International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 39 No. 2 July 2023, pp. 149-154

Several Characteristics of Ecological Factors in the Rafflesiaceae in Indonesia

Rizka Sefmaliza[1], Chairul*[2], M. Idris[3]

[1,2,3] Department of Biology, Faculty of Mathematics and Natural Sciences
Andalas University
Padang, Indonesia
*chairul57mahmud@gmail.com

Abstract— Rafflesiaceae is a parasitic family that depends on other plants as its host in the form of lianas Tetrastigma sp. which comes from the Vitaceae family (grapes). Rafflesiaceae has three members of the genus including Rafflesia, Rhizanthes, and Sapria. As an obligate parasitic plant, the host conditions originating from environmental conditions greatly affect the condition of this plant. The abiotic components that are measured are usually climatic factors, edaphic factors, and topographical factors. Abiotic factors measured and observed in the field can be used for ex situ germination of parasitic plants. This article was created to serve as a guide regarding data on environmental factors affecting plants from the Rafflesiaceae family in Indonesia. A systematic Literature Review (SLR) uses in this paper. Several plants from the Rafflesiaceae family live in almost homogeneous abiotic environmental conditions. The differences in each species are not too significant even though they are on different islands

Keywords—Abiotic Factor; Rafflesiaceae; Rafflesia; Rhizanthes; Tetrastigma SP.

I. INTRODUCTION

Rafflesiaceae is a parasitic plant on roots and branches of various hosts, thalloid, or vegetatively reduced to an almost endophytic mycelial system with only the flowers emerging from the host tissue, monoecious, dioecious, or rarely the flowers of one plant bisexual. Rafflesiaceae leaves are absent (or reduced to scales subtending the flowers). Flowers very small to very large, solitary (rarely in spikes), subtended by bracts, and actinomorphic. The fruit is a berry and the seeds are minute, numerous, and albuminous [1]. Rafflesiaceae is a parasitic family that depends on other plants as its host in the form of lianas *Tetrastigma* sp. which comes from the Vitaceae family (grapes) [2]. Rafflesiaceae has three members of the genus including *Rafflesia, Rhizanthes,* and *Sapria* [1]. Rafflesia is a unique plant because of its large flower size and presence, which is only realized when the flower buds open [3]. Rafflesia grows well on the forest floor of West Sumatra. There are three species in West Sumatra, named *R.arnoldii*, *R.haseltii,* and *R.gadutensis* [3], [4]. According to [5], *Rhizanthes* is an endemic plant that lives in several locations in tropical rainforest ecosystems. Rhizanthes plants can grow in moderate lowland to highland areas. Unlike Rafflesia, none of the Rhizanthes species are included in the Minister of Environment and Forestry Regulation No. P.20 of 2018 concerning Protected Plant and Animal Species.

As an obligate parasitic plant, the host conditions originating from environmental conditions greatly affect the condition of this plant. The host plant habitat's ecological factors will also affect parasitic plants [6]. Ecological factors that are measured and observed in biotic factors such as vegetation structure, human activities, and animal activities. The abiotic components that are measured are usually climatic factors (air temperature, air humidity, rainfall), edaphic factors (soil temperature, soil pH, soil texture), and topographical factors (altitude, slope, distance from water sources) [7]. Abiotic factors measured and observed in the

Corresponding Author: Chairul

field can be used for ex situ germination of parasitic plants [8]. This article was created to serve as a guide regarding data on environmental factors affecting plants from the Rafflesiaceae family in Indonesia. This environmental factor data is useful for adjusting the in situ environmental conditions of the plants if ex-situ germination is carried out which is usually used for conservation needs.

II. Research Methods

A Systematic Literature Review (SLR) was used in this paper. SLR is a method that aims to identify, review, evaluate, and interpret data in journals systematically according to the specified steps [9]. In searching for and collecting data related to a topic of environmental factors that affect the habitat of the Rafflesiaceae family. Data were analyzed descriptively and tabulated into tables to summarize all the data obtained.

III. Result And Discussion

Several studies have been conducted to look at data on environmental factors, especially abiotic factors that affect the habitat of plants from the Rafflesiaceae family in Indonesia. Data on the abiotic factors of some plants include:

1. Temperature (°C)

Several studies have been carried out and obtained temperature data in the habitat of several plants from the Rafflesiaceae family in Indonesia (Table 1).

Table 1 Temperature in the habitat of several plants of the Rafflesiaceae family in Indonesia

Name of Species	Location	Temperature (°C)	References
Rhizanthes deceptor	Hutan Pendidikan dan Penelitian Biologi Universitas Andalas Padang	22-29	[7]
Rafflesia arnoldii	Rhino Camp Resort Sukaraja Atas Taman Nasional Bukit Barisan Selatan	25-29	[10]
Rafflesia tuan mudae	Gunung Poteng Cagar Alam Raya Pasi Kalimantan Barat	25-26.1	[11]
Rafflesia arnoldii	Pandam Gadang Sumatra Barat	19-25	[12]
Rafflesia arnoldii	Hutan Pendidikan dan Pelatihan Universitas Muhammadiyah Bengkulu	25-26	[13]
Rhizanthes zippelii	Gunung Poteng Cagar Alam Raya Pasi Kota Singkawang Kalimantan Barat	24-25	[6]
Rhizanthes loweii	Taman Nasional Kerinci Seblat Resort Sungai Lambai	23.7	[14]
Rafflesia arnoldii	Bukik Pinang Mancuang, Kamang Mudiak, Agam	23	[15]

The optimal temperature for species from the Rafflesiaceae family in Indonesia ranges from 19-29°C. The lowest optimal temperature value is in the Rafflesia arnoldii species in Pandam Gadang, West Sumatra. Meanwhile, the highest optimal temperature value was found in the *Rhizanthes deceptor* species found at HPPB Andalas University (Table 1). Overall, the optimal temperature in the habitat of the Rafflesiaceae family plant species in Indonesia, especially from the data taken, is found on the islands of Sumatra and Kalimantan, which range from normal. This is to the opinion [16], plants maintain their life at a

temperature of 10ºC-40ºC. Temperature is an environmental factor that directly or indirectly influences plant growth and development. Temperature can play a direct role in almost every growth function by controlling the rate of chemical processes in the plant, while its indirect role is by influencing other factors, especially air supply [17].

2. Humidity (%)

Several studies have been carried out and obtained humidity data in the habitat of several plants from the Rafflesiaceae family in Indonesia (Table 2).

Table 2 Humidity in the habitat of several plants of the Rafflesiaceae family in Indonesia

Name of Species	Location	Humidity (%)	References
Rhizanthes deceptor	Hutan Pendidikan dan Penelitian Biologi Universitas Andalas Padang	74-96	[7]
Rafflesia arnoldii	Rhino Camp Resort Sukaraja Atas Taman Nasional Bukit Barisan Selatan	90	[10]
Rafflesia tuan mudae	Gunung Poteng Cagar Alam Raya Pasi Kalimantan Barat	83-89	[11]
Rafflesia arnoldii	Pandam Gadang Sumatra Barat	83-91	[12]
Rafflesia arnoldii	Hutan Pendidikan dan Pelatihan Universitas Muhammadiyah Bengkulu	86-93	[13]
Rhizanthes zippelii	Gunung Poteng Cagar Alam Raya Pasi Kota Singkawang Kalimantan Barat	80-99	[6]
Rhizanthes loweii	Taman Nasional Kerinci Seblat Resort Sungai Lambai	80	[14]
Rafflesia arnoldii	Bukik Pinang Mancuang, Kamang Mudiak, Agam	79.22	[15]

The moisture value of species from the Rafflesiaceae family in Indonesia ranges from 74-99%, which is high. The lowest humidity was found in the habitat of the species *Rhizanthes deceptor* found at HPPB Andalas University, which is in line with the highhigh-temperatureues. This was conveyed by [18] that changes in the pressure of some water vapor in the air are related to changes in temperature, so air humidity is a measure of the amount of water vapor in the air. Meanwhile, the highest humidity was found in the species *Rhizanthes zippelii* which was found in Mount Poteng, Raya Pasi Nature Reserve, Singkawang City, West Kalimantan. Overall humidity in the habitat of the Rafflesiaceae family plant species in Indonesia ranges from high humidity values. The exception is *Rafflesia arnoldii* which is found in Bukik Pinang Mancuang, Kamang Mudiak, Agam which takes average humidity data from several days of observation, even though the daily humidity value also reaches a value of 80% (Table 2). So, the humidity value that is suitable for the habitat of the Rafflesiaceae family or the Rafflesiaceae family can live and thrive in habitats with high humidity. This is the opinion [18] states that humidity is an important factor for plant growth. Humidity for each plant has a different level. Good and stable humidity values need to be maintained to maintain the growth process.

3. pH habitat

Several studies have been carried out and obtained pH habitat data in the habitat of several plants from the Rafflesiaceae family in Indonesia (Table 3).

Table 3 pH habitat in the habitat of several plants of the Rafflesiaceae family in Indonesia

Name of Species	Location	pH habitat	References
Rhizanthes deceptor	Hutan Pendidikan dan Penelitian Biologi Universitas Andalas Padang	5-6	[7]
Rafflesia arnoldii	Rhino Camp Resort Sukaraja Atas Taman Nasional Bukit Barisan Selatan	5.5	[10]
Rafflesia zollingeriana	Blok Krecek Resort Bandealit Taman Nasional Meru Betiri Jawa Timur	7	[19]
Rafflesia arnoldii	Pandam Gadang Sumatra Barat	7-7.8	[12]
Rafflesia arnoldii	Hutan Pendidikan dan Pelatihan Universitas Muhammadiyah Bengkulu	6.5	[13]
Rhizanthes loweii	Taman Nasional Kerinci Seblat Resort Sungai Lambai	7.1	[14]
Rafflesia arnoldii	Bukik Pinang Mancuang, Kamang Mudiak, Agam	7.28	[15]

Based on the data obtained, plants from the Rafflesiaceae family in Indonesia grow in acidic to neutral pH conditions. This is to the opinion [20] that soil pH is generally on a scale with a value of 4 to 10, with a pH scale ranging from 0 (strong acid) to 14 (strong base) to 7 (neutral). pH is a measure of the number of hydrogen ions in a solution. Usually, the soil in wet areas is acidic, while the soil in dry areas is alkaline. In acidic soils, the soil solution contains more hydrogen ions (H^+), whereas in alkaline soils the soil contains more hydroxyl ions (OH^-). So, plants from the Rafflesiaceae family in Indonesia will live in soils with acidic conditions and contain more hydrogen ions. Soils with low pH result in lower available P values and thus affect soil fertility where P is most easily absorbed in soils with neutral pH. The nature of N which is easily leached causes the value of N at the study site to be low. This occurs due to leaching that occurs due to high rainfall and water flow [21].

4. Light intensity

Several studies have been carried out and obtained light-intensity data in the habitat of several plants from the Rafflesiaceae family in Indonesia (Table 4).

Table 4 Light intensity in the habitat of several plants of the Rafflesiaceae family in Indonesia

Name of Species	Location	Light intensity	References
Rafflesia arnoldii	Pandam Gadang Sumatra Barat	130-800 Lux	[12]
Rafflesia arnoldii	Hutan Pendidikan dan Pelatihan Universitas Muhammadiyah Bengkulu	246-442 Lux	[13]
Rhizanthes zippelii	Gunung Poteng Cagar Alam Raya Pasi Kota Singkawang Kalimantan Barat	156-162 Lux	[6]
Rafflesia arnoldii	Bukik Pinang Mancuang, Kamang Mudiak, Agam	79.22 %	[15]

The intensity of light measured using a Lux meter on several plants of the Rafflesiaceae family in Indonesia ranges from 130-800 Lux. In the research conducted by [15], the results in the form of a percentage were obtained from values that ranged from the light intensity numbers of other plants as well. As an obligate parasitic plant, the Rafflesiaceae family is completely dependent on its host, Tetrastigma [22]. *Tetrastigma*'s life process, one of which is photosynthesis, will also affect the plants that become its parasites. Photosynthesis will certainly be related to light intensity or the amount of light received by plants.

Sunlight as a growth factor for plants is determined by three components, one of which is the intensity of sunlight which is a critical component that directly affects photosynthetic results in plants. According [23], states that the inhibition of the process of photosynthesis at high light intensity (> 10,000-foot candles) is an indirect effect of the intensity of the light, whereas, at a high light intensity, it will cause closure of the stomata and reduce evapotranspiration mainly through the leaves. Furthermore, there is inhibition of chlorophyll formation and damage to photosynthetic organs, namely chlorophyll lysis and all of these things will cause inhibition of the process of photosynthesis in the leaves as a whole [24]. The high intensity of light in the tropics cannot be used entirely by plants. The light energy used by plants in the photosynthesis process ranges from 0.5 to 2% of the total amount of solar energy available for the growth process. Meanwhile, the results of photosynthesis that are formed will decrease if the intensity of sunlight received is less than the optimal limit needed by plants, and this is very dependent on the type of plant [25].

IV. CONCLUSIONS

Based on several articles that have been obtained, it can be concluded that several plants from the Rafflesiaceae family live in almost homogeneous abiotic environmental conditions. The differences in each species are not too significant even though they are on different islands. This plant lives at normal temperatures with fairly high humidity. Low pH or moderately acidic to neutral soil conditions are very suitable for the growth of the Rafflesiaceae family. As well as a low light intensity value is needed for its growth as an obligate parasitic plant that depends on its host. This is of course related if the disturbance area in which there is land clearing will disturb the habitat of this plant family.

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