

Habitat of *Nepenthes* spp. in the area of Sampit Botanic Gardens, Central Kalimantan, Indonesia

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Abstract. Hidayat S, Dodo, Purnomo DW, Helmanto H, Supriyatna I. 2018. Habitat of *Nepenthes* spp. in the area of Sampit Botanic Gardens, Central Kalimantan, Indonesia. *Biodiversitas* 19: 1258-1265. *Nepenthes* spp are protected plant and most of them are at least concern criteria. The research purpose is to explore the habitat information that supports the existence of *Nepenthes* in the area around Sampit Botanic Gardens, Central Kalimantan. Three different sites have been selected in this research. In each sites, seven sampling plots have been made by purposively sampling, each plot measuring 5x5 m². In the Gelam Forest (*Melaleuca quinquenervia*), two *Nepenthes* species have been found, namely *Nepenthes gracilis* and *Nepenthes mirabilis*. In two other sites, in Peat Swamp Forest and Alang-alang Forest (*Imperata cylindrica*), dominated by *N. mirabilis*. *Combretocarpus rotundatus* is a tree in the Peat Swamp Forest that is mostly climbed by *Nepenthes*. *Scleria sumatrensis* and *Stenochlaena palustris* are two species of plants that are always found in the three research sites, but the dominant family is Melastomataceae primarily represented by *Melastoma malabathricum*. *Nepenthes mirabilis* can be found in the three research sites with an equal number, but *N. gracilis* was only abundant in the Gelam forest. By using imageJ software, obtained canopy cover in Gelam forest only 10%. Meanwhile, based on laboratory test, the soil in the Gelam forest is dominated by the dust fraction and is relatively more fertile than the Alang forest. In this case, *Nepenthes* favored open canopy, but was quite watery and relatively fertile.

Keywords: Habitat, *Nepenthes*, purposive sampling

INTRODUCTION

Nepenthes is the only genus in family Nepenthaceae, and comprises of 129 reported species (Mey 2010). It is distributed mainly in the Malesian region, in recognized centers of biodiversity (Robinson et al. 2009). Borneo has been recognized as the world's largest center of distribution of *Nepenthes*, with 32 recorded species (Arimy et al. 2017), but based on phylogenetic trees and distribution area of each species Borneo appears to be a secondary center of diversification for *Nepenthes* (Alamsyah and Ito 2013). It hosts almost 50% of Indonesian species, among them are *Nepenthes mirabilis* (Lour.) Druce and *Nepenthes gracilis* Korth. (Damayanti et al. 2011). These species are geographically widely distributed, found in Borneo, Sumatra, Peninsular Malaysia, and Celebes. They grow on exposed sites such as roadside clearings, secondary bush and low canopy heath forest, commonly at below 100 m asl and only rarely at higher altitudes up to 1200 m asl. Latief et al. (2014) show that *N. gracilis* has a high abundance and is found in almost all research plots, especially in open secondary forests. *N. gracilis* is known to be very common in Borneo especially related to soil type, light and water content and can be found in almost all types of vegetation.

Nepenthes gracilis included in the terrestrial climber with a height can reach 5 m. Lower and upper stems are triangular in shape, the stems are climbing up to 5 m high and the stem diameters are 2-5 mm thick. Leaves are sessile; the lamina is lanceolate to linear-lanceolate in shape with acute apex (Adam et al. 2011). The color is

often quite different, dark reddish or only green. Arimy et al. (2017) said that *N. gracilis* on open area colored more green and leaves size wider than that grown in the shade, while Susanty and Kencanawati (2017) said the pitchers are green or red, cylinder-shaped on the top or oval on the bottom. *Nepenthes mirabilis* has a round and long stem, the stem can reach 10 m. Stem color is light green to dark brown, can grow on the floor of transitional forest, on the roadside, can also grow hanging on other plants. The inflorescence of *N. mirabilis* generally appears at the tip of the stem or branches (Handayani 2017). *Nepenthes* has the highest adaptability among other plant species, therefore it can be found in some habitats, especially in open or somewhat shaded places in poor nutrient habitats and have high moisture.

Mansur and Brearley (2008) said that 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. The ecological study of *Nepenthes* in Central Kalimantan is very important, especially to attempt *ex-situ* conservation action. Based on Government Regulation No. 7/1999 on the Preservation of Plant and Animal Species, *Nepenthes* spp includes protected plants. Meanwhile, based on IUCN 2017 ver 2.3. , *N. gracilis* and *N. mirabilis* are in the lower risk/least concern criteria. *Nepenthes* populations in the wild are predicted to decline due to factors such as forest fires, illegal logging, conversion of forest land or shrubs into residential areas, shifting cultivation,

plantation, agriculture, or mining and forest reclamation for oil palm plantations (Damayanti et al. 2011).

As the third largest province in Indonesia, Central Kalimantan has a forest area of 10,294,388,72 ha or 64.04% of its total area. Central Kalimantan is an area with very large peatland, covering an area of 2,280,789.70 ha or 14.44% of the total province area and as one of the centers of dispersal of 'kantung semar' (*Nepenthes* spp.). One of the characteristics of Peat Swamp Forest that differentiates compared to other forest types according to Latief et al. (2014) is the forest floor that is always under water. Sampit Botanic Gardens is located in Monumental Forest Jl. General Sudirman KM 29-31, Penyang Village, Telawang Sub-district, Kotawaringin Timur District, Kalimantan Province. Much of this area is included in disturbed forest areas, including Peat Swamp Forest areas, but still retains a variety of unique and protected plants such as *Nepenthes*. The purpose of this research is to know the habitat of *Nepenthes* particularly vegetation and soil that support the growth of *Nepenthes* spp. in the area around Sampit Botanic Gardens.

MATERIALS AND METHODS

Research sites

The research was conducted in KHDTK area (Specially Design Forest Area) Sampit Botanic Gardens (Figure 1), Kotawaringin Timur District, Central Kalimantan Province, Indonesia on October 18-November 6, 2017. In this area selected three different habitat sites for sampling observations of *Nepenthes* presence. The three sites namely are: mixed Peat Swamp Forest, Alang-alang (*Imperata cylindrica* (L.) Raeusch.) Forest, and Gelam (*Melaleuca quinquenervia* (Cav.) S.T.Blake) Forest.

Sampling and data

At each site of the research, we determined plots of observations by purposive sampling based on the discovery population of *Nepenthes* spp. In each site were made seven observation plots, each plot measuring 5 x 5 m². In each plots we recorded species of plants that grow either in the form of herbs, shrubs, lianas or trees. Then count the number of *Nepenthes* individuals present in each plot. One *Nepenthes* individual is calculated based on the removal of the *Nepenthes* rods from the same root (Clarke 2006).

About 50 g of soil samples were taken from each research sites. This soil sample is then sent to the laboratory of PT. Wilmar International Plantation, Sampit for tested C/N content and soil texture. Local climate data obtained from BMKG. While the forest canopy cover is digitally photographed perpendicularly from the forest floor to the top/canopy.

Data analysis

The density of *Nepenthes* was calculated based on the number of *Nepenthes* individuals divided by total area of observation plot converted to ha size. Meanwhile, to obtain information on differences in plant species composition in *Nepenthes* habitat is calculated based on species similarity

index (IS), which is the following formula (Diserud and Odegaard 2007).

$$IS = (2w/a + b) \times 100\%$$

w: number of species found in both regions

a: number of species found in region a

b: number of species found in region b

The presence or absence of vegetation associations in *Nepenthes* habitat, calculated based on 2x2 contingency table and Chi-square value (λ^2). If value λ^2 count $> \lambda^2$ table means association occurs, otherwise when λ^2 count $< \lambda^2$ table means no association occurs. The value of λ^2 table with degrees of freedom 1 at the 5% level is 3.84. If the chi-square result shows association, then proceed to determine the positive or negative association. Positive if observed $a > E(a)$, that is the pair of species occurred together more than expected if independent. Negative if observed $a < E(a)$, that is the pair of species occurred together less often than expected if independent (Ludwig and Reynolds, 1988).

The area of canopy cover is calculated using the imageJ software. The results of digital photographs in the field are converted to percent canopy cover by this software. An open canopy percentage is assumed as the percentage of light that reached the forest floor.

RESULTS AND DISCUSSION

Density of *Nepenthes* spp.

Two species of *Nepenthes* are found in these research sites, namely *Nepenthes gracilis* and *Nepenthes mirabilis*. *Nepenthes mirabilis* was found in three sites of observation plots while *Nepenthes gracilis* was not found in Alang-alang forest.

Nepenthes mirabilis is found in a variety of habitat, but is usually most prevalent in disturbed areas, swamps, or grasslands. Most are found in the lowlands (up to 200 m asl), but can occur up to 1,000 m, and more rarely, up to 1,400 m. A large number of individuals *N. mirabilis* found in the research sites indicates that this plant is a species that has a high tolerance to various habitat conditions. Therefore this species can be found throughout the research site. Dino et al. (2016) state that *N. mirabilis* is able to grow in various places both in shaded areas and open areas and has a wide distribution. The existence of *Nepenthes mirabilis* is often found living together with shrubs.

Based on the observation result, the number of *Nepenthes* spp in each site is as shown in Table 1.

Table 1. Individual numbers of *Nepenthes* in each research sites

Type of vegetation	Number of individuals (density)	
	<i>N. gracilis</i>	<i>N. mirabilis</i>
Peat Swamp forest	1 (57)	30 (1714)
Alang-alang forest	-	19 (1085)
Gelam forest	14 (800)	40 (2285)

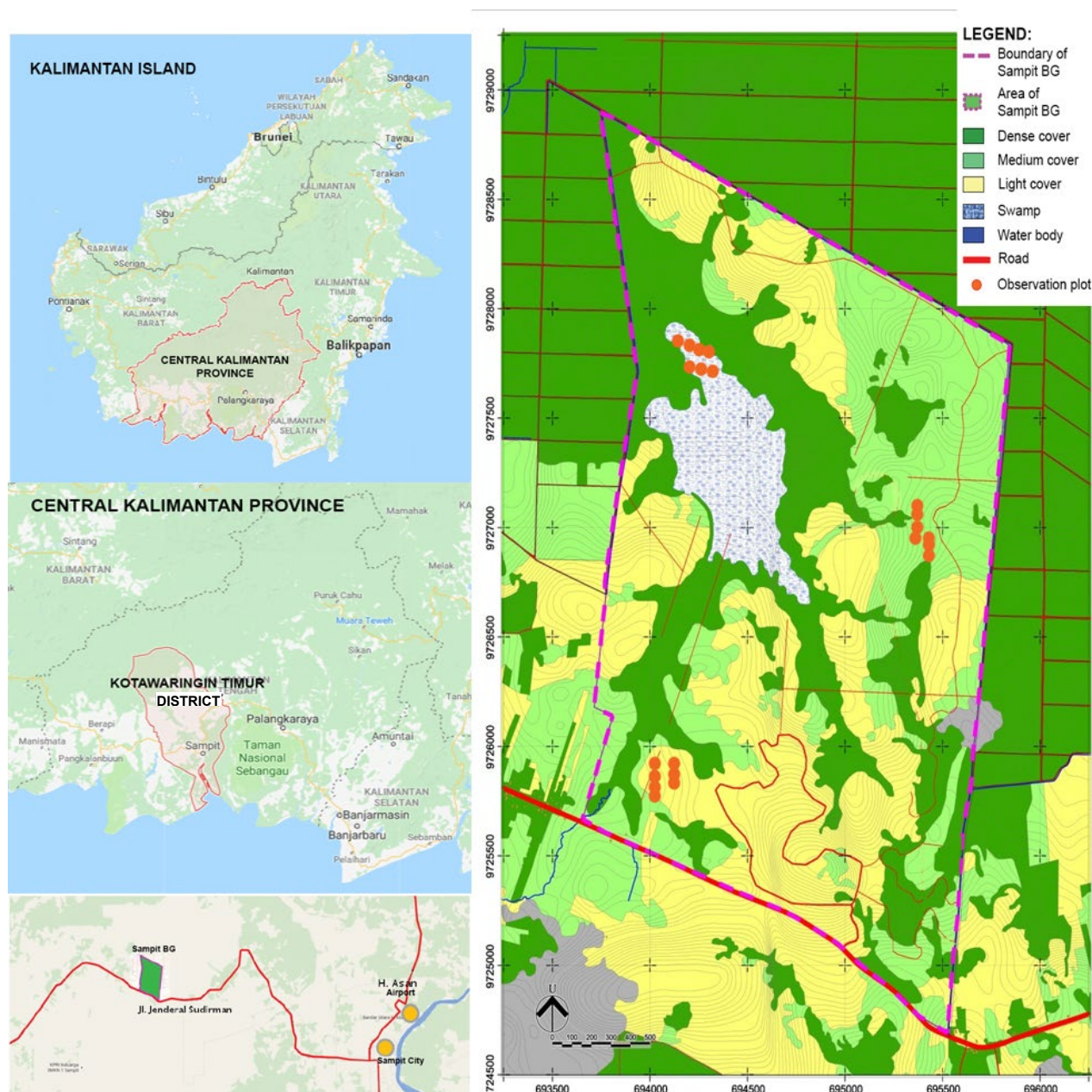


Figure 1. Research sites at Sampit Botanic Gardens, Kotawaringin Timur District, Central Kalimantan Province, Indonesia

Adam et al. (2011) said that differences in density of *Nepenthes* spp is influenced by combination of factors, which include topography, soil, habitat, different light intensities reaching the forest floor and water. From table 1 above, it appears that in the semi-open Gelam vegetation area, *N.mirabilis* is found to be more individual than in the other two sites. In the Peat Swamp Forest also found quite a lot of *N.mirabilis* but because the canopy covers is denser than the other two sites, so the species is found not densely in the Gelam forest. Based on field measurements, in Gelam Forest it can be said that 90-100% canopy is open, but in Peat Swamp Forest only 12-30% canopy is open. While *N. gracilis* was not found in Alang-alang Forest, it was found only in Gelam forest and one individual was

found in Peat Swamp Forest. *N. gracilis* prefers areas with high light intensity and lots of water. The average monthly temperature in Kotawaringin Timur District ranges from 27-35°C and the relative air humidity is above 50%. Lestariningsih and Setyaningsih (2017) said that habitat of *Nepenthes* spp. is in the peat forest or peat soil texture and tolerant to high moist condition and temperature between 27-29°C. Although the air temperature at the research sites during this research period including heat, but the area of Sampit Botanic Gardens quite often rain. This is because November is included in the wet months. In the Gelam Forest light is high enough and water is also quite available, because the floor is muddy. While in Alang-alang Forest, *N.gracilis* was not found, although this site is

quite open but not many stands can be used as a medium for the spread of this species. Hot temperatures and open places cause the Alang-alang Forest to be relatively dry compared to Gelam forest. In addition, in the Alang-alang Forest are more commonly found bush and vines that compete with *N. gracilis*, especially from fern species such as *Stenochlaena palustris* (Burm.f.) Bedd. and Climber *Uncaria gambir* (Hunter) Roxb. covering many trees. Growth of *N. gracilis* is attached to the stems or branches of other trees that live nearby, although this plant is also living on terrestrial peat soil surface. In the Peat Swamp Forest in this case, *N. gracilis* found only one individual, and grew on the edge of the forest where the canopy was quite open. In the Peat Swamp Forest, *Nepenthes* spp are commonly found below or climbing the *Combretocarpus rotundatus* (Miq.) Danser tree while in the Gelam area it is found climbing in *Cratoxylum glaucum* Korth. *Combretocarpus rotundatus* and *Cratoxylum glaucum* are pioneer plants in peatlands that bear fruit throughout the year and have an important contribution to forest succession. Thus both species of this plant is very reasonable when used as a tree supporting the growth of *Nepenthes*. Research on seed removal by ground-feeding

rodents in tropical peatlands (Blackham and Corlett 2015), indicates that not many *Combretocarpus* seeds move than other seeds. *Combretocarpus* had the highest proportion of seeds remaining at seed stations in habitats, with more than half the seeds (51.7%) remaining in forest. Thus, this species will regenerate continuously in the same place for supporting growth of *Nepenthes*.

Mansur and Brearley (2008) concluded that the abundance of *N. gracilis* would increase with the openness of the stand. As a comparison, the results of *Nepenthes* calculations by some researchers in some of the open areas are shown in Table 2.

Vegetation adjacent to *Nepenthes*

An important factor to support the growth of *Nepenthes* spp is a stand that can be used as a media to climb, considering *Nepenthes* is a climbing plant. Most *Nepenthes* are vines or subscandent shrubs inhabit, attaching themselves to adjacent vegetation by the use of looped tendrils which develop from the tips of the leaf blades (Moran and Clarke 2010). Based on the observation it can be concluded that some plant families dominate in this research area (Table 3).



Figure 2. Two species of *Nepenthes* in the research sites. A. *Nepenthes gracilis*, B. *Nepenthes mirabilis*

Table 2. Comparison of *Nepenthes* spp. density in some forest areas

Location	Individual number (density)		Habitat
	<i>N. gracilis</i>	<i>N. mirabilis</i>	
Guntung Ujung, South Kalimantan (Kissinger et al. 2015)	(142)	-	Fragmented land, trees rare
Nyarumenteng, Central Kalimantan (Kissinger et al. 2015)	(256)	-	Secondary stands
Sebangau National Park, Central Kalimantan (Lestariningsih and Setyaningsih 2017)	20 (160)	22 (176)	Open peat forest
Danau Sebedang, Sambas, West Kalimantan (Dino et al. 2016)	3 (100)	53 (1766)	Open area

Tabel 3. Vegetation adjacent to *Nepenthes* spp.

Vegetation type	Number of other plant species/family	Dominant family
Peat Swamp Forest	34/22	Melastomataceae-Rubiaceae
Alang-alang Forest	29/22	Rubiaceae-Compositae
Gelam Forest	20/13	Myrtaceae-Cyperaceae

Table 4. Non-tree plant species found in large quantities at the research sites

The most common non-tree species found in three different sites		
Peat Swamp Forest	Alang-alang Forest	Gelam Forest
<i>Artabotrys hexapetalus</i> (L.f.) Bhandari	<i>Stenochlaena palustris</i> (Burm.f.) Bedd	<i>Stenochlaena palustris</i> (Burm.f.) Bedd.
<i>Alocasia zebrina</i> Schott ex Van Houtte	<i>Scleria sumatrensis</i> Retz.	<i>Brachythecium plumosum</i> (Hedw.) Schimp.
<i>Stenochlaena palustris</i> (Burm.f.) Bedd	<i>Pteridium arachnoideum</i> (Kaulf.) Maxon	<i>Scleria sumatrensis</i> Retz.
<i>Trema orientalis</i> (L.) Blume	<i>Dicranopteris linearis</i> (Burm.f.) Underw.	<i>Scleria triglomerata</i> Michx.
<i>Scleria sumatrensis</i> Retz.	<i>Mentha × piperita</i> L.	<i>Patersonia umbrosa</i> Endl.
<i>Lygodium microphyllum</i> (Cav.) R. Br.	<i>Lycopodium clavatum</i> L.	<i>Melastoma malabathricum</i> L.
<i>Nephrolepis biserrata</i> (Sw.) Schott	<i>Lygodium microphyllum</i> (Cav.) R. Br.	<i>Bromheadia finlaysoniana</i> (Lindl.) Miq.
<i>Pandanus scandens</i> H. St. Jhon ex B.C. Stone	<i>Melastoma malabathricum</i> L.	<i>Ficus septica</i> Burm. f.
<i>Uncaria gambir</i> (Hunter) Roxb.	<i>Taenitis interrupta</i> Hook. & Grev.	<i>Chromolaena odorata</i> (L.) R.M. King & H. Rob.
<i>Smilax pumila</i> Walter	<i>Uncaria gambir</i> (Hunter) Roxb.	

Table 5. Index of similarity (IS) between research sites

Sites	IS value	Category
Peat swamp-Alang	19.05	Low
Peat swamp-Gelam	7.41	Low
Alang-Gelam	36.73	Low

Plant habitus that dominates *Nepenthes* habitat is a group of trees followed by shrubs and herbs. The number of plant habitus in each location is as follows: in Peat Swamp Forest found 19 species of trees, five species of bushes, four species of herbs, three fern species, two liana species, and one species of grass; in Gelam Forest found 11 tree species, two species of shrubs, two species of grass, two fern species, one herbaceous species and two epiphytic orchid species; whereas in Alang-alang Forest found 11 tree species, three species of shrubs, six species of herbs, six fern species, two species of grass and one species of liana. Although there are 11 species of tree habitus in Alang-alang Forest, only small trees are found and the numbers of tree are relatively small. This condition is not expected to be sufficient for the climbing medium of *N. gracilis*.

The Melastomataceae family, mainly represented by *Melastoma malabathricum* L., generally predominates throughout the research area. The results of this research are similar to those observed by Susanti et al. (2016) to the community of *N. mirabilis* in the IAIN Campus forest, Jambi who discovered the fact that *Melastoma malabathricum* occupies the dominant position followed by *Dicranopteris linearis* (Burm.f.) Underw. and *Acacia mangium* Willd. Similarly, Adam et al. (2011), in their study also mentioned some species that grow competitively with *Nepenthes*, especially *Dillenia suffruticosa* and *Melastoma malabathricum*. *Nepenthes gracilis* favored

growing in open area and partly shaded underneath by secondary plant species such as *Melastoma malabathricum*, *Dicranopteris linearis* and *Blechnum orientale*.

The above plant species are almost similar to the non-tree species found in the research sites (Table 4). As explained above *Combretocarpus rotundatus* is the main tree species found in Peat Swamp Forests in this research and is mostly climbed by *Nepenthes*. However, there were other tree species found in the Peat Swamp Forests such as *Baccaurea tetrandra* (Baill.) Murr. Arg., *Tetractomia tetrandra* (Roxb.) Merr., *Syzygium creaghii* (Ridl.) Merr. & L.M. Perry, and *Sterculia parviflora* Roxb.. In the Gelam Forest only *Melaleuca quinquenervia* and *Cratoxylum glaucum* are much climbed by *N. mirabilis*.

Index of similarities and Associations

There are two species that are always found in the three sites, are *Scleria sumatrensis* Retz. (Cyperaceae) and *Stenochlaena palustris* (Blechnaceae). Based on the calculation of the Sorensen's coefficient or similarity index showed no similarity in the composition of plant species that support habitat in the three research sites (Table 5.). The index Sorensen's coefficient developed an index called the similarity index, which measures similarity between two habitats, value varies between 0 and 1. Zero indicates no similarity and 1 indicates maximum similarity (Dubey et al. 2013). A low similarity index score between the three research sites indicated that these three sites had different types of vegetation.

Based on the result of calculation of 2x2 contingency table, it is obtained chi-square χ^2 which shows no association between *Nepenthes* with two species above (*S.sumatrensis* and *S.palustris*), as well as between the two species do not show any association (Table 6.). However, the tendency for the discovery of grass species and ferns

species above as the vegetation supporting the *Nepenthes* community is found in several cases of research. *Scleria sumatrensis* is found to grow in the community of *N. mirabilis* (Susanti et al. 2016). In research conducted by Nasution et al. (2015), *N. mirabilis* has been found in the same habitat as the growth of *Scleria ciliaris*. Handayani et al. (2005) said that *N. mirabilis* can grow well in the land where *Imperata cylindrica*, *Melastoma malabathricum* and *Gleichenia linearis* can be found frequently. *N. mirabilis* was more frequently found in open areas at either wet such as riverside or dried areas which is covered by fern *Gleichenia linearis*. Mansur and Brearley (2008) found *N. gracilis* growing in an open area among the bushes of the *Scleria purpurascens* Steud. (Cyperaceae). Cyperaceae such as *Fimbristylis miliaceae*, *Cyperus javanicus*, *Rhynchospora corymbosa* and *Scleria sumatrensis* most often found in and around the basin/pond with its smooth and humid substrate characteristics (Novianti et al. 2017). *Stenochlaena palustris*, is an endemic fern at central of Kalimantan (Zannah et al. 2015), it is a sun-loving plant that thrives in open areas, usually on swampy land (Chai 2016). The habitat where *S. palustris* grows, usually also can be found some species of *Nepenthes* (Firdaus 2017; Morley 2013; Asraf et al. 2011).

Soil

Nepenthes mirabilis generally grows on red podzolic soil or in swampy soil. In this research, pH value in Peat Swamp Forest is as follows pH H₂O with range values 3,83-4,47 and pH of KCL with value range 3,35-3,64, and C/N ratio is 20,52-40, 34. Lestariningsih and Setyaningsih (2017) said that habitat of *Nepenthes* spp. in the peat forest with soil pH ranging between 4 to 6.5. The range of soil pH values as mentioned above has a high tendency of Fe (Renge 2015). Rahim et al. (2007) said that *Nepenthes* sp can be used as a bioindicator for Fe. The forest floor in the Peat Swamp Area is a fairly thick pile of leaf litter, which makes it quite difficult to get sampled textured soil. Meanwhile, laboratory test results on soil in the other two types of vegetation are as Table 7.

The *Nepenthes* species are tropical vines that grow solely or coexist in different habitats such as heath forest,

peat swamp forest, mangroves, and cloudy montane forests on diverse infertile substrates including white sands, peat, cliffs, ultramafic soils, or epiphytic substrates. All these substrates are characterized by a scarcity of nutrients, especially nitrogen (Gaume et al. 2016). *Nepenthes* typically grows in Nitrogen-poor soil (Moran and Clarke 2010; Marina et al. 2018), these plants can obtain N from organic sources like insects or small animals (He and Zain 2012). Insects can walk upside down under the *N. gracilis* lid and harvest nectar but they regularly get knocked off by the impact of raindrops and end up as prey in the pitcher (Bauer et al. 2015). Few species of the genus *Nepenthes* developed mutualistic relationships with mammals for nitrogen supplementation. Yilamujiang et al. (2017) research show that carnivorous *Nepenthes* can harvest nitrogen in the form of urea “captured” in their pitchers and released upon cleavage by the plant’s urease. By Metagenome research, Chan et al. (2015) show that the *Nepenthes* pitcher fluid contains vast bacterial diversity and the culturomic studies confirmed the presence of biocatalytic bacteria within the *Nepenthes* pitcher juice which may act in symbiosis for the turn over of insects trapped in the *Nepenthes* pitcher fluid. Pitchers of *N. mirabilis* had higher bacterial diversity as compared to other *Nepenthes* species (Chou et al. 2014). Based on the above facts then it is natural that *Nepenthes* can grow on a poor land of nitrogen. Susanti et al. (2016) stated that *Nepenthes* are found in infertile soil areas, with low N, P, and K nutrient content, acid soils with a pH range of 2-4 or 5, and high humidity, rarely grown in dense forest and alluvial soil. This information is in accordance with the results of soil tests at the research sites as shown in table 7. Most of Sampit Botanic Gardens is classified Podzolic Red Yellow or Podzolic, and Organosol. Podzolic lands are washed lands. In general, the soil in Sampit Botanic Gardens is gray (gray) on the surface of the soil (depth 0-50 cm) and is red-yellow in the underground layer (> 30 cm). The gray color on the soil surface is largely the effect of changes in land conditions such as inundation and fire occurrence. While the yellowish red color can be suspected to be the influence of the parent material that has been decayed (Witono et al. 2016).

Table 6. The λ_2 in Peat Swamp Forests (RG), Alang Forest (HA) and Gelam Forest (HG)

	<i>Nepenthes</i> spp			<i>S. sumatrensis</i>			<i>S. palustris</i>		
	RG	HA	HG	RG	HA	HG	RG	HA	HG
<i>Nepenthes</i> spp.									
<i>Scleria sumatrensis</i>	1,07	0,47	0,47	0,47	1,43	1,27			
<i>Stenochlaena palustris</i>				1,86	1,26	2,91			

Table 7. Result of laboratory test of soil at research sites

Sites	pH H ₂ O	pH KCL	C	N	Sand (%)	Dust (%)	Clay (%)
Alang forest	5.81	3.58	0.5	0.02	91.9	3.8	4.2
Gelam forest	4.92	3.71	3.8	0.21	32.6	56.6	10.9

The existence of *Nepenthes* is an indicator of the low nutrients contained in the soil (Kissinger et al. 2015). In Sebangau, found *Nepenthes* grew on land with content of N, P, and K, generally low (Brearley and Mansur 2012). Insect predation mechanism by *Nepenthes* is a strategy to overcome the problem of nutritional limitations that can be obtained from the soil. In addition to the roots that absorb nutrients from the soil, this plant is also able to absorb nutrients from insects trapped in the pitcher. Clarke and Moran (2011) said that various morphological and geometric characteristics of *Nepenthes* pitchers play important roles in trap function or specialized methods of nutrient acquisition. Pitchers of all *Nepenthes* species secrete nectar to attract insect prey. Bauer et al. (2012) observed that ants harvesting nectar from the lower lid surface of *N. gracilis* in the field, were able to walk upside down on the wax crystal surface without difficulty, while the same ants would slip and fall from the waxy inner pitcher wall. These insects are destroyed by the enzyme proteolase or *nepenthesin* for the sucking of the juice. Lam et al. (2018) experiment result of *N. gracilis*, showing that fluid protein levels were even higher in the presence of dipteran larvae, than in their absence.

Based on the composition of the soil fraction from the results of laboratory tests, and then obtained the following results. The soil in Alang-alang forest is categorized as sand soil, while the soil in the Gelam Forest belongs to the category of dusty clay soil. Different soil textures will affect the ability of soil to store and deliver water, store and provide different nutrients. Sand texture is soil with sand content > 70%, it means some large pore space so that its good watering, fast conductivity of water, but the ability of storing nutrients is very low. In Gelam Forests, dust fractions are more dominant, dust-dominated soils will have moderate pores, dust-textured soils are generally more fertile than sand-textured soils. The parent material at the Sampit Botanic Gardens site is both frozen (conglomerate) and sedimentary rocks (limestone, foraminifera, and clay) as well as silt (lake sediments) derived from aging rocks. The advanced podsolization process will produce color yellowish-red soil (rust). This soil color indicates the remaining minerals in the soil are dominated by mineral oxides (iron and manganese) (Witono et al. 2016). Based on the texture tested in the field, most of the gray-colored soils on the top are affected by organic matter and ash from combustion. Forest fires often occur in Sampit Botanic Gardens. The gray color found in the lower layer, is the effect of flooding. Most of the land at the Sampit Botanic Gardens site has a shallow groundwater level (<1 m). This can lead to high gleization processes on soils characterized by gray soil color. Another soil is Tropohemist or Organosol, a soil that can be found on land with basin physiography. Based on survey results, this type of soil was not found. Fires occurring regularly at the site of Sampit Botanic Gardens are thought to have removed the peat layer (hemist) from the soil surface so that what remains is the mineral soil layer (Witono et al. 2016).

Nepenthes mirabilis, in this case, grows in three quite distinctly different types of soil, whereas *N. gracilis* is more commonly found in 'submerged' forests. Thus the soil

fertility factor does not seem to be a barrier to the growth of *N. mirabilis* and *N. gracilis* but more fertile soil would be preferred. *N. mirabilis* can be found in the three sites of this research but *N. gracilis* is not found in Alang-alang Forests that are relatively less fertile than in Gelam Forests as in the case of the KHDTK Sampit Botanic Gardens.

In conclusion, *Nepenthes* spp. have been found growing in the KHDTK area of Sampit Botanic Gardens especially in three different habitat sites with a considerable number of individuals. *Nepenthes mirabilis* is more common than *Nepenthes gracilis*, especially in Gelam Forest. Although this plant does not require shade for its growth, but the presence of tree habitus is needed as a medium to climb it, so woody plants have an important role for the survival of *Nepenthes*. *Combretocarpus rotundatus* in Peat Swamp Forest as a tree that many climbed by *Nepenthes*, while *Cratogeomys glaucum* is a tree that climbed by *N. gracilis* in the Gelam Forest. In general, *N. mirabilis* grew well in the three research sites, whereas *N. gracilis* was found only in relatively more open forests compared to swamp forests but also more water (muddy soil) than in dried Alang-alang Forests. Melastomataceae, Compositae, Cyperaceae and several species of ferns are another plant group that grows competitively in the *Nepenthes* habitat. While the soil in which *Nepenthes* grow has a wide texture range but in this case, dusty texture is preferred over sandy texture.

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