

BIOLOGICAL ASPECTS AND CONSERVATION OF *Rafflesia arnoldii* : INDONESIAN ENDEMIC PLANT CONSERVATION

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ABSTRACT

Rafflesia arnoldii is one of the rare endemic plants in Indonesia. This endemic plant has unique characteristics and has various kinds of modifications that differentiate it from other plants. However, this largest flower plant is classified as an endangered plant. It is due to its limited life cycle and distribution area. Many kinds of habitat destruction caused by human activities also threaten the existence of this endemic plant. Besides, it is highly dependent on the presence of its host plant, *Tetrastigma* spp. Therefore, conservation is needed. Conservation is implemented through in-situ and or ex-situ conservation. It can be optimized by utilizing ecotourism activities involving local communities.

Keywords: Conservation, Endemic Plant, *Rafflesia arnoldii*

INTRODUCTION

The biodiversity of both animals and plants in an area is the natural wealth source owned by the region. Each region has its unique plants and animals according to the vegetation characteristics of the region. Living things are found within various species with unique genetic variations according to their habitat. Meanwhile, the diversity of living things is known as biodiversity. Biodiversity comprises species diversity, genetic diversity, and habitat or ecosystem diversity (Kusmana & Hikmat, 2015).

Indonesia is one of the mega biodiversity countries located on the equator. The location and climate of Indonesia are suitable for the life of various kinds of plants and animals. Also, the tropical climate in Indonesia supports many organisms to grow and reproduce well. These conditions are the reasons why Indonesia has a wide variety of endemic plants and animals. Endemic animals and plants are valuable biological sources in Indonesia (Atmansyah *et al.*, 2017).

Indonesia has 25% of the total flowering plants globally, with species reaching up to

20,000 species. Based on the number of species, 40% of plant species found in Indonesia are endemic species or native to Indonesia. The most common plant family in Indonesia is Orchidaceae, which reaches 4,000 species. Woody plants include the Dipterocarpaceae family consisting of 386 species, Myrtaceae and Moraceae 500 species, and the Ericaceae family as many as 737 species (Kusmana & Hikmat, 2015).

One of the Indonesian endemic plants is *R. arnoldii*. *Rafflesia* is a genus of the Rafflesiaceae family, which has the largest flower diameter in the world. It has a unique developmental system that is still a mystery and is interesting to study. The flower has a large cavity in the middle (Nikolov *et al.*, 2013). The Rafflesiaceae family belongs to a holoparasitic endophytic family with certain modifications. This family has a reduced body and roots that are hard to identify (Nikolov *et al.*, 2014).

R. arnoldii lives in several regions of Sumatra Island, especially in Bengkulu Province. *R. arnoldii* has an annual life cycle and has small populations in nature.

Environmental problems and the length of the life cycle have caused this endemic Indonesian plant to be one of the endangered species, according to IUCN. This threat of extinction has led to the importance of the conservation effort of *R. arnoldii* (Ramadhani *et al.*, 2017).

The threat of the preservation of *Rafflesia* is a challenge that must resolve immediately to avoid the extinction of that endemic flower due to the uniqueness of this endemic flower is a valuable natural resource of Indonesia. *R. arnoldii* protection efforts need to be implemented as early and optimally as possible. Optimization of the protection of *R. arnoldii* applies to various conservation strategies. Conservation is a science developed to protect certain species and ecosystems. Conservation activities require the participation of local communities (Wuisang, 2015).

In this article, the author discussed some biological aspects of *R. arnoldii*. Also, the author discussed some essential conservation strategies to support the preservation of this endemic species.

METHODS

This study is a descriptive research. Descriptive research is a study that seeks to describe a phenomenon. The purpose of descriptive research is to describe the phenomena that occur in nature (Nugrahani & Hum, 2014; Alviana *et al.*, 2019). The method used in this research is the library search or literature study. A literature study is a research method limited to collect data from various data sources without conducting research directly into the field or laboratory. This type of research is possible with certain limitations when field research cannot be carried out (Sari & Asmendri, 2020). There are several stages in the library search method or literature review. They are designing the research, conducting the review process, conducting data analysis, and writing and describing data (Snyder, 2019).

Data Analysis

The data obtained and used in this study were secondary. Secondary data are data

obtained from various references. Secondary data analysis is the process of analyzing data obtained from many sources. The stages in secondary data analysis are developing the research questions, data identification, and data evaluation (Jonhston, 2014).

RESULT AND DISCUSSION

Habitat of *Rafflesia arnoldii*

R. arnoldii is a rare and unique species that grows in several regions in Indonesia, such as Bengkulu Province. This plant is used as the identity of the Bengkulu Province and is a natural resource of Indonesia (Muhaimin *et al.*, 2016).

R. arnoldii is mostly found in the Bukit Barisan National Park, located in Bengkulu-Lampung Province. The plant requires specific host plants, *Tetrastigma* spp. The hosts are lianas, including *T. tuberculatum*, *T. curtisii*, *T. dunculare*, *T. scortechinii*, *T. diepenhorstii*, *T. papillosum*, *T. quadrangulum*, *T. bratum*, *T. harmandii*, and *T. loheri* (Ramadhani *et al.*, 2017). The life cycle of this endemic plant is highly dependent on its host plants (Mursidawati *et al.*, 2015), as shown in Figure 1.



Figure 1. *Rafflesia* sp. Grows on the Root of *Tetrastigma* (Obtained from Mursidawati *et al.*, 2015)

This endemic plant lives in an area within a temperature of 25 – 29 °C. The humidity of its habitat is 95%, and the soil pH is around 5.5. *R. arnoldii* lives in a habitat with an altitude ranging from 480 – 558 masl. Additionally, the location is about 7 meters from the nearest water source (Ramadhani *et al.*, 2017).

Biological Aspects of *R. arnoldii*

R. arnoldii is one of the members of the Rafflesiaceae family. This family is an endoparasitic group of plants. It grows inside the host plant tissue and utilizes the nutrients from that host. The only external part of Rafflesiaceae plants is their flowers. Meanwhile, *R. arnoldii* has the largest flower among other flowering plants in the world. Its flower has a diameter of up to 107 cm and a weight of up to 7 kg (Twyford, 2017). The morphology of its flower is shown in Figure 2.



Figure 2. Morphology of *R. arnoldii* (Obtained from Wiatrowska, 2017)

R. arnoldii is an angiosperm plant that has undergone several modifications so that looking different from other angiosperm plants. The modifications that have occurred to this plant are still uncertain, the evolutionary concept of its flower formation is still confusing. It has a shaped-like bowls flower with a large cavity at the center. Biologists often refer to it as a blossom chamber (Nikolov *et al.*, 2013).

Its flower is included as the unisexual and dioecious or two-house flowers. The flower pollination process is quite complicated. Male and female flowers must bloom simultaneously within the same period to carry out pollination assisted by flies and insects. Without this complex pollination process, the flower could not grow and develop. If the pollination process does not occur, this unique flower will continue to multiply in the host plant's tissue but cannot grow out of the host tissue. This limitation

threatens genetic changes in the host plant and increases the rarity of this endemic plant in the future (Latiff, 2018).

R. arnoldii has a reddish-orange flower equipped with a cavity in the middle of the flower. The base and large cavity walls of the flower are formed from the perianth tube. The cover of the cavity is called the diaphragm. The cavity of its flower is surrounded by sterile organs known as the perianthial lobes, while the middle part or central column is the part that has fertile reproductive organs. The opening of the diaphragm serves as an entrance for insects that act as pollinators of the flower. The entry of insects, especially flies, is due to the pungent odor that comes from the cavity of its flower (Nikolov *et al.*, 2013).

It has five perianthial lobes that are similar to sepals in angiosperms in general. Its flower has petals attached and is equipped with a diaphragm that covers the cavity in the center of the flower. Each perianth has a protective function and attracts insects to pollinate (Nikolov *et al.*, 2014). The structure of the flower is shown in Figure 3.

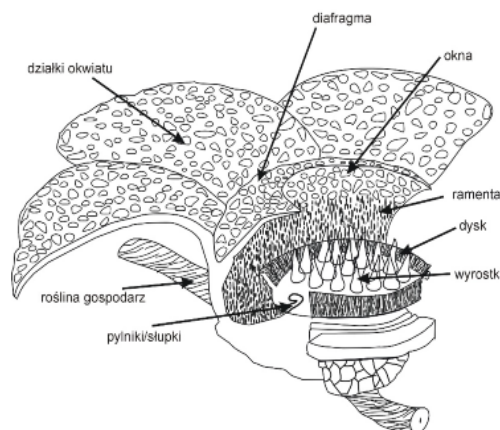


Figure 3. The Flower Structure of *R. arnoldii* (Obtained from Wiatrowska, 2017)

The blooming period of the flower ranges from 4 to 7 days. Several factors affect the length of its blooming period. Lack of available nutrients causes its flower unable to survive. Lack of water shortens the blooming period of the flower. Also, the blooming period can be disturbed by rodents that interfere with the flower's existence. The flower is prone to death within a diameter of

less than 3 cm (Ramadhani et al., 2017). Its flower appears on the roots or stems of the host plant, *Tetrastigma*. Moreover, the *Rafflesia* flower does not have leaves and chlorophyll. Therefore, the flower cannot carry out photosynthesis, so it is included as a holoparasite (Mursidawati et al., 2015).

Conservation of *R. arnoldii*

The narrow level of distribution in the wild is one of the threats to *R. arnoldii*. Also, environmental pressures such as deforestation, illegal logging, and uncontrolled activities decrease the ecosystem quality. If these problems do not overcome immediately, the extinction of this valuable endemic species will become real in the following few periods (Latiff, 2018).

Several threats to biodiversity are agricultural expansion, overexploitation, urbanization, industrialization, pollutions, wildfires, and global climate changes (Zegeye, 2017). Various environmental problems and the complex life cycle of the *R. arnoldii* cause this endemic Indonesian plant to be one of the endangered species, according to IUCN. These threats have led to the importance of the conservation effort of this endangered endemic species. The extinction of a species is an intolerable loss (Ramadhani et al., 2017).

Conservation of *R. arnoldii* needs to carry out due to biological, economic, scientific, and particular cultural-historical reasons and values. Based on Law No. 5 of 1990 regarding the conservation of natural resources, conservation is an effort made to manage living natural resources to utilize them wisely and ensure their sustainability and availability while maintaining and improving the quality of diversity and its values (Wuisang, 2015).

Conservation can be carried out to protect the ecosystem of many living things, including animals and plants. The activities aim to conserve and protect natural resources in an area. The strategies are implemented in various ways, such as through botanical exploration activities and the making of plant herbariums. Botanical exploration aims to determine the types of plants in specific

locations to support the conservation effort and strategy (Tamin et al., 2017).

Conservation of biodiversity generally has three fundamental reasons. The first reason is the UN Charter, which states that all living things have the same right to live regardless of their value to humans. It means that every human should not disturb or threaten the life of other living things. Also, biodiversity has an essential role in the balance of life to support human survival. Another reason is that biodiversity is a natural resource with high economic values (Wuisang, 2015). Conservation of *R. arnoldii* is implemented with various conservation strategies. They include protecting its habitat, preserving its specimens, and optimally exploiting the potential that can be extracted from the plant while still paying attention to conservation aspects, such as ecotourism activities. The strategies should be implemented according to their respective goals and functions because conservation means protecting Indonesian biological resources and their application in many fields of life (Samedi, 2015; Wuisang, 2015).

In-situ and Ex-situ Conservation of *R. arnoldii*

In-situ conservation is the protection strategy of biological diversity within its natural habitat. In-situ conservation is one of the most effective conservation methods applied through single-use wildland, multiple-use wildland, and converting an area as managed for biological resources. The multiple-use wildland managements include national parks, natural monuments, protected landscapes, and other reserves (Zegeye, 2017).

In-situ conservation of *R. arnoldii* is carried out by determining its natural habitat as a National Park. Based on the Government Regulation of the Republic of Indonesia No. 108/2015, the National Park is a natural conservation area that has an original ecosystem, managed by a zoning system used for research, science, education, cultural support, tourism, and recreation purposes. One of the National Parks that functions to

preserve *R. arnoldii* is the Kerinci Seblat National Park that stretches across several regions of Bengkulu, Jambi, West Sumatra, and South Sumatra (Desmiwati & Surati, 2017).

Meanwhile, ex-situ conservation is the strategy of protecting biological resources outside of their natural habitat. This strategy is implemented through the botanical garden, zoo, and collection of an organism's parts as sperm, seed, pollen, and tissue culture (Zegeye, 2017). The major ex-situ conservation strategies are nurseries, botanical gardens, zoos, breeding, sustainable reproduction centers, rescue and rehabilitation centers, germplasm banks, and aquariums (Mestanza-Ramón *et al.*, 2020).

Ex-situ collections are essential in preserving *R. arnoldii* as an endemic species with a high threat of extinction. Ex-situ collections are used for habitat restoration and natural habitat restoration. The growth and development processes of species collected ex-situ can be controlled to minimize extinction due to natural habitat destruction. Prioritized species in ex-situ collections are endangered species, economically potential, or have unique socio-cultural values (Rahman, 2015). Moreover, the Ex-situ conservation of *R. arnoldii* is promising (Mandiriati *et al.*, 2016) yet challenging. This endemic plant is highly dependent on its host. Therefore, conserving host plants is also needed to protect *R. arnoldii* and its habitat.

Ecotourism-based conservation of *Rafflesia arnoldii*

The other conservation strategy is ecotourism-based conservation. *Rafflesia arnoldii* has a unique morphological shape and color with a large flower diameter that attracts the community. This attraction is used as the support of its conservation effort by optimizing the ecotourism potential. Aesthetic values possessed by a species can attract people's attention, including refreshing, education, and research. This strategy is the funding source for facilities and infrastructures to support the conservation of this endemic plant (Atmansyah *et al.*, 2017).

Additionally, the conservation of *R. arnoldii* can not be separated from the community's interference, especially those who live around its ecosystem. Community involvement in conservation needs to carry out with a preliminary approach in education and socialization. Outreach activities for the local community aim to provide understanding and knowledge about the importance of local biodiversity sustainability as *Rafflesia arnoldii*. Through education and socialization, it is expected that the community will be able to actively participate in preserving this endemic plant (Tamin *et al.*, 2017).

CONCLUSION

R. arnoldii is one of the endemic plants in Indonesia. This endemic plant has a narrow habitat distribution, and its life cycle is highly dependent on the host plant. Also, many threats threaten this endemic plant. They cause *R. arnoldii* classified as one of the endangered species according to the IUCN. Therefore, the conservation effort is needed to persevere it. Conservation efforts include in-situ and ex-situ protection of its life support systems, protection of ecosystems where *R. arnoldii* grows, preserving specimens, and optimizing ecotourism-based conservation.

The author suggests the optimization of ex-situ and in-situ conservation of *Rafflesia arnoldii* involving the local community. Also, efforts to protect the host plant must be implemented to support the preservation of this endemic plant.

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