Vegetation Structure and Composition on *Rafflesia zollingeriana* Habitat in Meru Betiri National Park

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Abstract. Meru Betiri National Park (TNMB) has five forest formations, e.g. coastal forest, mangrove forest, swamp forest, rheophyte, and lowland rain forest. The study aims to analyze vegetation structure and composition on *Rafflesia zollingeriana* habitat and to map the distribution of trees in TNMB. Vegetation data, diameter at breast height, and canopy height obtained by using line-transect method and analyzed using vegetation analysis. The sampling method used purposive sampling. TNMB had 64 trees species with 1,366 seedlings and saplings, 257 poles, and 183 trees. Pancal kidang (*Aglaia variegata*) had the highest Important Value Index (IVI) amounting to 32.46%. The result showed that the community similarity index (IS) in two sample plots was 86.86%. *Tetrastigma* spp. is a liana as a host of *Rafflesia zollingeriana*, and only found pancal kidang, besuleh, welangan, magnolia flower, laban, and rauh trees.

1. Introduction

Meru Betiri National Park (TNMB) is a national park in Java Island that has five forest formations, e.g. coastal forest, mangrove forest, swamp forest, rheophyte, and lowland rain forest. TNMB designated as one of the world heritage and habitat for the conservation of flora and fauna [1]. Most of the area is a lowland rain forest and has a variety of flora as many as 518 species, 15 of which are protected species of flora.

*Rafflesia zollingeriana* Koord. is one of the protected flora species found in TNMB that also become an endemic flora of Java island. Belongs to Rafflesiaceae family, *R. zollingeriana* is a holoparasitic plant that depends entirely on other plants for food needs. This plant does not have a grain of chlorophyll but has a suction or Haustoria roots, and its host is a liana plant of the genus *Tetrastigma* [2]. Koorders initially discovered *R. zollingeriana* in Puger, Jember, in 1895 and on the south coast of Banyuwangi in 1918 [3]. This species grows in dry lowland forest at an altitude of 1-270 m above sea level. Recently *R. zollingeriana* population threatened due to the utilization of its flower buds as a medicine.

*R. zollingeriana*, which is a holoparasitic plant, much depends on host plants of *Tetrastigma*. The study of the existence of *Tetrastigma* can be done by analyzing its structure and composition to provide information enabling the environment for the growth of *Tetrastigma* and *R. zollingeriana*. Measurements of the structure and composition stands are useful to understand the distribution of plant species in the TNMB, particularly those that are protected. This study aimed to analyze the structure and composition of vegetation on the habitat of *R. zollingeriana* at TNMB.
2. Method

Number of *Tetrastigma* wrapped around the tree and vegetation data (name and number of species, diameter at breast height, and canopy height) collected in two sample plots (SP) of 100 m x 100 m. Each SP consists of 25 plots of 20 m x 20 m to observe tree level and 10 m x 10 m for pole level (Figure 1). The sampling technique used is purposive sampling based on the presence of *R. zollingeriana*.

![Figure 1. Samples plot of vegetation analysis at the level of the pole and tree.](image)

Where:

A = Subplot for the seedling stage (2 m x 2 m)
B = Subplot for saplings (5 m x 5 m)
C = Subplot for poles (10 m x 10 m)
D = Subplot for trees (20 m x 20 m)

The Importance Value Index (IVI) and Index of Similarity (IS) were analyzed using the below equations [4]. Importance Value Index (IVI) aims to analyze the dominance of species in a particular community by adding relative density, relative frequency, and relative dominance. The similarity index (IS) used to examine the similarity of vegetation at different sample plots.

\[
\text{Density} = \frac{\text{Number of species}}{\text{Total area sampled}}
\]

\[
\text{Relative density} = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100
\]

\[
\text{Frequency} = \frac{\text{Area of plots is which a species occurs}}{\text{Total area sampled}}
\]

\[
\text{Relative frequency} = \frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100
\]

\[
\text{Dominance} = \frac{\text{Total basal area of a species}}{\text{Total area sampled}}
\]

\[
\text{Relative dominance} = \frac{\text{Dominance of a species}}{\text{Total dominance of all species}} \times 100
\]

\[
\text{IVI} = \text{Relative density} + \text{Relative frequency} + \text{Relative dominance (poles and trees)}
\]

\[
\text{IVI} = \text{Relative density} + \text{Relative frequency (seedlings and saplings)}
\]

\[
\text{IS} = \frac{2W}{a + b} \times 100\%
\]

Where:

W: Lowest number of individuals of the same species in the stands that compared
a: The total number of individuals in the sample plot 1
b: The total number of individuals in the sample plot 2

3. Result and discussion

3.1 The Composition of The Species and Structure of Stands

Vegetation analysis clearly showed reverse J curve for the growth structure in TNMB (Figure 2). A total of 64 species found with 1,366 individuals at the regeneration levels (seedling and sapling), 257 individuals of the pole, and 183 individuals of the tree.

![Figure 2. The number of individual plants on each level of growth.](image)

Reverse J curve may reflect the curve of vegetation average growth in natural forests. The curve showed that forest in the sample plots still in stable condition and has not disrupted yet. The poles and trees are dominant if the IVI greater than 15% [5].

Based on 64 species IVI calculation, pancal kidang species (*Aglaia variegata*) has the highest IVI among all the species found (Tables 1 and 2). Dominant species has well adaptation toward environment factors than other species in the same location. The species that have a higher IVI will be more stable in terms of the resilience of species and growth. Pancal kidang would be adapted to its environment so that the existence of this species tend to be stable in the observation plots. Besides, the highest IVI of seedlings, saplings, and poles also belongs to pancal kidang species [7].

| Table 1. Tree species with the highest IVI in SP-1 |
|-----------------------------------------------|
| Species of plants | IVI (%) |
|-------------------|---------|
| *Aglaia variegata* | 32.46   |
| *Artocarpus elasticus* | 21.48 |
| *Tetrameles nudiflora* | 15.36 |
| *Kasapan* | 15.05 |
| *Vitex pubescens* | 14.46   |
| *Pometia tomentosa* | 14.40  |
| *Parkia roxburghii* | 13.73  |
| *Pterospermum diversifolium* | 13.17 |
| *Sandoricum koetjape* | 12.01 |

| Table 2. Tree species with the highest IVI in SP-2 |
|-----------------------------------------------|
| Species of plants | IVI (%) |
|-------------------|---------|
| *Aglaia variegata* | 53.90   |
| *Ficus spp.* | 27.59 |
| *Pterospermum diversifolium* | 21.02 |
| *Vitex pubescens* | 17.52 |
| *Berasan* | 15.41 |
| *Xanthophyllum vitellinum* | 15.23 |
| *Pometia tomentosa* | 11.22 |
| *Chydenanthus excelsus* | 10.47 |
| *Bischofia javanica* | 10.03 |

We found the canopy stratification that fills the ecosystem are trees with stratum B, C, and D. A 27-meters Laban (*Vitex pubescens*) categorize as Stratum B, which is the highest stratum with a height
ranging from 20-30 m. Stratum C consists of a tree with a height of about 4-20 meters filled with Pancal Kidang tree (*Aglaia variegata*), Sapan, Walnuts Forest, Kecapi (*Sandoricum koetjape*), Luwingan (*Ficus hispida*), Talesan Kuning, Burahol (*Stelechocarpus burahol*), Kasapan, and Welangan (*Pterospermum diversifolium*). Stratum D as a whole dominated by a small tree species Jejerukan of Rutaceae family. Figure 3 illustrate the vertical structure of vegetation in TNMB.

The vertical structure that filled by stratum B showed that dominant species populate the ecosystem were medium-sized trees species. The success of a particular species of tree stratum growth highly depends on climate factors and the environment in which it grows. The microclimate environment influenced by the availability of nutrients, organic, and inorganic materials. Soil plays an important role as the creator of certain physical conditions such as humidity, water content, and nutrients that, in turn, will determine the quality of habitat. The success of the tree stratum growth related to the regenerated seedlings (seedling and sapling) growing into a tree [8]. Topography in TNMB that hilly, undulating and mountainous also affect the stratification of trees and poles species.

The horizontal structure of vegetation described by the diameter class of each individual. The decrease in the number of individuals with increasing diameter classes (Figure 4) showed that the regeneration in the ecosystem was going normally.

### 3.2 Similarity and Dissimilarity Vegetation Index

The community similarity index (IS) on two sample plots was 86.86% while the index of dissimilarity of 13.13%. The value of the similarity index is more than 75% of both plots showed that species communities that populate the ecosystem in each sample plots were relatively the same. The difference in the species community on both of the sample plots may occur due to differences in the elevation of sample plots used, which will provide the different physiognomy of vegetation community constituent. These conditions cause the emergence of new species, indicate the start of a change in environmental conditions. The number of species and number of individuals found in SP-2 is higher than SP-1.

### 3.3 Rafflesia zollingeriana Habitat Tendency at The Site Level

The study found some spread points for *R. zollingeriana* habitat. *R. zollingeriana* is one of the *Rafflesia* species spread in Java that growing in dry lowland forest at an altitude of 1-270 meters asl [9]. Decreasing of *R. zollingeriana* existence, causing this species to be an endemic plant species in
TNMB [3]. The results showed that the habitat of *R. zollingeriana* found at a relatively tends rocky oblique tread where *Tetrastigma* sp, its host, forming buttresses at the roots.

![Graph showing distribution of Tetrastigma sp. by diameter class.](image)

Note: DC (Diameter class): A: 10 cm - <20 cm; B: 20 cm - <30 cm; C: 30 cm - <40 cm; D: 40 cm - <50 cm; E: 50 cm - <60 cm; F: 60 cm - <70 cm; G: 70 cm - <80 cm; H: 80 cm - <90 cm; I: 90 cm - <100 cm; A: 100 cm - <110 cm; K: > 110 cm

**Figure 4.** Distribution of the horizontal structure of vegetation by diameter class.

### 3.4 Distribution of *Tetrastigma* sp.

*Rafflesia* exists near *Tetrastigma* sp. as its primary host. *Tetrastigma* sp. a liana species of the family Vitaceae. *Tetrastigma* sp. rod is large, soft, and very porous, indicates the large of water content in the trunk. The content of water and nutrients in the *Tetrastigma* trunk is a source of nutrients for *Rafflesia*. *Tetrastigma* species found in TNMB are *Tetrastigma papillorium* and *T. lanceolarium*. These findings are the same with the results of research conducted by Lestari *et al.* [3] who found *Tetrastigma papillorium* and *T. lanceolarium* as a host of *R. zollingeriana*.

*Tetrastigma lanceolarium* is a liana found in the secondary forests, primary forest edges, riparian, upland forests, and lowland forests [11], while *T. papillorium* is a liana that can be found from 50-2000 m asl. Their habitat is at an open area of lowland to the mountain forest. This species can easily found in the riverside or habitat that has high humidity [10]. Thus, *Rafflesia* found on rocky slopes also be the habitat of *Tetrastigma* sp. In this case, *Tetrastigma* sp. found in dry areas on the edge of the primary forest.

### 3.5 The Influence of Vegetation Structure and Composition to the Spread of *Tetrastigma* sp.

*Tetrastigma* sp. is a liana that is intolerant and thus requires trees to propagate and reach the canopy to meet its needs for sunlight. In addition to requiring large-diameter trees, *Tetrastigma* sp. also needs small-diameter trees for the foundation of the vine [13], while plants that are becoming intermediaries to connect with the host tree is herbaceous plant [10]. Therefore, the structure and composition of vegetation affect the spread of *Tetrastigma* sp. Trees used by *Tetrastigma* to propagate on the sample plots described in Table 3.

**Table 3.** The tree used by *Tetrastigma* sp. to propagate at the sample plot.
| Vegetation types           | Number of individuals | On average class diameter (cm) |
|---------------------------|-----------------------|-------------------------------|
| Aglaia variegata          | 14                    | 10-40                         |
| Chydenanthus excelsus     | 2                     | 60-70                         |
| Pterospermum diversifolium| 2                     | 30-40                         |
| Michelia champaca         | 2                     | 20-30                         |
| Vitex pubescens           | 2                     | 30-40                         |
| Dracontomelon mangiferum  | 2                     | 30-40                         |

There were 24 distribution points of Tetrastigma sp at the sample plots. Tetrastigma sp. requires propagation of trees with more giant diameter trees and tree height of more than 10 m, while for the pedestal propagation, Tetrastigma sp. requires small-diameter trees or shrubs plant [10]. The average diameter of the tree being propagation tree is 30-40 cm, with trees height over 10 m. The dominant propagation tree is Pancal kidang (Aglaia variegata). There is no particular type of propagation tree for Tetrastigma sp. [10]. This study showed that the propagation tree for Tetrastigma sp. was trees with higher IVI. In general, propagation trees need much light for their growth.

Pancal kidang (Aglaia variegata) is a pioneer species lived in lowland forests and mixed dipterocarp forest [14], spread well at altitude 50-100 m asl. Other species, such as Welangan (Pterospermum diversifolium) and Besuleh (Chydenanthus excelsus), are another intolerant pioneer tree species found at the study site.

4. Conclusion

Rafflesia zollingeriana habitat stands have complete stratum (stratum A to E). Bandealit Resort has 64 number of trees species with a number of individuals is 1,366 individuals of seedlings and saplings, 257 individuals of poles, and 183 individuals of trees. Pancal kidang (Aglaia variegata) is species that has the highest IVI among all the species found, amounting to 32.46%. The result of the community similarity index (IS) in two sample plots is 86.86%. The host of Rafflesia zollingeriana (Tetrastigma sp.) found creeping on tree species Pancal kidang (Aglaia variegata), Laban (Vitex pubescens), Besuleh (Chydenanthus excelsus), Magnolia flower (Michelia champaca), Welangan (Pterospermum diversifolium), and Rauh (Dracontomelon mangiferum) that have a relatively large diameter. Tetrastigma require tall trees more than 10 meters and diameter at breast height relatively large to support life. Rafflesia zollingeriana in Bandealit Resort always found in the land that relatively oblique and tends to rocky hill.

Acknowledgments

We would like to express our gratitude to all those who gave us the possibility to complete this paper. Firstly to the whole team of Tree Species Group 2018 for helping to complete this research, both in data collection and data processing, so that this paper can be completed. Secondly, we would like to forward our gratitude to Dr Ir Iwan Hilwan, MS as lecturer and Tree Species Group 2018 supervisor who always helped us in completing this paper in all forms of assistance which is always given.

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