

# *Hoya* species of Belitung Island, Indonesia, utilization and conservation

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**Abstract.** *Rahayu S, Fakhurrozi Y, Putra HF. 2018. Hoya species of Belitung Island, Indonesia, utilization and conservation. Biodiversitas 19: 369-376.* Epiphyte greatly contributing to the forest biomass in the tropic. Heath forest as occurred in Belitung Island, Indonesia is a specific habitat for many endemic species, which are poor in nutrients and very fragile in response to any disturbance. We observed *Hoya* species-one of the epiphytic genus in the tropic in the heath forest and on other habitats of Belitung Island, Indonesia. *Hoya* species are plants with promising uses as functional ornamental plants (able to absorb pollutants from their growing environments), and as sources of certain medicinal and pharmaceutical compounds. A survey of *Hoya* was carried out on Belitung Island, off the southeast coast of Sumatra, in 2015, 2016 and 2017. There are two interesting *Hoya* species that grow well in the "padang community" of the heath forest, on the island: i.e. *H. coronaria* Blume and *H. imperialis* Lindl. These two have attractive flower size and color. Another species, *H. verticillata* (Vahl) G.Don, with less attractive flower color, is distributed in the mixed forest of the beach areas, while *H. multiflora* Blume and *H. scortechinii* King & Gamble, also with less attractive flower color, are distributed in mixed forest of upper elevations. The distribution and habitat preference of different *Hoya* species indicate different requirements for moisture and temperature, which we hypothesize also result in differences in the pollinator species visiting the plants. The "padang community" of the heath forest on Belitung experiences maximum temperatures up to 37°C in the afternoon. It is located in an Af climate type, with average rainfall, air temperature and humidity of ± 205 mm/month, 27°C and 77.5%, respectively. *Hoya coronaria* is the most contributing biomass in the heath forest compared to the other *Hoya* species in the community.

**Keywords:** Apocynaceae, Asclepiadoideae, biomass, distribution, habitat preference, heath forest, "padang" community, uses

## INTRODUCTION

Epiphytes are an important component in tropical forests which have greatly contribute to the forest biodiversity and biomass. Epiphytes contribute about 10-20 % of biomass (Benzing 2008) and the epiphyte biomass reach to 81.3% of the canopy biomass when woody tissues are excluded (Nadkarni et al., 2004). They also contribute to the global plant diversity and species richness up to 10 % and around 25-50% in tropical forests (Benzing, 2008).

Heath forest, known as "kerangas" in Indonesia, is a typical forest that grows on very poor, very acidic soils (pH less than 4) lacking in nutrients. The name "kerangas" originates from an Iban language, and refers to land that is too poor for rice growing once cleared (Proctor 1999). The soils are formed under ever-wet conditions from quartz or white sand with a low content of clay (Whitmore 1984; Richards 1996). The heath forest is common in eastern parts of Indonesia (Whitmore 1984), such as Sumatra, Bangka and Belitung Island (Teysmann 1876). The habitat of heath forest is fragile as it is easily damaged or disturbed by impacts such as forest fires and various human activities (Kusmana 1995). These conditions foster the growth of specialist plants such as the carnivorous pitcher plants *Nepenthes*, sundews *Drosera*, and bladderworts *Utricularia*. Heath forests generally are less species-rich than comparable dipterocarp forests. Large trees are rare, and epiphytes are common (Whitmore 1984).

*Hoya* is an epiphytic genus belonging to the family Apocynaceae, sub-family Asclepiadoideae (Endress et al. 2014). *Hoya* species have become increasingly popular as ornamental plants around the world. Many websites and social media groups have been established for *Hoya* lovers (who promote, identify, exchange and trade *Hoya* plants). *Hoya* lovers have been attracted by the beauty of the waxy star flowers and succulent leaves, and devote time to cultivating many species from collections. Not only is *Hoya* recognized for the beauty of its flowers, but some species (e.g., *Hoya carnososa*) have been reported as having pollutant-absorbing characteristics. Such plants grown indoors are useful for removing toxins in the atmosphere such as benzene, toluene, and xylene, derived from wall paints, furnishings, and so on (Yang et al. 2009). *Hoya* plants have also found use for medicinal purposes, in treating many kinds of adverse medical symptoms (Zachos 2005; Rahayu 2011a).

The geographical distribution of *Hoya* is concentrated in the tropics and sub-tropics of the region between Asia and Australia (Lamb and Rodda 2016). The natural distribution is from India in the west to Samoa and Fiji Islands in the east, and from southern Japan and China in the north to northeastern Australia in the south. Indonesia is located in the center of the dividing region between the Asian and Australian continental plates and represents the largest area in the distribution of *Hoya*. Kleijn and van Donkelaar (2001) estimates that Indonesia has the highest

species diversity in the genus. The description of new species is still ongoing, especially from Borneo; for example, species such as *Hoya undulata* S. Rahayu & Rodda, and *Hoya narcissiflora* S. Rahayu & Rodda were recently published, from West Kalimantan (Rahayu et al. 2015; Rahayu and Rodda 2017). An inventory of *Hoya* species in Indonesia is urgently needed, due to the high rate of habitat loss, especially in the heath forest. An inventory was previously developed for Sumatra (Rahayu and Wanntorp 2012), and more recently for the *Hoya* of Borneo (Lamb and Rodda 2016). These two regions both have heath forest habitats.

Belitung island, off the southeast coast of Sumatra, is known as a tin-mined island and has a typical type of heath forest called "padang". The heath forest in Belitung has been regarded as non-functional land by the local community, and so it has tended to be converted for non-traditional land-uses such as for oil palm plantations and other modern economic purposes. On the other hand, heath forest is also increasingly recognized as a unique habitat and ecosystem, which has recently been targeted as needing to be conserved. Heath forest is one of the IUCN red list priority habitats, categorized as vulnerable by their standardized criteria (IUCN 2014). In this kind of forest, the composition of the vegetation shares many features in common with moss forests of the upper montane zones, such as a dense undergrowth, abundant bryophytes, presence of conifers, and presence of casuarinas. The most abundant plants in "padang" are kayu gelam (*Melaleuca leucadendron*), *Vaccinium* and *Rhodomyrtus tomentosa* (Hilwan 2015).

Ground vegetation in heath forests generally is sparse, with a host of insectivorous plants such as *Nepenthes* and *Drosera* (Hidayat et al. 2005). The presence of insectivorous plants may be an evolutionary response to growing in nitrogen-poor condition. In other cases, a symbiotic relationship exists between plants and insects. Kartawinata (1980) found *Hydnophytum* spp., *Myrmecodia* spp., *Dischidia* spp., and *Dendrophthoe* spp. in the heath forest at Sebulu, East Kalimantan. *Dischidia* spp. had been reported to associate with ants (Kiew and Anthony 1996).

*Hoya* (*Hoya* spp.) is in the same family as *Dischidia* spp., in the Apocynaceae (Endress et al. 2014). They are epiphytic plants which have also been reported to have evolved in association with ants. It is important to know more about the presence and ecological role of *Hoya* species in the heath forest of Belitung. Thus, the research described in this paper had the aim of developing an inventory of *Hoya* species diversity in the heath forest and other habitats of Belitung Island.

## MATERIALS AND METHODS

### Study area

The study was conducted in Belitung Island, Province of Kepulauan Bangka Belitung, Indonesia. We explored 16 locations in Belitung island as listed in Table 1 and Figure 1. Priority was given to exploring the heath forest (padang)

habitat (7 locations), then to the non-heath forest habitats i.e. beach (5 locations), mixed forest (2 locations) and the agroforest ecosystem (2 locations).

## Procedures

### Exploration

The inventory was carried out in May 2015, June 2016 and November 2017 by exploring selected locations in Belitung Island (Figure 1). The method of exploration was by purposive sampling. All of the occurrences of *Hoya* species were noted and specimens were collected for detailed identification.

### Sample collection

A record was compiled of all *Hoya* species findings. The information recorded was species, population, altitude, latitude, longitude, and habitat conditions. Herbarium specimen vouchers were prepared for species and location using alcohol preservation, followed by oven-drying in the laboratory and by appropriate storage at Bogor Botanic Gardens. We also collected plant materials for living collection at Bogor Botanic Gardens, West Java, Indonesia for *ex-situ* conservation purposes.

### Identification

Sample identification was determined to species level based on the expertise of the first author, by comparing observed morphological characteristics to their descriptions in the published literature and observed type specimens stored at the herbaria (L, K, Sing. BO). Another confirmation was made by checking at the Plant List website (<http://www.theplantlist.org>), but most of *Hoya* species name listed at the Plant List website was unresolved. This due to the lack of revision studies in Genus *Hoya*, and confirmation at the Plant List website, so we still use the most valid name, cited for the recent publication (Lamb and Rodda 2016).

### Data analysis

Data was compiled and analyzed based on rigorous descriptive procedures.

## RESULTS AND DISCUSSION

### *Hoya* species distribution

There were two *Hoya* species in the heath forest especially in the "padang" community in Belitung, i.e., *Hoya coronaria* Blume, and *H. imperialis* Lindl. *Hoya coronaria* Blume was stated as an unresolved name in The Plant List website (<http://www.theplantlist.org>), but there is no other accepted name in the Plant List website which matches at the identification. This name also used in the recent publication by Lamb and Rodda (2016) in the recently published *Hoya* of Borneo. Three other *Hoya* species, i.e., *H. multiflora* Blume, *H. scortechinii* King & Gamble, *H. verticillata* (Vahl) G. Don were found in other habitats, i.e., mixed forest and agroforest. Similar to *Hoya coronaria* Blume, *Hoya scortechinii* King & Gamble was also listed as an unresolved name in The Plant List website.

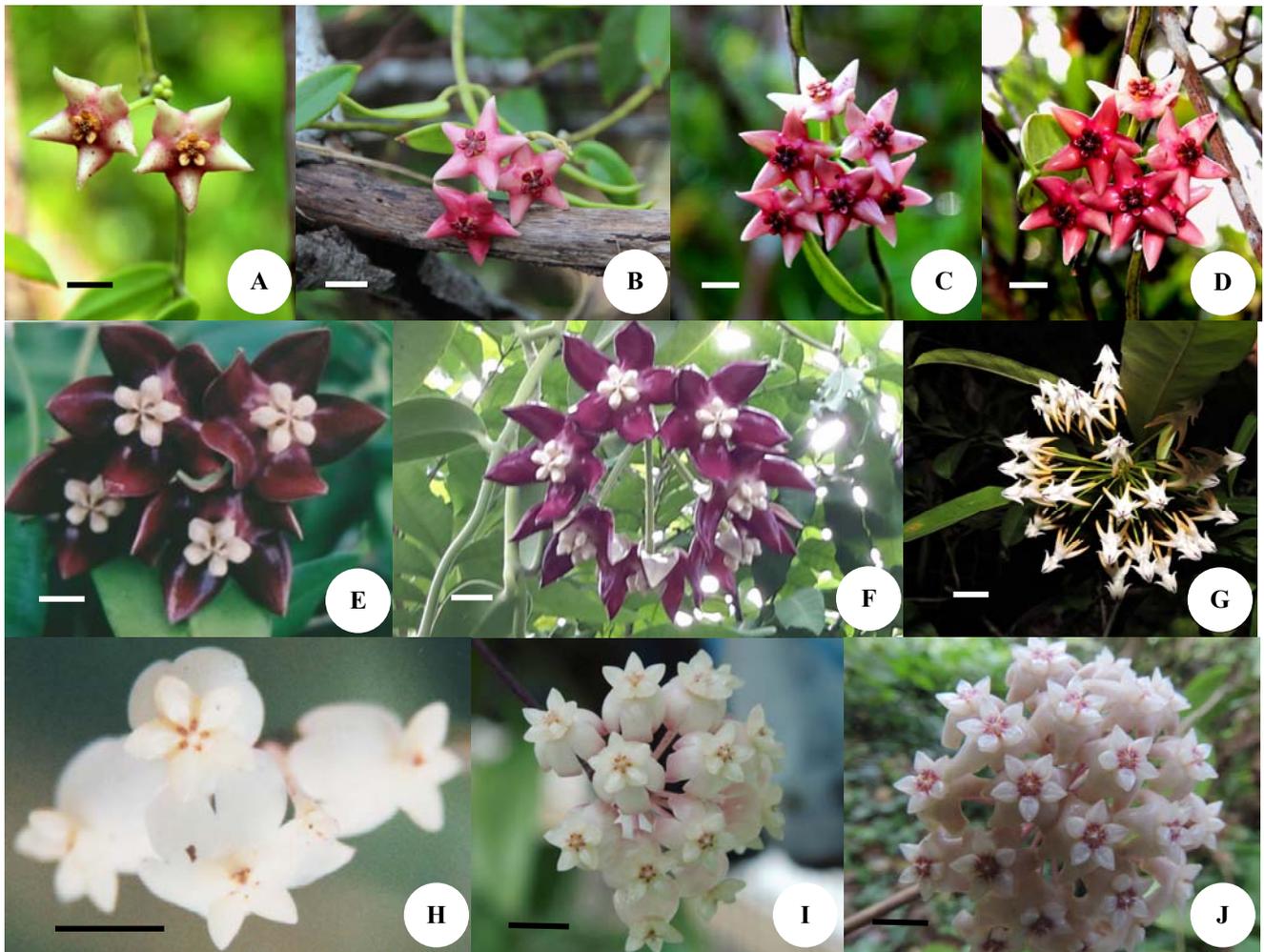


**Figure 1.** Study site (1) Tanjung Pandan, (2) Tanjung Binga, (3) Tanjung Kelayang, (4) Tanjung Tinggi, (5) Ru Island, (6) Membalong, (7) Bantan, (8,9) Seliu Island, (10) Penyabong, (11) Manggar, (12) Kelapa Kampit, (13) Gantung, (14) Gunung Tajam, (15) Batu Mentas, (16) Dandang

**Table 1.** Distribution of *Hoya* species in heath forest and other habitats of Belitung Island, Indonesia

Locations	Alt (m)	Habitat Type	<i>Hoya</i> species	Pop	Ants
Tj Pandan	1	Beach	-	-	-
Tj Binga	1	Beach	<i>H. verticillata</i>	*	+
Tj Kelayang	1	Beach	-	-	-
Tj Tinggi	1	Beach	<i>H. verticillata</i>	**	+
Ru Island	1	Heath forest	<i>H. coronaria</i>	***	+
Membalong	10	Heath forest	<i>H. coronaria</i>	**	+
			<i>H. imperialis</i>	**	+
Bantan	50	Agroforest	<i>H. scortechinii</i>	*	+
Seliu Island 1	3	Heath forest	<i>H. coronaria</i>	**	+
Seliu Island 2	3	Agroforest	<i>H. verticillata</i>	**	+
Penyabong Beach	1	Beach	-	-	-
Manggar	10	Heath forest	<i>H. coronaria</i>	***	+
Kelapa Kampit	30	Heath forest	<i>H. coronaria</i>	***	+
Gantung	30	Heath forest	-	-	-
Gn Tajam	200	Mixed forest	<i>H. multiflora</i>	*	+
Bt Mentas	100	Mixed forest	<i>H. scortechinii</i>	**	+
			<i>H. coronaria</i>	*	+
Dandang	10	Heath forest	<i>H. coronaria</i>	***	+
			<i>H. imperialis</i>	**	+

Note: \*Small populations (1-3) \*\*medium size populations (5-15) \*\*\*large populations (>15), + ants were discovered in *Hoya* roots



**Figure 2.** The diversity of *Hoya* species in Belitung Island as listed in Table 1. A-D. *H. coronaria*, E-F. *H. imperialis*, G. *H. multiflora*, H-I. *H. scortechinii*, J. *H. verticillata* (scale bar = 1 cm)

(<http://www.theplantlist.org>), but still used at Lamb and Rodda (2016). So we use that name in this paper before there is no recent conclusion, More *H. coronaria* was also found in the mixed forest habitats (Table 1, Figure 2).

Of the 16 locations observed, 7 locations were heath forest, 5 locations beach, 2 locations agroforest, and 2 locations mixed forest. The six locations of heath forest were mostly represented by two *Hoya* species *H. coronaria* and *H. imperialis*. There were two heath forest localities that had no *Hoya* species present, i.e., in Gantung and Limau Manis. These locations were area reforested after tin-mining. Six locations of heath forest were represented by *Hoya coronaria* in medium to large populations, while *Hoya imperialis* was only found in two localities in medium size populations. *Hoya coronaria* was also found growing from the forest floor, not only as an epiphyte. The forest floor of heath forest consists of white sand covered with moss and thick hummus. This form of *Hoya* is known as a saprophyte.

There was only one species found in the beach area, i.e., *Hoya verticillata*, found in two localities (Tanjung Binga and Tanjung Tinggi) growing along the beaches on big stones instead of trees. This is the form of *Hoya* known as a lithophyte. *Hoya verticillata* was found at the agroforest habitat in Seliu island as an epiphyte in large size populations.

There are two *Hoya* species found in agroforest ecosystems, i.e., *Hoya verticillata* (at Seliu) and *Hoya scortechinii* (at Bantan). Three *Hoya* species were found in mixed forest, i.e., *Hoya multiflora* (at Gunung Tajam), *Hoya scortechinii* (at Batu Mentas) and *Hoya coronaria* (at Batu Mentas). *Hoya coronaria* at Batu Mentas grew on stone in the river. This was a form of lithophyte.

#### Habitat description

Belitung is an island 480,060 ha in size, surrounded by smaller islands such as Ru Island in the northwest and Seliu Island in the southwest. Belitung Island is located off the southeast of Sumatra, at 02°30' -03°15'South (latitude) and

107°08'-108°3'East (longitude), next to Bangka Island which is larger in size. The ecology of Belitung is similar to that of Bangka Island, especially in the presence of Heath forest called "padang". Heath forest (padang) is distributed along the beach and in lowland areas up to elevation 100 m. Agroforest ecosystems are found at every elevation on the island, while the mixed forest occurs at the upper elevations. The highest elevation is on Gunung Tajam with the summit at 400 m., and the lowest elevation is at the beaches, some of which are interspersed with a swampy area.

**Beach and mangroves.** The coast of Belitung Island is typically dominated by mangroves and, in some localities, by typical white sand and boulders. The mangrove areas were not part of our initial observations because they were difficult to access and no *Hoya* species were apparent there. In the sandy and stony beaches, we observed only one species, i.e., *Hoya verticillata*.

**Heath forest (padang community).** Heath forest in Belitung occurs along the edges of the island behind the beach zone. Tanjung Pandan, Membalong, Mangga (Mundong), Kelapa Kampit, Gantung, Dendang, and Bantan are covered by heath forest. Two small islands were observed, Ru Island and Seliu Island. According to the climatic classification system of Schmidt and Ferguson (1951), this zone has an Af climate type, with average air temperature 28.3°C and humidity 72.8%. The "padang" community of heath forest of Belitung is typically covered with several species of Myrtaceae. The most common tree is kayu gelam (*Melaleuca leucadendron*), and bushes such as *Vaccinium* and *Rhodomyrtus tomentosa*. Another interesting plant is *Nepenthes gracilis* which was growing everywhere on the forest floor as well as scrambling onto the bushes. We also found *Drosera burmannii* in the heath forest of Kelapa Kampit (Belitung Timur). These species also occur in padang Pinang Anyang, East Belitung (Hidayat et al. 2005). The soil is very acid and fragile (Oktavia et al. 2015)

**Agroforest ecosystem.** Agroforest ecosystems on the island are man-made ecosystems based on fruit trees. They are located in the lowland environments. Agroforest ecosystems were observed in Belitung (Dendang and Seliu Island). The dominant tree was mangosteen (*Garcinia mangostana*), and other trees included durian (*Durio zibethinus*), melinjo (*Gnetum gnemon*), mango (*Mangifera indica*), jackfruit (*Artocarpus heterophyllus*), cempedak (*Artocarpus integer*), and coconut palms (*Cocos nucifera*). In some cases, the fruit trees were mixed with forest trees, such as *Ficus* spp., kayu gelam (*Melaleuca*), *Syzygium* spp. and *Macaranga triloba*.

**Mixed Forest.** Mixed forest in Belitung occurs at elevations above 100 m. The highest one is on Mount Tajam with a height of fewer than 500 meters. In Gunung Tajam and Batu Mentas, forest trees were dominated by *Syzygium* spp. Gunung Tajam has steep slopes, while Batu Mentas is an area along the river. This type of mixed forest is in an Af climate type, with average rainfall, air temperature and humidity of  $\pm 205$  mm/month, 27°C and 77.5%, respectively.

### **Hoya species description**

There were five *Hoya* species found on Belitung island, i.e. *Hoya coronaria*, *Hoya imperialis*, *Hoya multiflora*, *Hoya scortechinii*, and *Hoya verticillata*.

*Hoya coronaria* Blume was firstly described by Blume in 1923. *Hoya coronaria* plants from the heath forest of Belitung are epiphytic, lithophytic or saprophytic; climbing or creeping; stem ca. 3 mm in diameter, pubescence with a white latex; leaves coriaceous (thick not fleshy), oblong, ca. 7 x 3 cm, pubescent; inflorescence umbel, 1-8 flowered, convex, erect peduncle, corolla nearly flat or slightly campanulate, ca. 3 cm in diameter, color varied from white, yellow to red; corona blunt apex, color varied also as in corolla from white, pink to red. *Hoya coronaria* in the heath forest of Belitung has smaller and thicker leaves compared to *Hoya coronaria* from mainland Sumatra. The corolla color is red; we did not find white corolla colors as is usually found on mainland Sumatra. This species also occurred in Sumatra (Rahayu and Wanntorp 2012) and Borneo (Lamb and Rodda 2016). *Hoya coronaria* has been occupied most of the Padang community in Belitung Island.

*Hoya imperialis* Lindl. was first described by Lindley in 1847. The plants are epiphytic, climbing; stem robust, ca. 5 mm in diameter, pubescent, with a white latex; leaves coriaceous (thick not fleshy), oblong, ca. 12 x 5 cm, slightly pubescence; inflorescence umbel, 1-15 flowered, convex, pendulous peduncle; corolla inflexed, ca. 5 cm in diameter, red inside, yellowish green outside; corona blunt apex, erect, creamy white. This species also occurs in Sumatra (Rahayu and Wanntorp 2012) and Borneo (Lamb and Rodda, 2016)

*Hoya multiflora* Blume are epiphytic shrubs; stem ca. 3 mm in diameter, glabrous, white latex; leaves chartaceous (thin, papery), oblong, ca. 12 x 3 cm, glabrous; inflorescence umbel, 1-40 flowered, convex, erect peduncle, corolla reflexed, ca. 1.5 cm long, white sometime with yellowish apex; corona erect at the inner side, acute apex, white. This plant also reported found in the Malay Peninsula (Rintz 1978), in Java (Backer and Bakhuizen van den Brink Jr 1965) and refound in West Java (Rahayu et al. 2010a; Rahayu 2012), in Sumatra (Rahayu 2011b; Rahayu and Wanntorp 2012), and Borneo (Lamb and Rodda 2016). According to Goyder (2008), this species has wide distribution area from India to Papua New Guinea.

*Hoya scortechinii* King & Gamble. Epiphytic; stem twining, glabrous, ca. 2 mm in diameter; leaves thick and fleshy, lanceolate, glabrous, ca. 12 x 2 cm; inflorescence umbel, 1-8 flowered, convex, erect peduncle, corolla reflexed, ca. 1 cm, white; corona acute apex, white. This plant also reported found in the Malay Peninsula (Rintz 1978), Sumatra (Rahayu 2011b; Rahayu and Wanntorp 2012) and Borneo/Kalimantan (Rahayu 2006; Lamb and Rodda 2016).

*Hoya verticillata*, (Vahl.) G.Don. Epiphytic or lithophytic; stem creeping, twining, glabrous, ca. 2 mm in diameter; leaves fleshy and thick, elliptic to oblong, glabrous, ca. 10 x 4 cm; inflorescence umbel, 1-40 flowered, convex, erect peduncle, corolla slightly reflexed,

ca. 1.5 cm in diameter, white; corona acute apex, white with pink in the center. This plant also reported found in the Malay Peninsula (Rintz 1978) as (*Hoya parasitica*), in Java (as *Hoya rumphii*) (Backer and Bakhuizen van den Brink Jr 1965), in Sumatra (Rahayu 2011b; Rahayu and Wannatorp 2012) and Borneo (Lamb and Rodda 2016).

### Discussion

The biomass contribution of the *Hoya* species diversity of the Belitung Island was higher in the heath forest compared to the other habitat type, expressed by the population size estimation as shown in Table 1. Heath forest was nearly covered by *Hoya coronaria* in most sites visited. Compared to the *Hoya coronaria* population in the mixed forest in Batu Mentas which only found in a small population, indicating the most preferable habitat for this species was in the heath forest.

There are no endemic *Hoya* species found in Belitung Island. All *Hoya* species we found in Belitung Island have been recorded in other islands (places). All species occur in Borneo and Sumatra. We assume the *Hoya* species in Belitung Island have been distributed from another island such as the mainland of Sumatra or Kalimantan. The distribution of *Hoya* species depends on the seed dispersal syndrome. The *Hoya* form parachute type seeds, which are easily dispersed by wind. According to the observation of Rahayu et al. (2010b) on the distribution of *Hoya multiflora* in West Java, the seed of the species performed two types of dispersal, i.e., long distance and short distance dispersal. Long distance dispersal was correlated to the direction and speed of wind aloft behavior, i.e. winds above 2000m or 3000 ft above ground. Winds above 2000m has significant power changes (Canale et al., 2010) and the most powerfull is at between 8,000 and 10,000 m above ground (Archer and Caldeira 2009)., While short-distance dispersal correlated to the soft wind, i.e., winds below 500m above ground which has relatively constant wind power densities (Archer and Caldeira 2009) and the presence of ants (Formicidae) community (Rahayu et al. 2010b).

Two *Hoya* species in Belitung Island are adapted to the heath forest in the "padang" vegetation community; namely *Hoya coronaria* and *Hoya imperialis*, which have big flower size and bright corolla color. The leaves of both species are coriaceous and pubescent. The padang community is open to sunlight and is very hot at noon.

*Hoya multiflora*, *Hoya scortechinii*, and *Hoya verticillata* grow in shady places; they have a white corolla color and small flower size. *Hoya multiflora* has thin papery leaves (chartaceous) while *Hoya verticillata* and *Hoya scortechinii* have succulent leaves.

Based on *Hoya* leaf morphology, Rintz (1978) divided *Hoya* leaves type into three categories: i.e., chartaceous (thin leaves, non-succulent), coriaceous (thick but not fleshy, intermediate succulence) and fleshy leaves (succulent leaves). Rahayu (2011b) modified this differentiation of *Hoya* leaves into succulent leaves, and non-succulent leaves; taking into account their morpho-metabolism: leaf succulency in *Hoya* species was reflected in their anatomical structure as observed by Hakim et al.

(2013) and Hafiz et al. (2013). Leaf succulence was assumed to correlate with the Crassulacean Acid Metabolism (CAM) photosynthetic pathway, while non-succulent leaves were assumed to have a non-CAM pathway. Recent study has shown that succulent and intermediate leaf type *Hoya* species possess CAM, while non-succulent leaves possessed a modified C3 pathway (Robika et al. 2015). *Hoya coronaria* and *Hoya imperialis* both have coriaceous leaves types which have adapted to the open light of the heath forest habitat. The leaves of both species in the heath forest are thicker compared to the same species from mainland Sumatra (personal observation). Succulent (*Hoya verticillata* and *Hoya scortechinii*) and non-succulent (*Hoya multiflora*) leave types are adapted to the drier ecosystem of epiphytes and lithophytes in shady habitats.

Based on their flower morphology, *Hoya* shows variation in flower characteristics which are assumed to correlate with a pollinator syndrome (Liede 1996; Rintz 1980; Meve and Liede 1994; Forster 1992). The pollen grains of *Hoya* species (as in Asclepiads, generally) are compacted into a pollinarium. Forster (1992) reported that *Ocibadistes walkeri* is a pollinator for *Hoya australis*. According to Chasanah (2010), Vespidae and Trigona have been predicted as pollinators for *Hoya multiflora*. *Hoya coronaria* and *Hoya imperialis*, the two species adapted to the heath forest, have larger flower size and a bright red corolla color. The three other *Hoya* species we observed are adapted to shady habitat, have small size and white corolla color, including *Hoya multiflora*. *Hoya multiflora* from Belitung Island was observed to have smaller flower size compared to the same species from West Java. According to Rahayu et al. (2010a), *Hoya multiflora* expresses morphological variation even in the same population in West Java. We hypothesize that the pollinator in the heath forest is attracted by the flower color and is a large insect. On the other hand, we assume the pollinator (s) of the *Hoya* species in the shady habitat to be attracted by odor rather than color, and to be smaller in size.

*Hoya* species in many kinds of habitat have evolved in association with ants (Formicidae) especially located in the root system. There are different ant species in heath forest compared with the shady habitats. In the heath forest, we observed *Oecophylla smaragdina* and *Crematogaster* sp. of large size, whereas, in the shady habitat, we observed the smaller ants, aff. *Euprenolepis* sp. on the roots system of the *Hoya* species. Some *Hoya* species have been reported to be associated with ants in many aspects (Weissflog et al. 1999; Kleijn and van Donkelaar 2001; Rahayu et al. 2007; Apriani 2010; Rahayu et al. 2010a; Rahayu and Abdulhadi 2012). Some of them are myrmecophytes, with modified leaves that house ant colonies, such as in *Hoya undulata*, *H. mitrata* and *H. darwinii* (Rahayu et al. 2015).

From the viewpoint of utilization, *Hoya* species have recently become increasingly popular as ornamental plants while several have medicinal properties (Rahayu 2011a). As potential ornamental plants, *Hoya coronaria* and *Hoya imperialis* are the more interesting of the species we observed on Belitung Island, as they have larger flowers with colorful corollas and are adapted to sunny places,

hence are easier to maintain. *Hoya multiflora* has been reported to possess pharmaceutical properties, with potential as anti-rheumatism and stomach-ache medicines (Burkill 1966; Ambasta 1986). *Hoya verticillata* (as a synonym of *Hoya parasitica*) has been investigated and has antibacterial activity (Reza et al. 2007). This species was also investigated as possessing insecticidal activities against pre-adults of *Aedes aegypti* (dengue mosquito) (Rustandi 2005). Although there is no ethnomedicinal records of *Hoya* in Belitung Island, the reference of the uses of the species which distribute at the Belitung Island may improve their uses by the local people.

Conservation priorities for *Hoya* on Belitung Island should address the two species located in the heath forest. The heath forest is the most fragile of the Island's habitats, consisting of many potentially interesting plants.

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