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Managing and protecting of endangered *Rafflesia* species in Kelantan, Peninsular Malaysia

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Abstract. *Rafflesia* is the most magnificent and largest flower in the world. In Southeast Asia, the species becoming endangered due to anthropogenic activities such as logging, conversion of forest into large-scale agricultural areas, urbanization and unsustainable ecotourism. This paper has specifically highlighted the efforts that have been taken by the Kelantan State Forestry Department (KFD) in ensuring the sustainability and survival of this gigantic flower in its natural habitat. A survey by Universiti Malaysia Kelantan (UMK) shows that many populations of *Rafflesia* were situated in the forest reserves under the administration of KFD, such as in Lojing, Mt. Chamah, Mt. Basor and Mt. Stong. A lot of initiatives have been implemented by KFD such as organising scientific expeditions and the establishment of the High Conservation Value Forest (HCVF). In July 2011, the State Government of Kelantan declared an area of 404 ha (1,000 acres) bordering Sg. Berok Forest Reserve in Lojing Highlands as the *Rafflesia* Preservation Area. This recognition by the state government resulted from collaboration efforts of UMK, KFD and South Kelantan Development Authority (KESEDAR). To date, KFD has established a total of two HCVFs in Kelantan and a new area of 50 ha in Compartment 1, Lojing Forest Reserve has also been dedicated for the protection of *Rafflesia*. This paper was also briefly discussed several issues and challenges in conserving *Rafflesia* in Kelantan such as the expansion of large-scale agricultural plantation, participation of local community, tourism and income generation, international and internal funds for conservation works, and provide an integrated tourism and management plans. Hopefully, this effort will lead to the establishment of a centre of excellence in nature conservation, ecotourism and scientific research of *Rafflesia* in Kelantan.

1. Introduction

Malaysia hosts a portion of the important tropical rainforest belt known as West Malesia, and has a uniquely rich and diverse flora and fauna [1] with an estimated number of plant species of more than 25,000 [2]. However, the past efforts on plant conservation projects or activities were poor particularly due to a lack of strategic and effective enforcement. In the early 1960s, more than 75% of the total land area was forested. Forest resources then appeared to be inexhaustible. The land development



schemes initiated in the early 1960s into 1980s saw large areas of lowland forests converted to plantation schemes of rubber and oil palm under the FELDA (Federal Land Development Authority). The FELDA scheme alone has developed a total of 853,000 ha as plantations or settlement areas [3]. Therefore, conservation of endemic and rare species such as the Rafflesia is an indispensable task due to the accelerating rates of biodiversity loss since those places with the highest levels of biodiversity loss are the least protected.

In this regard, the Kelantan State Forestry Department (KFD) has always strived to ensure that forests especially in the southern part of the state continue to contribute to biodiversity conservation, as enshrined in the National Forestry Policy of 1978. Forest conservation efforts are always prioritised in the forest management of Kelantan state. Through KFD efforts, until now the forested area in Kelantan remains at 800,986.60 ha or 53.3% of the total area. Of this total, 623,848 ha have been gazetted as Permanent Forest Reserve (PFR) area of which 477,508 ha is production forest and the balance of 146,341 ha is protected forest areas [4]. Several networks of protected forest areas have been established for conservation, research, education and information gathering including an area categorized as High Conservation Value Forest (HCVF). Forest areas exceeding 1,000 meters above sea level and slope above 40° as well as those areas exposed to soil erosion risk, flash floods, landslides, deposition and nutrient losses are classified as Land Protection Areas.

To date, an estimated 40 species (excluding the incomplete species) of Rafflesia were recorded all over the world. From there, a total of 13 species were noted in Malaysia, of which eight species of found in Peninsular Malaysia, these are *Rafflesia azlanii*, *R. cantleyi*, *R. kerri*, *R. parvimaclata*, *R. sharifah-hapsahiae*, *R. su-meiae*, *R. tiomanensis* and *R. tuanku-halimii*. The other five species were recorded in Sabah and Sarawak, namely *R. hasseltii*, *R. pricei*, *R. keithii*, *R. tengku-adlinii* and *R. tuanmudae* [5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17].

2. Materials and methods

2.1. Study area

The survey on Rafflesia was conducted in several forest reserves such as Sg. Brooke, Lojing, Stong, Basor and Chamah which located in the southern part of Kelantan. This area is the richest biodiversity of the state and many areas are still covered by hill dipterocarp and sub-montane forests [18]. Previous surveys by [19] in Lojing shows that this area contains among the highest population of Rafflesia from the species of *R. kerri* in the world. It is becoming one of the popular sites for tourists, especially international tourists to visit and appreciate the Rafflesia flowers in wild. The southern part especially Lojing is also rich with other plant species such as mosses, ferns, wild orchids, gingers, pitcher plants and bamboo. For fauna, many interesting species of insect can be found besides the diversity of bird species and other small as well as big mammals. Some of the insect families noted in this area are Reduviidae (Hemiptera), Vespidae (wasp), Asilidae (robberfly), Coreidae (Hemiptera), Lycaenidae (butterfly) and Praying Mantis (Mantidae). Many bird species were also recorded such as swallows, Grey Throated Babbler, Magpie Robin and White Chested Babbler. Thus, some of the common mammals sighted include a monkey, slow loris and bats [20].

2.2. Methods

A total of six scientific expeditions was organised by the KFD in Kelantan to document the biodiversity of flora and fauna including the Rafflesia. The programmes are usually a collaboration effort between FDK, Universiti Malaysia Kelantan (UMK) and other related institutions. These scientific expeditions were successfully done in Mt. Stong (2005), Lojing (2009), Mt. Chamah (2013), Basor (2015), Pergau (2015) and Ulu Sat (2018). The findings were published through paper proceedings, monographs and pictorial books to educate and create awareness among the locals, government and state agencies in concerning and protecting the natural resources.

The establishment of HCVF for Rafflesia is one of the best practice in ensuring the sustainability of the species. The concept of HCVF is a classification of forest management used for forests that meet the criteria and principles introduced by the Forest Stewardship Council (FSC), a world certification

body for forest management and production sustainability. HCVF has been defined as brilliant or critical in terms of biological, ecological, social and cultural values and should be protected for the interests of the nation, region and world. The concept of HCVF was first introduced in 1996 and accepted by all FSC members as the Principles and Criteria in 1999 aimed at providing a framework for identifying forest areas with attractive and unique features and high value for biological diversity [21]. The suitability of HFCV in forest management is that it maintains the value of local conservation and the use of the principle of prevention. Therefore, this method is suitable for forest management, to ensure that HCVF does not deteriorate as a result of unsustainable development.

Undoubtedly, HCVF has interests that encompass various aspects. The use of the HCVF assessment is a process capable of taking into account critical security such as the need to fulfil national laws, conserving the endangered species, respecting the aborigine community as stipulated in the *Orang Asli* Affairs Act and land use rights. HCVF also has a mechanism to refer to a management plan established to maintain and enhance values implemented.

3. Results and discussion

The results show that three *Rafflesia* species were recorded in Kelantan, mostly distributing in the southern part of the state. They are *R. cantleyi*, *R. kerri* and *R. su-meiae* as also mentioned by [22]. The distributions of *R. cantleyi* are restricted to a few areas nearby and in the Kuala Koh National Park and Kuala Betis. However, a recent survey has also noted the occurring of this species in Ulu Sat and Chabang Tongkat Forest Reserves in the districts of Machang and Pasir Puteh.

The existence of *R. su-meiae* was only reported in Mt. Chamah, Kelantan and is very likely endemic. However, the distributions of *R. kerri* are widely distributed throughout the Main Range of the Kelantan State. The high populations of *R. kerri* in Lojing Highlands have attracted many tourists especially the tourist from abroad to visit Malaysia.

An intensive survey by the team from UMK in 2008 was discovered 26 populations of *Rafflesia* in Lojing [19]. All of 26 populations are situated in the statelands, however, further surveyed found many more populations in nearby forest reserves; Sg. Berok and Lojing Forest Reserves. The findings have led the KFD to establish an area of 50 ha as HCVF in Compartment 1, Lojing Forest Reserve in 2016, dedicated to conserving this gigantic flower.

To date, KFD has set up two HCVF areas in the State of Kelantan to protect two threatened and endemic tropical rainforest plant species, namely:

- (i) **Protection of *Licuala stongensis*** – The first HCVF in Kelantan and was established in 2015. This HCVF is located in Compartments 11, 17 and 19 of the Gunung Stong Forest State Park with a total area of 15 ha. *Licuala stongensis* was identified as a hyper-endemic plant and only found in Mt. Stong area.
- (ii) **Protection of *Rafflesia kerri*** – This HCVF was established in 2016 in Compartment 1, Lojing Forest Reserve, involves an area of 50 ha. *R. kerri* is a unique plant species, threatened and international icon for tourism. This species is the second largest flower species after *R. arnoldii* from Bengkulu, Indonesia. The latest survey by KFD [23] shows that six *Rafflesia* populations are in the category of active noted in this area. The *Rafflesia* host plant was also identified as *Tetrastigma hookeri*.

Several issues and challenges are facing by KFD in conserving *Rafflesia* in the State of Kelantan, as follows:

- (i) **Large-scale agricultural development** – The HCVF's *Rafflesia* in Compartment 1, Lojing Forest Reserve is surrounded by large-scale agricultural development. There is no clear buffer zone between the conservation area and the rest of the others. If no action is taken immediately, it will disturb the survival of *Rafflesia*. We know, the ecosystem of *Rafflesia* is very sensitive and depend on insects and small mammals as pollination and seed dispersal agents as stated by [18, 24].
- (ii) **Formulation of management plan** – A comprehensive management plan for *Rafflesia* need to be formulated. To date, no specific directions and guidelines on conservation, ecotourism,

involvement of local community, etc. of Rafflesia in Kelantan. Observation nearby this HCVF area shows that several habitats of Rafflesia are seriously disturbed due to improper tourists planning and other human activities.

- (iii) **Scientific research in Rafflesia** – Rafflesia is biologically unique and inspires scientific research for academic and educational purposes. Much is still unknown about these plants; for example, their evolution, co-evolution with the host, reproductive ecology, physiology, genetic variation, medicinal properties, and many other aspects. These are the academic challenges for the future. The establishment of a Rafflesia conservation area provides an opportunity for research for both local and international scientific communities.
- (iv) **Ecotourism** – Rafflesia has great potential to be promoted as a tourism attraction [25]. Many people are willing to come a long way to see and appreciate the largest flower on earth in its natural habitat. Presently, in Kg. Jedip, Lojing an average of two vans or 20 to 25 international tourists mostly from vicinity tourism area, i.e. Cameron Highlands, Pahang was noted to make a stop-over to this area on a daily basis. At present, a total of four tourist operators based at Cameron Highlands aggressively promote Rafflesia in Lojing as one of their main activity. A proper tourism management plan needs to be prepared before the HCVF is promoted and opened to tourists.
- (v) **Involvement of local community** – Conservation of Rafflesia and environment will generate sustainable income and provide an opportunity for alternative livelihood for the local community [26, 27]. It will educate locals that the flowers are more valuable left growing for sustainable income generation rather than being chopped down for instant benefits. The local community especially those who are involved in tourism such as tourist guides should be given knowledge and awareness on conserving Rafflesia through regular workshops and seminars.
- (vi) **Funding for Rafflesia** – Rafflesia is also one of the “international icons for nature conservation” that will bring in international and internal funds for conservation works. Thus, KFD should collaborate with related government agencies, local universities and NGOs to develop this HCVF area. Big conglomerate companies in Malaysia such as Petronas, Shell and Sime Darby also should be invited to contribute to this conservation work. A comprehensive conservation proposal should also be prepared to seek international funds such as from the World Wide Fund for Nature (WWF), United Nations Development Programme (UNDP) and Japan International Cooperation Agency (JICA).

4. Conclusions

In a conclusion, there is a lot to gain from the conservation of Rafflesia – both tangible and intangible. The image of KFD and Kelantan as a state concerns with the protection of natural resources will be portrayed in Malaysia and the world. In future, hopefully, the conservation works on Rafflesia in Kelantan will be recognised locally and internationally and this HCVF will be becoming an international centre of excellence in nature conservation, ecotourism and scientific research.

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