

The Ecological Potential of Wild Orchids for *in situ* and *ex situ* Conservation of Rare Species in Enrekang, South Sulawesi, Indonesia

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Abstract: The purpose of this study is to evaluate the ecological potential of Sulawesi wild orchids in their natural habitat as a basis for their *in situ* and *ex situ* conservation. A field survey was conducted from July to August, 2010 in the Bolli Forest in Enrekang, South Sulawesi. Purposive sampling method based on land forms, such as riparian, dry-plate and the slope zones was used to collect data on orchids in the field. Results showed that 37 species of orchids were mostly found in riparian zones, 36 of which species were mostly epiphytes attached to the first branching of host trees (39.4%) compared to 28.9% on the main tree trunk. The tree species associated with 10 or more species of orchids were *Eugenia* sp.1, *Vitex cofassus* and *Myristica inners*. Ecological studies indicated that on the riparian zone, there were only 4 out of 24 species of orchids have Important Value (IV) of 10%, namely: *Phalaenopsis ambonensis*, *Pholidota imbricata*, *Eria pubescens* and *Liparis condylobulbon*. In the dry-plate zone, there were only 6 out of the 22 orchid's species have IV above 10%, i.e.: *Bulbophyllum laxiflorum*, *Phalaenopsis ambonensis*, *Pholidota imbricata*, *Eria pubescens*, *Cymbidium finlaysonianum* and *Phalaenopsis amabilis*. In the slope zone, only 7 of the 12 orchids species have IV of above 10 i.e. *Dendrobium teretifolia*, *Aerides jarkianum*, *Pholidota imbricata*, *Phalaenopsi. amabilis*, *Eria pubescens*, *Dendrobium cruminatum*, and *Bulbophyllum laxiflorum*. The highest diversity index was found in dry-plate zone (2.55), followed by riparian zone (2.14), and slope zone (2.05), while the highest similarity index was found in the riparian-dry plate (50.16%) followed by riparian-slope (39.14%) and slope-dry plate zone (37.46%). There were several types of orchids that are found growing only in one zone with a low relative density and a narrow distribution of species, such as *Phalaenopsis amabilis* and *Dendrobium anosmum* var. *Huttoni*. The latter have large fragrant flowers and attractive colors. Both species are frequently hunted by the local forest communities. The natural population of orchid species is diminishing as a result of poaching, will be susceptible to local extinction if their habitat is disturbed, demanding the attention of those concerned for their much needed *in situ* and *ex situ* conservation.

Keywords: Wild orchid; ecology conservation; important value; diversity index; similarity index

1. Introduction

Orchids are known for its unique and exotic flowers and leaves shapes. This plant has attracted the attention of botanists worldwide, whose enjoyed ornamental plants since centuries ago (Livy, 2001). It is estimated that there are approximately 30.000 species of orchid growing worldwide, of which approximately 75% grow in the tropical region, and about 5.000 species grow naturally in Indonesia (Banks, 2004; and Handoyo, 2008). The diversity of wild or natural orchids of every region in Indonesia is very specific, including the island of Sulawesi, which is one of the islands located in the Wallace area. This area has a unique biota or typical orchids, which is a mix between Asian and Australian biota (Kinnaird, 1997). About 253 species of orchids were recorded grow in Sulawesi (Schleider, 1925 in Yuzammi and Hidayat, 2002).

Currently, many wild orchids from Sulawesi are collected and traded freely, as in the traditional market of Malino, Gowa regency; Rantepao, Tana Toraja and Poso District, Central Sulawesi and other markets. Similarly, the wild orchids in the Bolli Forest, Enrekang Regency of South Sulawesi were traded in the neighboring Rappang market of Sidrap Regency. Even though the forest police patrolled this area but due to extensive coverage, the uncontrolled exploitations by communities surrounding the forest has continued todate. If such action is allowed to continue, it will affect the existence and preservation of these orchids in the near future especially with the soon to be opened Botanical Garden near the City of Enrekang which for sure would attract poachers and

rare plant or wild orchid hunters to sell it for souvenirs to visitors.

The conservation efforts of wild orchids growing in this region would be very important before they become locally extinct or rare. These conservation efforts in the form of exploration of ecological studies of wild orchids, including the study of their abundance, composition and distribution in their natural habitat and environmental conditions that support their growth is reported here. The results of this study would show level of abundance of orchid species making up the community and their association with various types of the host trees.

2. Materials and Methods

2.1 Location and Description of Study Area

This study was conducted in the Bolli Forest of Tanete and Labuku Village, in the district of Maiwa, Enrekang Regency, South Sulawesi. The research was conducted from 26th July to 9th August 2010. The Bolli Forest location, or better known by local people as Colli Forest is one of the forest areas in Enrekang under the Bungin River Forest. This 30 years-old secondary forest has a 50.50 km long outer boundary with GPS coordinates between 03°37'00" - 03°38'00" South and 119°55'00" - 119°56'00" East. The total forest area of Enrekang was reported to be about 71,280.46 ha where 7,857.34 ha are in the Maiwa District (Badan Pusat Statistik, 2009).

2.2 Materials

Field survey tools and materials used include GPS (Geographical Positioning System), compasses, 10 mega pixel digital

cameras, binoculars, pH and soil moisture tester, thermometer, thermo-hygrometer, light meter, tape meter, small soldier hoes, machetes, scissors, cutters, soil ring samples, camping equipments, stationery supplies, herbarium kits, rope, tissue paper, newspapers, handy talkies, and plastic bags.

2.3 Methods

2.3.1 Data collection

The primary data was collected through interviews to gather information on perceptions and knowledge of communities living near the forest about wild orchids and their conservation. Survey method was used to study orchids in the field. Purposive sampling method based on topographic or land form, such as riparian zone, dry-plate zone, and the slope zone was used to collect orchids data in the field. The square plots 20 m x 20 m were used in each zone and repeated five times to obtain 15 square sampling plots in whole zone. To facilitate easier and efficient work, each square plot was divided into four quadrants.

Identification and individual counting in each square plot was carried out by looking at the individual or the number of clumps, its host tree species and the attached place of growth. The trees present in the plot

were also counted individually based on species. Field sampling includes record of habitat, flower specification, specification of stem, leaf shape, root type and forms.

Environmental parameters under the canopy such as light, air temperature, soil temperature, air humidity, soil moisture and soil pH were measured in both canopy gaps and canopy trees. At each plot location, soil sampling was also conducted at random on six points determined systematically across the four quadrants in each plot. All soil samples from the same zone were mixed thoroughly after air drying to make a composite soil samples.

2.3.2 Data analysis

Determination and analysis of plants and orchids samples were performed in the orchid screen house of the Department Agronomy, Faculty of Agriculture and Herbarium Laboratorium of the Faculty of Forestry, Hasanuddin University. Soil sample analysis was conducted in the Soil Laboratory, Faculty of Agriculture, Hasanuddin University. Data were analyzed by descriptive quantitative exploration to obtain the value of density, frequency and important value index (IV) calculated as follows:

$$\text{Density} = \frac{\text{Number of individuals of a species of orchid}}{\text{Area of the entire plot (m}^2\text{)}}$$

$$\text{RD (\%)} = \frac{\text{Density of a species of orchid}}{\text{The density of all species}} \times 100\%$$

$$\text{Frequency} = \frac{\text{The number of plots occupied an orchid species}}{\text{The total number of plots}}$$

$$\text{RF (\%)} = \frac{\text{Frequency of a species of orchid}}{\text{Frequency of all species}} \times 100\%$$

$$\text{IV (\%)} = \text{RD (\%)} + \text{RF (\%)}$$

Furthermore, Diversity Indices (H'), Species Richness index (R1), Evenness index (E1), and the index of similarity (IS) was calculated with the following formula:

$$H' = \frac{(N \log N - \sum ni \log ni)}{N} \quad R1 = \frac{S-1}{\log n}$$

$$E1 = \frac{H}{\ln(S)} = \frac{\ln(N1)}{\ln(N0)} \quad IS = \frac{2W}{A+B} \times 100\%$$

Description:

ni = IV one type or number of individuals of one species.

N = Number of IV-of all types or any number of individuals of all kinds.

S = Number of species in the plot;

n = Individuals in the plot;

W = IV lowest value in both zones compared

A = Value of the first zone IV compared

B = Value of the second zone IV compared

3. Results and Discussion

3.1 Characteristic of Bolli Forest

Bolli forests lies in the region around Tanete and Labuku village and is located

near 500 m above sea level. This area is classified into wet zone lowland tropical forest which has an elevation of 0-1,000 m above sea level (Junus *et al.*, 1984). Bolli Forest area has a varied topography and can be distinguished as the riparian zone, dry-plate zone, and the slope zone. The Riparian zone is always flooded in case of high rainfall whereas the Dry plate is the dry zone area, some of which their areas are once flooded in recent years where the slope angle is 10° below the surface. The Medium hill slope with an angle of 10°-15° is partly near the edge of the river and partly away from the river bank. These areas should be stable but are sometimes subjected to instability with heavy rainfall (Hirawan, 2010). The GPS coordinates of such locations are shown in Table 1.

Table 1. Coordinates of location of plots on each zone in the Bolli Forest, Maiwa District, Enrekang Regency, South Sulawesi, Indonesia.

| No. | Zone/Plot | Position | | |
|-----|-------------|----------------------|------------------------------------|---------|
| | | Elevation (m,asl) | GPS Readings | Village |
| 1 | Riparian/1 | 172 | S: 03° 37' 22.4"/E: 119° 55' 18,2" | Labuku |
| 2 | Riparian/2 | 174 | S: 03° 37' 21.3"/E: 119° 55' 20,2" | Labuku |
| 3 | Riparian/3 | 180 | S: 03° 37' 24.4"/E: 119° 55' 34,1" | Labuku |
| 4 | Riparian/4 | 188 | S: 03° 37' 26.3"/E: 119° 55' 36,1" | Labuku |
| 5 | Riparian/5 | 196 | S: 03° 37' 27.3"/E: 119° 55' 41,3" | Labuku |
| 6 | Dry-Plate/1 | 181 | S: 03° 37' 21.1"/E: 119° 55' 18,8" | Tanete |
| 7 | Dry-Plate/2 | 175 | S: 03° 37' 20.5"/E: 119° 55' 20,0" | Tanete |
| 8 | Dry-Plate/3 | 215 | S: 03° 37' 26.4"/E: 119° 55' 32,4" | Labuku |
| 9 | Dry-Plate/4 | 210 | S: 03° 37' 27.0"/E: 119° 55' 33,9" | Labuku |
| 10 | Dry-Plate/5 | 323 | S: 03° 36' 17.7"/E: 119° 54' 55,9" | Tanete |
| 11 | Slope/1 | 210 | S: 03° 37' 16.3"/E: 119° 55' 21,2" | Tanete |
| 12 | Slope/2 | 220 | S: 03° 37' 15.9"/E: 119° 55' 21,1" | Tanete |
| 13 | Slope/3 | 203 | S: 03° 37' 18.7"/E: 119° 55' 18,6" | Labuku |
| 14 | Slope/4 | 262 | S: 03° 37' 07.6"/E: 119° 55' 28,8" | Tanete |
| 15 | Slope/5 | 398 | S: 03° 36' 05.6"/E: 119° 55' 15,9" | Tanete |

The forest structure is still relatively good reaching up to three canopy layers with a canopy closure between 60%-80% giving a fairly high humidity with sunlight reaching the forest floor. Bolli Forest has a climate type B (wet) based on climatic classification by Schmidt and Ferguson (full data not shown), which have a relatively high rainfall reaching 3,970 mm year⁻¹ with an average of 1,999.2 mm year⁻¹ over the last 10 years (BPS, 2009) which explains the high humidity in this region.

Bolli Forest recorded an air temperature range of 24.98-26.08°C, soil temperature of 23.82-24.26°C, air humidity 89.04-94.66%, 100% soil moisture, soil pH 5.52-5.84, and the intensity of light in the range of 325.02 lux - 3:33x10³ lux. The Bolli Forest has a high soil nutrient content ranging between 1.49 - 1.72% C, 0.34 - 0.56% N, 10.77 - 11.44 mg L⁻¹ P₂O₅, and 0.16 - 0.42 cmol (+) kg⁻¹ K with the clay ash soil texture. All of these factors could effectively support host trees growth and affect the population of the orchids that are in existence today. From the above data, it can be confirmed that the orchids found in Bolli Forest are classified into low to medium altitude orchid (0 - 650 m above sea level) which requires a temperature range of 26 - 30°C during the day and 21 - 25°C at night. Other requirements include an air humidity ranging from 60 - 90% during the day and not more than 60% at night, and the intensity of light from almost cool between 10 - 15% to full sun or 100 % (Sutarni, 1986; Livy, 2001).

3.2 Orchid Species and their Ecological Distribution in Bolli Forest

A total of 288 specimens of orchids were found in the sampled area of Bolli

Forest. This specimen consists of 37 species and 20 genera, 36 of them are epiphytes and one is of terrestrial orchid, namely *Spathoglottis plicata*. Of the 36 epiphytic orchids, majority come from the genus *Eria*, namely with seven species, followed by five *Bulbophyllum* and four *Dendrobium* species. All 37 species of orchids found in the area surveyed could be classified into seven parts or groups of distribution, with different density of each species in each zone. The distribution of orchid in Bolli forest is shown in Figure 1, where every species in the group in each zone has a different density. There are several types of orchids that are found growing only in one zone with a low specific density and a small distribution of species, for example: *Dendrobium anosmum* var. *Huttoni*, was found only in areas of riparian zone. This orchid species have large, fragrant flowers and attractive colors, and is so popular and demanding amongst the local forest communities. The small distribution of this type of orchid showed that it is influenced by many specific environmental conditions and therefore limited to only some localities in the study area (Achmad, 2006).

Narrow distribution as mentioned above requires much attention in terms of their conservation. Orchid species with narrow distribution will be susceptible to local extinction if their habitat is disturbed. Large scale exploitation by the people living in or around the forest has been evident since 2008. Based on a personal communication and interviews with village community and officials, traded Bolli orchids in the nearest district market in Rappang, Sidrap Regency was so rampant. In addition to *Dendrobium anosmum* var. *Huttoni*, other orchid species

such as *Phalaenopsis amboinensis* and *Phalaenopsis amabilis*. are in high demand by the community. This population pressure will threaten the sustainability of wild

orchids in Bolli Forest demanding the attention of those concerned for their much needed protection and conservation.

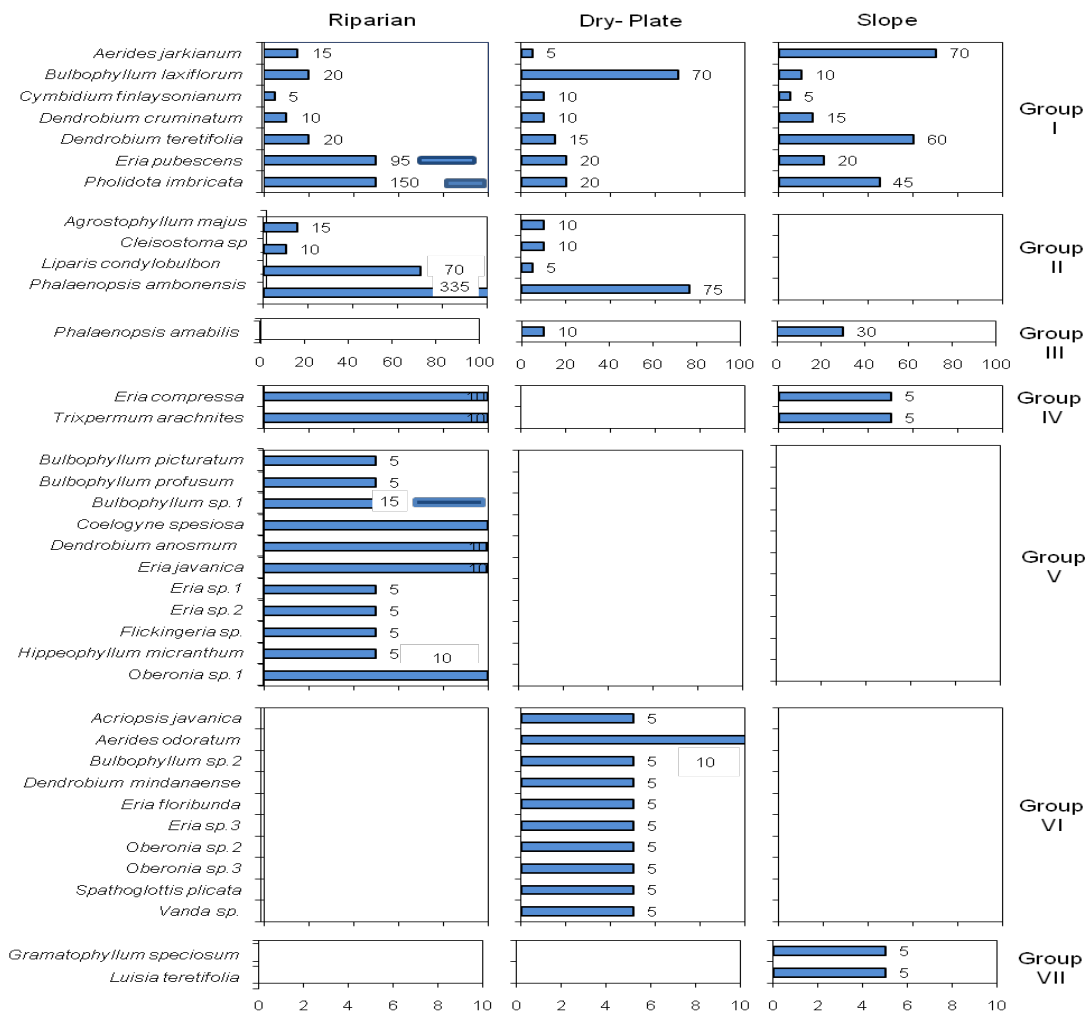


Figure 1. Orchid species distribution/clumps and density ha-1 on three zones in the Bolli Forest, Maiwa District, Enrekang Regency, South Sulawesi, Indonesia.

3.2.1 Important value

Ecologically, the Important Value (IV) shown by each species of orchids is an indication of the level of density of a dominant species from total density of all kind of species presence (100%), plus the frequency of occurrence in the plot of observation compared with other species in the area of survey in Bolli Forest. The IV of orchid species in riparian, dry-plate, and the slope zone are shown in Table 2.

In riparian zones, as many as 24 species of orchids were found with a total of 170 individual clusters. Total density of species reached 850 clusters/ha. A total of four types of orchids were calculated to have IV above 10%, namely *Phalaenopsis ambonensis* 50.52%, 28.76% *Pholidota imbricata*, *Eria pubescens* 20.07%, and *Liparis condylobulbon* with a value of 17.12%. The rest is a type of orchid that has a IV value of 2.81-9.02%. In comparison, as

many as 22 species of orchids were found in the dry-plate zone, with a total of 63 individual clusters. Total species density reached 315 clusters/ha. A total of six species of orchids have an IV value above 10%, namely *Bulbophyllum laxiflorum* 32.56%, *Phalaenopsis ambonensis* 30.71%, *Pholidota imbricata* 13.25%, *Eria pubescens* 13.25%, *Phalaenopsis amabilis* 10.07%, and *Cymbidium finlaysonianum* with a value of 10.07%. The rest are the types of orchids that have an IV of 5.04% - 8.21%.

Table 2. Important value of orchids found during survey in Bolli Forest

| No. | Name of Species | Riparian Zone | | Dry-Plate Zone | | Slope Zone | |
|-------|---|---------------|--------|----------------|--------|------------|--------|
| | | Indiv. | IV (%) | Indiv. | IV (%) | Indiv. | IV (%) |
| 1 | <i>Acriopsis javanica</i> | - | - | 1 | 5.04 | - | - |
| 2 | <i>Aerides jarkianum</i> | 3 | 6.21 | 1 | 5.04 | 14 | 38.49 |
| 3 | <i>Aerides odoratum</i> | - | - | 2 | 6.62 | - | - |
| 4 | <i>Agrostophyllum majus</i> | 3 | 6.21 | 2 | 6.62 | - | - |
| 5 | <i>Bulbophyllum laxiflorum</i> | 4 | 6.80 | 14 | 32.56 | 2 | 12.34 |
| 6 | <i>Bulbophyllum picturatum</i> | 1 | 2.81 | - | - | - | - |
| 7 | <i>Bulbophyllum profusum</i> | 1 | 2.81 | - | - | - | - |
| 8 | <i>Bulbophyllum sp.1</i> | 3 | 3.99 | - | - | - | - |
| 9 | <i>Bulbophyllum sp.2</i> | - | - | 1 | 5.04 | - | - |
| 10 | <i>Coelogyne speciosa</i> | 2 | 3.40 | - | - | - | - |
| 11 | <i>Cleisostoma sp.</i> | 2 | 3.40 | 2 | 6.62 | - | - |
| 12 | <i>Cymbidium finlaysonianum</i> | 1 | 2.81 | 2 | 10.07 | 1 | 6.17 |
| 13 | <i>Dendrobium anosmum</i> var. <i>Huttoni</i> | 2 | 5.62 | - | - | - | - |
| 14 | <i>Dendrobium cruminatum</i> | 2 | 5.62 | 2 | 6.62 | 3 | 14.15 |
| 15 | <i>Dendrobium mindanaense</i> | - | - | 1 | 5.04 | - | - |
| 16 | <i>Dendrobium teretifolia</i> | 4 | 9.02 | 3 | 8.21 | 12 | 39.21 |
| 17 | <i>Eria compressa</i> | 2 | 3.40 | - | - | 1 | 6.17 |
| 18 | <i>Eria floribunda</i> | - | - | 1 | 5.04 | - | - |
| 19 | <i>Eria javanica</i> | 2 | 3.40 | - | - | - | - |
| 20 | <i>Eria pubescens</i> | 19 | 20.07 | 4 | 13.25 | 4 | 15.97 |
| 21 | <i>Eria sp.1</i> | 1 | 2.81 | - | - | - | - |
| 22 | <i>Eria sp.2</i> | 1 | 2.81 | - | - | - | - |
| 23 | <i>Eria sp.3</i> | - | - | 1 | 5.04 | - | - |
| 24 | <i>Flickingeria sp.</i> | 1 | 2.81 | - | - | - | - |
| 25 | <i>Gramatophyllum speciosum</i> | - | - | - | - | 1 | 6.17 |
| 26 | <i>Hippeophyllum micranthum</i> | 1 | 2.81 | - | - | - | - |
| 27 | <i>Liparis condylobulbon</i> | 14 | 17,12 | 1 | 5.04 | - | - |
| 28 | <i>Luisia teretifolia</i> | - | - | - | - | 1 | 6.17 |
| 29 | <i>Oberonia sp.1</i> | 2 | 3.40 | - | - | - | - |
| 30 | <i>Oberonia sp.2</i> | - | - | 1 | 5.04 | - | - |
| 31 | <i>Oberonia sp.3</i> | - | - | 1 | 5.04 | - | - |
| 32 | <i>Phalaenopsis amabilis</i> | - | - | 2 | 10.07 | 6 | 23.95 |
| 33 | <i>Phalaenopsis ambonensis</i> | 67 | 50.52 | 15 | 30.71 | - | - |
| 34 | <i>Pholidota imbricata</i> | 30 | 28.76 | 4 | 13.25 | 9 | 25.06 |
| 35 | <i>Spathoglottis plicata</i> | - | - | 1 | 5.04 | - | - |
| 36 | <i>Trixpermum arachnites</i> | 2 | 3.40 | - | - | 1 | 6.17 |
| 37 | <i>Vanda sp.</i> | - | - | 1 | 5.04 | - | - |
| TOTAL | | 170 | 200 | 63 | 200 | 55 | 200 |

Indiv. = Individual; IV = Important Value

In the slope zone, there were only 12 types of orchids with a total individual of 55 clusters. Total species density reached 275 clusters/ha. A total of seven species of orchids that have IV above 10% were found in this zone, namely: *Dendrobium teretifolia* 39.21%, *Aerides jarkianum* 38.49%, *Pholidota imbricata* 25.06%, *Phalaenopsis amabilis* 23.95%, *Eria pubescens* 15.97%, *Dendrobium cruminatum* 14.15%, and *Bulbophyllum laxiflorum* with a value of 12.34%. Other orchid species (6.17%) have IV below 10%.

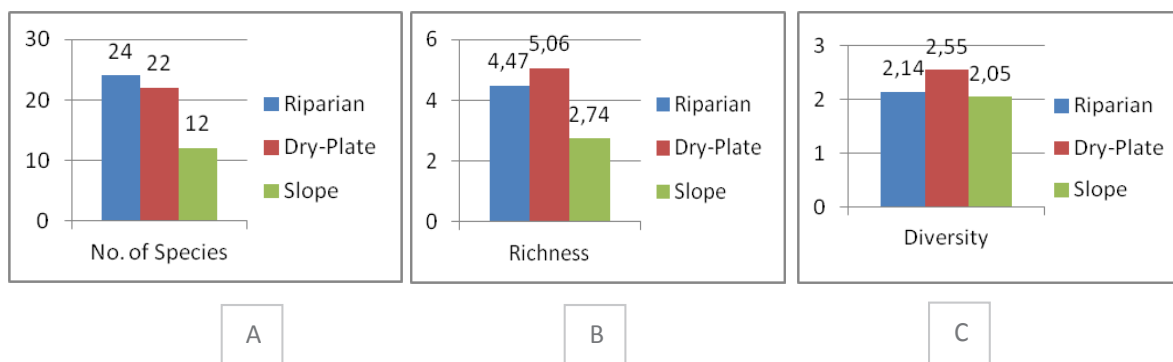
Table 2 shows that the number of orchid species found in riparian zones were relatively almost as much as that in the dry-plate zone, but two times greater than in the slope zone. Although the number of orchid species in the riparian zone and the dry-plate are relatively the same, the ratio of the number of clusters in the riparian zone to the dry-zone plate were larger, *i.e.* 170 versus 63 or approximately 3:1. The large number of clusters in the riparian zone were presumably because this region has relatively an open air or space (along the river) with little vegetation covers. The range of light intensity entering under the canopy would be more, ranging from 466.28 lux to 3.33×10^3 lux compared to dry-plate zone with a light intensity range from only 545.98

lux to 1.70×10^3 lux and the slope zone which range from only 325.02 lux to 1.85×10^3 lux. These conditions have allowed the riparian zone to be overgrown with a variety of orchids that require different day and night temperature and wider range of light radiation intensity with relatively high humidity for their growth (Sutarni, 1986; Livy, 2001).

The growth of other vegetation including orchids' host trees within the riparian zone is also supported by the carbon organic matter content (C) which was relatively higher than the other two zones. Results of analysis showed that the riparian zone soil has an organic C content of 1.72%, while the slope zone of 1:52% and the dry-plate zone of 1:49%. Organic matter is a stabilizing aggregate for soil, the source of plant nutrients and energy sources of the majority of soil organisms that support soil fertility (Hakim *et al.*, 1986).

3.2.2 Species diversity and similarity index

The result of calculation of species richness index, diversity and evenness of species of orchids in the Bolli forest, and the similarity index of orchid community based on their Important Values are shown in Figure 2.



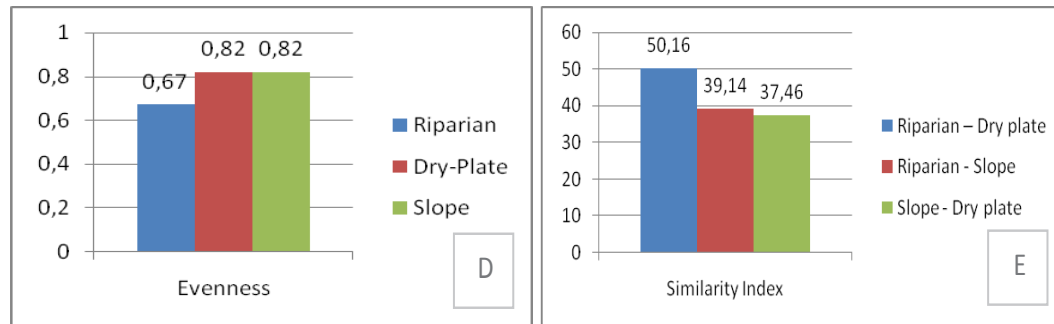


Figure 2. Results of calculation of diversity found in Bolli forest. A). No. of species; B). Richness; C). Diversity; D). Evenness; and E). Similarity Index

The diversity analysis of orchid species in the third zone showed that it is relatively almost the same in all zone. The highest diversity index was found in dry-plate zone, which is equal to 2.55. This value is greater than the index of diversity in riparian zones, which is 2.14. The lowest diversity index value of 2.05 was found in the slope zone (Fig. 2[C]). These diversity index values are categorized as medium (Magurran, 1988). The index of species diversity in riparian zones compared to the dry-plate was low even though the number of orchid species was relatively bigger (Fig. 2[A]). Presumably this was because of that the riparian zone has the orchid *Phalaenopsis ambonensis* with larger number of individuals compared with the number of individuals of other species (Table 2). This significantly bigger population was causing the index of species evenness in the riparian zone becomes low, so that biodiversity index values become smaller.

In the similarity analysis (Fig. 2[E]), the similarity index of riparian-dry plate zone showed the value of 50.16%, which is

significantly larger than the riparian-slope zone of 39.14% and slope-dry-plate zone of 37.46%. The relatively high value of orchid species similarity index between the riparian zone with a dry-plate zone was made possible since both of these locations were relatively close together. The result of similarity analysis also showed that the index of similarity were in low category, none achieved SI values > 75%. This is because of variations in environmental conditions, whether physical, chemical, and interactions between species along the studied zone, so that the living species varies. Suin (2002) stated that the highest index of similarity that could be achieved between the two habitats being compared is 100%, *i.e.* when the on both habitats lived the same species living biota.

3.2.3 Species association

A total of 47 species of trees from the 198 species recorded in the research plots are host tree for the orchids found. The types of trees that hosted the orchid, and the number of orchid species associated with host tree species are shown in Table 3.

Table 3. Host trees associating with 10 or more types of orchids

| No. | Host Trees | Orchid Species |
|-----|-----------------------------|---|
| 1. | <i>Eugenia</i> sp.1 | 1. <i>Pholidota imbricate</i> 2. <i>Eria pubescens</i> 3. <i>Dendrobium teretifolia</i> 4. <i>Eria javanica</i> 5. <i>Phalaenopsis ambonensis</i> 6. <i>Trixpernum arachnites</i> 7. <i>Cymbidium finlaysonianum</i> 8. <i>Liparis condylobulbon</i> 9. <i>Bulbophyllum</i> sp.1 10. <i>Dendrobium cruminatum</i> 11. <i>Bulbophyllum picturatum</i> 12. <i>Eria</i> sp.2 13. <i>Bulbophyllum profusum</i> 14. <i>Cleisostoma</i> sp. 15. <i>Agrostophyllum majus</i> 16. <i>Oberonia</i> sp.1 17. <i>Flickingeria</i> sp. 18. <i>Hippeophyllum micranthum</i> 19. <i>Coelogyne spesiosa</i> 20. <i>Bulbophyllum laxiflorum</i> 21. <i>Eria compressa</i> |
| 2. | <i>Myristica inners</i> | 1. <i>Pholidota imbricata</i> 2. <i>Agrostophyllum majus</i> 3. <i>Eria pubescens</i> 4. <i>Dendrobium teretifolia</i> 5. <i>Dendrobium cruminatum</i> 6. <i>Phalaenopsis ambonensis</i> 7. <i>Bulbophyllum laxiflorum</i> 8. <i>Phalaenopsis amabilis</i> 9. <i>Cleisostoma</i> sp. 10. <i>Vanda</i> sp. |
| 3 | <i>Vitex copassus</i> | 1. <i>Agrostophyllum majus</i> 2. <i>Bulbophyllum laxiflorum</i> 3. <i>Cymbidium finlaysonianum</i> 4. <i>Bulbophyllum</i> sp.2 5. <i>Dendrobium teretifolia</i> 6. <i>Dendrobium cruminatum</i> 7. <i>Eria pubescens</i> 8. <i>Liparis condylobulbon</i> 9. <i>Gramatophyllum speciosum</i> 10. <i>Phalaenopsis amabilis</i> |
| 4 | <i>Arthocarpus</i> sp. | 1. <i>Phalaenopsis ambonensis</i> 2. <i>Oberonia</i> sp.2 3. <i>Oberonia</i> sp.3 4. <i>Eria floribunda</i> 5. <i>Eria</i> sp.3 6. <i>Liparis condylobulbon</i> 7. <i>Eria pubescens</i> |
| 5 | Pute-pute | 1. <i>Liparis condylobulbon</i> 2. <i>Phalaenopsis amabilis</i> 3. <i>Eria pubescens</i> 4. <i>Pholidota imbricata</i> 5. <i>Aerides jarkianum</i> 6. <i>Luisia teretifolia</i> 7. <i>Phalaenopsis ambonensis</i> |
| 6 | Camu | 1. <i>Bulbophyllum laxiflorum</i> 2. <i>Eria pubescens</i> 3. <i>Eria compressa</i> 4. <i>Dendrobium mindanaense</i> 5. <i>Pholidota imbricate</i> 6. <i>Dendrobium teretifolia</i> |
| 7 | <i>Leea indica</i> | 1. <i>Aerides jarkianum</i> 2. <i>Eria pubescens</i> 3. <i>Dendrobium anosmum</i> var. <i>huttoni</i> 4. <i>Liparis condylobulbon</i> 5. <i>Pholidota imbricate</i> 6. <i>Phalaenopsis ambonensis</i> |
| 8 | Landak | 1. <i>Eria pubescens</i> 2. <i>Liparis condylobulbon</i> 3. <i>Pholidota imbricata</i> 4. <i>Dendrobium cruminatum</i> 5. <i>Phalaenopsis amabilis</i> |
| 9 | <i>Ficus</i> sp. | 1. <i>Pholidota imbricate</i> 2. <i>Dendrobium teretifolia</i> 3. <i>Dendrobium cruminatum</i> 4. <i>Cymbidium finlaysonianum</i> |
| 10 | Lamonjong | 1. <i>Eria pubescens</i> 2. <i>Liparis condylobulbon</i> 3. <i>Agrostophyllum majus</i> 4. <i>Phalaenopsis ambonensis</i> |
| 11 | Maracoppo | 1. <i>Bulbophyllum laxiflorum</i> 2. <i>Pholidota imbricata</i> 3. <i>Eria pubescens</i> 4. <i>Dendrobium teretifolia</i> |
| 12 | Maranne | 1. <i>Pholidota imbricate</i> 2. <i>Aerides jarkianum</i> 3. <i>Dendrobium teretifolia</i> 4. <i>Eria pubescens</i> |
| 13 | <i>Cinnamomum celebicum</i> | 1. <i>Phalaenopsis amabilis</i> 2. <i>Phalaenopsis ambonensis</i> 3. <i>Eria pubescens</i> |
| 14 | <i>Cynometra</i> sp. | 1. <i>Aerides jarkianum</i> 2. <i>Bulbophyllum laxiflorum</i> 3. <i>Phalaenopsis ambonensis</i> |
| 15 | <i>Diospyros</i> sp. | 1. <i>Dendrobium cruminatum</i> 2. <i>Bulbophyllum laxiflorum</i> 3. <i>Dendrobium teretifolia</i> |

| | | | |
|----|-----------------------------------|--|---|
| 16 | <i>Euphorbia</i> sp.2 | 1. <i>Pholidota imbricate</i> 2. <i>Eria pubescens</i> | 3. <i>Phalaenopsis ambonensis</i> |
| 17 | Kalasida | 1. <i>Pholidota imbricate</i> 2. <i>Phalaenopsis ambonensis</i> | 3. <i>Dendrobium anosmum</i> var. <i>Huttoni</i> |
| 18 | <i>Palaquinum</i> sp. | 1. <i>Eria</i> sp.1 2. <i>Liparis condylobulbon</i> | 3. <i>Phalaenopsis ambonensis</i> |
| 19 | Rubiaceae 1 | 1. <i>Pholidota imbricate</i> 2. <i>Eria javanica</i> | 3. <i>Eria pubescens</i> |
| 20 | <i>Aglaia elliptica</i> | 1. <i>Bulbophyllum laxiflorum</i> | 2. <i>Phalaenopsis ambonensis</i> |
| 21 | Unknown 1 | 1. <i>Agrostophyllum majus</i> | 2. <i>Pholidota imbricate</i> |
| 22 | <i>Calophyllum soulatrii</i> | 1. <i>Aerides jarkianum</i> | 2. <i>Eria pubescens</i> |
| 23 | Cendana | 1. <i>Bulbophyllum laxiflorum</i> | 2. <i>Liparis condylobulbon</i> |
| 24 | <i>Cratoxylum celebicum</i> | 1. <i>Acriopsis javanica</i> | 2. <i>Bulbophyllum laxiflorum</i> |
| 25 | <i>Koordersiodendron pinnatum</i> | 1. <i>Dendrobium teretifolia</i> | 2. <i>Pholidota imbricate</i> |
| 26 | Londo | 1. <i>Cymbidium finlaysonianum</i> | 2. <i>Eria pubescens</i> |
| 27 | <i>Nauclea orientalis</i> | 1. <i>Aerides jarkianum</i> | 2. <i>Pholidota imbricate</i> |
| 28 | <i>Pterocarpus indicus</i> | 1. <i>Trixpermum arachnites</i> | 2. <i>Aerides odoratum</i> |
| 29 | Sapponi | 1. <i>Pholidota imbricata</i> | 2. <i>Aerides jarkianum</i> |
| 30 | Unknown 3 | <i>Dendrobium cruminatum</i> | |
| 31 | <i>Bischofia javanica</i> | <i>Phalaenopsis ambonensis</i> | |
| 32 | Bolli | <i>Aerides jarkianum</i> | |
| 33 | Cempaka | <i>Phalaenopsis ambonensis</i> | |
| 34 | Dama-dama | <i>Liparis condylobulbon</i> | |
| 35 | <i>Dillenia serata</i> | <i>Dendrobium cruminatum</i> | |
| 36 | <i>Elaeocarpus sphaericus</i> | <i>Trixpermum arachnites</i> | |
| 37 | <i>Gironniera neruosa</i> | <i>Aerides odoratum</i> | |
| 38 | <i>Horsfieldia</i> sp. | <i>Pholidota imbricata</i> | |
| 39 | <i>Hortensia</i> sp. | <i>Phalaenopsis amabilis</i> | |
| 40 | Kakaci | <i>Phalaenopsis ambonensis</i> | |
| 41 | Kawai | <i>Phalaenopsis ambonensis</i> | |
| 42 | Kayu Bu'bu | <i>Bulbophyllum laxiflorum</i> | |
| 43 | Kopi Ale' | <i>Cleisostoma</i> sp. | |
| 44 | Lasa tedong | <i>Phalaenopsis amabilis</i> | |
| 45 | Palau | <i>Dendrobium teretifolia</i> | |
| 46 | Palli | <i>Phalaenopsis ambonensis</i> | |
| 47 | Talise | <i>Pholidota imbricata</i> | |

A total of 36 species of epiphytic orchid were found attached to the main trunk and up to its fourth branching. Figure 3 indicated that the trees most often found with orchids attached on the first branch were in riparian and slope zones with a value of 45% and 49.1%, respectively. A total of 50% orchids were found growing attached to the main stem mostly found on a dry-plate zone. On average for all zones,

the first branch has higher percentage than others (39.4%) followed by the main trunk (28.9%). Especially in dry-plate zone, most orchids were found attached to the main trunk of tall trees, most possibly associated with relatively lower light intensity in this zone compared to other zones. The orchids in this zone were more adaptable on the main trunk of tall trees to obtain the required light intensity.

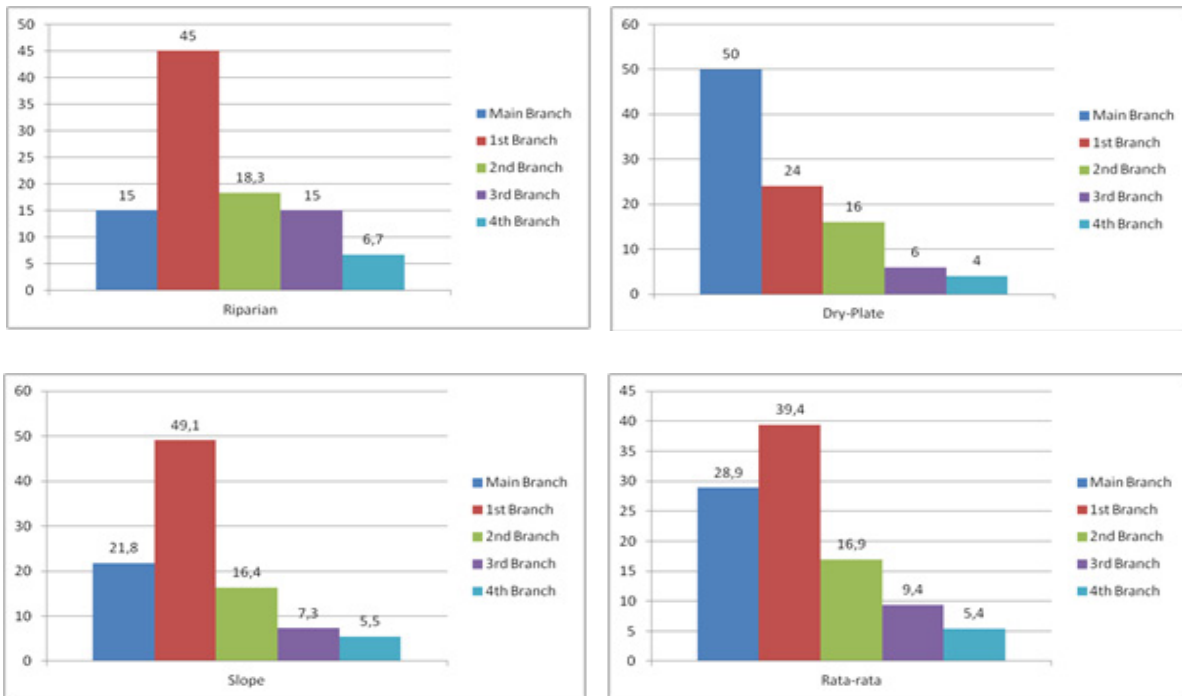


Figure 3. Comparison of parts of host trees where orchid likely to attach and grow in the three zone studied.

4. Conclusion

Based from the analysis of vegetations, it can be concluded that there was as much as 37 species of orchids found mostly in riparian zones. A total of 36 species are mostly epiphytes attached to the first branching of host trees (39.4%) and 28.9% on the main stem. There are three types of trees that are associated with 10 or more species of orchids, namely: *Eugenia* sp.1, *Vitex cofassus* and *Myristica inners*. The results of ecological studies indicated that the highest diversity index was found in dry-plate zone at 2.55, followed by riparian zone at 2.14, and the slope zone at 2.05. While the highest similarity index was found in the riparian-dry plate for 50.16%, followed by riparian-slope 39.14% and slope-plate dry 37.46%. *Dendrobium anosmum* var. *Huttoni*, a species of orchid with large, attractive colors and fragrant flowers was found only in areas of riparian zone making it easily hunted

and poached. The small distribution and low specific density of this orchid showed to be very susceptible to local extinction if their habitat is disturbed. This population pressure will threaten the sustainability of wild orchids in Bolli Forest, demanding the attention of those concerned for their much needed conservation efforts in the future.

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