

DISTRIBUTION OF *Hoya multiflora* Blume AT GUNUNG GEDE PANGRANGO NATIONAL PARK, INDONESIA

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ABSTRACT

Hoya multiflora is one of the valuable germplasm in Indonesia that has been utilized as ornamental and medicinal plant. This epiphytic plant faces problems in decreasing habitat. As a means for developing a habitat framework for describing the distributions and ecological relations of *H. multiflora* at Gunung Gede Pangrango National Park, Bogor, Indonesia, ecological study of this species was established over the ranges of altitudes and characteristic vegetation structural types (primary and secondary forest, and plantation) present in the Park. Recognizing the fact that such study requires multidisciplinary data, this paper explores the evidences from both herbarium sheets and field observations. The result of the study showed that the population of this species was only found at the Bodogol Research Station at elevation of 700 - 900 m above sea level (a.s.l.). Thus, the facts contradict with the evidence from the herbarium sheets of the Herbarium Bogoriense which have presumed that this species has a wide variation of altitudinal range from 20 to 1500 m a.s.l. (Indonesia) or 200 - 1400 m a.s.l. (Java). The Bodogol's population showed the clumped type of dispersion (Morisita's Index = 1.35), which indicated such environment that was characterized by patchy resources. Direction and speed of wind coupled with the topography are ecological factors that affect to the distribution of this parachute typed seeds of the *H. multiflora*.

Keywords: Gunung Gede Pangrango National Park, *Hoya multiflora*, plant ecology, population distribution

I. INTRODUCTION

Hoya multiflora Blume (Asclepiadaceae) is one of the ornamental plants with the medicinal properties (Zachos, 1998). This species has been used traditionally to treat arthritis-rheumatism (Burkill, 2002), and stomach/intestinal ailments (Ambasta, 1986). So far, the active compound of this plant has not been identified yet, but presumably it contains indomethacin-like compound. It is a common non-steroidal anti-inflammatory drug (NSAID) that has been used for more than 30 years to treat symptomatic pain of arthritis-rheumatism. Recently, this compound has been tested for a new drug as anti

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HIV (Bourinbaier and Lee-Huang, 1995), and it seems to be specific since no toxicity has been observed at the IC_{50} dose, and unrelated NSAIDs have not shown the activity at clinical doses.

Hoya multiflora is widely distributed throughout India to New Guinea (Schlechter, 1914; Thaitong, 1994), at the elevation of 200 - 1200 m a.s.l. (Backer and van der Brink, 1965; Rintz, 1980). This species is characterized by its short (non vein) plant, leathery (non succulent) oblong leaves, white coronas flowers and yellow/white reflexed corollas (Wanntorp *et al.*, 2006). There can be up to 40 of these rockets like flowers in an umbel and they produce lots of nectar and white latex from all of its part (Goyder, 2008). In Indonesia, as an ornamental plant, this species is highly demanded and commonly sold as cuttings, either rooted or unrooted at IDR 15000 - 30000 (equivalent to USD 1.60) per stick for seedling, and IDR 75000 - 100000 (equivalent to USD 9.50) per pot (Rahayu, 2006). Unfortunately, most of the traded plants have been harvested directly from the wild.

Despite of their high economic importance, little is known about their population ecology, particularly the ecological factors that affect its distribution. Thus, it is imperative to study the population ecology of *H. multiflora*, including those which are present at the Gunung Gede Pangrango National Park (GGPNP), West Java, Indonesia.

The objectives of this study was to evaluate the ecological factors that affect the distribution of *H. multiflora* in GGPNP, West Java. It is expected that the result of the study will provide complete information on the status of such species in this National Park.

II. METHODS

The process of data collection was conducted by observing herbarium sheets, field observations, and plot sampling. Herbarium observation was conducted on the all of herbarium sheets collection of *H. multiflora* from Indonesia's Islands in the Herbarium Bogoriense. A total of 70 sheets was observed. The information recorded was the collector's notes, i.e. collection date, location, altitude, longitude (if any), topography and habitat.

Field observation was implemented in two steps: (1) Inventory to the occurrence of *H. multiflora* at the GGPNP by different elevation, and (2) the distribution of populations at the habitat (at the sites where *H. multiflora* found). Inventory was done by belt transects observation (Cox, 2002) vertically from below to the top of mountain at different elevation, from 700 to 1500 m a.s.l. The sampling was done at four different sites (research stations) as follows: (i). Cibodas (at the elevation of 1450 m a.s.l.); (ii) Bodogol (at the elevation of 760 m a.s.l.); (iii) Situ Gunung (at the elevation of 1000 m a.s.l.); and (iv) Cugenang/Gedeh (at the elevation of 900 - 1500 m a.s.l). The observations were done at the sample plots of 20 m x 20 m at every 100 m of elevation.

The population distribution was observed at the site where *H. multiflora* found (i.e. Bodogol). The field observations were conducted at the four selected hilly areas with different sides/directions. Two of those four hills were facing east and west directions, whereas the other two hills were selected facing north and south sides/directions, and physiographical condition of those hills are characterized by different forest and vegetation types. The elevation coverage is between 650 (lowest valley) and 900 m a.s.l. (highest hill), that lies between latitudes 6°45'51.2" S - 6°46'57.0"S and longitudes 106°50'29.6"E - 106°51'38.7"E. The pattern of distribution was measured using Morisita Index of dispersion (Krebs, 1989) as follows:

$$Id = n \cdot \frac{(\sum x^2 - \sum x)}{(\sum x)^2 - \sum x}$$

where:

Id = Morisita's Index of dispersion

n = Number of observation

x = Number of individual plants

The pattern of distribution was defined by Chi-square test as follows:

$$Mu = \frac{\chi_{0.975}^2 - n + \sum x_i}{(\sum x_i) - 1} \text{ for uniform pattern,}$$

$$Mc = \frac{\chi_{0.025}^2 - n + \sum x_i}{(\sum x_i) - 1} \text{ for clumping pattern}$$

where:

Mu = Morisita's Index of dispersion for uniform pattern

Mc = Morisita's Index of dispersion for agregatif (clumped) pattern

$\chi_{0.975}^2$ = Chi-square at db (n-1), 97.5%.

$\sum x_i$ = Number of individual plants at sample unit -i

n = Number of sample units

Morisita's Index (Ip) was measured by four formulas as follows:

1. If $Id^3 Mc > 1.0$, then:

$$Ip = 0.5 + 0.5 \left(\frac{Id - Mc}{n - Mc} \right)$$

2. If $Mc > Id^3 1.0$, then:

$$Ip = 0.5 \left(\frac{Id - 1}{Mc - 1} \right)$$

3. If $1.0 > Id > Mu$, then:

$$Ip = -0.5 \left(\frac{Id - 1}{Mu - 1} \right)$$

4. If $1.0 > Mu > Id$, then:

$$Ip = -0.5 + 0.5 \left(\frac{Id - Mu}{Mu} \right)$$

The pattern was defined by the Ip number as follows:

$Ip = 0$, *random pattern*

$Ip < 0$, *uniform pattern and*

$Ip > 0$, *clumped pattern*

III. RESULTS AND DISCUSSION

A. Results

1. Herbarium Observations

The herbarium observation was done at the 70 sheets which have indicated that *H. multiflora* is widely distributed. This species was found throughout Sumatra to Maluku, and has broad physiographic division - lowlands, midlands and highlands. The lowland starts at the elevation of 20 m to the high mountain at the elevation of 1500 m (Table 1).

Table 1. The distribution of *H. multiflora* in Indonesia based on the observation of herbarium sheets of Herbarium Bogoriense, Bogor, Indonesia

Island	No of sheets observed (n=70)	Elevation (m a.s.l.)	Year of sheets produced	Habitats	Topography
Sumatra	10	20-1500	1916-1983	Secondary forest/ durian plantation	Hill forest
Java	38	200-1400	1896-1978	Secondary forest	Hill
Kalimantan	7	20-600	1925-1977	Dry forest, rivulet	-
Sulawesi	9	300-1000	1893-2002	Forest	Gentle slope
Nusa Tenggara	5	50-600	1927-1961	Rock near river, deciduous forest	-
Maluku	1	50	1921	Buru Island, no info habitat type	-

Results in Table 1 indicate that the species tolerates a wide range of habitat and has high adaptability to the ecological diversities of the region. However, there is no evidence of *H. multiflora* herbarium sheet from GGPNP. The species was not listed in “Flora Taman Nasional Gede Pangrango” of Sunaryo and Rugayah (1992). The elevation range at GGPNP was formerly from 900 to 3,019 m a.s.l. After 2003, the area was extended to the lower elevation, from 650 m a.s.l at Bodogol (Balai Taman Nasional Gunung Gede Pangrango official, personal communication). Based on the herbarium sheet observations, particularly the 38 herbarium sheets of Java, most of *H. multiflora* (68 %) are present at the elevation of 500 - 1,000 m a.s.l. (Table 2).

Table 2. Number of *H. multiflora* Blume herbarium sheets according to level of elevation

No	Elevation (m a.s.l.)	Sumatra		Java		Kalimantan		Sulawesi		Nusa Tenggara		Maluku		Total	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
1	0-250	4	40	3	8	5	71	-	-	1	20	1	100	14	20,0
2	250-500	3	30	7	18	-	-	4	44	3	60	-	-	17	24,3
3	500-750	1	10	11	29	2	29	-	-	1	20	-	-	15	1,4
4	750-1000	1	10	15	39	-	-	5	56	-	-	-	-	21	30,0
5	>1000	1	10	2	5	-	-	-	-	-	-	-	-	3	4,3
Total		10		38		7		9		5		1		70	

2. The Occurrence of *H. multiflora*

Based on the field observations, the results showed surprising evidences that *H. multiflora* were not present at the three sites of the park, i.e. Cibodas (1400 m), Situgunung (1000 m), and Cugenang/Gedeh (950 m). It was only found at the Bodogol Research Station at the elevation of 700 - 900 m a.s.l. (Table 3). Thus, this fact contradicts with the evidence from the herbarium sheets of the Herbarium Bogoriense which have presumed that this species has a physiographic division of an altitudinal range from 20 to 1500 m a.s.l. (Indonesia) or 200 - 1400 m a.s.l. (Java). Although there is no herbarium sheet of *H. multiflora* from GGPNP, it was presumably there was *H. multiflora* at any location at GGPNP under the elevation of 1500 m a.s.l.

Table 3. The occurrence of *H. multiflora* Blume at GGNP

Track/Station	RH* (%)	AT* (°C)	RF* (mm/year)	700-1000 m a.s.l.	1000 - 1500 m a.s.l.
Cibodas /1450 m a.s.l. (Pacet)	81.75	20.81	3113.7	Not observed	Not present
Bodogol /650 m a.s.l. (Citeko)	83.08	21.03	3190.3	Present at 750-900 m	Not present
Situgunung/950 m a.s.l. (Goalpara)	84.67	20.83	3250.2	Not present	Not present
Gedeh/ 950 m a.s.l. (PSarongge)	82.36	20.32	188.0	Not present	Not present

* source: BMKG station (2008): RH=relative humidity; AT= average temperature; RF = rainfall

3. Distribution and Habitat of *H. multiflora* at Bodogol Research Station

As reported by the Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) of Citeko BMKG station, in the last 5 years (2004-2008) the average annual rainfall was 3041.36 mn year⁻¹ (3190.3 mm in 2008); the relative humidity was 83.21 % (83.08 % in 2008) and the temperature was 21.09 °C (21.03°C in 2008). Table 4 shows that the population of *H. multiflora* is only found at east-west faced hill (Figure 1) at the elevation of 765 - 872 m a.s.l.; and lies between 106°50'45.7"E - 106°51'36.4"E, and between 6°46'32.3"S - 6°46'39.8"S.

The population distribution of *H. multiflora* at the Bodogol does not concordance by forest type or vegetation type presence as expected before. Similar condition at the other hills does not result with the same preference of *H. multiflora* (Table 4).

Table 4. Population occurrence of *H. multiflora* Blume at Bodogol Research Station

Plot	Hill Aspect	Slope Aspect	Forest Type	Vegetation			Density of <i>H. multiflora</i>
				Dominant tree	Dominant pole	Dominant understory	
1	East west 1a	North	SF	<i>Maesopsis eminii</i>	<i>Cyathea contaminans</i>	<i>Sellaginella</i> sp.	42/Ha
2	East west 1a	South	PF	<i>Nauclea lanceolata</i>	<i>Pinanga</i> sp.	<i>Donax</i> sp.	11/Ha
3	East west 1b	North	SF	<i>Altingia excelsa</i>	<i>Pandanus furcatus</i>	<i>Musa acuminata</i>	11/Ha
4	East west 1b	South	SF	<i>Agathis damara</i>	<i>Cyathea contaminans</i>	<i>Sellaginella</i> sp.	0
5	East west 2	North	PF	<i>Schima wallichii</i>	<i>Pinanga</i> sp.	<i>Pinanga</i> sp.	0
6	East west 2	South	PF	<i>Quercus</i> sp.	<i>Pinanga</i> sp.	<i>Calamus</i> sp.	0
7	North south 1	East	SF	<i>Pinus merkusii</i>	<i>Calliandra</i> sp.	<i>Selaginella</i> sp.	0
8	North south 1	West	SF	<i>Pinus merkusii</i>	<i>Calliandra</i> sp.	<i>Selaginella</i> sp.	0
9	North south 2	East	SF	-	-	<i>Alpinia</i> sp.	0
10	North south 2	West	SF	<i>Sehima wallichii</i>	-	<i>Chromolaena odorata</i>	0

Forest Type: PF= Primary Forest; SF= Secondary Forest (Formerly planted by PT Perhutani)

It was also noted that the *H. multiflora* only found at the upper areas of the hill and slope, not in the valley area. The seed dispersal strategy by wind and the intensity of sun light are reasons for the site selection.

The type of dispersion is clumped with the Morisita's Index of dispersion=1.35; $\chi^2=22.4$ (95% valid) (see Figure1). Clumped distribution is the most common type of dispersion found in nature. In clumped distribution, the distance between neighboring individuals is minimized. This type of distribution is found in environment that is characterized by patchy resources.

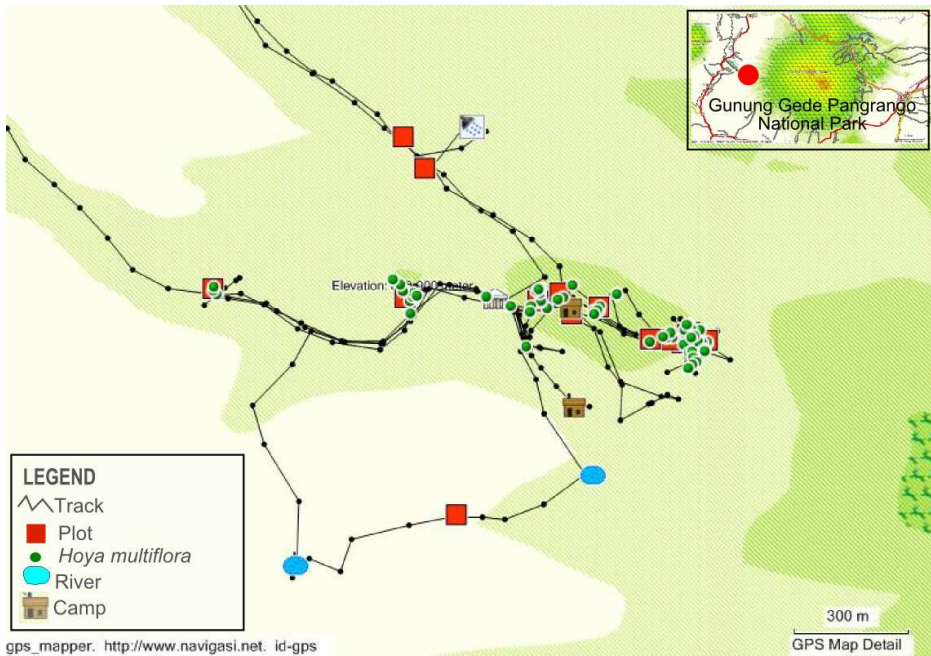


Figure 1. The distribution of *H. multiflora* Blume population at Bodogol Research Station, Gunung Gede Pangrango National Park, Bogor, Indonesia

B. DISCUSSION

According to the type of distribution, a species can be categorized as cosmopolitan or endemic species. As *H. multiflora* has a wide range of geographic distribution, thus, this species is classified as cosmopolitan species. However, based on the field observations at Gunung Gede Pangrango National Park, *H. multiflora* was only present at the Bodogol at the elevation of 750 - 900 m. The three other locations lay at higher elevation above 900 m a.s.l. As the result from the herbarium observation from Java, most of the sheets (68%) were found in elevation between 500 - 1000 m a.s.l.

The physiographic distribution of organisms will continually be shifted, expanded, and contracted depending on situation with the passage of time (Begon *et al.*, 2006). These changes are the result of two contrasting processes: establishment and extinction (Cuddington and Beisner, 2003). According to Krebs (2001), factors that limit distributions are biological dispersal, habitat selection, interrelations with other species and temperature, moisture and other physical-chemical factors. The habitat condition including physical-chemical factors at all locations of GGPNP is quite similar to the other mountains in West Java, where *H. multiflora* is found up to the elevation of 1400 m a.s.l (herbarium observation).

The dispersal seems to be the key factor to the distribution of *H. multiflora* at GGPNP. Biological dispersal refers to a species movement away from an existing population. Through simply moving from one habitat patch to another, the dispersal of an individual has consequences not only for individual fitness, but also for population dynamics, population genetics, and species distribution (Clobert *et al.*, 2004). Understanding dispersal and the consequences on an ecosystem level requires understanding on the type of dispersal and the dispersal mechanisms involved.

Biologically, *H. multiflora* has follicle type fruits and tiny seeds bearing lots of silky hairs. This characteristic allows the seeds to travel the wind current and gentle breezes of the earth. Wind dispersal of seeds, or anemochory, is one of the more primitive means of dispersal. Wind dispersal can take on one of two primary forms: seeds can float on the breeze or alternatively, they can flutter to the ground (Irwin and Taylor, 2007). In the case of this species, it has plumose crown of hairs (pappus) above a slender seed. This type of dispersal adopted this typical characteristic of a parachute seed so this plant evolved parachute method of seed dispersal by wind (Armstrong, 1999).

The *H. multiflora* dispersal at the Bodogol Research Station can be said primarily depends on the wind speed and direction at the time of fruit opening. Measurement by using (portable) anemometer at the observation time resulted in the southerly wind with the low speed (1-3 knot/hour). According to the data from the Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) 2008 (personal communication), wind direction above GGPNP (3000 feet) is southwesterly (January-March), southerly (April - May and November - December) and southeasterly (June-October). In areas where there is rugged topography that significantly interrupts the environmental wind flow, the wind circulation between mountains and valleys is the most important contributor to the prevailing winds. Hills and valleys substantially distort the airflow by increasing friction between the atmosphere and landmass by acting as a physical block to the flow, deflecting the wind parallel to the range just upstream of the topography, which is known as a barrier jet. This barrier jet can increase the low level wind by 45 percent (Doyle, 1979). Wind direction also changes due to the contour of the land (ANCAR, 2006).

IV. CONCLUSION

H. multiflora has widespread geographic distribution found in almost all parts of Indonesian archipelago ranging from 20 to 1500 m above sea level. The distribution of *H. multiflora* at the Gunung Gede Pangrango National Park is between 650-900 m above sea level at the Bodogol Research Station. The main factor affecting the spatial distribution is seed dispersal which mainly depends on the wind as a primary dispersal agent, rather than habitat factors. The speed and direction of the wind also influence on the long and short distant dispersal of this species.

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