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ASOSIASI PROTALIUM DENGAN BERBAGAI KELOMPOK TUMBUHAN EPIFIT PADA TIGA JENIS POHON INANG

ASSOCIATION OF PROTHALLIUM WITH VARIOUS EPIPHYTE GROUPS IN THREE TYPES OF HOST TREE

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Abstrak

Salah satu kelompok epifit vaskular penting adalah paku-pakuan dengan fase awal pertumbuhan disebut sebagai protalium. Tumbuhnya protalium di suatu lokasi menjadi penentu bahwa lokasi tersebut potensial ditumbuhi paku-pakuan dewasa. Asosiasi antara protalium dengan tumbuhan lainnya mungkin bermanfaat untuk menentukan potensi satu jenis inang sebagai tempat hidup dari banyak jenis tumbuhan epifit. Oleh karena itu, dilakukan studi asosiasi antara protalium dengan paku dewasa, lumut, liken dan epifit spermatofita pada tiga jenis pohon inang, yaitu *Archontophoenix alexandrae*, *Bichofia javanica* dan *Dacrycarpus imbricatus*. Metode yang digunakan dalam penelitian ini adalah *purposive sampling* yang menentukan tiga jenis pohon inang dengan diameter pohon 30–100 cm. Pengambilan sampel protalium dan epifit vaskular lain diambil pada masing-masing zonasi menggunakan *milimeter block.* Hasil penelitian menunjukkan terdapat lima kombinasi, yaitu protalium dengan paku, lumut dengan epifit spermatofita, protalium dengan epifit spermatofita, protalium dengan lumut, dan paku dengan lumut. Asosiasi positif dengan nilai tertinggi adalah 23,12; dua kombinasi yang memiliki asosiasi negatif ialah liken dengan lumut dan antara epifit spermatofita dengan liken; dan tiga kombinasi yang tidak berasosiasi ialah protalium dengan liken, paku dengan liken, dan paku dengan epifit spermatofita. Hal tersebut menunjukkan bahwa protalium berbagi karakter habitatnya dengan tiga kelompok tersebut dan tidak dengan kelompok lainnya. Penelitian ini sangat berguna untuk mengetahui jenis pohon dan karakteristik lingkungan yang sesuai untuk pertumbuhan protalium.

Kata kunci: Asosiasi; Epifit; Pohon inang; Protalium

Abstract

One of the important epiphyte vascular groups is ferns which the beginning phase of their growth called prothallium. Prothallium's growth in one location becomes an indicator that the location has the potential to be grown by mature ferns. The association between prothallium and other plants may be beneficial to determine the potential of a host species as the host of many epiphytes. Therefore, research about the association between prothallium and mature ferns, mosses, lichens, spermatophyte epiphyte also was conducted on three species of host trees namely Archontophoenix alexandrae, Bichofia javanica and Dacrycarpus imbricatus. Purposive sampling method was used in this research to determine three types of host trees with a size of 30–100 cm for each tree diametre. The sampling of prothallium and other vascular epiphytes was taken in each zone using millimeter blocks. The research showed that there are five combinations, prothallium with ferns, mosses with spermatophyte epiphytes, prothallium with spermatophyte epiphytes, prothallium with mosses and fern with mosses. Positive association with the highest value is 23.12, two combinations with the negative association are lichen with mosses and spermatophyte epiphyte with lichens, three combinations that are not associated, prothallium with lichens, ferns with lichens and ferns with spermatophyte epiphyte. It showed that prothallium shares its habitat character with those three groups, not with other groups. This study has valuable benefits of knowing tree species and environmental characteristics that are suitable for prothallium growth.

***Keywords**: Association; Epiphyte; Host tree; Prothallium*

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INTRODUCTION

Bedugul Botanical Garden is one of the Indonesian botanical gardens in Tabanan regency, Bali with a high level of humidity that is suitable for growing a variety of epiphytes. Epiphytes are typical plants of complex humidity tropical rainforest. (Gentry & Dodson, 1987), including epiphytic communities in the Bedugul Botanical Gardens (Bramantyo, 2008). An epiphyte is a plant that lives attached to other plants that need nutrients, minerals and water from water vapor during its life cycle (Benzing, 1990). A distinguished group of vascular epiphytes is ferns.

The initial phase of epiphytic nail growth from spore dispersal is prothallium (Ranker & Haufler, 2008). The presence of prothallium at a particular location on the host tree trunk indicates that the location is potential for the growth of young nails into adults and other epiphytes, such as mosses, lichens, and spermatophytes. A plant community consisting of various species allows interaction between species in the community (Aussenac, Bergeron, Gravel, & Drobyshev, 2019), for example, some plants live to compete to get nutrients from their habitat. Then another example is there are plants that live dependent on other plants to obtain nutrients or to obtain shade (Arsyad, 2017).

Kurniawan, Undaharta, and Pendit (2008) explained that the interest in plants to grow together is called Nakajima Association. Association is a form of interaction in a population with similar floristic composition, has a uniform physiognomy and a unique habitat distribution (Daunbenmire, 1968). Some associations are positive, negative, or not associated. Positive associations occur when a plant species is present together with other plant species, or species pairs occur more frequently than expected. Negative associations occur when a plant species is not present together with other plant species or species pairs occur less than expected (Kurniawan et al., 2008).

Prothallium epiphytic ferns grow depending on the environmental conditions provided by the host tree. According to Sutisna, Kalima, and Purnadjajav (1998), different tree species have characters with different types of branching and bark texture so that they can be essential factors for epiphytic plant diversity. Host tree characters that affect the distribution and abundance of epiphytes, including (adult) ferns have been carried out (Akas, 2008).

However, specifically for the prothallium phase, there is no specific research that looks at this relationship, whereas prothallium is the initial phase of growth of ferns from spores, which will later compile the adult spikes community. Therefore, research on the association of prothallium with various epiphytic groups in three host tree species, namely *Archontophoenix alexandrae, Bichofia javanica*, and *Dacrycarpus imbricatus* was conducted to determine the relationship of prothallium with various groups of epiphytic plants in the three host tree species.

MATERIALS AND METHODS

This research was conducted at the Eka Karya Bedugul Botanical Garden, Bali on April 14-16, 2018, from 7 AM to 6 PM.

Host Determination

The method used in this study was *purposive sampling* to determine three types of host trees, namely *Archontophoenix alexandrae, Bichofia javanica* and *Dacrycarpus imbricatus* with each tree diameter of 30–100 cm. The selection of the three tree species based on Wardhani (2018, *unpublished data*) is the most common types of large trees found in the Eka Karya Bedugul Bali Botanical Garden. The selection of large tree species commonly planted in the botanical gardens guarantees the availability of sufficient samples with the potential to accommodate many individual epiphytes per host tree.

Category of Epiphyte

Determination of epiphytic plant data collection used in this study were fern prothallium, all types of mosses obtained, lichen, all types of spike plants obtained, and other types of spermatophytes such as the *Araceae* and *Piperaceae* plant groups.

Method of Data Collecting

Prothallium and other vascular epiphytic samples were taken at each zone. The zone is following the Johansson method (1975), which can be observed in Figure 1.

In this study, the zone used was only 1-3 zones; this was due to the limited tools used to reach zones 4-5. To calculate the percentage of prothallium cover and other vascular epiphytes, a 20 mm x 20 cm millimeter block was used which filled with 5 mm small boxes. In this study, environmental factors were also measured as supporting data from the results obtained, consisting of the humidity of the bark of the host tree measured using a protimeter and humidity of the air measured using a hygrometer.

Data Analysis

Percentage of prothallium and other vascular epiphytic coverage data were then processed for association analysis. Associations between plant species were determined by the formula associations to find the relationship between the two species, which interact used association analysis calculated based on the formula found by Goodal (1953) in Mueller-Dombois & Ellenberg (1973) contained in Table 1.

Determination of the presence or absence of an association between one plant species with other plant species was calculated by Chi-square value ($\chi 2$). The type of interaction is determined by calculating the value of E (a) (Ludwig & Reynolds, 1988): $E(a) = \frac{rm}{N}$

Details: r= a+c; m = a+b; N = number of observation plots. a>E(a) means positive association, and a<E(a) means negative association.

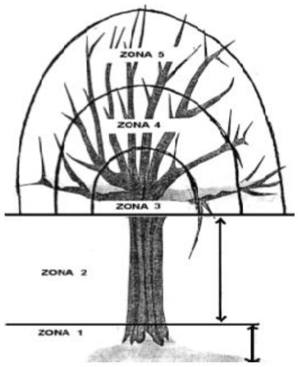

Figure 1. Division of vertical distribution zones of epiphytic plants (Johansson (1975). Information: zone 1= tree base (1/3 main trunk); zone 2= main stem until the first branch (2/3 main stem); zone 3= basal branching (1/3 branch length); zone 4= Middle branching (1/3 middle branching); zone 5= outermost branching (1/3 outermost branching)

Tabel 1. Tabel of Contigency 2x2

		Type B		
		exist	no exist	amount
Type A	exist	A	B	a + b = m
	no exist	C	D	c + d = n
	amount	a + c = r	b + d = s	N = a + b + c + d

$$X^2 = \frac{(ad - bc)^2\ n}{(a+b)(c+d)(a+c)(b+d)}$$

Details: a= number of observation plots containing types a and b; b= number of observation plots containing species b; c= number of observation plots containing type a; d= number of observation plots which do not contain types a and b; n= number of observation plots

RESULTS

Results on vegetation epiphytes in Eka Karya Botanical Garden Bedugul Bali showed that there were five combinations of positively associated, among others prothallium with spikes, mosses with epiphytes spermatophyte, prothallium with epiphytes spermatophyte, prothallium with mosses and spikes with mosses. There were two combinations of negative associations, namely between lichen with mosses and between epiphytes of spermatophytes with lichens. Moreover, three combinations were not associated with prothallium with lichens, spikes with lichen, and spikes with epiphytes of spermatophytes (Table 2). Epiphyte associations were observed to occur under environmental conditions as listed in Table 3.

Table 2. The association value and the type of interaction of all epiphytic groups in all three types of host

Prothallium				
23.12 / +	spike			
6.33 / +	5.6 / +	Mosses		
.20	0.47	11.9 / -	Lichens	
15.4 / +	2.88	17.6 / +	11.5 / -	Spermatophyte epiphytes

Table 3. Canopy opening environment data and humidity ratio (range (mean ± standard of error)

Spikes		Mosses	
OC	MR	BK	MR
14.17 - 43.39 (23.94 ± 3.3)	0.37 - 1.06 (0.76 ± 0.07)	11.25 - 43.39 (22.4 ± 2.0)	0.36 - 1.14 (0.8 ± 0.05)
Lichen		Spermatofita epiphytes	
11.25 - 43.39 (22.5 ± 2.4)	0.36 - 1.06 (0.75 ± 0.06)	15.66 - 28.21 (22.5 ± 3.6)	0.54 - 1.14 (0.8 ± 0.1)

Details: OC= opening canopy; MR= moisture ratio

DISCUSSIONS

Based on the results of the calculation of associations between communities conducted from 10 combinations, five combinations have positive associations, two combinations that have negative associations, and three combinations that were not associated.

Positive Association

Five combinations were positively associated, including prothallium with spikes, mosses with spermatophyte epiphytes, prothallium with spermatophyte epiphytes, prothallium with mosses and spikes with mosses. According to Kurniawan *et al.* (2008), positive associations occur when a plant species is present together with other plant species, or species pairs occur more frequently than expected. If one group is found in one *sampling* or plot, it is likely to find another group nearby.

The combination of spikes and prothallium has the most significant association value of 23.12. It is because prothallium is one stage of the development of the gametophyte phase in the spikes life cycle. Then the opportunity to be in one area is tremendous. The presence of prothallium in a particular location on the host tree trunk indicates that the location is a potential location for young nail growth into adulthood.

Whereas the combination of mosses with spermatophyte epiphytes, prothallium with spermatophytes epiphytes, prothallium with mosses and spikes with mosses each had an association value of 17.6; 15.4; 6.33; and 5.6. It is because the four groups can live in damp places (Costa, Zotz, Hemp, & Kleyer, 2018). According to Gonzales-Mancebo, Losada-Lima, and Patino (2004), the growth of epiphytic mosses on the stem is strongly influenced by climatic factors that are around, especially by humidity. Lichen, which is the result of a symbiotic mutualism between fungi and algae, has its mechanism. According to Muchroji (1997), to survive the component of the lichen fungus requires a temperature of 16-22 °C and humidity of 80-90%, with sufficient oxygen content and sunlight around 10%.

Negative Association

Two combinations showed negatively associated, namely between mosses and lichens, and between spermatophyte epiphytes and lichen. Pratama, Laode, and Joeni (2018) explained that negative associations showed no tolerance for living together, in the same area or the absence of mutual relationships. The existence of various species in plant communities raises opportunities for competition; this was explained by Solikin (2015) the existence of various types of plants in the community lead to competition between individuals within species or between species which ultimately formed diverse compositions and dominance.

Both combinations that are negatively associated are equally linked to lichen. It is because lichen can excrete a variety of secondary metabolites (Calcott, Ackerley, Knight, Keyzers, & Owen, 2018). Secondary metabolites in the form of chemicals accumulate on the surface of hyphae (Goga *et al.*, 2018). The function of these chemicals is photoprotection, allelopathic, allelochemical, antitumor, antimicrobial and antioxidant (Molnár & Farkas, 2010).

One of the secondary metabolites function produced by lichen is allelophatic, which can affect the growth and development groups around the epiphytic lichen, like mosses, fungi, epiphytes other spermatophyta, as well as microorganisms (Macias & Galindo, 2007). Competition occurs between lichen and epiphytic groups around lichen to get space and light intensity on the substrate occupied and to determine the structure of the lichen community and individual distribution (Armstrong, 2004).

Several types of lichen can survive in low humidity or polluted environments (Nakajima, Fujimoto, Yamamoto, Amemiya, & Itoh, 2019). According to Kansri (2003), the structure of the lichen has a lower cortex in the form of *rhizines*, that is a tool to absorb food for lichen so that it can grow well even in a polluted environment.

As for mosses, light moisture and light intensity are essential factors that have a considerable influence on mosses growth (Proctor, 2008; Gradstein & Culmsee, 2010). Mosses are only able to survive in the light humidity and sufficient light intensity. If the intensity of the incoming light is too high, it will have an impact on increasing water vapor and resulting in environmental humidity will decrease (Windadri, 2009).

Not Associate

Three combinations were not associated, including prothallium with lichen, spikes with lichen, and spikes with spermatophyte epiphytes. It means that there are epiphytic groups that are not associated with other epiphytic groups, because the presence of other species doses not influence them and the plants have a high tolerance to various environmental conditions. According to Sykora, Bogetr, and Berendse (2004), the physical condition of the soil affects the composition of the associated plant species due to microclimate (light, radiation, wind, temperature and humidity).

Besides, these plant groups have different habitat character requirements for survival. According to Hardini (2010), lichen does not require high living conditions and is resistant to water shortages for an extended period, and thallus growth is prolonged. Lichen is also resistant to scorching heat (Solhaug, Gauslaa, Nybakken, & Bilger, 2003). If the weather is hot, color of lichen will change, but not die. If it is doused with water, lichen will come back to life (Tjitrosoepomo, 1998).

Prothallium and spike generally live in places that contain a lot of water and sufficient light intensity. Spikes require high humidity to continue to survive and will die faster or not be able to grow properly if the temperature is too hot, less water and environmental humidity begin to decrease.

In the spermatophyte epiphytes, one of them is that the orchid requires adequate site conditions. According to Latif (1960), when the orchid receives too little light it will be dark green leaves, flowers sometimes do not come out, the plants susceptible to disease either by bacteria and fungi, and if light received is too large the effect is the same. Orchids cannot grow well if the environmental conditions are adverse.

CONCLUSION

Five combinations showed positive associations, namely prothallium with spikes, mosses with epiphytes of spermatophytes, prothallium with epiphytes of spermatophytes, prothallium with mosses and nails with mosses. Two combinations showed negative associations, namely lichen with mosses and epiphytes of spermatophytes with lichen, and three combinations were not associated with prothallium, namely prothallium with lichen, spikes with lichen, and spikes with epiphytes of spermatophytes. Prothallium, spikes, mosses and epiphytes of spermatophytes generally can live in conditions with high humidity and sufficient light intensity, while lichen can survive with conditions of low humidity and are resistant to high light intensities.

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