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Inventory of Pitcher Plant (*Nepenthes* sp.) and Its Existence in North Sumatra Indonesia

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Abstract. *Nepenthes* sp. is a carnivorous plant with unique shape and color shades. This unique plant has a special leaf modification called a pitcher which has the capability in catching insects and small animals. The purpose of this research was to know the types and habitat of *Nepenthes* sp. that found in six regencies in North Sumatra. The pitcher plants inventoried from South Tapanuli, Central Tapanuli, Humbanghasundutan, Toba Samosir, Dairi and Samosir regency in North Sumatra. The research type and method were conducted by descriptive qualitative and survey method research. The morphology data of *Nepenthes* sp. used to identify the types of *Nepenthes* sp. in North Sumatra. Inventory result of *Nepenthes* sp. from six regency showed that there were five original species in North Sumatra namely *Nepenthes tobaica*, *Nepenthes gracilis*, *Nepenthes ampullaria*, *Nepenthes eustachya*, *Nepenthes rhombicaulis* and one natural hybrid species *Nepenthes reinwardtiana x spectabilis*. *Nepenthes tobaica*, *Nepenthes gracilis* had upper and lower pitchers while *Nepenthes ampullaria*, *Nepenthes eustachya*, *Nepenthes rhombicaulis* and *Nepenthes reinwardtiana x spectabilis* just had an upper or lower pitcher. All species lived in low or high lands and most of them found in peat area, high humidity, and high light intensity.

1. Introduction

Indonesia is one of the world's richest nations in terms of its biodiversity. Indonesia is an archipelago made up of about 17,000 straddling the equator in Southeast Asia. About six thousands of the islands are inhabited. Indonesia has at least 47 distinct natural ecosystems which are rich in plant and animal resources and large number of island endemics, with the total known species about 1.46 million. From total known species, estimated that there are 42,584 species of plants (39% endemic) distribute in many areas in Indonesia [1]. Amongst the plant diversity, *Nepenthes* sp. is the most popular pitcher plant.

Nepenthes sp. is carnivorous plant that leaves apex modified into jug shaped structures that contain a pool of digestive enzymes to attract traps and digest animals for its nutritional values [2]. *Nepenthes* sp. belongs to monotypic family Nepenthaceae which is the largest genus of pitcher plants. Pitchers of *Nepenthes* sp. have various colors and shapes, passive, and gravity-driven traps that show distinct functional zones on their inner surfaces [3]. When prey capturing, an extra nutrition also can be



extracted from other scenario such as litter fall with “carpets” of pitchers at ground level and animal faces (Tupaia Montana's faces of *N. lowii*) [2, 3, 4].

Nepenthes sp. is known as tropical pitcher plant or monkey cups (Indonesian: kantong semar) is distributed in Southeast Asia, the Seychelles, Madagascar, and Australia [3]. The diversity of *Nepenthes* sp. in the world line with data on International Union for Conservation of Nature (IUCN) comprises about 122 species. 116 species of them found in Southeast and South Asia, and 63 species of which are found in Indonesia [5]. Record on the diversity of *Nepenthes* sp. in Indonesia had been adequately reported from the large islands such as Sumatra (31 species), Kalimantan (20 species), Papua (12 species), Sulawesi (10 species), Moluccas (4 species), and Java (3 species) [5]. From them all, Sumatra is the island that has the most commonly of *Nepenthes* sp. in Indonesia.

However, *Nepenthes* sp. existence situation in the world currently is critical, as stated on the IUCN red list. As much as 8.1% of *Nepenthes* sp. in the world are classified as critically endangered, 11.4% are threatened with endangered and 17.2% are vulnerable. This is usually caused by forest fires, logging, and conversion of forest land or shrubs into residential areas, cultivation, plantations, forest degradation [6]. The exploitation of *Nepenthes* sp. in nature is done for economic purposes only. That was a reason the existence of *Nepenthes* sp. protected by the enactment of Law No. 5 in 1994 for the ratification of the United Nations Convention on Biological Diversity and Government Regulation No.7, 1999 concerning Protected Plant and Animal Types [7].

2. Methods

Inventory of pitcher plants in North Sumatra was conducted from May to June 2019. The plants were collected by exploring various types of *Nepenthes* sp. in six regency locations, South Tapanuli (Batang Angkola), Central Tapanuli (Sibuhuan Raya), Humbanghasundutan (Bakti Raja), Toba Samosir (Onan Runggu), Dairi (TWA Sicike-cike), and Samosir (Taman Eden Parapat) regencies. This research was conducted using a survey method. The tools used in this research were ruler, camera phone, black cloth 15 cm x 15 cm, and gauge.

Researches were made on observation of *Nepenthes* sp habitat and morphology. Habitat *Nepenthes* sp. was observed based on field data, such as altitude, soil type, temperature, and humidity. Morphology observations include pitcher of plant. Morphology of *Nepenthes* sp. pitcher observed based on the length, width, structure, color, and shape. The results of these observations were used to identify the types of *Nepenthes* sp. Identification of *Nepenthes* sp. types using some literatures such as Morfologi Tumbuhan book by Gembong Tjitrosoepomo, *Nepenthes* of Sumatra and Peninsular Malaysia book Charles Clarke, and *Nepenthes* of Borneo book by Charles Clarke also related journals.

3. Results

3.1. Types of *Nepenthes* sp. in Sumatra Utara

The diversity of *Nepenthes* sp. in North Sumatra recorded in this research comprises of six species. Four of the six species found were classified as endemic species in North Sumatra, *Nepenthes tobaica*, *Nepenthes rhombicaulis*, *Nepenthes esutachya* and the latest species are the natural hybrid of *Nepenthes reinwardtiana* x *spectabilis*. The other two species are not endemic species in North Sumatra, *Nepenthes ampullaria*, *Nepenthes gracilis*. All species classified based on their pitcher types. The total upper pitcher species are four same with total of lower pitcher species. *Nepenthes tobaica* and *Nepenthes gracilis* found both upper pitcher and lower pitcher. Meanwhile, the other species just found an upper or lower species. For the whole individual plants were found, the numbers are 8 individual plants. The lower pitcher of *Nepenthes tobaica* has the highest number of individual plants.

3.2. Morphological Characters of *Nepenthes* sp. Pitchers

3.2.1. *Nepenthes tobaica*. Pitchers of *Nepenthes tobaica* are soft-textured, such membranes and have varying colors, green, red and purple. Waist-shaped pitcher, the top (waxy zone) and bottom of the

(digestive zone) pitcher appear to be separated by pitcher rib. The height of upper pitcher is about 7-12 cm and lower pitcher is about 5-10 cm. The pitcher bottom part (digestive zone) is rounded with length 3 cm - 5 cm which is greater than pitcher top part (the waxy zone) with length 5 cm - 8 cm is oval in shape. Upper pitcher of *Nepenthes tobaica* there are no wings, but there is a clear lyrical on the front side of green colored pitcher. Whereas, in the upper pitcher there are wings with thorns, tight between 0.1 - 0.5 cm, not sharp, flexible and soft. The inside of the pitcher sometimes has red spots. Lips (peristome) are thin, tight, unclear, green and circular as an oval or round shape. The front lip is flat or lower while the rear lip rises. Cover is ovoid-shaped, rounded at the tip and notched at the base, green and red color. Green and red tendril, with upper pitcher tendril 0.3 cm - 0.5 cm, lower pitcher tendril 0.2 cm - 0.4 cm, without branches until branching 3.

3.2.2. *Nepenthes ampullaria*. Lower pitcher *Nepenthes ampullaria* has soft texture but thicker and harder. The pitcher of this species has flasks or ampoules (pumpkins) shape, do not appear to be separate between the waxy zone and the digestive zone, but rather look combining from top to bottom. The arrangement of the pitcher shaped like a ball (urceolate) with a variety of colors, there is plain green, but there are also red and brown patterned green colors. The pitcher height is 4-7 cm and width is 4 cm - 5 cm. In the pitcher bottom part there are wings with spines that are dense between 0.3 - 1 cm, not sharp, flexible, and soft. Pitchers covers are small between 1 cm - 2.5 cm, elliptical and light green with a position opposite the mouth of the pitcher so that rain water easily enters the pitcher. The pitcher mouth is round to ovate and flat shape, does not rise and does not lower over a number of parts. Lips (peristome) are thin, tight, clear, green and red or alternately on the mouth of the pitcher. Peristome are quite wide, curved and wide between 0.3 cm - 0.7 cm. Green and brown colors, branchless and 1 branch tendril in length 0.2 cm - 0.6 cm.

3.2.3. *Nepenthes gracilis*. Pitchers of *Nepenthes gracilis* are soft textured like membranes, waist-shaped, bottom part (digestive zone) is oval and top part (waxy zone) is cylindrical then spread to the mouth. Upper pitcher has light green and plain color, lower pitcher has yellowish green with red spots quite a lot. The height of upper pitcher is between 8 cm - 10 cm, lower pitcher is 5 cm - 7 cm and the width of upper pitcher 1.25 cm - 2 cm, the width of lower pitcher 1 cm - 1.5 cm. In the upper pitcher there are no wings, but there are two clear slashes on the front of the red pitcher. In the lower pitcher there are wings in the form of small spines which are parallel to the top reddish red-yellow color. The mouth of the pitcher is round with the lip (peristome) are thin, tight, unclear, green and surrounds the mouth of the pitcher. Front and back lips (peristome) is flat. Pitcher cover is green, has a hanging shape at the base and tapered at the end with length 0.75 cm - 1.25 cm. Tendril is green color, length 0.25 cm - 0.4 cm and without branches.

3.2.4. *Nepenthes rhombicaulis*. Lower pitcher *Nepenthes rhombicaulis* has waist shape with bottom part (digestive zone) in ovoid to ventricular shape and the top part (cylindrical zone) in a cylindrical shape. Pitcher texture is soft, yellow and red color with sparse scarlet red spots. The height of the pitcher is classified as short or small, ranging from 4cm to 5cm. The width of the waxy zone is 2 cm-3 cm, the width of the digestive zone is 1 cm-1.5 cm. There are wings, tight, soft spines from top to bottom. The mouth of the pitcher is round and tilted, the front is lower and the back is raised. Lips (peristome) are thin, tight, clear, red color around the mouth of the pitcher. The cover is yellowish red with patches of red and ovoid, rounded at the tip and notched at the base. The tendrils are red with length 0.5 cm and are not branched.

3.2.5. *Nepenthes eustachya*. Upper pitcer *Nepenthes eustachya* are slim waist with oval shape at the bottom part (digestive zone) and cylinder shape at the top part (waxy zone). The pitcher is light green color with bright green or plain white color insides. The height pitcher classified ± 12 cm. The width of the waxy zone is ± 3 cm, the width of the digestive zone is ± 2.23 cm. The width of the digestive zone is the same as the width of the mouth of the pitcher. Pitcher mouth is round and tilted, the front is

lower and the back is raised. The uniqueness of *Nepenthes eustachya* pitcher is on the lip, where the color is intermittent between red and green. Lips (peristom) are thin, tight, clear, and encircle the mouth of the pitcher. There are no wings, but there are dual red lyrical on the front of the pitcher. Pitcher cover is greenish-yellow with ovoid shape. The tendrils are red, ± 0.5 cm long and are not branched.

3.2.6. *Nepenthes reinwardtina x spectabilis*. The upper pitcher of *Nepenthes reinwardtina x spectabilis* has a slender waistline with an oval shape at the bottom part (digestive zone) and a cylinder shape at the top part (waxy zone) then widens at the mouth of the pitcher. The pitchers color are yellow with dominating red patches. The pitcher height is ± 11 cm. The width of the waxy zone is ± 3 cm, the width of the digestive zone is ± 2.2 cm. Pitcher mouth is round and tilted, the front is lower and the back is raised. Lips (peristom) are thick pockets expand not too hard, jagged tightly and are very clear, greenish yellow with dark red stripes. It has no wings, but there are dual red-colored slices on the front of the pitcher. The lid is ovoid and greenish yellow with dominant red patches. Red color tendrils with ± 0.5 cm long, cylindrical and has no branch.

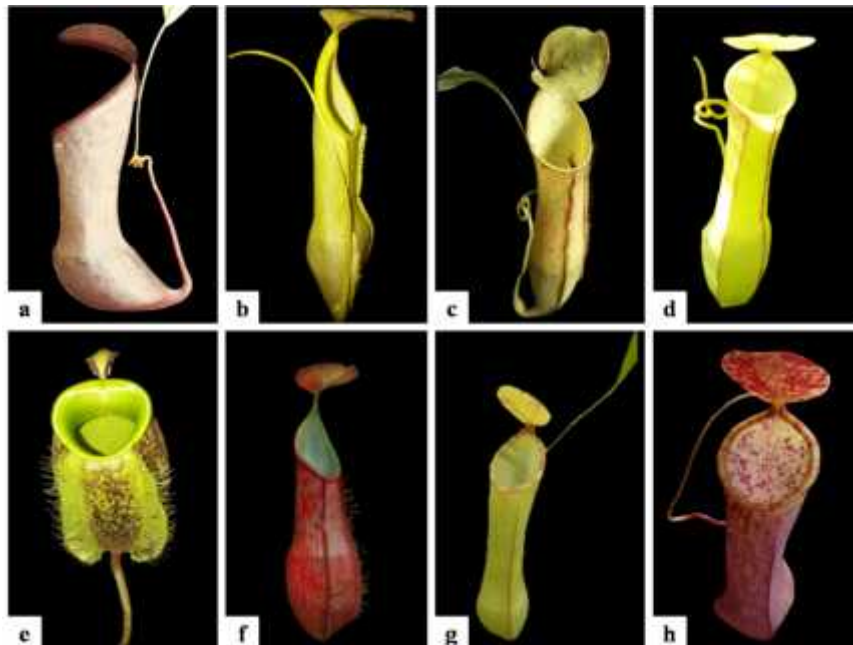


Figure 1. Pitcher morphology of *Nepenthes* sp. was found in North Sumatra. (a) upper pitcher *N. tobaica*, (b) lower pitcher *N. tobaica*, (c) upper pitcher *N. gracilis*, (d) lower pitcher *N. gracilis*, (e) *N. ampullaria*, (f) *N. rhombicaulis*, (g) *N. eustachya* and (h) *N. reinwardtina x spectabilis*.

3.3. The Existence of *Nepenthes* sp.

Whole species of *Nepenthes* sp. was found in various localities in North Sumatra. Variety localities *Nepenthes* sp. found to consist of lowland and highland habitat. Overall species found in highland habitat (> 1.000 m asl), two species able lived in lowland habitat (< 1.000 m asl), *Nepenthes ampullaria* and *Nepenthes gracilis*. The different location *Nepenthes* sp. found causing differences in the existence of each species. The existence of *Nepenthes* sp. observed based on altitude, soil type, temperature, and humidity in every habitat location. Mostly, *Nepenthes* sp. species was found in North Sumatra had approaching altitude, soil type, temperature, and humidity. The differences existence within each species is slightly (table 1).

Table 1. The Existence of *Nepenthes* sp. which was found in North Sumatra

Species	Types	Localities	Altitude	Soil Type	Temperature	Humidity
<i>Nepenthes tobaica</i>	Upper pitcher	Dairi Regency	1,320 m asl	Peat	20°C	90%
		Humbanghasundutan Regency	1,208 m asl	Alluvial	24°C	86 %
	Lower pitcher	Dairi Regency	1,320 m asl	Peat	20°C	90%
		Toba Samosir Regency	1,240 m asl	Alluvial	23°C	80 %
		Humbanghasundutan Regency	1,208 m asl	Alluvial	24°C	86 %
<i>Nepenthes ampullaria</i>	Lower pitcher	Toba Samosir Regency	1,240 m asl	Alluvial	23°C	80 %
		Central Tapanuli Regency	30 m asl	Peat	32°C	77%
<i>Nepenthes gracilis</i>	Upper pitcher	Central Tapanuli Regency	30 m asl	Peat	32°C	77%
		South Tapanuli Regency	345 m asl	Peat	28°C	78%
	Lower pitcher	South Tapanuli Regency	345 m asl	Peat	28°C	78%
<i>Nepenthes rhombicaulis</i>	Lower pitcher	South Tapanuli Regency	1,019 m asl	Alluvial	25°C	79%
<i>Nepenthes eustachya</i>	Upper pitcher	Samosir Regency	1,812 m asl	Peat	22°C	67%
		Toba Samosir Regency	1,240 m asl	Alluvial	23°C	80%
<i>Nepenthes reinwardtiana x spectabilis</i>	Upper pitcher	Samosir Regency	1,115 m asl	Peat	20°C	90 %

The location where the most pitcher plants were found in this research was South Tapanuli Regency. In South Tapanuli regency, two species of pitcher plants were found consisting of upper and lower pitcher of *Nepenthes gracilis* and lower pitcher of *Nepenthes rhombicaulis*. The six species found in this research were spread from the lowlands to the highlands in North Sumatra with most of them growing in the highlands habitat. Pitcher plant species that grow in the highlands habitat with the highest altitude was *Nepenthes tobaica* 1,302 m above sea level in Dairi Regency. While pitcher plant species that grow in the lowlands with the lowest height was lower pitcher of *Nepenthes ampullaria* in Central Tapanuli Regency and *Nepenthes gracilis* in Central Tapanuli and South Tapanuli Regency with 30 m above sea level.

Peat soil type is the most widely grown type of soil pitcher plant in North Sumatra. 8 of 14 individual pitcher plants total were found in peat soils. The temperature of the pitcher plants environment were found between 20 ° C-32 ° C. Pitcher plants that grow in the highlands have an ambient temperature between 20 ° C-24 ° C. While pitcher plants that grow in the lowlands have an ambient temperature between 28 ° C-32 ° C. The humidity in the place where the pitcher plants sprout grows ranges from 67% -90%. The upper pitcher of *Nepenthes tobaica* in Dairi and the lower pitcher of *Nepenthes reinwardtiana x spectabilis* in Samosir grew with the highest air humidity of 90%. While *Nepenthes eustachya* grows with the lowest humidity of 67%.

4. Discussion

All six species of *Nepenthes* sp. was found by classifying based on upper and lower pitcher. Based on the research results, the types of upper pitcher found were *Nepenthes tobaica*, *Nepenthes gracilis*,

Nepenthes eustachya, and *N. reindwartiana x spectabilis*. The types of lower pitcher found were *Nepenthes tobaica*, *Nepenthes gracilis*, *Nepenthes ampullaria* and *Nepenthes rhombicaulis*. All species are identified one by one to determine the types of *Nepenthes* sp. found using existing books or literature. The species that found location in extreme is *Nepenthes gracilis*. It was found in high and lowland with the height range is quite different. This is caused by *N. gracilis* has a higher adaptability compared with other *Nepenthes* sp. so that this type is found in various places. *N. gracilis* is able to live in different types of habitats and soil types, with high adaptability [6,8].

The diversity of habitat variations suitable for *Nepenthes* sp. growth is another important factor. *Nepenthes* sp. in these islands varies in forest habitats. But not only in the forest, *Nepenthes* sp. is also reported to grow terrestrially and epiphytically in mossy forest and mountain peaks at an altitude of 1100-2900 m asl [9]. However, from both factors it can be concluded that the type of *Nepenthes* sp. prefers the place to grow in open condition or rather open [6].

There are six species of *Nepenthes* sp. was found in a variety of different habitats in North Sumatra. Four of the six species found [10] are Sumatran endemic semicarp plants namely *Nepenthes tobaica*, *Nepenthes rhombicaulis*, *Nepenthes eustachya* and *Nepenthes reinwardtiana x spectabilis* while the other two species of species namely *Nepenthes gracilis* and *Nepenthes ampullaria* are not classified as Sumatra endemic plants. *Nepenthes tobaica*, *Nepenthes rhombicaulis* and *Nepenthes reinwardtiana x spectabilis* are classified as endemic plants in North Sumatra [11, 12] because their natural habitat is usually found in the area around Lake Toba or Tanah Batak. For *Nepenthes eustachya* is endemic to Sumatra, but its natural habitat is not only found in North Sumatra but also can be found in West Sumatra.

Whole species found in the lowlands and highlands habitat. *N. tobaica* can live in the lowlands 380 m-1,800 m above sea level until the plateau reaches 2,710 m above sea level [9]. This is consistent with the results of research in which this species was found at an altitude of 1,320 m asl in Dairi Regency, 1208 m asl in Humbanghasundutan Regency and 1,240 m asl in Toba Samosir Regency. *N. gracilis* according can grow at an altitude of 0-750 m asl but is generally found below an altitude of 500 m asl [2]. In this research, *N. gracilis* species can be found at an altitude of 30 m asl in Central Tapanuli Regency and 345 m asl in South Tapanuli Regency.

N. ampullaria was found in the lowlands 30 m above sea level in Central Tapanuli Regency [2] where *N. ampullaria* can grow at an altitude of 0-1,000 m above sea level and in the highlands of 1,240 m above sea level in Toba Samosir Regency. *N. rhombicaulis* can live in lowlands 1,000 m above sea level up to 1,000 m above sea level in accordance with *N. rhombicaulis* found in South Tapanuli Regency at an altitude of 1,019 m above sea level [9]. *N. eustachya* can grow at an altitude of 0-1,600 m asl, while on research the species *N. eustachya* grown at an altitude of 1,240 m asl in Toba Samosir and 1,812 m asl in Samosir Regency [10]. *N. reindwartiana x spectabilis* based on its parent plant *N. reindwartiana* can live in the lowlands to a height of 0-2,200 m asl [10] and *N. spectabilis* can live at a height of 1,400-2,200 m asl [13]. This is consistent with the results of the research, this species was found in Samosir Regency with an altitude of 1,151 m above sea level.

The type of pitcher plants soil is one of the environmental factors that influence the growth of pitcher plant. The Panti Branch Research Station has 8 different habitat types, including the main *Nepenthes* sp. habitat, namely: peat swamp forest, clear water swamp forest, alluvial soil forest, lowland sandy stone forest, lowland granite forest, lowland forest highland granite, mountain forest and kerangas forest [14]. This is supported by the discovery of *Nepenthes* sp. species that can live well in peat soils such as *Nepenthes tobaica*, *Nepenthes ampullaria*, *Nepenthes gracilis*, *Nepenthes eustachya*, and *N. reindwartiana x spectabilis*. As well as those found in alluvial soils such as *Nepenthes rhombicaulis* and some *Nepenthes tobaica*, *Nepenthes ampullaria*, and *Nepenthes eustachya*.

The temperature factor also influences the growth of *Nepenthes* sp. The temperature of highland species during the day ranges between 18-21°C while at night the temperature is around 13°C [15]. This is consistent with the results of pitcher plants in the highlands, where the temperature of *Nepenthes tobaica* 20-24°C, *Nepenthes ampullaria* 23°C, *Nepenthes rhombicaulis* 25°C, *Nepenthes*

eustachya 22-23°C and *N. reindwartiana x spectabilis* 20°C . Similarly, species in the lowlands, during the day have a temperature of 27-38 danC and at night the temperature ° 21°C [15]. According the research, *Nepenthes ampularia* in the lowlands has temperature 32°C and *Nepenthes gracilis* 28- 32°C.

Pitcher plants generally grow at high humidity. Optimal humidity for *Nepenthes* sp. is 70% -90% [16], while good humidity for *Nepenthes* sp. growth is 60% -90% [17]. In this reasearh, humidity in Dairi Regency was 90%, Humbanghasundutan Regency 86%, Tobasa 80%, Central Tapanuli 77%, South Tapanuli 78% -79%, and Samosir 67% -90%.

5. Conclusion

The North Sumtra Province has found six species of *Nepenthes* sp. namely *Nepenthes tobaica*, *Nepenthes ampularia*, *Nepenthes gracilis*, *Nepenthes rhombicaulis*, *Nepenthes eustachya* and one natural hybrid *N. reindwartiana x spectabilis*. The most commonly individual species found was lower pitcher *Nepenthes tobaica*. *Nepenthes tobaica*, *Nepenthes gracilis* had upper and lower pitchers while *Nepenthes ampullaria*, *Nepenthes eustachya*, *Nepenthes rhombicaulis* and *Nepenthes reinwardtiana x spectabilis* just had an upper or lower pitcher. *Nepenthes* sp. of North Sumatra reported in this research is found in various existences include high and lowland habitat. All species lived in low or high lands and mostly found in peat area, high humidity, and high light intensity.

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