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RAFFLESIA AND ITS HABITAT CHARACTERISTICS IN MANDAPAJAYA FOREST, KUNINGAN DISTRICT, WEST JAVA PROVINCE, INDONESIA

Toto Supartono[1*], Nina Herlina[2]
[1,2]*Department of Forestry, Forest Faculty, Kuningan University*
* E-mail: toto.supartono@uniku.ac.id

A B S T R A C T

Rafflesia is a rare species and its distribution has never been recorded in forest areas of Kuningan District. The study aimed to describe the morphology and identify *Rafflesia* species, analyze the physical environment, host species characteristics, and vegetation. The methods used were a direct measurement of morphology, physical environmental conditions and host plant characteristics, and sample plots of vegetation characteristics. The results showed that the *Rafflesia* species found in Kuningan District was *Rafflesia rochussenii* and occupied a very steep and rocky location. The host species was liana and possibly belong to the genus *Tetrastigma* and the trees vegetation were dominated by *Villebrunea rubescens* species.

Keywords : conservation, endemic, *Rafflesia rochussenii*, rare species, *Tetrastigma*

1. Introduction

The information about *Rafflesia* species and its habitat characteristics needs to be explored continuously to support conservation because the status of the species is endangered and endemic; its distribution is limited to several locations in the tropical rain forest of Southeast Asia (Zuhud et al., 2001). The *Rafflesia* is classified into a holo parasite plant (Mursidawati, 2012) which has no chlorophyll, but have a suction root or haustorium that serves to remove food from host plants into her bodies (Suwartini et al., 2008). Since it is scarce and endemic, this species is classified into plants protected by the Government of the Republic of Indonesia through Government Regulation No. 7 of 1999. However, little is known about the specific location of distribution and its utilization (Suwartini et al., 2008).

The previous studies suggested that the distribution of *Rafflesia* in Indonesia included Kalimantan Island (Adam et al., 2016), Sumatra, and Java (Mursidawati et al., 2015). The species was distributed in the Bukit Barisan Selatan National Park for Sumatera (Ramadhani et al., 2017), Nusa Kambangan Island (Mursidawati et al., 2015), Pangandaran Nature Reserve (Mursidawati, 2012), Leuweung Sancang Nature Reserve (Zuhud et al., 1998), Gunung Gede Pangrango (Saadudin, 2011), and Bojonglarang Jayanti Nature Reserve (Ali, 2014) for Java Island. In addition, this species was also found in forest ecosystems of Kuningan District. However, its distribution had not been recorded by previous researchers so that the species name and the characteristics of growing location were also unknown. Furthermore, if *Rafflesia* is distributed in the conservation areas for several areas, but it is found in the production forest areas for Kuningan District.

The information and problems – as served in the last part of the second paragraph above – have raised a number of questions, including: belonging to what species of *Rafflesia* is found in Kuningan District?, and how is the characteristics of host plants and vegetation around the species growing location? In order to answer these questions, the study in Kuningan District has been conducted and this paper provides an overview and analysis of: morphological and identification of the species, physical environmental of growing place, and characteristics of host species and vegetation.

2. Methods

2.1. Study Sites

This study was carried out at part of Gunung Subang (S 07º10'41,9" and E 108º33'05,3"), Mandapajaya Village, Kuningan District. The site of data collection is secondary natural forest remaining in Eastern of West Java, 563 meters above sea level, and very steep. This location is a forest ecosystem that borders between West Java Province and Central Java Province. In addition, this ecosystem is also part of production forest managed by The Forestry Management Unit (KPH) of Kuningan designed as a local protection area.

2.2. Data Collection

To answer the emerging questions, as mentioned in the introduction section, the variables collected include physical characteristics of *Rafflesia*, vegetation and abiotic conditions around growing place, and the characteristics of host plants. The data collected for the characteristics of *Rafflesia* were the diameter of the knop, diaphragm diameter, height, and number of petals. The method used was to measure the parameters by using tape measure. The data collected for physical environment were slopes, air temperature, altitude, and substrate or soil depth. The method used for temperature was measuring the temperature of the air around the growing place by using an alcohol thermometer, altitude was a direct measurement using an altimeter, the slope of the place was visual and crosscheck against the map, the substrate was visual, and the depth of the soil was measurements using the ruler.

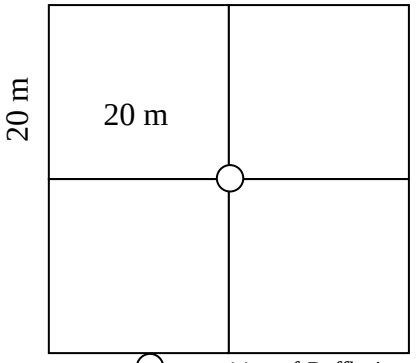

Figure 1. Sample Plot for Vegetatian

Associated with the characteristics of vegetation, the data collected were the type and number of each plant, and the diameter of the plant stems for pole and tree levels. The method used was a sample plot measuring 20x20 as many as four piece with the center point location of the existence of *Rafflesia* (Figure 1). Associated with the characteristics of host plants, the data collected were the type and type of habitus. The method used was visual.

2.3. Analysis

The analysis conducted on the data collected is descriptive. Especially for plants, the analysis also calculated density of each growth rate: seedlings, sapling, poles, and trees.

3. Results and Discussion

3.1. Morphological and Species

The presence of *Rafflesia* at the study site was first discovered by researchers on November 24, 2014. The species has five crown leaves and red. The dome is white and has no spikes (Figure 2). The species found in this site has the same description as *Rafflesia rochussenii* Teijsm. et Binn. inhabiting Gunung Gede Pangrango National Park (Figure 3) (Saadudin, 2011). In addition to *R. rochussenii*, *R. fatma* is also a type of *Rafflesia* spread in Central Java and West Java (Zuhud et al., 1998; Mursidawati ,2012; Suwartini et al., 2008). However, the species encountered at the study sites have different characteristics from the *R. patma* (Mursidawati, 2012). Although both have five crowns, but the colors are different and the dome of R. fatma has thorns (Figure 4) (Mursidawati, 2012). Therefore, the researchers believe that the species located in the research location is *Rafflesia rochussenii* Teijsm. et Binn.

The flower of the species at the study site was 13-14 cm in diameter. Backer in Zuhud et al. (1998) mentioned that the inter-species of *Rafflesia* have flower varying in diameter, which ranges from 20-150 cm. Therefore, flower of this type is smaller than other general type. In other words, this type can be categorized as small *Rafflesia*.

Observations were made again on November 20, 2016. The study did not find *R. rochussenii* in flowering. Researchers only see knop and flower remnants (Figure 5). Knop encountered was two pieces, one of that was destroyed and the other has begun to rot and apart from the host plant. Meanwhile, the remains of flowers only found one individu. However, the knop that begins to rot can still be measured in diameter, height, and number of petals. The results showed that the knop has 11 cm in diameter, 7 cm in diaphragm, 5 cm in height, and 8 pieces in petals (Figure 6). Knop is the beginning of the *Rafflesia* cycle, including *R. rochussenii* (Saadudin, 2011). In *R. rochussenii*, the first knop until the flowers will bloom within 739 days; flowers will bloom until complete takes 35 days; and flowers bloom until wilting takes 7 days (Saadudin, 2011).


Figure 2. *Rafflesia* in study site


Source: Saadudin (2011)
Figure 3. *Rafflesi rochussenii* in Gunung Gede Pangrango National Park

Source: Mursidawati (2012)
Figure 4. *Rafflesi patma* in Pangandaran Nature Preserve

This study has not known exactly the cause of death of flowers and knobs. At the time of the research, there were marks of erosion. The loss of soil layer is thought to be the cause of death, both the flower and the knop because the erosion resulted in the release of flowers and knobs from the host. Not only flowers and knobs are experiencing death, but also the bottom of host plants were rotting. In addition to erosion, the death of *Rafflesia* and host trees is also suspected due to other factors, such as wild boar disturbances. The roots of host plants is easily injured by the footprints and nails of animals, so that the roots of host plants and *Rafflesia* are infected (Nugroho 1991). Another assumption related to the cause of death was the high humidity of the soil which can ultimately decompose buds, the diameter of host plants is too small, drought or lack of water and poor quality of seeds (Zuhudet al., 1993). Although the investigators suspect that the death of *Rafflesia* and host plants is more caused by erosion, it is not enough evidence that further research is needed to get a definite answer on the disturbances and factors causing death of the species and host plants at the study site. However, besides being the cause of the death of *Raflesia* sp., wild pigs are also thought to play a important role in the spread of *Rafflesia* sp. seeds, along with deer, squirrels and various ant types (Zuhud, 1999).

Figure 5. Dead *Rafflesia rochussenii*

3.2. Physical Environment

Slopes are one of the most decisive habitat factors for plant spread (Zuhud et al., 1998). The results showed that *Rafflesia*'s growing site at the study site had a very steep topography. This result was different from the results of Saadudin (2011) research in Gunung Gede Pangrango National Park; *R. rochussenii* was never found on the slope class > 45%, but on the slope 7-43%. However, the most common locations are in the 15-45% slope class and the slope class is the most suitable habitat for *R. rochussenii* (Saadudin, 2011). Agustini et al. (2004) at the Tapos Resort found that *R. rochussenii* is mostly found in slopes of 10-20%. The low spread of *R. rochussenii* in a very steep area is suspected because in that class the animals acting as seed dispersers is difficult to pass (Saadudin 2011). For *R. zollingeriana* in Meru Betiri National Park, many species are found on a very steep slope class; 61-80% (Zuhud, 1989) and for *R. patma* in Pangandaran Nature Reserve and Leuweung Sancang Nature Reserve, many species are spread over 0-8% slopes (Gamasari, 2007; Herdiyanti, 2009).

In addition to slopes, altitude is one of the important habitat factors for the spread of plants (Zuhud et al., 1998). Based on its height, this research encountered *R. rochussenii* at an altitude of 536 masl. This research is not different from the statement Nais (2001) which showed that *R. rochussenii* found from 700 masl in height. In Gunung Gede Pangrango National Park, *R. rochussenii* found at an altitude of 1246 - 1375 masl, but the location of the most common is from 1310 mdpl (Saadudin, 2011). Zuhud et al. (1998) also mentions that *R. rochussenii* has a place to grow at an altitude of 1350 masl and Agustini et al. (2004) encountered the species at an altitude of 1150-1300 masl. However, the results of this study have shown that the distribution of *R. rochussenii* is not limited to mountainous forests, but can also grow in lowland forest ecosystems with hilly conditions.

This study also has recorded the temperature of the air in the growing place of *R. rochussenii*. The results show that the air temperature in the place is 26ºC. The results of this study are not much different from the results of research Saadudin (2011) in Gunung Gede Pangrango National Park. Species *R. rochussenii* can grow in locations with air temperature ranging from 15-25ºC, with humidity 85-95% (Saadudin, 2011). The air temperature at which *R. rochussenii* grew at the study site was one degree higher than in Gunung Gede Pangrango National Park because the location of *Rafflesia* encountered at the study sites was lower than in the conservation area. The temperature will tend to decrease as the altitude increases from the sea surface. This study did not measure the temperature of the soil. In Gunung Gede Pangrango National Park, the average temperature of the land where *R. rochussenii* grows is 20ºC (Saadudin, 2011).

For soil, this study is limited to the depth measurement of the soil layer. The results showed that the depth of solum of soil where the *Rafflesia* grows is very thin, only 7 cm. In addition to having a very steep topography, the condition of the forest floor around where *Rafflesia* grows within a radius of 20 meters is mostly rocky. Steep and rocky topography is one of the causes of the thin solum of the soil. This is because the steep topography allows the soil to erode and the rate of erosion will be higher than the weathering rate of both soil and rock. Ground conditions at the site where *Rafflesia* grows and its host have a sour to slightly acidic pH, relatively high N and C element content; the content of P, Ca and Mg were relatively low and K and Na were medium (Saadudin, 2011).

In the first encounter, the condition of the land where *Rafflesia* grows (in this case its host) is wet which is marked by the amount of water seepage in the lower part of the soil. The condition of the wet soil is due to the rainy season. In a study conducted in November 2016, the condition of the soil is relatively dry compared to late 2014. Although according to Saadudin (2011) the condition of the land where the *Rafflesia* hosts grow is not very moist, but this research has shown that *R. rochussenii* can also grow on land rather wet.

3.3. Host Characteristics

The existence of host plants is very important for the survival of *Rafflesia*. Research has also observed the characteristics of plants that act as host *R. rochussenii*. The host plant is classified as liana, the skin surface is uneven, grooved, and cracked (Figures 7a and 7b). As with other types of lianas, the host plant has a compound leaf system and fingers, with five leaves (Figure 8). These characteristics are similar to descriptions of the type *Tetrastigma leucostaphylum* (Backer & Van den Brink, 1983 in Julianti, 2006; Suwartini et al., 2008) which is one of the hosts of R. rochussenii (Zuhud et al., 1998). However, researchers have not been able to determine whether the host plant is a type of *T. leucostaphylum*. Researchers can

only mention the host plant to the level of the genus, namely *Tetrastigma* sp.

Fig. 7a. Stem of *Tetrastigma* sp.

Fig. 7b. Rooting of *Tertrastigma* sp.

Fig. 8. Host Leaves of *Tetrastigma* sp.

The study obtained results that the diameter of the host plant stems on the bottom (close to the ground surface) 0.9-1.9 cm. The diameter is smaller than the diameter that is commonly overgrown by Rafflesia. Earlier researchers mentioned that Tetrastigma that mostly overgrown with *Rafflesia* generally ranges from 1.5-3.4 cm (Suwartini 2008).

Tetrastigma belongs to the seed plant of the Vitaceae family and belongs to the plant of two houses (dioeceus), where the pistil and stamens are present in different individuals (Priatna, 1989). *Tetrastigma* is an intolerant plant (requiring direct sunlight to survive) so that in order to obtain direct sun the *Tetrastigma* must propagate in the surrounding tree (Suwartini et al., 2008). Research also shows that *Tetrastigma* propagates to the top of the canopy to obtain sunlight and requires a supportive tree. This study obtained the result that the tree that is the supporter of *Tetrastigma* is *Villebrunea rubescens*. This result is different from the results of previous research at Leuweung Sancang Nature Reserve (Suwartini et al. 2008). The trees species supporting the *Tetrastigma* were *Terminalia catappa*, *Eugenia cymosa*, *Actinodaphne procera*, and *Ficus altissima* (Suwartini et al., 2008). Research in the Leuweung Sancang Nature Reserve did not encounter nangsi as trees supporting *Tetrastigma* (Suwartini et al., 2008). The difference is suspected because of differences in vegetation characteristics. However, the results of this study also can not say whether there is an association or not between *Tetrastigma* and the type of tree that can be a supporter so it needs to do further research.

The diameter of the tree supporting the *Tetrastigma* in this study ranged from 10 to 30 cm, whereas in the study of Suwartini et al. (2008) is 40 cm up in generally. The results of this study also show that the diameter of trees that can be a supporter of *Tetrastigma* varies, depending on condition of the habitat, and trees with the growth rate of the pole can also be a supporter of *Tetrastigma*. However, a larger diameter tree helps *Tetrastigma* propagate over the canopy to get more sunlight than a small diameter tree.

3.4. Vegetation Characteristics

Research conducted on 4 plots of samples with a total area of 0.16 ha has recorded tree level plants as many as 59 individuals from 13 species or about 8 species per 0.1 ha. The number of tree species in this study area is higher than the number of tree species in the habitat of *R. patma* in the Leuweung Sancang Nature Reserve, ie 5 species of trees per 0.1 ha (Suwartini et al. 2008). At the sappling level with 0.01 ha sample plots were obtained as many as 9 individuals from 5 species. At the seedling level, 2 species and 2 individuals were recorded, while at the shrubs level found 3 species and 11 individuals (Table 1). At the sapling, seedling and shrubs, the number of species per unit area at the study sites is lower than that in the area covered by *R. patma* in the Leuweung Sancang Nature Reserve (Suwartini et al., 2008). Therefore, this study shows that plant biodiversity at the tree level at the study site is higher than in Leuweung Sancang CA, whereas at the stake, seed and lower plant level is lower (Suwartini et al., 2008).

Table 1. The Condition of Vegetation Found Around *Rafflesia* Sp.

No	Pohon	Number of Species	Number of Individuals	Density (ind/ha)
1	Tree and Pole	13	59	175
2	Sapling	5	9	300
3	Seedling	2	2	625
4	Shrubs	3	11	1250

Table 1 shows that the highest plant density is found in the lower plants, which is 1250 ind/ha and the lowest vegetation density is at the tree level of 175 ind/ha. The higher number of shrubs found in the study sites shows that much sunlight enters the forest floor due to the rarity of canopy and tree density. Sunlight and shade are two of the many factors that affect the growth of shrubs (Setyawan et al., 2006). The relatively low tree density at the study site is thought to be due to the thin and rocky soil layer that makes it difficult for trees to grow in large quantities.

An important value index is a quantitative parameter that can be used to express the degree of dominance of species within a plant community (Soegianto 1994). Dominant species within a community will have a high value index (Indriyanto, 2010). This study obtained results that the location where *R. rochussenii* grows is dominated by *Villebrunea rubescens* for tree level, *Nephelium* sp. for the sapling (Table 2). At the seedling level, the species found are *Sterculia oblongata* and one unknown species, both of which have the same INP. At the shrubs level, of all three species encountered, all have not been identified scientifically, and there is one species that dominates with INP of 127.27%.

Tree level species that dominate Rafflesia's growth sites in this study is different with in Gunung Gede Pangrango National Park (BTNGGP 2003). In TNGGP, tree growth rates are dominated by Schima walichii. Other types of plants that exist are *Ficus ribes*, *Syzygium* sp., *Castanopsis argentea*, *Quercus* sp., *Altingia excelsa*. For the shrub level, the growing species include *Ardisia fuliginbia*, *Pandanus* sp., *Pinanga* sp., and *Laportea stimulants*. For the lower plants, the growing species are *Begonia* sp., *Cyrtandra picta*, and *Curculigo latifolia* (BTNGGP 2003). In the Leuweung Sancang Nature Reserve, the species dominating *R. patma* site is also different from the dominating species in the study sites. The types of trees that dominate where *R. patma* is grown are *Ficus altissima*, *Terminalia catapa*, *Eugenia cymosa*, and *Actinodaphne procera*. For shrubs and seedlings, the dominating species are *Bridelia glauca*, *Tetrastigma leucostaphyllum*, and *Smilax macrocharpa* (Suwartini et al., 2008). This difference occurs because of many factors, such as differences in the characteristics of the place of growth and altitude. Differences in composition and species of trees that dominate *Rafflesia*'s growing site in research sites elsewhere such as TNGGP show that the presence of *Rafflesia* species is not associated with the presence of a tree species.

Table 2. Important Value Index (IVI) at All Levels

No	Scientific Name	Local Name	Family	IVI (%)
Tree*				
1	*Musa paradisiaca*	Pisang		43.69
2	*Evodia samentoda*	Ki sampang	Rutaceae	15.31
3	*Villebrunea rubescens*	Nangsi	Urticeae	99.46
4	*Laportea stimulans*	Pulus	Urticeae	20.33
5	*Bridelia monoica*	Kanyere	Verbenaceae	3.41
6	Unidentified	Langkap	Arecaceae	9.14
7	*Ficus fistulosa*	Beunying	Moraceae	6.24
8	*Artocarpus elasticus*	Teureup/Benda	Moraceae	27.64
9	*Erythrina variegate*	Dadap	Fagaceae	7.1
10	*Lithocarpus* sp.	Pasang		27.15
11	Unidentified	Ipis kulit		12.26
12	*Sterculia campanulata*	Beurih	Sterculiaceae	21.74
13	Unidentified	Unidentified		6.52
Sapling				
1	Unidentified	Ki gedong		22.22
2	*Syzygium* sp.	Kopo lalay		22.22
3	*Laportea stimulan*	Pulus	Urticeae	22.22
4	*Nephelium* sp.	Rambutan hutan	Sapindaceae	66.67

5	Unidentified	Unidentified	44.44
6	Unidentified	Unidentified	22.22
Seedling			
1	*Sterculia oblongata*	Hantap	100
2	Unidentified	Unidentified	100
Shrubs			
1	Unidentified	Unidentified	127.27
2	Unidentified	Unidentified	18.18
3	Unidentified	Unidentified	36.36
4	*Sterculia oblongata*	Hantap	18.18

* although it is not a category of trees, this study includes bananas and family Arecaceae

4. Conclusion

The study concluded that *Rafflesia* located at the study site is *Rafflesia rochussenii*. The place to grow is very steep, has a shallow soil layer and rocky. Hosts can only be identified up to the genus level, *Tetrastigma* sp. The habitats are secondary natural forests and are dominated by *Villebrunea rubescen* species and belong to the secondary natural forest.

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