

Research Article

The Autecology of Genus *Dischidia* (Asclepiadaceae) in Bangka Island: Characteristics of Vegetation and Abiotic Environmental Factors Affecting Abundance

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ABSTRACT

Dischidia is an epiphytic plant, it is used as herbal medicine and has economic value. In addition, *Dischidia* also has an ecological function. Moreover, some species of *Dischidia* are endemic in a particular region. Various forest types occur in Bangka Island serves as natural habitat for this epiphytic plant. This research aimed to record the diversity and abundance of *Dischidia* and analyze those environmental factors which affect its abundance. The research was conducted in August – September 2016 at Bangka Island. Three plots of 20 × 20 m² were placed with a minimum interval of 50 m in the habitat where *Dischidia* are found. The species diversity and abundance of *Dischidia* as well as abiotic factors such as temperature, humidity, light intensity, wind speed, and altitude were recorded in these plots. The vegetation structure was analyzed based on index of diversity, index of dominance and index of evenness. Data on the environmental condition and abundance of *Dischidia* were then analyzed using Canonical Correspondence Analysis (CCA) method with Canoco 4.5 software. Five species of *Dischidia* were found in Bangka Island that are *Dischidia bengalensis*, *Dischidia imbricate*, *Dischidia nummularia*, *Dischidia rafflesiana*, and *Dischidia hirsute*. *Dischidia* is found in 14 species of host plants. *D. imbricate* (23 individual plants) occurred in the heath forest at Pejem showed the highest abundance. Epiphytic fern plants, the *Asplenium nidus* (27 individual plants), was the dominant epiphytes found in the host tree of *Dischidia*. The CCA showed that light intensity, temperature and humidity influenced the abundance of *Dischidia*.

Keywords: Bangka Island, *Dischidia*, environmental factors, epiphyte

Introduction

Dischidia, is one of epiphytic plant genus in the family of Asclepiadaceae, consists of 80 species which are native to tropic and sub tropic area in Asia. It is closely related to another epiphytic genus in the Asclepiadaceae the *Hoya* [1]. *Dischidia* does not have root beneath the ground. Therefore, this plant twists its body on another plant [2] or form a hanging huge mass on the host plant [1].

Some of *Dischidia* can be utilized as a medicine; *Dischidia pectinoides* are used for a breathlessness [3]. Another species, *Dischidia imbricate* contains some secondary metabolites such as alka-

loids, flavonoids, and steroids or triterpenoids which enable to serve as an anti-cancer and anti-tumor [4]. Moreover, *Dischidia* also has an ecological function; *Dischidia major* has mutualism with ant, *Lasius fuliginosus* which has storage inside of the leave of *D. major* which is used for nurturing the larva and accumulating organic debris that will be used by *D. major* as a source of nitrogen [5]. In addition, *Dischidia* has potential to be an ornamental plant; *Dischidia hirsute* is one of ornamental species which has high economic value [6].

In some countries such as Philippine and New Guinea, some species of *Dischidia* are endemic

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species. *Dischidia torricellensis* is endemic in New Guinea, and *Dischidia cleistantha* is only found in Philippine [7]. *Dischidia* grows in lowland forests (0 – 600 masl) and mountain forests. The species *Dischidia bengalensis* requires full light, therefore this species grows in lowland forests on the canopy open with an elevation of 600 masl. Whereas, *Dischidia lanceolata* is found on altitude of 1300 – 2000 masl in humid forests of Sumatra and Lombok. *Dischidia nummularia* grows in mountain forests in West Java at an altitude of 1300 – 1800 masl [8].

Several species of *Dischidia* are categorized from their vulnerability to the endangered condition, but data pertaining to their ecological status remains limited. *Dischidia acutifolia* is listed as critically endangered plant in Singapore [9]. *Dischidia litoralis* was listed as a category of vulnerable in Queensland by the rare and endangered Nature Conservation Act (1992) by The National Red List 2012. Besides, *D. nummularia* is also categorized as critically endangered by The Nasional Red List 2012 of Sri Lanka [10].

Bangka Belitung is one of the archipelago provinces in Indonesia. It is located on the eastern Sumatera across South Sumatera province. One of the main islands of the province is Bangka Island. Some of the forests on this island belong to the heath forest [11], a unique natural vegetation found only in Bangka Belitung Island and a small part of Kalimantan. These forest characters are sandy soils, acidic, and poor nutrients [12], thus causing a different flora compared to other lowland rainforests. Currently, three quarters of the island of Bangka is a tin mining area that threatens the sustainability of the forests. Tin mining has impacts on the destruction of natural landscape and natural habitat for biodiversity [14] including the diversity of *Dischidia* species. The impact of this damage is feared reduce the number of plant species. It is therefore necessary to search the diversity and abundance of *Dischidia*, and its hosts, other epiphytic plants associate with *Dischidia* as well as the environmental factors affecting the abundance of it.

Material and Methods

Time and locations

This research was conducted during August – September 2016 on 12 locations which distributed

in four districts of Bangka Island: Toboali and Koba (South Bangka Regency), Nangka Island and Sungaiselan (Central Bangka Regency), Pejemb, Kemuja, Riausilip, Petaling, Mangkol, Bakam, and Pemali (Bangka Regency), Mentok (West Bangka Regency).

Location plotting

The research locations were determined by exploring the secondary forests, heath forests and lowland tropical rain forests in four districts in Bangka Island to obtain the distribution location of *Dischidia*.

Sampling methods

Three plots measuring 20 m × 20 m were placed by a purposive sampling with a minimum interval of 50 m in the habitat where *Dischidia* is found. Specimen *Dischidia* was collected and made as herbarium by following the previous specimen collecting method [15]. The amount and names of the host tree species of *Dischidia* in the plot were calculated and recorded. In addition, bark texture, roughness, and pH of bark were also recorded. The type and number of individual by *Dischidia* and other epiphytes in each host tree were also recorded.

Data coordinates of location where the *Dischidia* species occurred were taken used GPS map Garmin 62s. Climatic data (micro climate) were measured on the plot: the light intensity by using lux meters, the wind speed and humidity by using hand-land 4 in 1 environmental meter, the air temperature determined using thermohigrograph.

Vegetation structure analysis

Plots of nested quadrat method were used for analyzing the composition (density and dominance) of vegetation of different stage: 20 × 20 m² for tree, 10 × 10 m² for pole, 5 × 5 m² for sapling, 2 × 2 m² for seedlings, shrubs, and ground cover plants.

Environmental data and analysis of *Dischidia* vegetation structure abundance

Data were analyzed to describe the vegetation structure of the habitat of *Dischidia* based on several parameters: Shannon Wiener index (H') [16], Evennes index (E), and Dominance index (D) [17]. Environmental data and *Dischidia* abun-

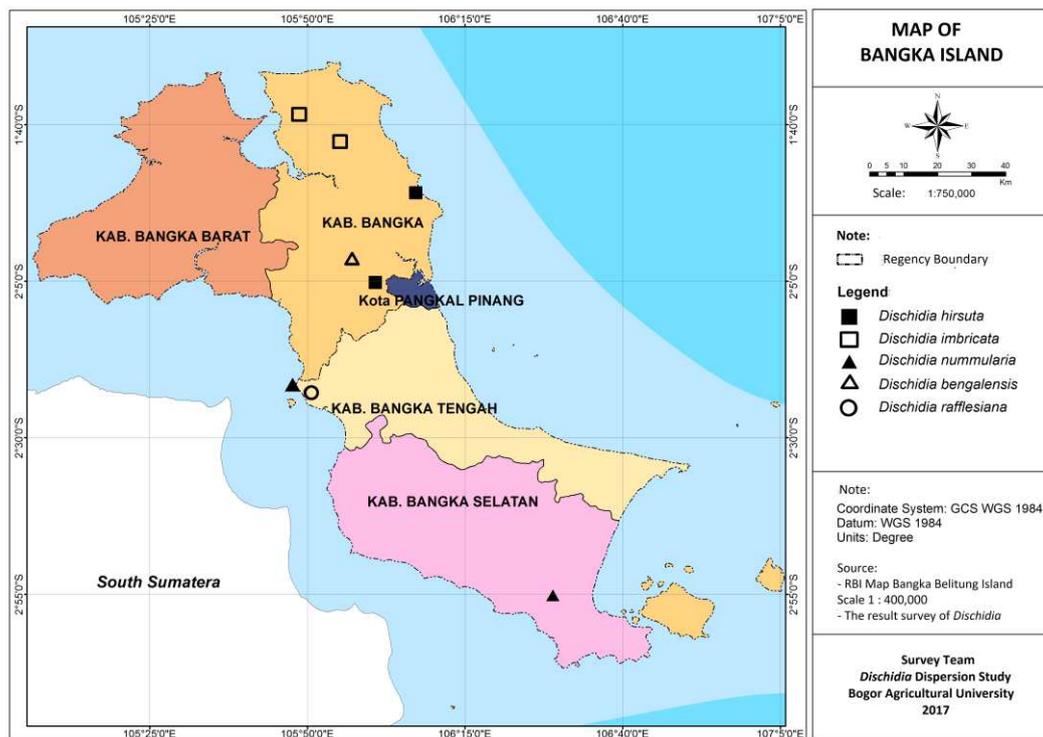


Figure 1. Map showing distribution of *Dischidia* species in Bangka Island

Table 1. Abundance of *Dischidia* species (number of individuals in 3 plots 20 m × 20 m) in their habitat at seven sites in Bangka Island

Location	Type of vegetation	Species	Number of individuals
Pejem (Central Bangka)	Heath forest	<i>D. imbricate</i>	23
Nangka Island (Bangka)	Heath forest	<i>D. rafflesiana</i>	8
	Heath forest	<i>D. numularia</i>	2
Toboali (South Bangka)	Secondary forest	<i>D. numularia</i>	4
Riausilip (Bangka)	Secondary forest	<i>D. hirsute</i>	2
Petaling (Bangka)	Secondary forest	<i>D. hirsute</i>	5
Kemuja (Bangka)	Secondary forest	<i>D. bengalensis</i>	2
Mangkol (West Bangka)	Secondary forest	<i>D. hirsute</i>	7

dance were analyzed by Canoco for windows 4.5 software with RDA method [18]. This analysis was used to determine the relationship between light intensity, wind speed, humidity, temperature, and altitude of *Dischidia* abundance.

Results and Discussion

Diversity of *Dischidia*

The exploration of *Dischidia* was conducted on 12 locations which is distributed in four districts of Bangka Island. *Dischidia* populations were found in seven locations, i.e Toboali (South Bangka Regency), Nangka Island (Central Bangka Regency), Pejem, Kemuja, Riausilip, Petaling and

Mangkol (Bangka Regency) (Figure 1). Exploration in five other locations, i.e. Bakam and Pemali (Bangka Regency), Sungaiselan (Central Bangka Regency), Koba (South Bangka Regency, and Mentok (West Bangka Regency) did not find the population of *Dischidia*. In this current study, five species of *Dischidia* were found. However, only one species of *Dischidia* was found in each explored location, except for Nangka island in which found two species, *D. rafflesiana* and *D. nummularia* (Figure 1).

The species *D. rafflesiana* was found only on the Nangka island. *Dischidia* distribution in Bangka island is mostly found in Bangka Induk Regen-

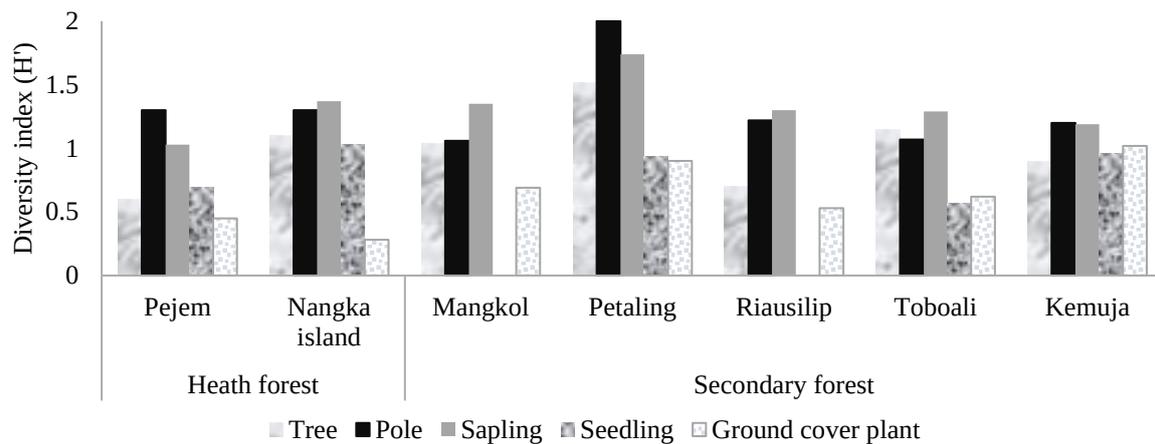


Figure 2. Diversity index (H') at the research sites on Bangka Island on trees, poles, sapling, seedlings and ground cover plants

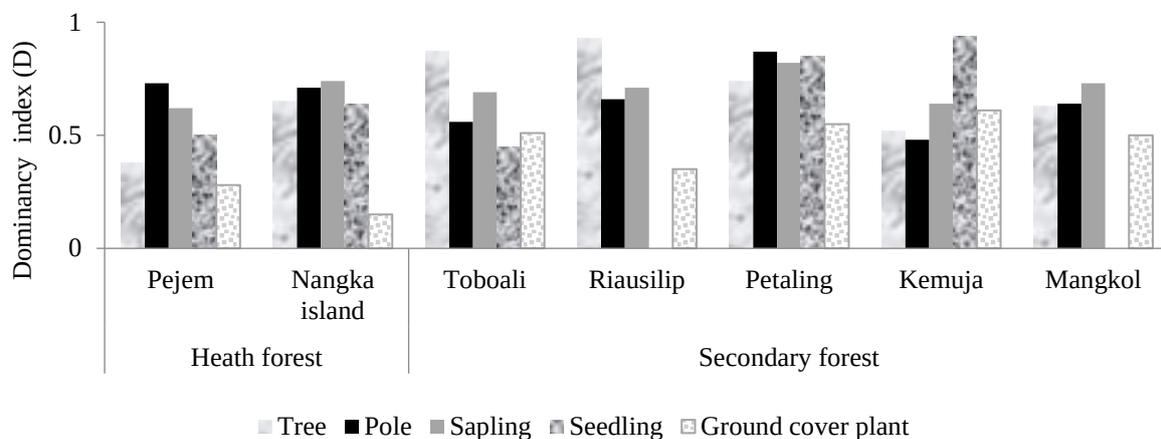


Figure 3. Dominance Index (D) at the research sites on Bangka Island on trees, poles, sapling, seedlings and ground cover plants

cy which is in four locations with total diversity of 5 species. The *Dischidia* species previously reported in Indonesia are *D. acutifolia* (Borneo, Java, Sulawesi, Sumatra), *Dischidia albida* (Borneo, Sulawesi, Sumatra), *Dischidia asthepana* (Borneo), *D. bengalensis* (Borneo, Java, Sulawesi, Sumatra), *D. hirsute* (Borneo, Sumatra, Java, Sulawesi), *D. lanceolata* (Java), *D. imbricate* (Borneo, Java, Sumatra), *Dischidia latifolia* (Java), *D. major* (Borneo, Sulawesi, Sumatra, Java) [19].

The abundance of *Dischidia* in the habitat

D. rafflesiana was found in the heath forest, while *D. hirsute* and *D. bengalensis* were spotted in secondary forests. *D. numularia* and *D. imbricate* were found in secondary forests and heath forests. The abundance of *Dischidia* in the heath forest is higher than in the secondary forest. *D. imbricate*, the most abundant species (23 individu-

als), was found in the Pejem heath forest. A total of 14 individuals from two species *Dischidia* were found in the heath forest of Nangka island. The *Dischidia* that is found in secondary forest was only 2 – 7 individuals (Table 1). *Dischidia* in the heath forest tended to be abundant because this forest was categorized as an opened forest with high light intensity. Generally, *Dischidia* lives in opened forests with high light intensity [19].

Vegetation structure of *Dischidia*

Diversity index (H')

Biotic factors that may capable of affecting the presence of *Dischidia* is the vegetation structure. Based on the Shannon Wiener (H') Diversity Index in all researches, the highest H' value was attributed to tree strata (1.52), pole (2), sapling (1.74) in secondary forest of Petaling, seedling (1.03) in heath forest of Nangka island and ground

cover plants (1.02) in secondary forest of Kemuja. The lowest H value was attributed to tree (0.6) in the Pejem heath forest, pole (1.06) in secondary forest of Kemuja, sapling in secondary forest of Riausilip (1.03), seedlings (0) in secondary forest of Mangkol and Riausilip and ground cover plants (0.28) in the secondary forest of Nangka island. The secondary forests of Petaling have higher diversity, with exception in that the lower seedling and ground cover plants strata of the secondary forest (Figure 2).

Secondary forests in Mangkol and Riausilip have lower diversity in comparison with other sites in both secondary forests and heath forests in all strata. The low value of H' in the forest was caused by the low composition of tree species vegetation in this forest because some species could replace other species (redundant) [20].

The vegetation in heath forest was dominated by Myrtaaceae (*Tristaniaopsis* and *Baeckea frutescens*), and several species of Melastomataceae. In the forest, the growth rate from tillers to adulthood was slow [20]. The soil condition of heath forest is nutrient-poor, thus only certain species could reach their optimum growth in such condition.

Dominance index (C)

The dominance index for all strata in all locations ranged from 0 to 0.94. The highest value was attributed to seedling strata (0.94) in secondary forest of Kemuja, while the lowest value was attributed to seedlings (0) in secondary forest of Riausilip and Mangkol (Figure 3). The high dominance index indicates that the place has a low diversity and an uneven distribution. The presence of dominance demonstrates that not all plants have the same adaptation.

Evenness index (E)

Distribution of a balanced plant if it has an evenness index values ranging from 0.6 to 0.8 [16]. The highest evenness (E) values were found in the tree (0.98) in the heath forest of Nangka islands, the pole (0.98) in the secondary forest of Petaling, the weaning (0.97) in the secondary forest of Mangkol and Petaling, the seedling (1) in the heath forest Pejem and undergrowth strata in secondary forest Mangkol. The lowest E values for the tree (0.67) in the secondary forest of Riausilip, the pole (0.77) in secondary forest Kemuja, sap-

ling (0.85) in the Toboali secondary forest, the seedling in the secondary forests of Mangkol and Riausilip, and the ground cover plant (0.4) in the heath forest of Nangka islands. The strata of trees and columns for all locations showed a steady-state deviation of > 0.6 [21]. This indicated that the sustainability of species diversity in both stands was properly maintained. The high strata of trees and poles are favorable for epiphytic plants because supplies for the host are high.

Microclimate conditions of *Dischidia* habitat

The microclimate condition of secondary forests and heath forests was dissimilar. The average temperature in both observation sites was recorded from 31°C to 37.5°C. The highest average air humidity value reached 79.4% in secondary forest of Mangkol. The highest light intensity was recorded on the heath forest of Pejem (2036.5 Lux). Habitat conditions in the location were quite open and very close to the beach, leading to higher temperature. Additionally, heath forest was observed to have higher wind speed compared to secondary forest (1.3 km/s). Heath forest seems to have sparse population of the trees, thus enhancing the wind speed, as presented in (Table 2).

The CCA analysis (Figure 5) shows the correlation of environmental factors to the abundance of *Dischidia* plant. Abundance *D. rafflesiana* was affected by wind speed. *Dischidia* were found in the heath forest having specific conditions such as more open condition and close to the beach. However, another species such as *D. bengalensis* was more affected air humidity. Furthermore, *Dischidia* was also found in secondary forests having more closed habitats. *D. hirsute*, *D. imbricate*, and *D. nummularia* were excluded from cluster of the observed environmental variables because they were general species.

Host availability for *Dischidia*

The results showed that available host of pole strata was higher than that of tree strata, except for Nangka island and Toboali. *Dischidia* was more found in host pole strata (21 individual hosts) than tree strata (13 individual hosts) (Table 3).

Diversity of *Dischidia* host

Dischidia was found in 14 species of host plants. The diameter of the host tree *Dischidia* ranged from 13.6 to 45.5 cm. The *Dischidia* grew

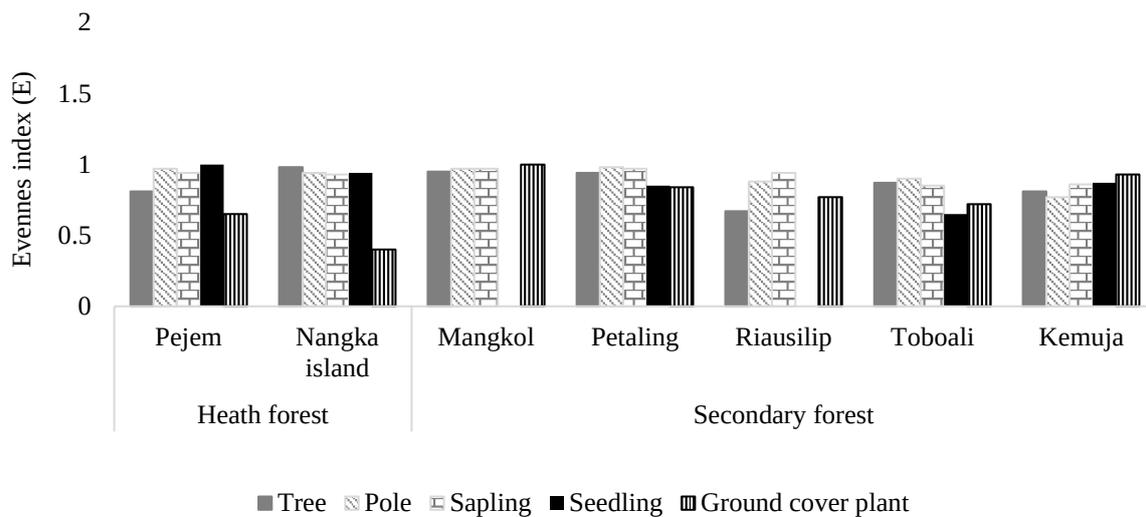


Figure 4. The evenness index (E) at the research sites on Bangka Island on trees, poles, sapling, seedlings and ground cover plants

Table 2. Type of vegetation and microclimate conditions of *Dischidia* habitat in seven locations on Bangka Island

Type of vegetation	Location	Altitude (masl)	Microclimate			
			IC (Lux)	KA (km/s)	RH (%)	T (°C)
Heath forest	Nangka island	10	1927	1.2-1.3	67.1	35.2
Heath forest	Pejem	27	2036.3	0.2-0.3	57.6	37.5
Secondary forest	Toboali	43	1250	0.12	78.2	31
Secondary forest	Riausilip	52	1353.3	0	78.6	33.1
Secondary forest	Petaling	120	1323.3	0	69.3	33.7
Secondary forest	Kemuja	132	1370.6	0.16-0.2	79.3	32.1
Secondary forest	Mangkol	379	1250	0.2-0.3	79.4	31.1

Note: IC= light intensity; KA= wind speed; RH= humidity; T= temperature

on the branch and or main stem with a host height of 0.6 – 8 m (Table 4). The tree enables to improve growth of epiphytes which need sunlight. *D. imbricate* and *D. rafflesiana* are species found with the highest host elevation.

D. imbricate was found in 9 individual hosts of the species *B. frutescens*, and each individual host of the *Acacia* sp., *Artocarpus heterophyllus* and *Theobroma cacao* species. Each host species has an individual *Dischidia* except on *B. frutescens* with 19 individuals and *Acacia* sp. with 4 individuals *Dischidia*. *D. imbricate* is found in the host on the tree and/or pole strata (5.8 – 26.6 cm) with the average height of *Dischidia* position at the host 5 m. *D. nummularia* is found in a host of *Durio zibethinus* and three hosts of *Mangivera indica*, with 3 – 4 individuals of *Dischidia* in each host. The previous research reported that species

D. nummularia was found in *Mangivera* sp. and *Tectona* sp. which often attached as epiphytic plants [22]. *D. nummularies* was found in hosts with tree strata (38.5 – 45.6 cm) with a height of 4 – 7 m.

The results CCA of the analysis between the abundance of *Dischidia* and the characteristics of the host tree showed that *D. rafflesiana* and *D. imbricate* correlated positively with growth location (F-ratio = 0.93; P-value = 0.47). Species *D. nummularia* and *D. imbricate* correlated significantly with roughness (F-ratio = 0.7; P-value = 0.57). Species *D. bengalensis* and *D. hirsute* were positively correlated with skin pH (F-ratio = 2.81; P-value = 0.02) (Figure 5). The highest correlation level is the pH of the bark because of the value $0.05 < P\text{-value} > F\text{-ratio}$. *Dischidia* was found in bark with pH 6.7 – 7. Epiphytic plants live on bark

Table 3. Total availability of substrate (Σ tree and Σ pole) and host availability of *Dischidia* in 3 plots 20 m \times 20 m

Location	Σ available host		Σ host on board <i>Dischidia</i>		Σ individual	Species name
	Tree strata	Pole strata	Tree strata	Pole strata		
Nangka island	13	12	1	4	2	<i>D. rafflesiana</i>
			1	-	4	<i>D. nummularia</i>
Pejem	8	11	2	8	23	<i>D. imbricate</i>
Toboali	11	10	3	-	8	<i>D. nummularia</i>
Riausilip	13	28	1	1	2	<i>D. hirsuta</i>
Petaling	19	31	3	2	5	<i>D. hirsuta</i>
Kemuja	14	42	-	2	2	<i>D. bengalensis</i>
Mangkol	8	14	2	4	7	<i>D. hirsuta</i>
Number	86	148	13	21	53	

Table 4. Species diversity and features of host stem and *Dischidia* position on host

<i>Dischidia</i> species	Location	Host species	Σ host	D (cm)	pH	TK	TP	LT
<i>D. nummularia</i>	Toboali	<i>M. indica</i>	3	75.6	7	3	4	1
	Nangka Island	<i>D. zibethinus</i>	1	83.5	6.9	2	6-7	1
<i>D. imbricate</i>	Pejem	<i>B. frutescens</i>	9	18.2	7	3	1-5	2
		<i>Acasia</i> sp.	1	71.7	7	2	8	2
	Riausilip	<i>A. heterophyllus</i>	1	20.1	6.8	2	7	1.2
		<i>T. cacao</i>	1	31.6	7	2	1	2
<i>D. rafflesiana</i>	Nangka Island	<i>S. baccatum</i>	3	24.9	6.7	2	1-5	1.2
		<i>D. zibethinus</i>	2	68.5	6.9	2	8	2
<i>D. hirsuta</i>	Petaling	<i>Macaranga</i> sp.	4	37.5	7	3	6-7	1
		<i>A. integer</i>	1	82.3	6.8	2	3	1
	Mangkol	<i>T. obovata</i>	4	19.7	7	3	0.6	1
		<i>L. resinosa</i>	2	35.4	7	3	5	1
<i>D. bengalensis</i>	Kemuja	<i>T. merguensis</i>	1	20.5	7	1	0.5-1	1
		<i>Calophyllum</i> sp.	1	21.1	6.9	3	1.5	1

Note: TP = height of *Dischidia* position on host; D = diameter; pH = pH of bark; TK = level of roughness (crude and cracked = 3, slightly crude and slightly cracked = 2 fine = 1); LT = position of *Dischidia* at host part (branch = 1, main stem = 2)

trees with a slightly acidic to neutral pH level [23].

Furthermore, the location (stem and branch) in which *Dischidia* species are grown also affected their growth. Mostly, *Dischidia* was found at the branch of host tree. In addition, the level of roughness also affects the abundance of *Dischidia*. The rougher the surface of a rod, the higher the chance of epiphytic growth. Ewusie (1990) found that skin characteristics (rough, groove, slit) could improve growth of epiphytic plants [25]. The need for high environmental conditions to lie in the diverse host trees allows for significant epiphytic species linkage with the host tree, while rather

slippery skin of the host tree will cause plants to stick and grow on the tree [26].

Other epiphytic plants around *Dischidia*

Nine species of epiphytes were found coexist with *Dischidia*. *Asplenium nidus* epiphytic plants (27 individuals), is the dominant epiphytes found in the host tree *Dischidia* (Figure 6). *A. nidus* occupies many species of host trees because it has a good adaptation in the condition of shady forest, exposed to partial or complete sunlight [24]. In addition, 25 individuals of Orchidaceae epiphytes were also found in the host tree *Dischidia*.

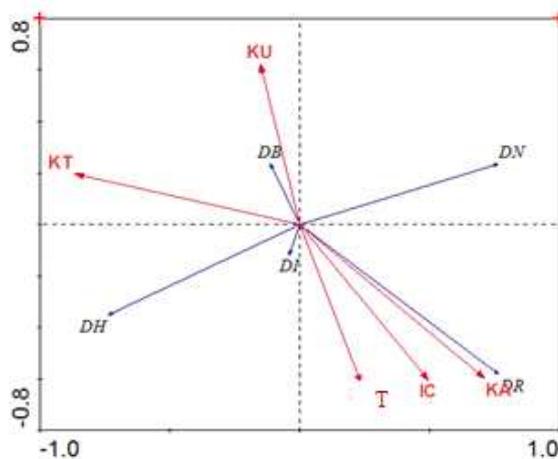


Figure 5. Correlation analysis of abiotic factor to the abundance of *Dischidia*. KA: wind speed; IC: light intensity; T: temperature; KT: altitude; KU: humidity; DR: *D. rafflesiana*; DN: *D. nummularia*; DH: *D. hirsute*; DB: *D. bengalensis*; DI: *D. imbricate*

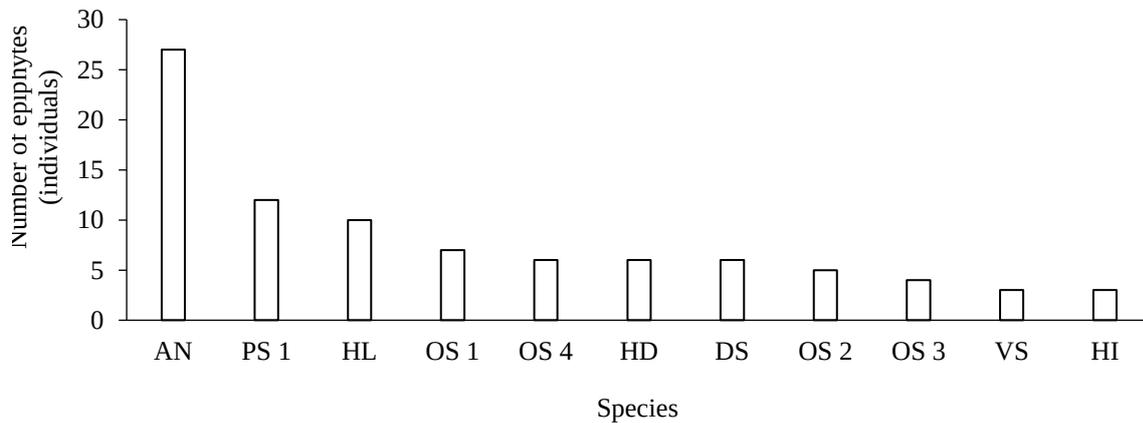


Figure 6. Total individuals of each epiphytic species found in *Dischidia* host from all plots at all sites. AN. *Asplenium nidus*, PS 1. Paku species 1, HL. *Hoya lacunosa*, OS 1. Orchidaceae sp.1, OS 4. Orchidaceae sp.4, HD. *Hoya diversifolia*, DS. *Dendrobium* sp., OS 2. Orchidaceae sp.2, OS 3. Orchidaceae sp.3, VS. *Vanda* sp., HI. *Hoya imprevialis*.

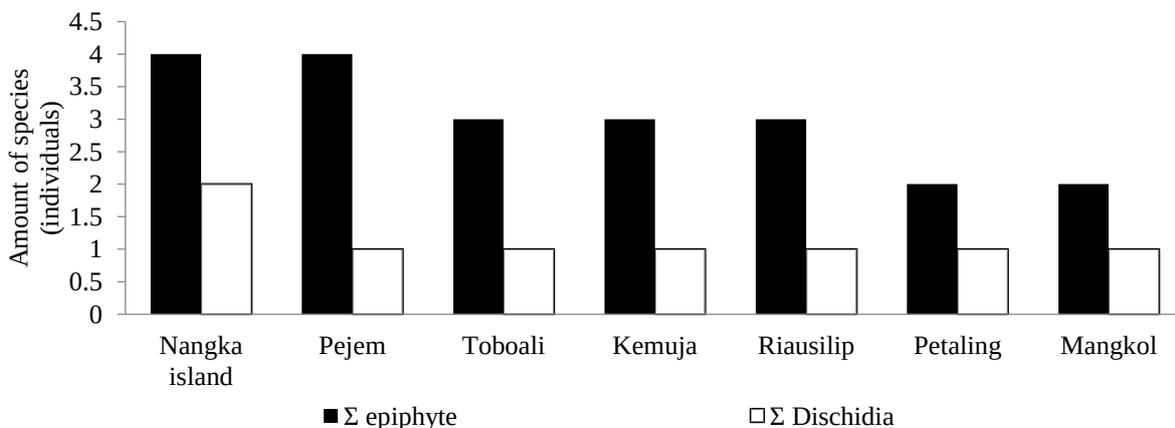


Figure 7. Comparison of the number of *Dischidia* species and number of the other epiphytic species at each research

Figure 7 shows that the number of epiphytic species in each location is higher when compared with the number of *Dischidia* species. The highest number of epiphytic species was found in heath forest of Pejem and Nangka islands (4 species for each location). Epiphytes are found living side by side with *Dischidia* and utilizing the same nutrients. However, neither of them interferes with each other.

Conclusion

Number of species of *Dischidia* were found in Bangka Island, i.e. *D. bengalensis*, *D. imbricate*, *D. nummularia*, *D. rafflesiana*, and *D. hirsute*. *D. imbricate*, the most abundant species (23 individuals), was found in the Pejem heath forest. The *Dischidia* that is found in secondary forest was only 2 – 7 individuals. *Dischidia* were found in 14 species of host plants i.e. *D. zibethinus*, *M. indica*, *B. frutescens*, *Acacia* sp., *A. heterophyllum*, *T. cacao*, *Sapium baccatum*, *Macaranga* sp., *Artocarpus integer*, *Tristania obovata*, *Litsea resinosa*, *Tristanopsis merguensis*, and *Calophyllum* sp. Factors affecting the abundance of *Dischidia* are the intensity of light, temperature, and humidity.

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