud found in Lojing Highlands.

Figure 4.3: A dead bud found in Lojing Highlands.

Figure 4.4: A healthy bud found in Lojing Highlands.

4.2 Buds Stages

Table 4.2 below shows the bud stages of *Rafflesia* found in Legup Cebur, Lojing Highlands.

Table 4.2: The *Rafflesia*'s bud stages found in Lojing Highlands.

No.	Bud Stages	No. of Buds
1.	Stage I	1
2.	Stage II	18
3.	Stage III	15
	Total	34

A total of 34 buds were found in the study site, Lojing Highlands, Kelantan during this study. There were three bud stages that were identified from the *Rafflesia*'s bud found in Lojing Highlands. Number of bud found for Stage I is one bud only. Next, numbers of buds found for Stage II are 18 buds and lastly numbers of buds found for Stage III are 15 buds. The highest number of buds found in Lojing Highlands during this study was in Stage II bud and the lowest number of bud found at the study site was Stage I bud.

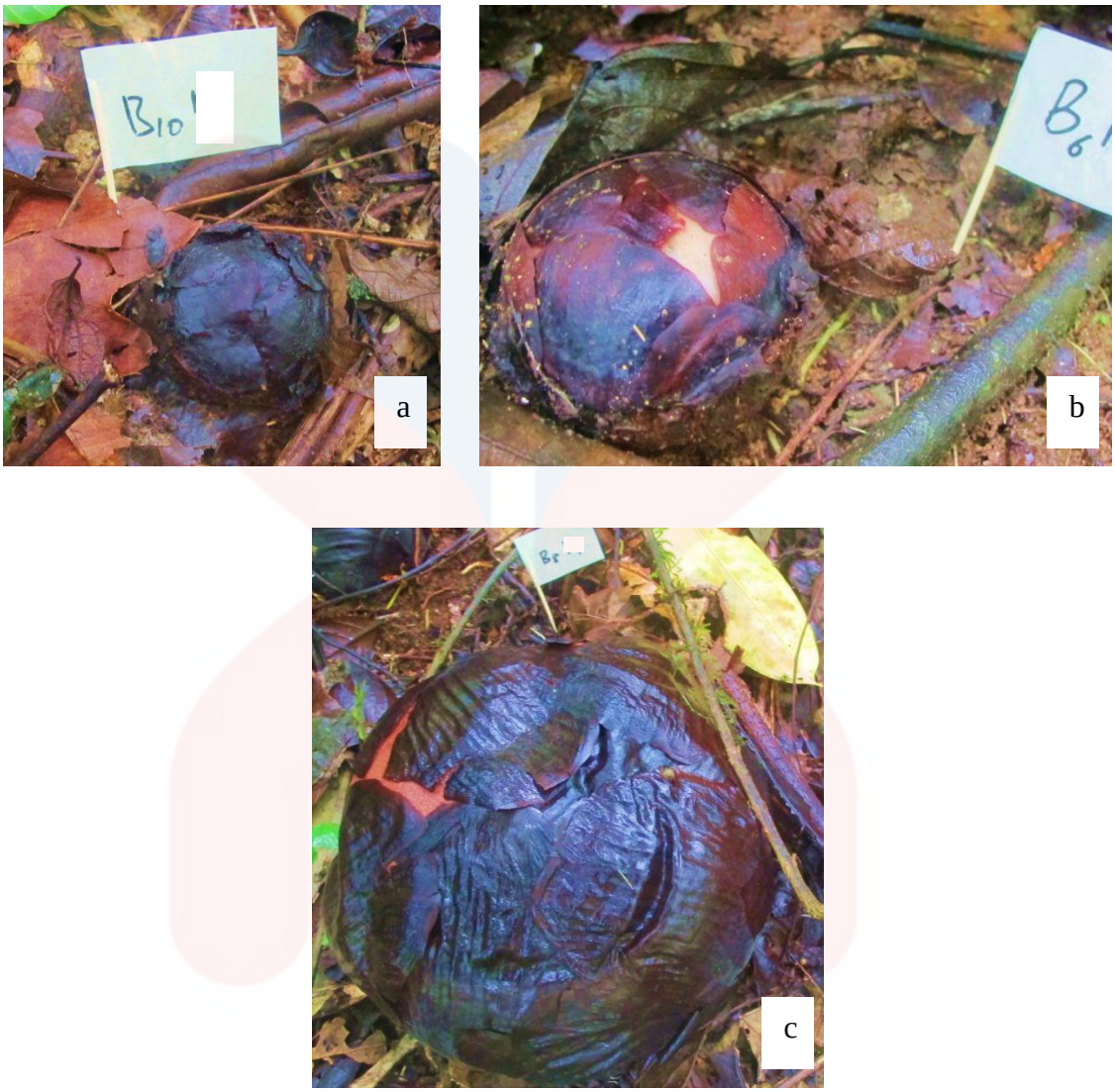

Figure 4.5: *Rafflesia kerri* Meijer bud found in Lojing Highlands, Kelantan with different stages. (a: Stage I, b: Stage II, and c: Stage III)

Figure 4.5 shown the *Rafflesia*'s bud that found in Lojing Highlands, Kelantan with different types of stages. From the Figure 4.5, it can be seen that the size of each bud is different.

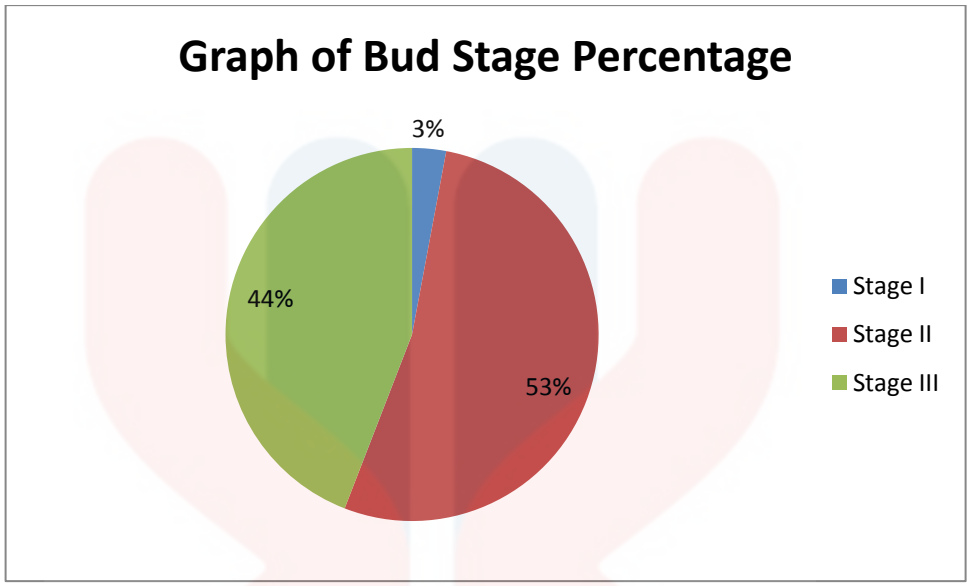

Figure 4.6: The percentage of *Rafflesia*'s bud stages.

Figure 4.6 shows the percentage of each *Rafflesia*'s bud stages that found in Lojing Highlands, Kelantan. The highest percentage of *Rafflesia*'s bud was in Stage II. Meanwhile the lowest percentage was in Stage I.

4.3 Population Density of *Rafflesia kerri* buds

The population density of the *R. kerri* buds were calculated and determine by using the formula in equation (3.2). The total number of *R. kerri* buds that was found in 3 hectare plot in Lojing Highlands is equal to 34 buds but 6 of them already death. So the amount of buds left that still in good condition is equal to 28 buds only. From the amount of buds that still in good condition, it is then divided by the area of the location which is 3 hectare to get the amount of its population density. Next, the population density of *Rafflesia kerri* buds is equal to 9 buds/ha. From population density of the *Rafflesia*'s bud in a hectare plot it can be said that the status of the buds in a hectare plot was high in density. This is because the bud population is nearing to 10 buds/ha.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Several conclusions can be summarized from this study as follows; the total numbers of *Rafflesia*'s buds found in Lojing Highlands are 34 buds. Where 28 buds were still alive or healthy and 6 buds were dead. Next, the bud stages that dominant in the 3 ha plot are Stage II (Bract Stage) and the least are bud in Stage I (Cupule Stage). Lastly, the population density for the buds in 3 ha plot are 9 buds/ha. From the population density of the buds in a hectare it shows that the status of the buds in 3 ha plot was high.

5.2 Recommendations

Rafflesia is the largest and unique flora on the Earth. But nowadays the populations of this species around the world are decreasing day by day. This can lead to extinction to this rarest flora species. For *R.kerri* species, the distribution of this species can be found in Thailand and Peninsular Malaysia only as described by Willem Meijer (1984) in (Nais, 2001).

As in Lojing Highlands, the population of this flower can be influenced by the surroundings where there is a lot of deforestation done to build a vegetable farm (agriculture activity). There should be steps that can be taken to protect this species from continuing to be threatened. Here are some recommendations to protect *R. kerri* for future research or purposes. The first one is to make *in-situ* conservation. *In-situ* conservation can be done by doing a tissue culture method (*in-vitro*) to reproduce the *Rafflesia* outside its habitat. Another method that can be done is *ex-situ* conservation. *Ex-situ* conservation can be done by gazette the area that has *Rafflesia* as a protected area in its natural habitat.

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APPENDIX A

Table a.1: GPS reading, elevation, and the bud status.

Bud	GPS Reading	Elevation (m)	Bud Status
B_1	N 04˚37.94’ E 101˚30.274’	1042	Healthy
B_2	N 04˚37.94’ E 101˚30.274	1042	Healthy
B_3	N 04˚37.933’ E 101˚30.282’	1048	Healthy
B_4	N 04˚37.933’ E 101˚30.279’	1047	Healthy
B_5	N 04˚37.937’ E 101˚30.281’	1049	Healthy
B_6	N 04˚37.925’ E 101˚30.283’	1049	Healthy
B_7	N 04˚37.925’ E 101˚30.285’	1054	Healthy
B_8	N 04˚37.925’ E 101˚30.285’	1054	Healthy
B_9	N 04˚37.924’ E 101˚30.285’	1051	Healthy
B_{10}	N 04˚37.928’ E 101˚30.285’	1052	Healthy
B_{11}	N 04˚37.928’ E 101˚30.285’	1052	Healthy
B_{12}	N 04˚37.925’ E 101˚30.285’	1054	Dead
B_{13}	N 04˚37.922’ E 101˚30.271’	1046	Healthy
B_{14}	N 04˚37.920’ E 101˚30.271’	1046	Dead
B_{15}	N 04˚37.914’ E 101˚30.269’	1045	Healthy
B_{16}	N 04˚37.914’ E 101˚30.269’	1045	Healthy
B_{17}	N 04˚37.914’ E 101˚30.269’	1045	Healthy
B_{18}	N 04˚37.914’ E 101˚30.269’	1045	Healthy
B_{19}	N 04˚37.913’ E 101˚30.262’	1047	Healthy
B_{20}	N 04˚37.929’ E 101˚30.261’	1051	Healthy

B_{21}	N 04˚37.929’ E 101˚30.261’	1051	Healthy
B_{22}	N 04˚37.929’ E 101˚30.261’	1051	Healthy
B_{23}	N 04˚37.945’ E 101˚30.252’	1042	Dead
B_{24}	N 04˚37.945’ E 101˚30.252’	1042	Healthy
B_{25}	N 04˚37.944’ E 101˚30.244’	1041	Healthy
B_{26}	N 04˚37.944’ E 101˚30.244’	1041	Dead
B_{27}	N 04˚37.945’ E 101˚30.244’	1041	Healthy
B_{28}	N 04˚37.945’ E 101˚30.244’	1041	Dead
B_{29}	N 04˚37.966’ E 101˚30.250’	1036	Healthy
B_{30}	N 04˚37.969’ E 101˚30.251’	1037	Dead
B_{31}	N 04˚38.039’ E 101˚30.273’	1026	Healthy
B_{32}	N 04˚38.035’ E 101˚30.271’	1028	Healthy
B_{33}	N 04˚38.015’ E 101˚30.272’	1028	Healthy
B_{34}	N 04˚38.015’ E 101˚30.272’	1028	Healthy

Table a.2: The bud diameter in cm.

No. of Buds	Diameter of a Circle (*Rafflesia*'s Bud Diameter) in cm		
	Reading 1	**Reading 2**	**Average**
B_1	6.5	5.0	**5.75**
B_2	8.0	8.5	**8.25**
B_3	13.0	14.0	**13.5**
B_4	15.0	14.0	**14.5**
B_5	8.0	5.0	**6.5**
B_6	7.0	6.5	**6.75**
B_7	11.5	12.0	**11.75**
B_8	23.5	22.0	**23.25**
B_9	20.0	18.5	**19.25**
B_{10}	5.0	4.6	**4.8**
B_{11}	5.9	5.3	**5.6**
B_{12}	5.2	4.9	**5.05**
B_{13}	9.0	8.1	**8.55**
B_{14}	15.9	15.0	**15.45**
B_{15}	15.2	13.0	**14.1**
B_{16}	8.9	8.0	**8.45**
B_{17}	13.8	14.0	**13.9**
B_{18}	6.1	7.1	**6.6**
B_{19}	12.1	14.0	**13.05**
B_{20}	6.5	6.9	**6.7**
B_{21}	9.5	10.0	**9.75**
B_{22}	12.0	13.0	**12.5**
B_{23}	13.0	14.0	**13.5**
B_{24}	6.3	5.5	**5.9**
B_{25}	11.0	12.0	**11.5**
B_{26}	12.5	13.0	**12.75**
B_{27}	9.5	10.0	**9.75**

B_{28}	7.5	7.0	**7.25**
B_{29}	49.0	50.0	**49.5**
B_{30}	7.0	5.5	**6.25**
B_{31}	7.8	6.7	**7.25**
B_{32}	5.0	5.5	**5.25**
B_{33}	8.5	8.0	**8.25**
B_{34}	20.0	17.0	**18.5**

Average Total, $\overline{X} = \frac{389.65}{34}$

$= 11.46$ cm

Table a.3: The bud circumference in cm.

No. of Bud	Circumference of Circle (Bud Circumference) in cm	
	Diameter, *d*	**Circumference, *C***
B_1	5.75	18.06
B_2	8.25	25.92
B_3	13.5	42.41
B_4	14.5	45.55
B_5	6.5	20.42
B_6	6.75	21.21
B_7	11.75	36.91
B_8	23.25	73.04
B_9	19.25	60.48
B_{10}	4.8	15.08
B_{11}	5.6	17.59
B_{12}	5.05	15.87
B_{13}	8.55	26.86
B_{14}	15.45	48.54
B_{15}	14.1	44.30
B_{16}	8.45	26.55
B_{17}	13.9	43.67
B_{18}	6.6	20.73
B_{19}	13.05	41.0
B_{20}	6.7	21.05
B_{21}	9.75	30.63
B_{22}	12.5	39.27
B_{23}	13.5	42.41
B_{24}	5.9	18.54
B_{25}	11.5	36.13

B_{26}	12.75	40.06
B_{27}	9.75	30.63
B_{28}	7.25	22.78
B_{29}	49.5	155.51
B_{30}	6.25	19.63
B_{31}	7.25	22.78
B_{32}	5.25	16.49
B_{33}	8.25	25.92
B_{34}	18.5	58.12

Average Circumference, $\overline{C} = \frac{1\ 224.14}{34}$

$= 36$ cm

Table a.4: The bud stages of *R. kerri* found in Lojing Highlands.

Bud	***Rafflesia*'s Bud Stage**
B_1	Stage II
B_2	Stage II
B_3	Stage III
B_4	Stage III
B_5	Stage II
B_6	Stage II
B_7	Stage III
B_8	Stage III
B_9	Stage III
B_{10}	Stage I
B_{11}	Stage II
B_{12}	Stage II
B_{13}	Stage II
B_{14}	Stage III
B_{15}	Stage III
B_{16}	Stage II
B_{17}	Stage III
B_{18}	Stage II
B_{19}	Stage III
B_{20}	Stage II
B_{21}	Stage II
B_{22}	Stage III
B_{23}	Stage III
B_{24}	Stage II
B_{25}	Stage III
B_{26}	Stage III
B_{27}	Stage II
B_{28}	Stage II
B_{29}	Stage III
B_{30}	Stage II
B_{31}	Stage II
B_{32}	Stage II
B_{33}	Stage II
B_{34}	Stage III

APPENDIX B

Table b.1: Planning of FYP I & FYP II

FYP I	FYP II
• Research title discussion with supervisor: (February – March) • Writing research proposal: (March – April) • Presentation of research proposal: (April) • Submission of final draft proposal: (June)	• Fieldwork and data collection: (October) • Submission of first draft chapter 1 – chapter 5: (November) • Submission of final report: (December) • Viva (Colloquium): (December) • Submission of hardbound and CD to faculty: (January 2019)

- Fieldwork : 9/10/2018 - 10/10/2018