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Epiphytic Host Tree Identification In Samarinda Botanical Garden

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Abstract. Epiphytes are one of the most diversified plant life forms, whose species richness peaks in the tropics and subtropics. The aim from this research is to found out the various kinds of phorophyte. This research used the single plot method, as many as 100 plots, each measuring 10m x 10m, randomly distributed in Research Zone of the Samarinda Botanical Garden. The following data were recorded in each plot: species name and individual numbers of the phorophytes. The phorophyte in the old secondary forest area to the amount of 66 trees are consisting of 30 species of 29 families, with 36 trees (54,5%) each of them has a diameter runs 21-38 cm. The Family of Dipterocarpaceae and species of *Borassodendron borneensios*, being the phorophyte which has got the mostone in which each 8 species and 9 trees are existed in the forest.

1. Introduction

The tropical forests of Indonesia are a habitat for flora and fauna whose abundance is unmatched by any country in the world with the same area (Rambe et al, 2021), no less than 35 000 species of animals, 28 000 species of plants and 10 000 species of microbes and is still growing becauseevery scientific expedition that is carried out always produces new species, with the existenceof various major biographic areas and an extraordinary diversity of habitat types. It is recognized as a very unique natural resource with a very close and inseparable relationship with each other (Attenborough, 1995, Lee et al, 2016).

In an area of 1 hectare of forest in Kalimantan, more than 150 species of trees may be found, not including plant communities that have certain characteristics, including palms, shrubs, climbers, stranglers, parasites and epiphytes including ferns (Lee, et al 2016). Several colonies and epiphytic ferns in an ecosystem can only be found in certain tree species or in certain parts of the tree, otherwise they can also be found in every tree species and in every part of the tree. It is because of its dependence on the condition of the forest stand in a habitat. The function of the host plant is only to get a placeexposed to sunlight, so that all of its life needs for nutrients and water can only be obtained high above the tree. The fulfillment of nutrient needs is mainly obtained from rain water containing dissolved materials, partly from the accumulation of air particles and partly from the weathering of bark or other plant parts of the host tree (Zytynska et al, 2011; Timsina, etal, 2016; Ingram and Nadkarni, 1993; Malcolm, 1999).

Furthermore, according to Hosokawa and Odani (1957), Whitmore (1975) in Sujalu (2015, 2008), the distribution and abundance of epiphytic species vertically on trees are grouped into 3, namely: a) Epiphytic that grows and develops at the base of the trunk; b) Epiphytic that grows and develops on the trunk; c) The epiphytic that develops on the crown of the tree which includes branches and twigs. As according to Sujalu (2015) in each type of forest, epiphytic habitat can be grouped into 4 (four), namely: a) At the base of the tree, with shade-tolerant epiphytes; b) Branch-free trunks, characterized by the very poor presence of epiphytes; c) In the crown, is the most common habitat for epiphytes; and d) outside the crown (the outer most twigs of the crown), this habitat is dominated by epiphytes.

Each of the trees that epiphytes grow on is referred to as a host tree (phorophyte), these trees have different canopy architecture, chemical and physical bark characteristics. Their host trees will influence the presence and diversity of epiphytes. In their natural habitat, a wide variety of epiphytic plants are found attached not to all types of host trees, but only to a few types of host trees. Epiphytes are essential in a tropical forest ecosystem. Epiphyte abundance and diversity are positively correlated with host species diversity. Therefore, it is very important to study the type and number of host trees, which also indicate the level of stability and characteristics of tropical forests.

2. Materials and Methods

This research was conducted in Main Protected Zone of the Samarinda Botanical Garden with the assumption that it is a old secondary forest area that is relatively undisturbed by direct and indirect community activities. This research used the single plot method which covers a total area of measuring 1 hectares, then divided into 100 randomly placed sub plots, each measuring 10m × 10m. Observations of epiphytic host trees included identification of tree species and dimensions. Identification of phorophytes obtained will be carried out at the Mulawarman University Forest Conservation Laboratory and East Kalimantan Dipterocarp Forest Ecosystem Research and Development Centre.

3. Results And Discussion

3.1. Research Location

Since 1997 the Samarinda Botanical Garden (KRS) has developed into a natural recreation area of ± 65 hectares (from an area of about 300 hectares) funded by the Japan Bank for International Cooperation (JBIC) Loan No.IP-459 Project The Overseas Economic Cooperation Fund - Japan International Cooperation Agency (OECF-JICA) project.

This area generally has a hilly topography and a few plains with an altitude of 40 – 50 meters above sea level. Some of the hills there are small rivers and on the plains in addition to small rivers there are puddles. The soil in this area is of the type yellow red podzolic. This type is red to yellow, cloddy to angular clods, firm, acid, low base saturation. Physical and chemical properties soil are moderate to poor.

The study area has a tropical climate type tropical climate type where there is no clear distinction between the rainy and dry seasons. According to the Schmidt-Ferguson climate classification, the climate in the research area is classified as type B with an average value of dry months (2 months) compared to the average value of wet months (9 months) multiplied by one hundred percent (Q) which is equal to 17,57%. Supporting data obtained from field, namely the average air temperature of 27 ° C and air humidity of 60-90%.

3.2. Host Tree Identification

Overall, the number of trees (woody and non-woody) at the pole and tree level (> 10 cm in diameter) in the Samarinda Botanical Garden covering an area of 1 ha (100 research subplots) found as host trees was 72 individual trees or 10.8% of all vegetation > 10 cm in diameter. The host trees found included 35 species from 24 genera belonging to 18 families. Host trees from the Dipterocarpaceae family were found with the highest number of individuals, namely 14 individuals or 19.4% of all individuals (2.1% of 667 trees > 10 cm in diameter in10 research subplots or 1 ha) which included 2 host tree species or 5.4% of all host tree species, namely *Borassodendron borneensios* and *Arenga sp.*

Table 1. The top 15 families with the most host tree species

No.	Famili	Number of individuals

1	Dipterocarpaceae	8
2	Lauraceae	5
3	Moraceae	5
4	Bombaceae	4
5	Sapotaceae	4
6	Thymelaceae	4
7	Myristicaceae	4
8	Melastomataceae	3
9	Dilenaceae	3
10	Sterculiaceae	3
11	Theaceae	3
12	Myrtaceae	3
13	Thymelaceae	3
14	Burseraceae	2
15	Aracaceae	2

`Species from the Dipterocarpaceae family were found to be the most common host trees because they have a distinctive canopy structure, with many web-like structures wrapping leaves in the form of leaf buds (or, when weathered, known as fibers) at the base of the leaf midrib. Therefore, the base of petiole may accumilate leaves debrish or other litters and makes this part is moist and has suitable micro environment for the growth of epiphytic flora, especially fern (Shalihah, 2010; Romadi et all, 2011). Although the base of the midrib itself is generally quite wide (almost half of the trunk circumference for each leaf), it is also a good place to collect litter, in addition to the general rough, bumpy and cracked nature of the host tree. The bark cracks allow epiphytic Bryopsida and mineral nutrients to "get stuck", Putrika (2012) explains that species richness on this type of bark is higher than on smooth-textured bark.

The bark of each tree species has distinctive physical characteristics and properties. A number of physical properties and characteristics of tree bark that influence the presence of epiphytic plants include stability, roughness, hardness, ability to capture water, neutral acidity, and the presence of nutrients in the bark. Tree bark that is stable is more favored by epiphytes as a place to live because stable bark is more able to with stand mass and is more solid as a place to attach. In unstable bark trees, few epiphytes are found because unstable bark is easily weathered, which causes the bark to peel off easily, making it unable to maintain the presence of epiphytes. These host trees in the logged-over forest are trees in relatively good physical condition (umbrella-shaped crowns with intact branching and not too dense), including those from the Dipterocarpaceae family. These trees generally have an outer bark structure that is compatible with most host trees (Nurfadillah, 2015; Einzmann et al 2005; Lyons B, etal 2000). This was due to the tree's tall, large, multi-branched stature and its age reaching decades, allowing the substrate deposited on the surface of the bark to be thick. This greatly affects the storage of water and nutrients. Furthermore, this tree is known as a native plant ofthe local ecosystem and is friendly to the surrounding vegetation, by not producing toxic exudates

For vascular epiphytes, the presence of their host trees is essential for the establishment and permanence of their populations. However, due to differences in host traits, not all trees offer the same conditions for the establishment and development of epiphytic orchids and pteridophyte (Wagner et al., 2015). For example, rough bark texture can affect the capture of seeds rugose and scaly barks favor seed adherence compared to smooth barks (Adhikari and Fischer, 2011; Gowland et al., 2013; Timsina et al., 2016)], while an ability to retain and release water can favor the germination of seeds barks with higher water retention capacity and slower release rates favor seed germination (Callaway et al., 2002; Einzmann et al., 2015). This will reduce the adverse effects of rain drops and water flow, as well as facilitate the attachment of epiphytes (Timsina et al., 2016 quoting from Richard, 1952; Adhikara et al 2017). Moreover, the relatively large size and branching structure (sometimes almost the same as the diameter of the stem) and relatively horizontal will allow the collection and formation of humus, and so that epiphytic seeds are not easily washed away by water through crown flow or stem flow (Trimanto and Danarto (2020).

Tabel 2. Most common host tree species in a 1-hectare plot at the Samarinda Botanical Garden.

No	Species	Family	Number of individuals
1	*Borassodendron borneensios*	Aracaceae	9
2	*Arenga* sp.	Aracaceae	5
3	*Hopea mengarawan*	Dipterocarpaceae	4
4	*Durio acutifolius*	Bombaceae	4
5	*Payena lucida*	Sapotaceae	3
6	*Scima wallichii*	Theaceae	3
7	*Pternandra glabra*	Melastomataceae	3
8	*Myristica maxima.*	Myristicaceae	3
9	*Artocarpus kemando*	Moraceae	3
10	*Aquillaria malaccensis* Lamk.	Thymelaceae	3

The most common of the 10 host tree species was *Borassodendron borneensios* (9 individuals or 12.5% of all host tree individuals) and *Arenga sp* (Table 2). The most common trees found as host trees generally have rough, cracked bark, many grooves that allow the flow of water from the crown that carries humus and litter, as well as fog to bond and collect more easily. *Borassodendron borneensios* and *Arenga sp* is a secondary forest species and it forms such a reservoir of epiphytes in that it possesses features which make it very convenient and conducive for epiphytic growth. Such features are retention of dust particle due to its rough bark and its retention of water after rain fall. These features enable the formation of appropriate microclimate for growth of many epiphytes (Praptosuwiryo et al. 2019). According Trimanto and Danarto (2020) the presence of epiphytic plants on phorophytes is determined by branches containing humus and moisture substrate that are accumulated from other epiphytic plants such as fern. So that not only epiphytes use it as a place to attach but also ferns and mosses, evenclimbing plants (lianas). Similarly, *Borassodendron borneensios*, despite its smaller trunk size, has very effective branching for the growth of epiphytic species (Praptosuwiryo et al. 2019).

In the present study, *Schima wallichii* trees were only attached by *Pholidota globosa*, which is the only epiphyte species that has a small body size so that it can attach to the trunk which is also small. This tree, named after the “Puspa area”, has a branching architecture that allows the growth of various epiphytic species. Setyawan's (2000) study in Jobolarangan, however, found 23 species of epiphytes on the trunk of this tree. Perhaps its monoculture as a reforestation plant in industrial plantations reduces the opportunity for epiphytes to invade. An observation made by Mamonto et (2003) on a large number of trees of various species in tropical forests showed that almost all species of higher epiphytes, including orchids, ferns and seed plants, grew mostly in cracks in the bark, grooves in the tree and large branching sites. More mature trees will have rougher bark, more crevices and larger branches than younger trees, although this does not necessarily mean that older trees of the same species will have more abundant epiphytes. It has also been observed by Hirata et al (2011) that the spread of epiphytes is strongly influenced by the condition of the substrate (host tree bark) which includes the slope and roughness of the bark and litter accumulation.

Epiphytes attach to the outer bark of stems, branches, and twigs or leaves. Mezaka (2008) explains that the distribution and abundance of epiphytes are influenced by substrate characteristics. Substrate characters can be interpreted as stem diameter (DBH), bark pH, and bark texture. However, according to Azemi et al (1996) and Einzmann, et al (2015), the presence ofepiphytes on their host trees is tightly related to the amount of sunlight penetration into the interior of forest stands, which are the main controlling factor in the vertical spread of epiphytes on their host trees. However, according to Callaway et al (2002) and Esses (1996) in addition to the influence of environmental conditions, in particular climatic elements, the type and size of the host tree also affect the abundance and distribution of epiphytes, specifically epiphytes that have a form of body structure (growth) hanging (non vascular pendant ephiphyte). For this reason, within forest communities, the distribution of epiphytes is often irregular in terms of both type and arrangement and stratification.

The bark color of host trees associated with epiphytes is basically brown. This brown color is quite varied from one tree to another, such as brown, dark brown, light brown, blackish brown, and yellowish brown. Differences in bark color can occur due to age, environmental conditions around the tree, and the intensity of sunlight shining on the tree. From the obtained data, all tree bark has a brown color and no green color which indicates that the epiphytes grow on the surface of the bark of trees that are mature or old (Callaway, et al. 2002; Einzmann, et al 2015).

In this research, epiphytes are mostly found on tree species whose bark is not gummy. More epiphytes were found on trees with non-gummy bark, suggesting that epiphytes are less fond of tree bark with sap. This is because the sap may contain substances that are harmful to their survival. The observations of the tree bark structure can be observed anatomically from the cross section of the tree bark in general the tree bark consists of two layers of periderm tissue and secondary phloem. This multi-layered arrangement increases the thickness of the bark, causing cracks and deep fissures, but the bark remains stable. The barkthat is deeply fissured and stable is very good for epiphytic root attachment. Unstable bark isless able to maintain the position of epiphytic plants attached to the bark, so that the types of epiphytes attached to this type of tree are epiphytes with small sizes such as *Eria retusa* and *Pholidota carnea* (Nurfadillah, 2015; Paramitha, 2017).

The diameter of the trunk, which broadly indicates age, seems to be associated with the number of epiphytes attached to a host tree species. Regardless of species, genus and family, the relatively large diameter host trees tend to have more epiphytes, both in number of species and number of individuals. Generally, trees with large diameters have bark conditions that are favourable for epiphyte growth, because generally the bark is rough, cracked and has many grooves, and the holes of broken or decayed scars are inhabited by humus, which will make it easier for epiphytes to attach. This however does not mean that every large-diameter tree, even of the same species, will always have more epiphytes; in fact, some trees do not have epiphytes at all, such as in *Koompassia excelsa* and *Agathis borneensis* (or similar species with damaged, deciduous, and almost bare crowns), and never in pioneer trees.

The number of host trees in the Main Protected Zone forest of Samarinda Botanical Garden is mostly in the diameter class between 21-38 cm, because the trees in the diameter range are in a condition of mutual protection so that the humidity between the trees is relatively higher than the general air humidity. Sujalu's research (2015; 2010; 2008) in the lowland Dipterocarpa forest of the Malinau watershed showed that stem diameter seems to be closely related to the number of species and abundance of epiphytes, out of 3933 trees (diameter > 10 cm) recorded only 387 trees (9.84%) that were covered by epiphytes. Without distinguishing the type, large diameter trees tend to be more covered by epiphytes both in terms of the number of species and their abundance.

While tree diameter generally indicates age, it also determines the number of individuals and types of epiphytes attached. This also corresponds with the observations of Callaway, et al (2002) who showed that regardless of the type of epiphyte and where they live at the base of the tree, trunk, branches, or on tall twigs, the abundance and clustering of the number and type of attached epiphytes are generally more often influenced by the age of the host tree. Adhikara et al (2021, 2017) The findings suggest that the causes of differences in the composition and vertical distribution of epiphytes in each tree species or similar trees are extensive, which makes the vertical stratification of epiphytes in a tree difficult to classify, although the presence and distribution of epiphytes are commonly found on branches and twigs, especially on branches and twigs that grow relatively flat or sloping at various heights of the tree crown, and only a few can be found on parts of the tree (branches, limbs, or twigs) that grow perpendicular to the ground. The extent of bark exfoliation and branch fragility can lead to differences in mortality rates due to epiphyte fall (López- Villalobos et al, 2008); and the nutrient quality of stem and crown streams can affect the growth and fecundity of epiphytic orchids (higher amounts of nutrients can improve growth and fertility rates) (Einzmann et al., 2015; Ticktin et al., 2016).

Furthermore, the characteristics of these and other such host trees may not only affect epiphytes directly, but also indirectly by providing different microclimatic conditions for mycorrhizal fungal communities, which are necessary for orchid seed germination. Moreover, according to Timsana et al (2016) and Nurfadillah (2015), specific differences in the need for environmental conditions or epiphytic tolerance to the environment in the form of inherent height of the host tree or differences from one tree to another are very diverse, so there is nosignificant relationship between the epiphyte species and its host tree.

4. Conclusion

From the overall research results, the following conclusions, the diameter tree is the most important parameter explaining the abundance and species richness of epiphytes, especially from the Dipterocarpaceae family, and *Borassodendron borneensios*. Host trees generally have relatively horizontal branches with rough and cracked bark, and have the ability to accommodate litter and heavily over grown on their leaf midribs for Aracaceae. Accordingly, tree age is likely an important indicator for epiphyte diversity. Increasing tree age enhances the tree attributes such as diamater, bark rugosity and canopy cover.

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