Biosaintifika 11 (1) (2019) 91-99

Biosaintifika

Journal of Biology & Biology Education

http://journal.unnes.ac.id/nju/index.php/biosaintifika

Habitat Suitability for *Hoya* spp. (*Apocynaceae*) in The Bodogol Conservation Area, West Java

Masrayani Sulaeman[1], ✉Sulistijorini[2], Sri Rahayu[3]

DOI: http://dx.doi.org/10.15294/biosaintifika.v11i1.13021

[1]Plant Biology Graduete Program, Department of Biology, Faculty of Mathematics and Natural Sciences, Institut Pertanian Bogor, Indonesia
[2]Department of Biology, Faculty of Mathematics and Natural Sciences, Institut Pertanian Bogor, Indonesia
[3]Bogor Botanical Gardens Plant Conservation Center, Lembaga Ilmu Pengetahuan Indonesia, Indonesia

History Article

Received 30 January 2019
Approved 19 March 2019
Published 30 April 2019

Keywords

Epiphyte; Habitat Suitability; *Hoya*; Phorophyte

Abstract

Hoya is a tropical flowering plant that has great potential as an export commodity. It needs to be cultivated to ensure its sustainability in nature. Information about the suitable habitat of *Hoya* was not widely known yet. This study aimed to compare the habitat characteristics of several species of *Hoya*. The research was conducted by exploring the sample plots determined by purposive sampling based on the differences of habitat characteristics. The biotic components observed were phorophyte species type and the number of individual of each *Hoya* species. The abiotic components measured in each plot were altitude and geographical position, air temperature, humidity, light intensity, wind speed, and canopy cover. *Hoya* 's diversity was analyzed using the Shannon Winner Index. Environmental factor data and biotic factors were analyzed with Canoco for Windows 4.5 software. There were 6 species of *Hoya* namely *Hoya multiflora, Hoya imperialis, Hoya vitellinoides, Hoya hasseltii, Hoya campanulata* and *Hoya lacunosa* found in this study. The highest biodiversity index was obtained in an altitude of 700-800 m.a.s.l (H'=1.41) and in hillsides area (H'=1.3). *Hoya* 's most frequent phorophyte was *Schima wallichii.* Factors affecting the presence of *Hoya* in the phorophytes were the position of attachment to the main stem and the rough surface characteristics of the tree. *Hoya* 's preference place was on the bark fracture. Abiotic factors that most influencing the existence of *Hoya* were air humidity and canopy cover. The data of this research can be used as basic information for carried out the conservation efforts and cultivation strategy in the future.

How to Cite

Sulaeman, M., Sulistijorini & Rahayu, S. (2019). Habitat Suitability for *Hoya* spp. (*Apocynaceae*) in The Bodogol Conservation Area, West Java. *Biosaintifika: Journal of Biology & Biology Education*, 11(1), 91-99.

✉ Correspondence Author:
Jl. Raya Dramaga, IPB Dramaga, Bogor, West Java, Indonesia, 16680
E-mail: sulistijorini@gmail.com

p-ISSN 2085-191X
e-ISSN 2338-7610

INTRODUCTION

Indonesia is a tropical country, endowed with high floral diversity, including *Hoya* from the family of *Apocynaceae* and sub family *Asclepiadoideae* (Endress et al., 2014). *Hoya* is a genus comprised of at least 200-300 species spread from Asia to New Guinea (Wanntorp & Kunze, 2009). *Hoya* is creeper (rarely shrubs) epiphytic plant, attaching the host plants (Kleijn & van Donkelaar, 2001). *Hoya* plant flourish best in enough light and humid air (Hansen et al., 2007), some is found along rivers and lakes (Rahayu, 2010). *Hoya* is used as cosmetics and medicinal plant, it is also potential to be developed as an ornamental plant, and has a high economical value (Rahayu, 2011). For example *H. parasitica* which is used in the treatment of gout, headaches, paralysis, arthritis, tetanus, rheumatic, tumors, coughs, asthma, body pain, jaundice, and fever (Khisha et al., 2012). *Hoya* is popular among the public as an ornamental plant. Many websites and social media groups have been established for *Hoya* lovers (Rahayu, 2018). The popularity and potential of *Hoya* began to be developed in some countries including in Indonesia through exploration, research, and cultivation.

Demand of *Hoya* that increased in society, leads to an opportunity to exploit the plant in its natural habitat. Exploitation is the main threat resulted in habitat damage. As an epiphyte that lives depend on the existence of a phorophyte *Hoya,* it is very vulnerable for logging. (Rahayu, 2010).

Development of cultivation and conservation requires basic knowledge of habitat diversity. Data on *Hoya*'s habitat and microclimate are needed as additional informations for conservation and cultivation development activities. Conservation activities can be an effort to keep the plant sustainability.

The Bodogol Conservastion Area, located at an altitude of 700-1500 m.a.s.l, serves as a support environment for the high biodiversity. Several types of flowering plants, medicinal plants, ornamental plants with high diversity so this place is suitable to be used as a study of *Hoya's* habitat (Jao, 2012). Research on the diversity of *Hoya's* habitat, especially in Bodogol has been carried out only for one species. That research discussed the population and habitat diversity of *Hoya multiflora* Blume in Gunung Gede Pangrango National Park and Sukamantri Gunung Halimun Salak National Park (Rahayu et al., 2011). Information about the suitability of the habitat *Hoya* biotic and abiotic, component interactions associated with biotic and abiotic component, interactions with other phorophytes. Improvement program regarding *Hoya* rather less. Therefore, it was necessary to conduct a study on the suitability of the habitat of each *Hoya* species. The aimed of the study were to study and compare the habitat characteristics of some *Hoya* species, as well as to understand the diversity of *Hoya* in Bodogol Conservation Area. In detail, this study was also conducted to understand the diversity of *Hoya* species and to identify its phorophyte as well as, to analyze the environmental factors affected their existence in the study area.

Information of the habitat specificity of *Hoya* can contribute as basic information in developing the conservation effort both *ex situ* and *in situ*. In addition, it can provide wider infromation about the benefits of *Hoya* and increase the sale value in the international market as an ornamental plant.

METHODS

Plotting and Observation of Biotic Components

Observation was carried out in the eleven hiking routes in the Bodogol Conservation Area. The locations for collecting the data were divided based on differences of altitudes (600-700, 700-800, 800-900, and 900-1000 m.a.s.l) and differences of topography includeed ridge, hillsides, and valleys. Data were retrieved using purposive sampling and exploration method (Sutomo & Mukaromah, 2010). Nested quadrats/plot were used to determine the vegetation diversity by nesting plot technique, with tree phase size (20x20) m^2, pole (10x10) m^2, sapling (5x5) m^2, and bush (2x2) m^2. Each tree has been found made measuring subplots (20x30) cm^2. The biotic data recorded on each quadrat included the species type of *Hoya* and its phorophyte, number of *Hoya* individuals , and intensity of *Hoya*. The position of *Hoya* on the phorophyte was divided into 5 zones. Zone 1 (in the base of the tree with a height of less the in 1 m), zone 2 (in the mainstem with a height of more than 1 m), zone 3 (in the one-third part of the base branching), zone 4 (in the middle of the branching), and zone 5 (in the outermost branches) (Johanson 1975, in Mariyanti et al., 2015).

Abiotic Factors

Abiotic factors observed were light intensity, humidity, air temperature, wind speed, and vanopy cover. Measurement of micro-climate was performed at 09.00 am to 01.00 pm with

three times of repetition.

Data analysis

Hoya and plants vegetation found on eleven hiking paths in the Bodogol Conservation Area were analyzed by using the index of diversity. Data of species type of *Hoya* and its porophyte, as well as the, number of *Hoya* individuals, and intensity of *Hoya* were presented in the form of figures and tables. The analysis of biotic data was performed by (Redundancy Analysis) RDA in Canoco for Windows 4.5 program. Principle Component Analysis (PCA) was used to investigate zonation of *Hoya* (Leps & Smilauer, 2003). Shannon-Wiener diversity index of was used based on this following formula (Soerianegara & Indrawan, 2008):

$$H' = -\sum_{i=1}^{n}[\frac{ni}{N}\ ln\frac{ni}{N}]$$

where:
H' = diversity index
N = number of individuals of all species in plot
Ni = number of individuals of one specific species
Ln = log natural

RESULTS AND DISCUSSION

***Hoya's* Diversity in The Bodogol Conservation Area.**

The result of this study indicated that there were 6 species of *Hoya* i.e. *Hoya campanulata, H. hasseltii, H. multiflora, H. lacunosa, H. vitellinoides, and H. imperialis* (Figure 1 and 2) were found in this study. Distribution of *Hoya* in this area was lower than in Central Sulawesi region as many as 8 species (Kleijn & van Donkelaar, 2001) and in Bukit Batikap Central Kalimantan as many as 9 species (Rahayu, 2006). Generally, the diversity and the number of *Hoya* species in the Bodogol Conservation Area. showed a reduction in the number of species. Rahayu (2012), stated that the number of *Hoya* species in Gunung Gede Pangrango was many as 8 species. The decline in the number of species of Hoya in Indonesia was caused by the deforestation. The disturbances come not only from local residence located close to the Bodogol Conservation Area but also from the activities inside the Bodogol Area such as tourism activities, climbing, encroachment, and high utilization of forest products. The threat is even greater for *Hoya* habitat's authenticity, due to an easy access to Bodogol Conservation Area which tends to elevate the susceptibility of *Hoya's* natural habitat. Bermuli (2017) reported that several factors that cause the decrease in the number of *Hoya* species allegedly due to disturbances on its natural habitat and human activities such as land conversion.

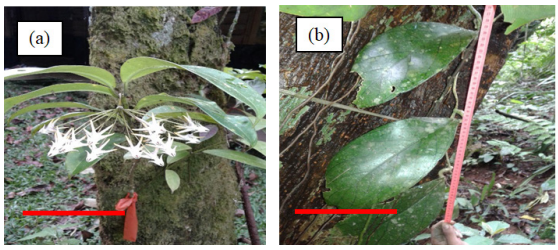

Figure 1. *Hoya multiflora* (a) and *Hoya vitellinoides* (b). Bar 5 cm

Hoya's diversity (H') based on altitude of places including in low to middle (0-1.41) category. The results showed that the highest Hoya's diversity (H') was middle category. It was found at altitude of 700-800 m.a.s.l (H'=1.41) with 32 individuals from 6 species. In the lowest altitude 900-1000 m.a.s.l, *Hoya's* diversity was low (H'=0) with 7 individuals from only one species *H. campanulata.*

Table 1 shows that *H. campanulata* and *H. imperialis* were found at three altitudes (600-700, 700-800 and 900-1000 m.a.s.l), while *H. multiflora* was found in two altitudes of 700-800 and 800-900 m.a.s.l. Three others species (*H. hasseltii, H. lacunosa,* and *H. vitellinoides*) were found only at analtitude of 700-800 m.a.s.l.

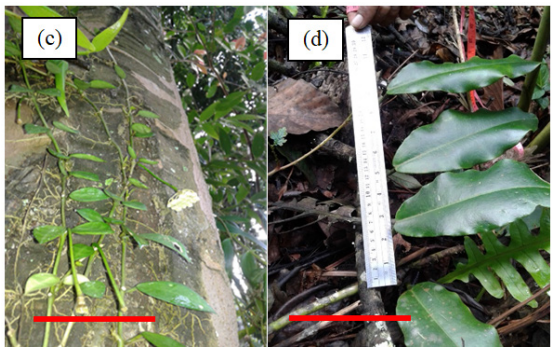

Figure 2. *Hoya lacunosa* (c) and *Hoya imperialis* (d). Bar 5 cm

Hoya 's diversity (H') based on topography was rated low to middle (0.15-1.1). Based on the topography, most of *Hoya* species (28 individuals of 6 species) was found in hillsides (H'=1.3). The *Hoya* diversity index was found in the valley (H '= 0.15) with 9 individuals from 3 species (Table 2). *H. campanulata, H. multiflora* and *H. imperialis* were found on three topography as follows: *H.*

Table 1. Diversity and abundance of *Hoya* species found in the Bodogol Conservation Area based on altitudes

Altitude (m.a.s.l)	Species name	Number of individual	Total of individual	Diversity index (H')
600-700	*H. campanulata*	6	8	0.56
	H. imperialis	2		
700-800	*H. campanulata*	13	32	1.41
	H. hasseltii	2		
	H. multiflora	6		
	H. lacunosa	10		
	H. vitellinoides	1		
	H. imperialis	1		
800-900	*H. multiflora*	29	30	0.15
	H. imperialis	1		
900-1000	*H. campanulata*	7	7	0

Table 2. Diversity and abundance of *Hoya* species found in the Bodogol Conservation Area based on topography

Topography	Species name	Number of individual	Total of individual	Diversity index (H')
Ridge	*H. lacunosa*	8	41	1.1
	H. multiflora	15		
	H.campanulata	16		
Hillsides	*H. multiflora*	16	28	1.3
	H. imperialis	2		
	H. vitellinoides	1		
	H. hasseltii	2		
	H.campanulata	5		
	H. lacunosa	2		
Valley	*H.campanulata*	6	9	0.15
	H. multiflora	2		
	H. imperialis	1		

lacunosa in ridge and hillsides, whereas *H. vitellinoides* and *H. hasseltii* were found in hillside. The results are in contrast with statement of Rahayu (2010) that most of the *Hoya* is easily found in the watershed because as an epiphyte, it likes a habitat with high humidity.

Phorophyte Characteristics

Hoya was found attached to 29 species of phorophyte. *Schima wallichii* and *Laportea stimulants* were the most frequent phorophyte found. The number of *Hoya* found on *Schima wallichii* phorophyte was 13 individuals from 2 species. *Schima wallichi* was the most frequent phorophyte among all phorophytes found with a tree diameter of approximately 12.7-45.5 cm and height of 1.7-15.0 m. *Laportea stimulant* was the second most frequent phorophyte 8 individuals, from 2 species. The tree height was 2.0-6.0 m with diameter of tree ranged from 9.2-25.4 cm. *Maesopsis eminii* was the type of phorophyte with the largest diameter, between 39.4-101.9 cm. Large diameter trees provide a place for plants grow and develop (Zotz, 2013). In addition, tree height can support epiphytic growth that requires high light intensity.

On the other hand, surface texture of the phorophyte variated from slightly coarse to coarse (Table 3). The results showed that *Schima wallichii, Laportea stimulant,* and *Maesopsis eminii* have rough and notched bark textures, allowing species of *Hoya* to growing well. Such wood surface conditions can facilitate humus and litter for

epiphytic growth. Moss spores and soil or dust particles that become humus and litter are a source of nutrients for *Hoya* (Kiraly & odor, 2010).

Rahayu (2010) found four types of attachment site of *Hoya,* ant nest holes, trunk bark fissures, midrib, and *Asplenium nidus*. However, *Hoya* is mostly found in bark fissures. The physical condition of bark influence the progress of epiphytic plant abundance (Puspitaningtyas, 2007). Generally, hollow and cracked bark with rough surfaces will retain better water, and the presence of cracks allows *Hoya migrula* to become easily caught. While slippery bark will be complicated for the litter or plant waste.

Table 3. Characteristics of Hoya's phorophyte

Name Species	Species of *Hoya*	Number of *Hoya* individual discovered	LG	TH (m)	TD (cm)	TS
Aglaia elliptica	HM,HCP,HV	3	BF	1.5-7.0	4.7-43.9	SR
Altingia excelsa	HCP, HL	4	BF, AN	0.3-12.0	35.0-90.7	R
Arenga pinnata	HCP	1	BF	2.5	19.1	R
Artocarpus elasticus (tumbang)	HI	1	AN	0.5	76.4	R
Calliandra calothyrsus	HM, HL	2	BF, BF	3.0-4.5	12.7-20.7	SR
Castanopsis argentea	HM	2	BF	2.0-4.0	50.9	SR
Cyathea medullaris	HM, HCP	7	BF, BF,AN	0.8-5.6	12.7-25.4	SR
Elaeagnus triflora	HM	1	BF	2.5	34.7	SR
Evodia aromatica	HCP	1	ASH	2.4	9.5	SR
Ficus annulata	HCP	4	BF, AN	25-1.4	35.0-95.5	R
Ficus ribes	HM	1	AN	2	19.1	SR
Gigantochloa apus	HH	1	BF	2	3.1	SR
Gnetum gnemon	HCP	1	BF	0.5	16.5	R
Knema cinera	HI, HH	2	AN, BF	2.5-6.0	19.1	SR
Laportea stimulans	HM, HL	8	AN,BF,ASH	2.0-6.0	9.2-25.4	R
Litsea glutinosa	HCP	1	BF	6	15.9	R
Macaranga rhizinoides	HM	2	BF	2.5-4.5	20.3-22.2	SR
Maesopsis eminii	HM	4	AN	0.4-10.0	39.4-101.9	R
Melochia umbellata	HI	1	ASH	4	15.9	R
Myristica fragrans	HCP	1	BF, AN	0.5-1.0	3.1	R
Pandan furcatus	HM, HC	4	M	0.5-6.8	3.1	SR
Pinus merkusii	HL	2	BF	0.5	52.8-57.3	R
Pometia pinnata	HCP	1	BF	1	3.1	R
Schima wallichii	HM, HL	13	BF, ASH	1.7-15.0	12.7-45.5	R
Symplocos fasciculata	HM, HCP	1	BF, AN	4	14.6	SR
Syzygium lineatum	HCP	6	BF, AN	20-1.3	1.5-9.5	R
Trema orientalis	HCP	1	BF	0.3	63.6	R
Turpinia sp	HCP	2	AN	0.7-0.7	8.9	R
Villebrunea rubescens	HM, HL	2	BF, BF	2.5-4.0	13.6-19.1	R

Note: LG=Location of grow; TH = tree height; TD = tree diameter; TS = tree surface ASH = ant nest holes; AN = *Asplenium nidus*; BF = bark fissures; M=midrib; SR = slightly rough; R = rough; HM = *Hoya multiflora*; HL = *Hoya lacunosa*; HCP = *Hoya campanulata*; HV = *Hoya vitellinoides*; HI = *Hoya imperialis*; HH = *Hoya hasseltii*

Composition and Diversity of Vegetation

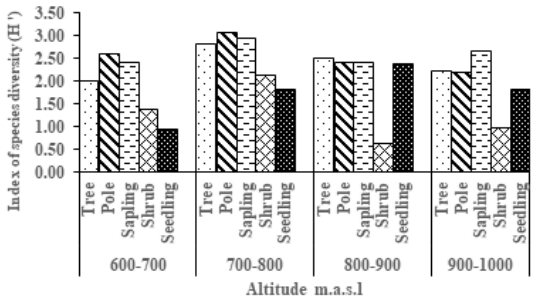

Figure 3. Index of species diversity (H') based on the altitude on the four of altitudinal zones in Bodogol Conservation Area.

The diversity of vegetation based on Shannon-Wienner Index (H') at various altitudes rated between (0.88-3.09). Index of species diversity for tree and pole at an altitude of 700-800 m.a.s.l was 2.82 and 3.09 respectively. The value of H' at an altitude of 800-900 m.a.s.l for tree and pole was relatively equal i.e. 2.51 and 2.43. Respectively, index of species diversity in altitude of 900-1000 m.a.s.l for tree was 2.24 and poles was 2.22 (Figure 3).

Diversity index of species based on the topography are in low to high category rated from 1.43-3.48 (Figure 3). Index of species diversity of trees was higher on the hillside (2.69) and ridge (2.40) than on the valley (2.28). The highest Diversity Index of pole and shrub was found in the ridge and hillsides, whereas, the lowest diversityindex of pole was found in the valley (1.43), ridge (2.95) and hillsides (3.32). Diversity Index of seedling on the ridge (2.22) was higher than in the hillsides (1.52).

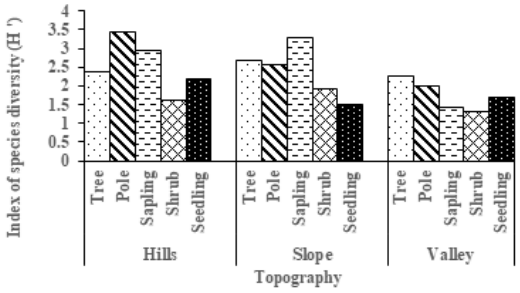

Figure 4. Index of species diversity (H') based on topography difference in Bodogol Conservation Area.

Enviromental parameters

The results showed that most of *Hoya* individuals found grew at altitudes of 700-800 and 800-900 m.a.s.l. The condition of micro climates in both altitudes was not remarkably different. The air temperature was 22.7-29.1 ◦C, the air humidity was 67.5-88.4%, light intensity was 95-2048 Lux, canopy cover was 3.80-16.16% and wind speed was 0-2.8 km/h. In altitude of 900-1000 m.a.s.l, the air temperature was 24.2-25.7 ◦C and humidity was 80.1-85.8%. Habitat conditions at these altitudes were highly open and the *Hoya* found was only from one species (*H. campanulata).* In altitude of 600-700 m.a.s.l the light intensity was 1525-1724 Lux with 1.89-3.54% canopy cover. There were two species of *Hoya* found in the this habitat i.e. *H.campanulata* and *H.imperialis* (Table 4). The area of valley topography had a temperature of 25.0-26.7 ◦C with air humidity of 79.1-87.5%. In this habitat, only one species was found, i.e. *H. campanulata*.

Table 4. Environmental parameters of observation locations in the Bodogol Conservation Area. by altitudes

Habitat Type	Air Temperature (◦ C)	Air Humidity(%)	Canopy Cover(%)	Light Intensity (Lux)	Wind Speed (km/h)
Altitude (m.a.s.l)					
600-700	25.1-26.7	79.1-80.4	1.89-3.54	274-1108	0-0.9
700-800	22.7-29.1	67.5-88.4	3.80-16.16	95-2048	0-2.8
800-900	25.1-27.7	71.8-87.2	7.53-12.01	212-1163	0-0.3
900-1000	24.2-25.7	80.1-85.8	7.71-33.01	453-835	0-1.1
Topograph					
Ridge	23.5-31.5	67.8-88.8	16.3-60.5	168-2048	0-7.5
Hillside	22.7-27.6	67.5-89.7	2.16-10.38	65-1724	0-2.1
Valley	25.0-26.7	79.1-87.5	11.3-24.0	51-1370	0-0.9

Zonation of *Hoya*

The result of the Pricncipal Component Analysis (PCA) showed the correlation between the division of species and zonation of *Hoya*. The highest number of *Hoya* species type was found in zone 2, which was as many as four species, (*H. imperialis, H. multiflora, H. hasseltii,* and *H. vitellinoides)*. All of these species showed a positive correlation against zone 2. The highest positive correlation was found in *H. multiflora, H. hasseltii* and *H. vitellinoides* as an epiphyte group which is able to adapt to indirect sunlight (Figure 5).

The distribution of epiphytic zonation on trees was more affected by sunlight exposure. Each zonation has different climatic conditions. The epiphytes at zone one included *H. campanulata* that is prefer to grow at the base of the tree. Air humidity in stem base is higher than in the upper stem (Sporn et al., 2010). *H. campanulata* is included in *xerophytic* that requires shade place (Benzing, 2008). *H. lacunosa* is epiphytic which able to adapt to the sunlight exposure (*sciophytic*) (Benzing, 2008). Commonly, it is found in basal branch of high tree. In addition, *H. lacunosa* leaves are succulent, that is able to retard the excessive evaporation.

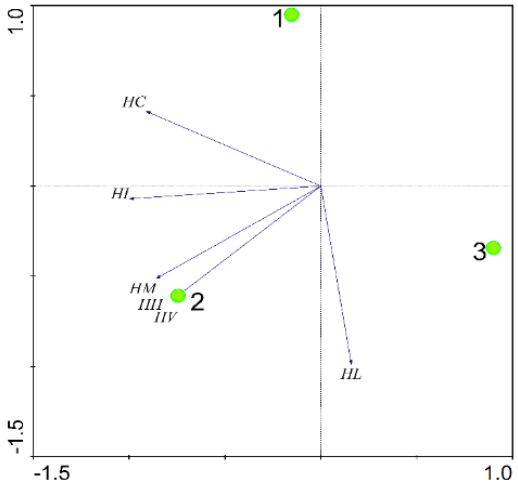

Figure 5. Zonation of *Hoya*. 1 = base of tree; 2 = main stem; 3 = branching base; HC = *Hoya campanulata*; HM = *Hoya multiflora*; HH = *Hoya hasseltii*; HL = *Hoya lacunosa*; HV = *Hoya vitellinoides*; HI = *Hoya imperialis*

Correlation of *Hoya* Habitat Suitability

Based on Redundancy Analysis (RDA), an altitude of 700-800 m.a.s.l had more species of

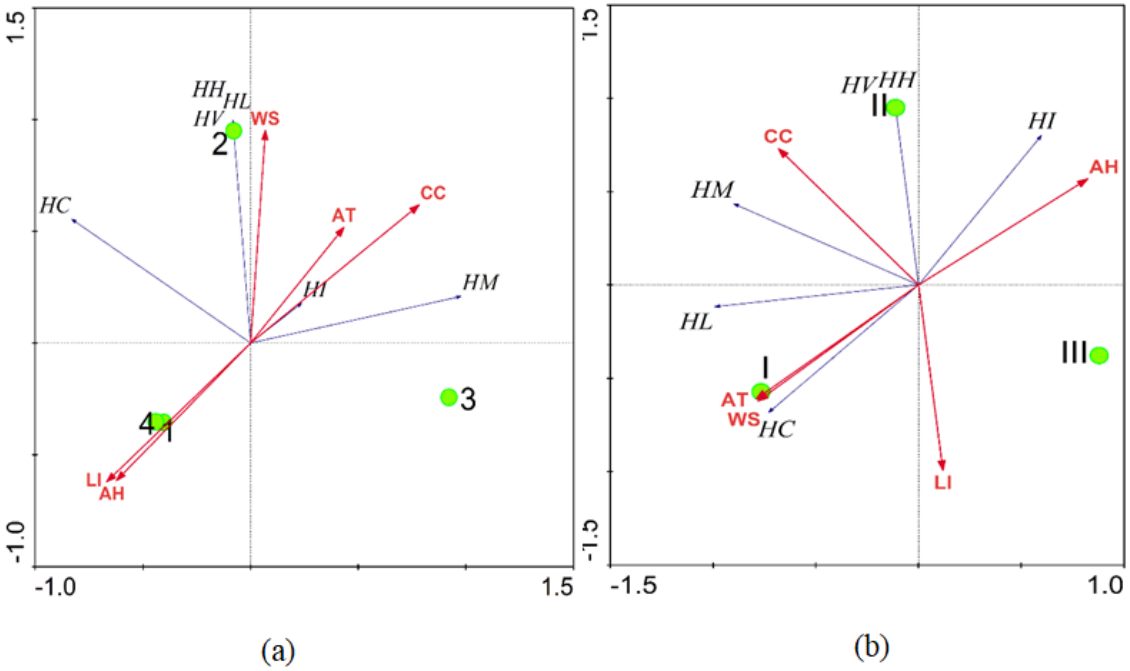

Figure 6. Correlation of *Hoya* habitat environment with altitude (a) and topography (b) in Bodogol Conservation Area; 1 = 600-700 m.a.s.l, 2 = 700-800 m.a.s.l, 3 = 800- 900 m.a.s.l, 4 = 900-1000 m.a.s.l, 1 (b): I = ridge, II = hillside, III = valley, HC = *Hoya campanulata*, HH = *Hoya hazeltii*, HM = *Hoya multiflora*, HL = *Hoya lacunosa*, HV = *Hoya vitellinoides*, HI = *Hoya imperalis.*

Hoya than any other altitudes. H. vitellinoides, H. lacunosa, H. hasseltii were positively correlated to wind speed. H. imperialis and H. multiflora were positively correlated with air temperature and canopy cover. The highest correlation was shown by H. imperialis with canopy cover (Figure 6a). Environmental parameter that mostly affected the habitat suitability of H. vitellinoides, H. lacunosa, H. hazeltii was the speed of the wind. Species of H. imperialis was strongly influenced by the canopy cover.

The presence of *H. campanulata* and *H. lacunosa* in hillside topography is more influenced by wind speed and air temperature. The highest correlation was shown by *H. campanulata* with wind speed and air temperature. The finding of *H. multiflora, H. vitellinoides, H. hasseltii* and *H. imperialis* in the hillside was positively correlated with canopy cover and air humidity, with the highest correlation was shown by *H. imperialis* with air humidity (Figure 6b). The environmental parameters that most influence of the *Hoya* habitat's suitability for the *H. campanulata* are the factors of wind speed and air temperature were found in the ridge. *H. imperalis* and *H. multiflora* found in hillside were influenced by air humidity and canopy cover.

This study provides information regarding the habitat specivity of *Hoya* that can be used in developing the conservation effort for *Hoya* both *ex situ* and *in situ*. Ex situ with an inventory of diversity and collect the local characteristics of the plant specimen is then maintained and developed (Hidayat, et al., 2017). In addition it provides wider infromation about the benefits of *Hoya* cultivation and increase cultivation area Conservation Bodogol. When the plants grown in the garden's collection could be would be the added value for the benefit of education and research, and the dissemination of knowledge to science and the public.

CONCLUSIONS

As many as six types of *Hoya* were found in thise study. They were distributed in two types of habitat based on altitudes and topography in the Bodogol Conservation Area. The *Hoya* species found were *H. campanulata, H. hasseltii, H. multiflora, H. lacunosa, H. vitellinoides,* and *H. imperialis*. The highest diversity of *Hoya* was found attributed in an altitude of 700-800 m.a.s.l (H' = 1.41) and in the hillside area (H' = 1.3). The most frequent phorophyte was *Schima wallichii* (13 individuals) and *Laportea stimulans* (8 individuals). Factors affecting the *Hoya's* preference on phorophyte are coarse and notched bark textures presented in the main stem, while *Hoya* is more preferred to grow in the bark fissures. The most influencing abiotic factors for *Hoya imperialis's* existence are air humidity and canopy cover.

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