

## ECOLOGICAL STUDIES ON *NEPENTHES* AT BARITO ULU, CENTRAL KALIMANTAN, INDONESIA

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### Abstract

*Ecological studies on the Nepenthes species at Barito Ulu, Central Kalimantan, Indonesia were conducted between August 2005 and September 2006. Surveys and two small plot inventories were used to determine the diversity and population of Nepenthes at the study site. We found eight Nepenthes species around the Barito Ulu study area: N. albomarginata, N. ampullaria, N. gracilis, N. hirsuta, N. rafflesiana, N. reinwardtiana, N. stenophylla, and N. hispida. Plot A was dominated by N. rafflesiana with one other species found; whilst in plot B we found five species but it was also dominated by N. rafflesiana. In plot A, the one year stem length growth rate of N. albomarginata was faster than N. rafflesiana (5.0 and 3.5 cm respectively). While in plot B, N. gracilis (21.7 cm) and N. reinwardtiana (13.1 cm) showed faster growth rates than N. albomarginata (5.2 cm), N. rafflesiana (7.0 cm) and N. stenophylla (8.5 cm). Generally, the habitat of Nepenthes in the study site is heath forest.*

**Key words :** *Nepenthes, diversity, population, growth rates, kerangas habitat, Barito Ulu, Central Kalimantan.*

### 1. INTRODUCTION

The number of *Nepenthes* species discovered continues to increase, especially over the last ten years. More new *Nepenthes* species are expected to be found, especially in the Malesiana region (Indonesia, Malaysia, Singapore, Brunei, The Philippines, and New Guinea).

In 1996, Phillips and Lamb reported that there were 80 *Nepenthes* species in the world, then Charles Clarke in 2001 reported 87 species. In 2006, it was estimated that there are least 97 species, with around 64 species to be found in Indonesia<sup>1)</sup>

Borneo is the third largest island in the world which has an area of 752 000 km<sup>2</sup>; this island is the center of *Nepenthes* biodiversity and has 31 species (24 species are reported to be endemic), while Sumatra has 29 species<sup>2,3)</sup>. The diversity of *Nepenthes* in other islands is less well known, but from examining herbarium specimens in the Herbarium Bogoriense, Indonesia, it is known that there are at least ten species in Sulawesi, nine species in New Guinea, four species in the Moluccas and two species in Java<sup>4)</sup>. The number of

*Nepenthes* species known is increasing as more new species are found, such as; *N. rigidifolia* from Sumatra<sup>5)</sup>, *N. platychila*, *N. glandulifera*<sup>6,7)</sup> and *N. chaniana* from Sabah and Sarawak<sup>8)</sup> and *N. adriani* from Central Java<sup>9)</sup>.

The area of forest damaged or destroyed in Kalimantan is increasing, especially in the last five to ten years. This damage leads to *Nepenthes* habitats being disturbed and some species of *Nepenthes* (especially the rarer species) may become easily lost. In Indonesia, all species of *Nepenthes* are protected. The ecological study of *Nepenthes* in Central Kalimantan is very important, especially to attempt *ex-situ* conservation action, so that endangered species of *Nepenthes* can be conserved. Barito Ulu is found in Central Borneo in Central Kalimantan. In 1995, Harris carried out a small study on the protease activity of 5 species of *Nepenthes* pitcher plants, but an ecological study of *Nepenthes* species found in the area has not yet been conducted.

## 2. METHODS

The field study was conducted in August 2005 and September 2006 at Project Barito Ulu. Administratively, the site is found in Desa Muara Joloi, Kecamatan Sumber Barito, Murung Raya District, Central Kalimantan Province.

The inventory of *Nepenthes* was conducted by survey in and around the study area. Herbarium collections of *Nepenthes* were taken in every location visited and kept in the Herbarium Bogoriense, Bogor, Indonesia (BO). Two small plots (20 x 50 m and 20 x 20 m) were established for a population study; both plots were divided into 10 m x 10 m subplots. All *Nepenthes* species in the plots were noted and numbered by aluminium tags. The coordinates (x, y) stem diameter, stem length and number of fresh leaves of each species was recorded. The top leaf each individual was punched with a small hole in order to

determine the growth rate of each species. Soil pH and moisture was measured in every sub plot. *Nepenthes* population data were determined, namely: frequency (F), density (D), relative frequency (RF), relative density (RD), basal area (BA), relative dominance (RD) and importance value (IV) according to the methods in Greig-Smith (1964) and Cox (1967).

## 3. RESULTS AND DISCUSSION

### 3.1 Habitat at the study site

Project Barito Ulu is a research area (c. 430 ha) which is located in the upper Barito River and is within the Heart of Borneo protected area. The typical *Nepenthes* habitat in the research area is heath forest which is dominated by *Shorea* spp., *Eugenia* spp., *Casuarina sumatrana*, *Cotylelobium* spp., *Vaccinium laurifolium* and *Swintonia glauca*. In this area, we made two permanent plots: plot A (20 m x 50 m) at 160 m altitude with coordinates 00°05'.507" S and 114°00'.973" E and plot B (20 m x 20 m) at 400 m altitude and with coordinates 00°06'.357" S and 114°01'.386" E.

### 3.2 Inventory

We found eight *Nepenthes* species in four locations visited. These were: *N. albomarginata*, *N. ampullaria*, *N. gracilis*, *N. hirsuta*, *N. rafflesiana*, *N. reinwardtiana*, *N. stenophylla*, and *N. hispida* (Table 1). Three species were found near the waterfall at 165 m altitude (00°02'.924" S and 114°00'.548" E), five species in heath forest A at 160 m altitude (00°05'.507" S and 114°00'.973" E), seven species in heath forest B at 400 m altitude (00°06'.357" S and 114°01'.386" E), and six species in heath forest C at 300 m altitude.

Three species (*N. stenophylla*, *N. hirsuta* and *N. hispida*) are new records for Central Kalimantan. Before our collections there were no specimens of *N. stenophylla*, *N. hirsuta* and *N. hispida* from Central Kalimantan in Herbarium Bogoriense. Clarke<sup>2)</sup> reported that *N. stenophylla* has a

wide distribution in the highlands of north-western Borneo at 900-2600 m altitude. Also in 1981, Kato, Okamoto and Walujo (based on herbarium specimen in Herbarium Bogoriense) found this species in East Kalimantan at 1150-1700 m altitude. At the Barito Ulu study site, we found *N. stenophylla* can grow well at 400 m altitude in heath forest. *N. hirsuta* is also a new record for Central Kalimantan, before, this species was only recorded from western

Borneo, Brunei, northern Sarawak<sup>2)</sup>, and East Kalimantan (based on herbarium specimens in Herbarium Bogoriense).

*N. rafflesiana*, *N. reinwardtiana*, *N. stenophylla*, and *N. gracilis* were commonly founded in rather open areas, while *N. hirsuta*, *N. albomarginata*, and *N. hispida* commonly grew in more shaded areas. As well as growing terrestrially, *N. reinwardtiana* and *N. albomarginata* were also found as epiphytes on tree branches.

Table 1. List of *Nepenthes* species found in four locations, Barito Ulu.

<i>Nepenthes</i>	Locations			
	Wf	Hf A	Hf B	Hf C
<i>albomarginata</i>	-	+	+	+
<i>ampullana</i>	-	-	-	+
<i>gracilis</i>	-	-	+	+
<i>hirsuta</i>	+	+	+	+
<i>hispida</i>	+	+	+	+
<i>rafflesiana</i>	-	+	+	+
<i>reinwardtiana</i>	+	+	+	-
<i>stenophylla</i>	-	-	+	-

Note: Wf = Waterfall, Hf A = Heath forest A, Hf B = Heath forest B, Hf C = Heath forest C

### 3.3 Population

Plot A had 137 individuals per 1000 m<sup>2</sup> in two species, *i.e.* *N. rafflesiana* (114 individuals) and *N. albomarginata* (23 individuals). *N. rafflesiana* is the dominant species in this plot with an importance value (IV) of 230.6 (Table 2). In the plot, *N. rafflesiana* grows terrestrially, whereas *N. albomarginata*, as well as growing terrestrially, is also found epiphytically on low tree branches. *N. hirsuta* and *N. reinwardtiana* were growing adjacent to the plot as small populations. Mean soil pH and moisture in this plot were 4.61 and 61 % respectively.

Plot B had 186 individuals per 400 m<sup>2</sup> from 5 species: these were *N. gracilis* (65), *N. rafflesiana* (60), *N. reinwardtiana* (37), *N. stenophylla* (23) and *N. albomarginata* (1). In plot B, *N. rafflesiana* was also the dominant species with an importance value of 99.2 (Table 3). *N. gracilis*, *N. reinwardtiana* and *N. rafflesiana* had importance values much the same to one

another. Plot B had more *Nepenthes* species and a greater number of individuals compared with plot A even though it was of a smaller size. This habitat is pure heath forest which commonly has white sand soils. Mean soil pH and moisture were 4.83 and 58 % respectively. *N. hirsuta* and *N. hispida* were found growing outside of the plot.

The horizontal distribution pattern of *Nepenthes* in the plots can be seen in Figures 1 and 2. *N. rafflesiana* is more widespread than other species in plots A and B.

### 3.4 Growth

The growth rate of *N. gracilis* and *N. reinwardtiana* was more rapid than *N. albomarginata*, *N. rafflesiana*, and *N. stenophylla* (Tables 4 and 5). It is known that *N. gracilis* and *N. reinwardtiana* are closely related species.

Table 2. Population analysis of *Nepenthes* spp. in plot A (1000 m<sup>2</sup>).

Species	F	D	BA (cm <sup>2</sup> /1000 m <sup>2</sup> )	RF (%)	RD (%)	RDM (%)	IV (%)
<i>N. albomarginata</i>	7	23	4.33	41.2	16.8	11.4	69.4
<i>N. rafflesiana</i>	10	114	33.64	58.8	83.2	88.6	230.6
Sum	17	137	37.97	100.0	100.0	100.0	300.0

Note: F = Frequency, D = density, BA = basal area, RF = Relative frequency, RD = relative density, RDM = relative dominance, IV = importance value.

Table 3. Population analysis of *Nepenthes* spp. in plot B (400 m<sup>2</sup>).

Species	F	DS	BA (cm <sup>2</sup> /400 m <sup>2</sup> )	RF (%)	RD (%)	RDM (%)	IV (%)
<i>N. albomarginata</i>	1	1	0.50	5.9	0.54	0.90	7.3
<i>N. gracilis</i>	4	65	2.59	23.5	35.0	4.6	63.1
<i>N. rafflesiana</i>	4	60	24.33	23.5	32.3	43.4	99.2
<i>N. reinwardtiana</i>	4	37	12.10	23.5	19.9	21.6	65.0
<i>N. stenophylla</i>	4	23	16.58	23.5	12.4	29.6	65.4
Sum	17	186	56.11	100.0	100.0	100.0	300.0

Note: F = Frequency, DS = density, BA = basal area, RF = Relative frequency, RD = relative density, RDM = relative dominance, IV = importance value.

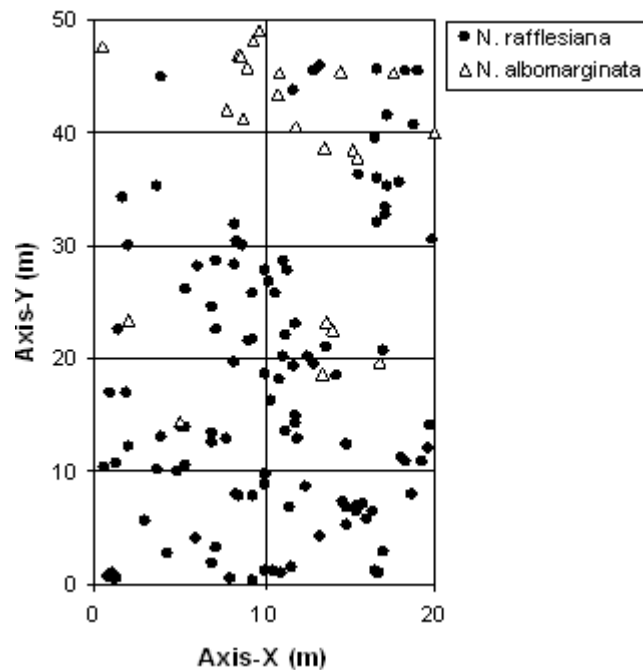


Figure 1. Horizontal distribution of *Nepenthes* spp. in plot A

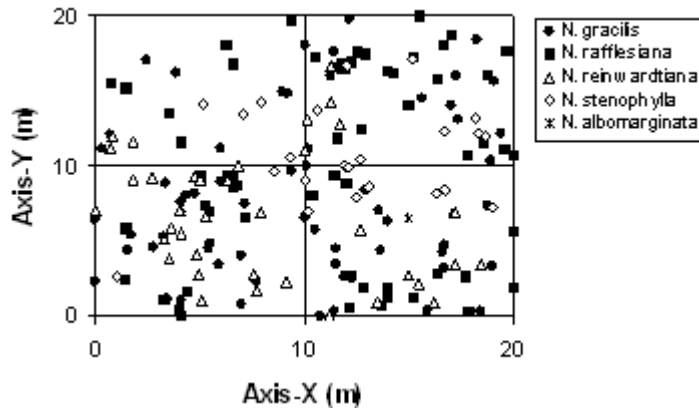


Figure 2. Horizontal distribution of *Nepenthes* spp. in plot B.

Table 4. Additional stem length (cm), new leaf number and stem diameter (mm) in one year of *Nepenthes* growth in plot A (160 m altitude), 20 m x 50 m.

Species	Stem length (cm)	Leaf (No.)	Stem diameter (mm)
<i>N. albomarginata</i>	5.00	7.50	1.01
<i>N. rafflesiana</i>	3.51	3.76	0.76

Table 5. Additional stem length (cm), new leaf number and stem diameter (mm) in one year of *Nepenthes* growth in plot B (400 m altitude), 20 m x 20 m.

Species	Stem length (cm)	Leaf (No.)	Stem diameter (mm)
<i>N. albomarginata</i>	5.20	10.00	0.30
<i>N. gracilis</i>	21.74	7.05	0.23
<i>N. rafflesiana</i>	7.01	3.31	0.83
<i>N. reinwardtiana</i>	13.10	7.57	0.54
<i>N. stenophylla</i>	8.51	3.23	0.75

#### 4. CONCLUSIONS

At the Barito Ulu study site we found eight *Nepenthes* species, these were: *N. albomarginata*, *N. ampullaria*, *N. gracilis*, *N. hirsuta*, *N. rafflesiana*, *N. reinwardtiana*, *N. stenophylla*, and *N. hispida*. The *Nepenthes* were typically found in heath forest with white sand soils. In two plots, *N. rafflesiana* was noted as the dominant species. Growth rates of *N. gracilis* and *N. reinwardtiana* were higher than other species.

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