Biodiversity exploration of host trees (phorophyte) of epiphyte orchids in the natural habitat

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Abstract. Epiphyte orchids host trees grow naturally in tropical rainforests. Nowadays tropical rainforest destruction could decreased these specific host trees alongside with the various epiphyte orchids. Little information could be found on epiphyte host trees in Indonesia. The aim of this research was to explore the biodiversity of epiphyte orchid host trees (phorophytes) at Highway Forest Park Raden Soeryo and supported by exploration data in 2003, 2005, 2018 at Bromo Tengger Semeru National Park, and in 2006, 2007 at Highway Forest Park R. Soeryo. Exploration of epiphyte orchid host trees at Jogging Track site and Coban Watu Ondo site, Highway Forest Park R. Soeryo, East Java was conducted in May-July 2019. The research methode was carried out using a purposive sampling methode at Jogging Track and line transect at Coban Watu Ondo. From the main transect 30 plots were made with the area of each plot 20 m x 20 m with a distance between plots of 60 m at Jogging Track site and 100 m at Coban Watu Ondo. From the exploration we found at Jogging Track site 15 species of 173 hosts trees with diversity index 1.57 (medium). While at Coban Watu Ondo 10 species of 171 host trees with diversity index 1.52 (medium). Host trees bark characterizes by rough, grooved, hard skin no latex, tree diameter 20.00-85.00 cm, canopy medium-sparse. The biodiversity of porophyte trees exist in the area of National Park Bromo Tengger Semeru and Highway Forest Raden Soeryo south of Mt Arjuno Lalijiwo and east of Mt Anjasmoro regions is quite diverse.

Keywords: Host trees, epiphyte orchid, biodiversity, exploration

1. Introduction

Epiphyte orchids host trees grow naturally in tropical rainforests. Nowadays increasing tropical rainforest destruction like illegal logging and overexploitation could decreased these specific host trees alongside the epiphyte orchids germplasms. Little information could be found on epiphyte host trees in Indonesia. Nurfadilah [1] found 9 phorophyte species at Coban Trisula Bromo Tengger Semeru National Park East Java, Indonesia. Phorophyte preference by epiphyte orchids apparently depend on morphological characters of its barks [2]. Rugose and scaly barks [2] favour seed adherence compared to smooth barks [3]. Epiphyte orchids show a clear preference for a particular phorophyte species because of its bark roughness [4]. Beside age and canopy character which may provide favourable microclimate [5].
To save the existence of phorophyte and epiphyte orchids, it is necessary to keep them from the threat of extinction. Some efforts that could be done is by conducted exploration, inventory and conservation activities periodically.

Highway Forest Park Raden Soeryo is located at 112°30’-112°40’ and 7°45’-7°50’ SA, covering forest region at group of Mt Arjuno-Lalijiwo as part of four districts: Mojokerto district (North), Pasuruan district (East), Malang district and Batu city (South), and Jombang district (West) [6]. Highway Forest Park R. Soeryo characterized by primary forest, green mountain forest at 2000-2700 asl and savanna [7] [8]. It is a conservation region for collection of plants and endemic or introduced animal. The utilization of this area covers the need for research, culture, recreation, plantation and farming. The location of Highway Forest Park Raden Soerjo is in the western part of Malang City, while National Park Bromo Tengger Semeru is North-East of Malang City.

The aim of this research was to explore the biodiversity of epiphyte orchid host trees (phorophytes) at Highway Forest Park Raden Soeryo and supported by data resulted from exploration in 2003, 2005, 2018 at Bromo Tengger Semeru National Park, and in 2006, 2007 at Highway Forest Park R. Soeryo.

2. Methodology

Exploration was carried out using a purposive sampling method at Jogging Track site and line transect at Coban Watu Ondo. From the main transect 30 plots were made with the area of each plot is 20 m x 20 m with a 60 m distance between plots at Jogging Track site and 100 m at Coban Watu Ondo. The coordinates of each plot was recorded using GPS. The first step was pre-survey to determine the coordinates of the track based on the information from HFP R. Soeryo forest ranger on the accessibility of the tracks and the presence of epiphyte orchid host trees.

Identification of orchid host tree species was carried out by using Flora of Java volume I and II [9]. The parameters in the identification of orchid host trees were morphological characters which included physical characteristics of tree bark, diameter (DBH) and canopy.
Figure 1. Map of the research location in Highway Forest Park Raden Soeryo East Java Indonesia
Vegetation analyses were: density, relative density, frequency, relative frequency, important value index and Shannon-Wiener diversity index, dominance:

\[ D_i = \frac{\sum N_i}{A} \]  
Di = Density species i.  
Ni = Total amount species i.  
A = Field (m²)

\[ Rdi = \frac{D_i}{\sum D} \times 100\% \]
Rdi = Relative density of species i.  
Di = Density species i.  
D = Total of density species.

\[ F_i = \frac{F_i}{\sum F} \]
Fi = Frequency of species i  
Ji = Total plot that have i species inside 
K = Total plot.

\[ RFi = \frac{F_i}{\sum F} \times 100\% \]
RFi = Relative frequency of species i.  
Fi = Frequency species i.  
\( \sum F \) = Total of i species frequency.

Shannon-Wiener Diversity Index (Sarma and Das, 2015; Indriyani, Flamin and Erna, 2017):

\[ H = -\sum \left( \frac{n_i}{N} \ln \left( \frac{n_i}{N} \right) \right) \]  
Pi = \( \sum n_i/N \)  
H = Shannon-Wiener Diversity Index  
Ni = Important Value Index  
N = Total of Individu

Dominance (Fachrul, 2007):

\[ D = \frac{\text{Total flat area of a species}}{\text{Area of sampling}} \]

Note: Flat area of a species = Flat area of a species \( \frac{1}{4} \pi D^2 \)

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

Important Value Index for tree [10]:

\[ IVI= Rdi + RFi + DR \]
3. Results

Exploration was conducted from May until July 2019 in between the end of wet season and the beginning of dry season in Indonesia. At Jogging Track site 1641-1785 m asl; coordinate -7° 7' 42.70” latitude 112° 5’ 34.95 longitude to -7° 7’ 45. 29” latitude 112° 5’35.45” longitude (Figure 1); temperature 17°C-24°C; RH 79-93%. It has been successfully identified 15 phorophytes species of 173 individual trees. *Engelhardia spicata* has the highest IVI of 125.89 (Figure 2) with morphological characters of bark rough, grooved, hard, no latex (Figure 3). *Dysoxylum leschenaultianum* has the lowest IVI of 1.97 (Figure 2) with morphological characters of semi rough, grooved, hard skin, no latex (Figure 3). Diversity Index Shannon-Wiener 1.57. In this area, we found 8 non phorophytes species of 537 individual trees. *Ficus lepicarpa* has the highest ivi of 137.13 (Figure 4) with morphological characters of bark smooth and has latex (Figure 5). The lowest ivi is *Rhamnus nepalensis* kin with ivi 1.94 (Figure 4); with morphological characters of bark smooth no latex (Figure 5). Diversity Index Shannon-Wiener 1.87. The phorophyte trees is 24.37 % and non phorophyte is 75.63 from total trees in the exploration area.

![IVI Of Host Tree Epiphyte Orchids in 2019](image)

*Figure 2. Important value index of host trees at Jogging Track site*
| Species                  | IVI   | Morphological characters                              | Picture |
|--------------------------|-------|-------------------------------------------------------|---------|
| *Engelhardia spicata*    | 125,89| Rough, grooved, hard, no latex                        |         |
|                          |       | Tree diameter 20.00-85.00 cm                           |         |
|                          |       | Canopy medium-sparse                                   |         |
| *Dysoxylum leschenaultianum* | 1.97  | Semi rough, grooved, hard, no latex                    |         |
|                          |       | Tree diameter 33.00 cm                                 |         |
|                          |       | Canopy medium                                         |         |

**Figure 3.** Bark performance of the highest and lowest IVI of host trees at Jogging Track site.

**Figure 4.** Important value index of non host trees at Jogging Track site
| Species                  | IVI   | Morphological characters                        | Picture |
|-------------------------|-------|------------------------------------------------|---------|
| *Ficus lepicarpa*       | 137,13| Smooth, latex                                   |         |
|                         |       | Tree diameter 20.00-27.00 cm                    |         |
|                         |       | Canopy medium                                  |         |
| *Rhamnus nepalensis*    | 1.94  | Smooth, no latex                               |         |
|                         |       | Tree diameter 20.00-21.00                      |         |
|                         |       | Canopy medium                                  |         |

**Figure 5.** Bark performance of the highest and lowest IVI of non host trees at Jogging Track site.

At Coban Watu Ondo 1500-1648 m asl; coordinate -7° 72’ 996” latitude 112° 52’ 276” longitude to -7° 73’969” latitude 112°52’ 282” longitude; temperature 19.5°C-23.3°C; RH 80-99%. We identified 10 species phorophytes of 171 individual trees. *Engelhardia spicata* has the highest IVI of 130.44 (Figure 5) with morphological characters of bark rough, grooved, hard, no latex (Figure 6). *Casuarina junghuhniana* has the lowest IVI of 3.87 (Figure 6) with morphological characters of bark rough, grooved, hard, no latex (Figure 7). Index Diversity Shannon-Wiener 1.52. There are 7 species non phorophyte of 536 individual trees. Index Diversity Shannon-Wiener 1.96. *Macaranga sp* has the highest IVI of 68.84 and *Toona sureni* has the lowest IVI of 28.69 (Figure 8). With morphological characters which are smooth skin, latex but also no latex (Figure 9). The phorophyte trees is 24.19 % and non phorophyte is 75.81 from total trees in the exploration area. Supported data from earlier explorations was recorded as follows:

At National Park Bromo Tengger Semeru South of Mt Semeru resort Pronojiwo 7 species phorophyte were found. They were *Quercus platicarpa, Lithocarpus platycarpus, Ficus retusa, Ficus benjamina, Radermachera gigantea, Ficus ampelas* [11].

At National Park Bromo Tengger Semeru East of Semeru resort Senduro 16 species phorophyte were found, they were: *Agathis dammara, Artocarpus heterophyllus, Bischofia javanica, Celtis wightii Planch, Ficus hispida Linn., Ficus virens W.Ait, Ficus septica, Litsea sp, Magnolia blumei Prantl, Quercus elegans, Quercus teysmannii, Ficus benjamina, Croton sp, Pinanga coronaria, Ficus retusa, Trema orientalis* (L) BI.; and resort Pronojiwo there were 7 species phorophyte: *Quercus sp, Lithocarpus platycarpus, Ficus retusa, Ficus benjamina, Ficus ampelas* [12].

At East and South of Mt Arjuno Lalijiwo 20 species phorophyte, they were: *Trema orientalis* (L), *Basella rubra* Linn, *Engelhardia spicata* (BL), *Ficus sp, Quercus platicarpa, Quercus sp, Agathis dammara, Nauclea sp, Quercus cyrtoryncha, Albizia falcata, Swietenia macrophylla, Swietenia mahagoni, Erythrina lithosserma, Ficus hispida Linnf, Melastoma malabatricum (L), Actinodaphne procera, Cassia mimosoides L, Payuna leerii Kurz, gempur gunung, and enthongan (Rama, 2006) [13]. At East of Mt Arjuno Lalijiwo 14 species phorophyte, they were: *Entada phaseoloides, Ficusbenjamina, Eritrium tristagliah, Dalbergia sakulabium, Erythrina sp, Ricinus communis Linn, Artocarpus communis, Ficus hispida Linn.f, Swietenia mahagoni, Swietenia macrophylla, Hibiscus tiliaeus, Poliati sp, Parasierianthes falcata, Syzygium sp. At South of Mt Arjuno Lalijiwo 17 species phorophyte: *Trema orientalis* (L), *Berasan, Maglietta glauca* Boerl, *Casuarina junghuhniana, Agathis alba, Ficus sp, Opuntia vulgaris, Capparis micracantha, Engelhardia spicata lach (BL), Litsea chinensis Lamk, Basella rubra Linn, Helminthostachys zeylanica, Actinodaphne procera Nees, Lithocarpus sundicus (BL), Quercus cyrtorncha Miq, Melastoma malabatricum* (L). [14].
At East Mt Anjasmoro 9 species phorophyte, they were: Anonase, Eben, Flacortiace, Ficus hispida Linn F, Bischofia javanica, Turpinia phaerocarpahassh, Engelhardia spicata Lach, Quercus elegans, [15].

**Figure 6.** Important value index of host trees at Coban Watu Ondo

| Species                  | IVI  | Morphological characters                                      | Picture |
|--------------------------|------|----------------------------------------------------------------|---------|
| *Engelhardia spicata*    | 130.44 | Rough, grooved, hard, no latex. Tree diameter 20.00-85.00 cm. Canopy medium-sparse. | ![Engelhardia spicata](image) |
| *Casuarina junghuhniana* | 3.87  | Rough, grooved, hard, no latex. Tree diameter 30.00-44.00 cm. Canopy sparse. | ![Casuarina junghuhniana](image) |

**Figure 7.** Bark performance of the highest and lowest IVI of host trees at Coban Watu Ondo
**Figure 8.** Important value index of non host trees at Coban Watu Ondo

| Species         | IVI | Morphological characters                               | Picture |
|-----------------|-----|--------------------------------------------------------|---------|
| *Macaranga* sp  | 68.84| Smooth skin, latex. Tree diameter 20-27 cm. Canopy medium-sparse. | ![Image](image1.jpg) |
| *Toona sureni*  | 28.69| Smooth skin, no latex. Tree diameter 20-24 cm. Canopy medium-sparse. | ![Image](image2.jpg) |

**Figure 9.** Bark performance of the highest and lowest IVI of non host trees at Coban Watu Ondo

At National Parks Bromo Tengger Semeru resort Pronojiwo 21 species phorophyte. They were: *Alstonia scholaris* (L)R.Br., *Garuga floribunda* Dence, *Trema orientalis* (L) Blume, *Elaeocarpus pierrei* K&V, *Sloanea sigun* (B1.) K.Sch, *Bischofia javanica* Blume, *Wetria insignis* (Steud) Airy Shaw, *Lithocarpus elegans* (B1.), *Lithocarpus sundaeicus* (B1.) Rehder, *Engelhardtia spicata* Lechen ex Bl, *Litsea glutinosa* (Lour.) C.B. Rob, *Litsea noronhae* Blume, *Erythrina lithosperma* Miq, *Toona sureni* (Blume) Merr, *Ficus ampelas* Burm.f, *Myrica javanica* Blue, *Eugenia operculata* Roxb, *Dacrycarpus imbricatus* Blue, *Psydrax dicoccos* Gaertn, *Facourtia rukam* Zoll. & Mor, *Laportea stimulans* Miq. [16].

At National Park Bromo Tengger Semeru resort Senduro 19 species phorophyte were found. They were: *Trema orientalis* (L) Bl, *Ficus retusa*, *Engelhardia spicata*, *Bischofia javanica*, *Croton sp*, *Litsea sp*, *Quercus elegans*, *Myrica javanica* Bl, *Pinanga coronaria*, *Dacrycarpus imbricatus* Bl, *Omalantus sp*, *Magletia glauca*, *Garuga floribunda*, *Ficus padana*, *Kerpang* [17].
4. Discussion
Exploration in 2019 at Highway Forest Park Raden Soerjo South of Mt Arjuno Lalijiwo (Jogging Track site) had successfully identified 15 species phorophytes of 173 individual trees. *Engelhardia spicata* has the highest ivi of 125.89 (Figure 2). *Dysoxylum leschenaultianum* has the lowest ivi of 1.97 (Figure .2). Diversity Index Shannon-Wiener 1.57. *Engelhardia spicata* is the dominant phorophyte and *Dysoxylum leschenaultianum* is less dominant phorophyte in the area of Jogging Track. It could be explained by the characteristics of the tree.

We found in the area 8 species non phorophytes of 537 individual trees. *Ficus lepicarpa* has the highest ivi of 137.13 (Figure .3) with morphological characters of bark smooth and has latex. The lowest ivi is *Rhamnus nepalensis* with ivi 1.94 with morphological characters of bark smooth no latex (Figure .3). Diversity Index Shannon-Wiener 1.87.

The phorophyte trees is 24.37 % and non phorophyte is 75.63 % of total trees in the area.

At Highway Forest Park Raden Soerjo East of Mt Anjasmoro (Coban Watu Ondo) we identified 10 species phorophytes of 171 individual trees. *Engelhardia spicata* has the highest ivi of 130.44 (Figure .6) with morphological characters of bark rough, grooved, hard, no latex, tree diameter 20.00-85.00 cm canopy medium-sparse (Figure .6). *Casuarina junghuhniana* has the lowest ivi of 3.87 (Figure .6) with morphological characters of bark rough, grooved, hard skin, no latex, tree diameter 30.00-44.00 cm, canopy sparse (Figure .6). Diversity Index Shannon-Wiener 1.52. *Engelhardia spicata* is the dominant phorophyte and *Casuarina junghuhniana* is less dominant phorophyte in the area of Coban Watu Ondo.

Phorophyte trees has morphological characters of rough bark, grooved, hard skin, no latex, tree diameter 23.00-85.00 cm, canopy medium-sparse. One of the example is *Engelhardia spicata* (Figure .3). This species dominated the area with the highest IVI of 125.89. (Figure .2). While *Dysoxylum leschenaultianum* has the lowest ivi of 1.97 (Figure .1). It has bark characters semi rough, grooved, hard skin, no latex; tree diameter 33.00 cm, canopy medium (Figure .3).

Non phorophyte trees *Ficus lepicarpa* has the highest IVI of 137.13 (Figure .4) with morphological characters of smooth bark and latex (Figure 5). The lowest IVI is *Rhamnus nepalensis* with IVI 1.94 (Figure .4); with morphological characters of bark smooth no latex (Figure 5). *Ficus lepicarpa* dominated the area while *Rhamnus nepalensis* exist only in few numbers.

Host trees characteristic which influence epiphyte orchids preference include host species, bark rugosity, canopy, and tree size [5] [18] [19] [2]. Trees with rough bark highly preferred by epiphyte orchids than those with smooth bark [20] [21]. Host bark traits i.e. stable surface vs unstable surface, affect the characteristic of epiphyte orchids that grow on trunk surfaces [22]. Epiphyte orchids were able to occured on the smooth-barked host species if they were in association with a moss clump [22]. Physical bark characteristics affect the number of epiphytic orchids. It was highest in host trees with fissured bark and lowest in smooth bark [23]. Apparently host tree also influenced leaf nutrition of epiphyte orchid, as in the case of *Dendrobium guamense* Ames [24].

In our results it is confirmed that phorophyte tree species has rough bark and no latex (Figure .2) while non phorophyte tree species has smooth bark and some have latex (Figure .4; Figure .8).

From from recent exploration and supported data in 2003, 2005, 2006. 2007 and 2018. showed the biodiversity of phorophyte trees species exist in the area of National Park Bromo Tengger Semeru and Highway Forest Raden Soeryo south of Mt Arjuno Lalijiwo and east of Mt Anjasmor region is quite diverse.

Phorophyte tree *Engelhardia spicata* evidently exist in the National Park Bromo Tengger Semeru resort Senduro and Pronojiwo ; and also in the Highway Forest Raden Soeryo region south of Mt Arjuno Lalijiwo and east of Mt Anjasmor. *Quercus platicarpa* exist in Pronojiwo and Arjuno Lalijiwo. *Trema orientalis* exist in Senduro, Pronojiwo and Arjuno Lalijiwo.

From the recorded 85 phorophyte trees species, 23 species have a wide ecological region in the tropical mountainous areas (Table 1.).
Table 1. Phorophyte trees species which exist at several locations.

| No | Phorophyte trees species | Locations |
|----|--------------------------|-----------|
|    |                          | Mt Anjasmoro | Mt Arjuno Lalijiwo | Mt Arjuno South | Mt Arjuno East | Mt Semeru South Pronojiwo | Mt Semeru East Senduro |
| 1  | *Engelhardia spicata*    | √           | √                  | √               | √              | √                       |
| 2  | *Ficus hispida*          | √           | √                  | √               |                |
| 3  | *Quercus elegans*        | √           |                    |                |
| 4  | *Quercus platicarpa*     | √           |                    |                |
| 5  | *Trema orientalis*       | √           | √                  | √               | √              |
| 6  | *Erythrina lithosperma*  | √           |                    |                |
| 7  | *Basella rubra*          | √           | √                  |                |
| 8  | *Ficus sp*               | √           | √                  |                |
| 9  | *Quercus sp*             | √           |                    |                |
| 10 | *Agathis dammara*        | √           |                    |                |
| 11 | *Swietenia macrophylla*  | √           | √                  |                |
| 12 | *Swietenia mahagoni*     | √           | √                  |                |
| 13 | *Melastoma malabaricum*  | √           | √                  |                |
| 14 | *Actinodaphne prosera*   | √           | √                  |                |
| 15 | *Gempur gunung*          | √           | √                  |                |
| 16 | *Ficus benjamina*        | √           | √                  | √              |
| 17 | *Ficus retusa*           | √           | √                  |                |
| 18 | *Cuwut*                  | √           | √                  |                |
| 19 | *Bischofia javanica*     | √           | √                  |                |
| 20 | *Myrica javanica*        | √           | √                  |                |
| 21 | *Dacrycarpus imbricatus* | √           | √                  |                |
| 22 | *Garuga floribunda*      | √           | √                  |                |
| 23 | *Lithocarpus sundaiticus*| √           | √                  |                |

Diversity index of phorophyte trees species as well as non phorophyte trees species at both sites is in category medium. *Mangifera indica* and *Arenga pinnata* were the most preference phorophyte in Bulu Pattunang Protected Forest-Maros South Sulawesi, Indonesia [25]. In the central Himalaya, Nepal, both *Ficus religiosa* and *Schima wallichii* were significant phorophyte which needs to be protected [19].

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