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Taxonomic classification and conservation status of pitcher plant species in selected areas of Bucas Grande Island, Socorro, Surigao Del Norte, Philippines

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Key words: Carnivorous pitcher plants, *Nepenthes mirabilis, Nepenthes merrilliana,* Endemic plants, Bucas Grande Island

Abstract

The endemic carnivorous pitcher plants remarkably increased its diversity in Philippines due to unending research discovery of the species and conservation measures applied to these plants. The current study aimed to identify and classify the observed Pitcher plant species vegetation in the steep sloping areas along the watershed river and swampy areas in Bucas Grande Island as well as to determine the conservation status of the said species. The obtained field data about the external morphological description of the pitcher plants species, descriptively matched to the known carnivorous pitcher plant species-*Nepenthes mirabilis* and *Nepenthes merrilliana* that are endemic carnivorous pitcher plant species in the country. The study concluded that there are two species of pitcher plant in Bucas Grande Island, Socorro which are *Nepenthes mirabilis* and *Nepenthes merrilliana*. *N. merrilliana,* however, is currently categorized as a vulnerable species which needs a careful monitoring for an appropriate conservation measures.

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Introduction

Pitcher plant is known as a carnivorous flowering plant luxuriously growing in disturbed and natural tropical rainforest (Adam *et al*., 2011). Philippines is one of the place where there is an abundance of pitcher plant because of the climate in the area (Gronemeyer *et al*., 2014). Having the highest rates of endemism of this family is considered a center of diversity of the genus Nepenthes along with Sumatra and Borneo and recent explorations in Mindanao and Luzon has raised the Philippine number of Nepenthes species to 52 (Amoroso *et al*., 2017).

The forest habitat destruction incurred an impact to the pitcher plant species due to plantation businesses like pineapple plantation, palm plantation, mining operations and forest fires (PAWB-DENR 1998; Lagunday *et al*., 2017). It is sad to note that at present time, many carnivorous plants are increasingly threatened by anthropogenic activities. Indeed, over half of the carnivorous plant species assessed by the International Union for the Conservation of Nature (IUCN) are listed as threatened (Jennings 2011). Furthermore, conservation research is essential to help inform the science-based management of environments that support threatened and endangered wildlife (Doi and Takahara 2016). Normally, taxonomic classification and conservation are interdependent and other disciplines have direct implications for the management of species and ecosystems, captive breeding and reintroduction, genetic analyses, and habitat restoration (Mace 2004; Gerber 2010). We should rethink the way we prioritize conservation to recognize the critical role that small, isolated patches play in conserving the world's biodiversity and reconnecting small isolated vegetation patches should be an immediate conservation priority (Wintle *et al*., 2019)

In relation to this, a study about pitcher plant species in the perceived vegetation in Bucas Grande Island, Socorro was conducted with the aim to identify, and classify the pitcher plant species and determine its conservation status. In doing so, can ensure relevant and applicable to all regions and that the information necessary for the conservation of threatened species is available to conservation practitioners; specifically to the local government unit (LGU) and to the Department of Environment and Natural Resources (DENR) about the pitcher plant species in the area and for conservation purposes.

Objectives of the Study

The study aimed to classify and determine the conservation status of pitcher plant species in three (3) selected sites in Bucas Grande Island, Socorro, Surigao del Norte.

Specifically, this study aimed to:

1. describe the morphology of pitcher plant species
2. identify and classify pitcher plant species in the area; and
3. determine the conservation status of Pitcher Plant species in Bucas Grande Island, Socorro.

Materials and methods

Study Area

The study was conducted in are three(3) areas as prescribed by the MENRO-Municipal Environment and Natural Resources Office of Socorro Municipality namely: Brgy Rizal ("9.64250000 N, 125.97055556 E"), Brgy Sering ("9.67444444 N, 125.94333333 E"), and Brgy Salog ("9.69527778 N, 125.92944444 E").

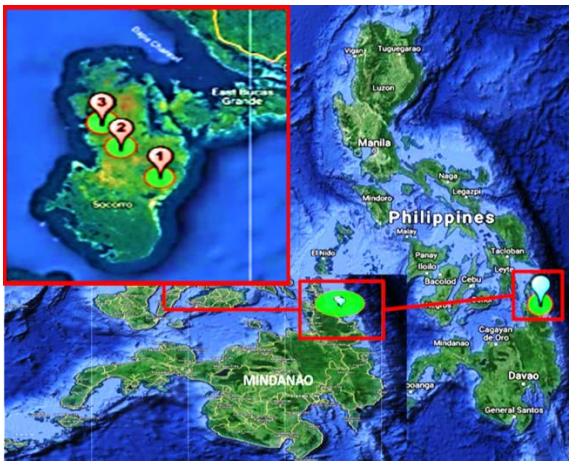

Fig. 1. Locale of the study: The upper left portion showing the three (3) selected sampling areas of Pitcher Plant species in Bucas Grande Island, Socorro, Surigao del Norte, Philippines.

Establishment of the Sampling sites

This study was conducted in three selected Barangay as our study area and only one sampling site in each

Barangay. A total of six (6) sampling stations established in all study sites. Station 1 and 2 established in each adjacent river vicinity of the watershed in Brgy Rizal. Station 3 and 4 in each adjacent river vicinity of Brgy Sering. And station 5 and 6 in the dry land to swampy areas of Brgy Salog. Further, stations were selected based on the availability of the pitcher plant vegetation and its accessibility.

Data Gathering and Analysis

The researchers applied transect walk method using a transect line approximately measured 200 meters length and with a width of 5 meters in both sides of the sampling area. Samples of pitcher plant found within transect line were noted. The species, morphology was documented by photographed, and recorded and described by its shape and its characters. Discrimination of the documented samples was done by mean of Phenetics approach and the traditional method by comparing the images, descriptions and taxonomic characters based on the available references from the reliable internet sources. Samples were subjected to further verification by a pre-identified research consultant with a doctoral degree in Botany in order to ensure the identification and classification of pitcher plant samples Bucas Grande Island, Socorro.

Result and discussion

Taxonomy of the Pitcher Plant in the study area

The physical characteristics or the external morphology of percieved pitcher plant species in the sampling areas were described and emphasized on the pitcher cup of the plant specimens. The very basis in determining pitcher plants was their very own pitcher-shaped leaves (Gaume and Forterre, 2007). There were two (2) distinct species observed within the study areas. The images of each samples species, especially the pitcher cup, were compared to the available references in the internet and other related studies to determine the pitcher plant species' taxon name.

The first representative samples of pitcher plant species, was coded in this present study as PPS1- Pitcher Plant Species No.1, were observed in Brgy Rizal, Brgy Sering and Brgy Salog, in of Bucas Grande Island, Socorro, Surigao del Norte Norte and were compared and identified. Samples of PPS1- Pitcher Plant Species No.1, revealed a close similarity to *Nepenthes mirabilis* as shown in Fig. 2. The column 1 in fig. is compose of the representative images of the present study, while Column 2 is compose of images taken from Rule 2018 (Brgy. Honrado, Municipality of Socorro, Surigao del Norte). The Column 3 in the fig. 2 is composed of representative images from other countries: Malaysia, Hongkong and India.

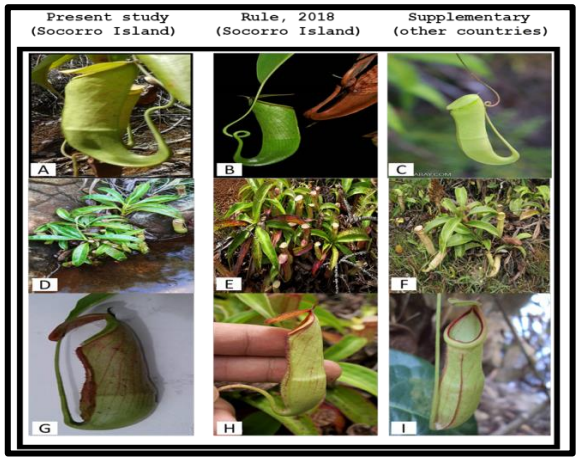

Fig. 2. Selected images used in comparative identification and verification of the PPS1- Pitcher Plant Species No.1 with known species *Nepenthes mirabilis*: *[(A,B,C:upper* pitcher cup); (A- present study), (B-http://131.230.176.4/imgs/pelserpb/r/ Nepenthaceae_Nepenthes_mirabilis_136191.html),(C -https://travel.mongabay.com/malaysia/images /borneo_4990.html. [(D,E,F:basalrosette); (D-present study), (E-http://131.230.176.4/imgs /pelserpb /r/Nepenthaceae_Nepenthes_mirabilis_ 136035. html), (F-http://www.herbarium.gov.hk/PlantInfo /NEPENTHACEAE/Nepenthes/mirabilis/88150/ 108_Nepenthes%20mirabilis_%E8%B1%AC%E7%B1 %A0%E8%8D%89_31-12-2009_88150_LR_WM. jpg). [(G,H,I : lower pitcher cup); (G-present study) , (H- http://131.230.176.4/imgs/pelserpb/r/ Nepentha ceae_Nepenthes_mirabilis_136191.html), (Ihttp:// nepenthesoutthere. blogspotcom/2012/05/ nepenthes-mirabilis-in-thepha.html).

Furthermore, the second representative pitcher plant species coded in this study as PPS2- Pitcher Plant Species No.2 were observed only in Brgy Rizal, and Brgy Sering in Municipality of Socorro, Surigao del

Norte were compared and identified. Comparison of PPS2- Pitcher Plant Species No. 2 revealed a close similarity to *Nepenthes merrilliana* as shown in Fig. 3. The column 1 is composed of representative images colleted in this study, while Column 2 are the images taken from Dinagat Island, Surigao del Norte (Pelser and Barcelona 2016) and Column 3 are representative images of *N. merrilliana* of Samar Island (Robinson 2012). Based on the morphological structure of the samples taken there are observed two (2) different species of pitcher plant found in the study area.

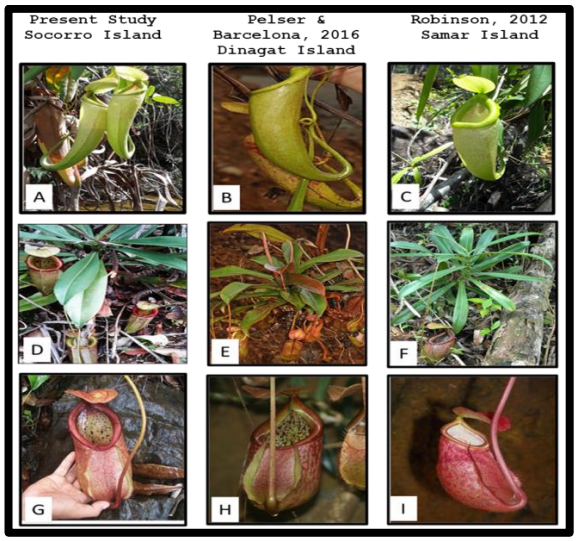

Fig. 3. Selected images used in comparative identification and verification of the PPS2- Pitcher Plant Species No.2 with known species *Nepenthes* merrilliana: [(A,B,C:upper pitcher cup);(A- present study), (B- http:// phytoimages. siu. edu/imgs/ pelserpb /r/Nepenthaceae_Nepenthes_merrilliana _108486.html=), (C-http://photobucket.com/ gallery/user/asrobinson/media/bWVkaWFJZDo4Nj U4NTQ1NQ==/?ref=).[(D,E,F: basal rosette);(D- present study),(E- http://www.phytoimages.siu.edu /imgs/pelserpb/r/Nepenthaceae_Nepenthes_mer rilliana_108581.html), (F-http://www.http:/ /photo bucket. com/gallery/user/asrobinson/media/bWVka WFJZDo4NjU4NTQ 1Nw==/?ref=). [(G,H,I: lowerpitchercup); (G-present study),(H-http:// phytoimages.siu.edu/imgs/pelserpb/r /Nepenthaceae _Nepenthes_merrilliana_58936.html),(Ihttp://photo bucket.com/gallery/user/asrobinson/media/bWVka WFJZDo4NjU4NTQ1Mw==/?ref=).

The two (2) species were identified as *Nepenthes mirabilis* and *Nepenthes merrilliana*. It was observed that all pitcher plant species found in the area displayed unique ornamental parts having climbers or scrambling stem and the basal rosette. The flowers of both species were all infloresence. This is accompanied with morphosis of pitcher cup in a manner that there are changes in forms and modification in the lower and upper pitcher cup. This means that in one plant there are differences in the form of pitcher cup in climbing stem and basal rosette of *N. mirabilis* and *N. merrilliana* as shown in the *in situ* images provided and presented in Fig. 4 and Fig. 5.

Nepenthesis mirabilis species

The distinctive feature of *Nepenthesis mirabilis* is the presence of “the hip” structure located in the midway to the lower half of the upper pitcher cup and lower to the third or quarter portion in lower pitcher cup (see Fig. 4 emphasized with red arrows served as the key taxonomic character of *N. mirabilis* species essential to this study. Morphosis occurs between the lower and the upper pitcher cup. The lower pitcher cup, with about 18cm width x 11cm length, possess pitcher wings from simple to bearing multicellular fringe elements distinctly channelled on the upper surface. While the upper pitchers were simple, sometimes winged or non-winged, measuring to about 13cm wide x 9cm long with lid.

Lower leaves have fimbriate margin and each leaf consists of a petiole, its a blade is acute to rounded, simple or rarely decurrent for half the length to the internode, and a coiled zone or tendril and petioles about 3.5-10cm long. A similar study to Clarke & Kruger, 2005 as to the description of *Nepenthes mirabilis* in Australian tropical pitcher plants. *Nepenthes mirabilis* has an acute to rounded leaf blade, simple insertion of tendril to leaf blade, and have a simple bearing multicellular fringe elements. Across its variety, *N. mirabilis* displays abundant variability in terms of pitcher morphology and colour, and it has the most alternative expression of all Nepenthes species (Schlauer 2010). This same species was documented by Rule of 2018 from Brgy. Honrado, Municipality of Socorro, Philippines.

Fig. 4. The *in situ* images of samples of Pitcher Plant species, *Nepenthes mirabilis*: (A) upper pitcher cup shape of climbing stem, (B) lower pitcher cup shape of basal rosette. (see red arrows pointing distinct feature "the hip" on the pitcher cup).

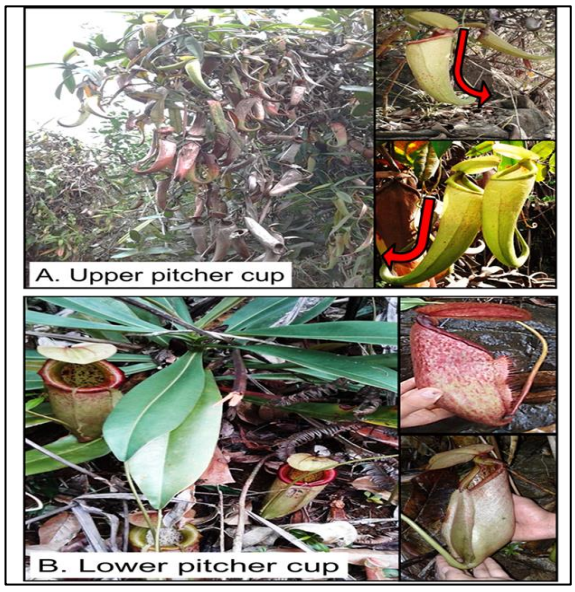

Fig. 5. The *in situ* images sample of Pitcher Plant species, *Nepenthes merrilliana* : (A) upper pitcher cup shape of climbing stem, (B) lower pitcher cup shape in basal rosette. (see upper right image, red arrows emphasized narrowing of the pitcher cup body).

Nepenthes merrilliana species

The distinguishing characteristics of Nepenthes merrilliana is the unique shape of the its upper pitcher cup body having a wide peristome with lid and narrowing or forming funnel like shape to the lower portion in the digestive zone of the pitcher body to the tendrils (see Fig. 5. Red arrows emphasize the direction of the narrowing). The lower pitcher cup at the basal rosette described as a wide mouth with lid and from peristome to the digestive zone is a globose pitcher body.

Morphosis occurs between the lower and the upper pitcher cup. The lower pitcher cup ossess pitcher wings from simple to bearing multicellular fringe elements distinctly channelled on the upper surface. Sizes of pitchers measured to about 27cm in width x 26cm length in lower and upper about 18cm width x 17cm length. Leaf shape is long attenuate-spathulate, sessile with an obtuse apex. The parallel description of the leaf morphology referred to Jebb and Cheek 1997. Further, the same species of N. merrilliana was recorded in Dinagat Island of Surigao del Norte in the study of Lillo *et al.*, 2018 on Plant diversity and structure of forest habitat types on Dinagat Island, Philippines. Similar species recorded in Samar Island, Philippines by Robinson 2012.

Taxonomic Classification of Pitcher Plant Species

The hierarchical classification of the study specimen code PPS1-Pitcher Plant Species No.1 i.e. *Nepenthes mirabilis* found in Brgy. Rizal, Brgy. Sering and Brgy Salog in Municipality of Socorro, Surigao del Norte, Mindanao, Philippines categorized into Kingdom: Plantae, Division: Tracheophyta, Class: Magnoliopsida, Order: Nepenthales, Family: Nepenthaceae, Genus: Nepenthes, Species: *mirabilis*.

Based on the characteristics and descriptions of the pitcher plant samples' derived taxonomic classification of specimen code PPS1-Pitcher Plant Species No.1 i.e. *Nepenthes mirabilis* provided by the International Union for Conservation of Nature - IUCN and reinstated as a separate species in 2005 by Clarke, C.M in 2014. On the other hand, the taxonomic classification of specimen code PPS2-Pitcher Plant Species No.2 i.e. *Nepenthes merrilliana* provided by the International Union for Conservation of Nature - IUCN (Clarke *et al.* 2000).

Furthermore, the hierarchical classifica tion of the study specimen code PPS2-Pitcher Plant Species No.2 i.e. *Nepenthes merrilliana* found in Brgy. Rizal and Brgy. Sering in Municipality of Socorro, Surigao del Norte, Mindanao, Philippines categorized into Kingdom: Plantae, Division : Tracheophyta, Class: Magnoliopsida, Order: Nepenthales, Family: Nepenthaceae, Genus: Nepenthes, Species : *merrilliana*.

This family consist only the genus Nepenthes, the circumscription of which has never presented taxonomists with difficulties because of the unique pitcher cup formed in all known species (Schlauer 2010). Both species have a common name as tropical pitcher plant and locally known in Socorro as "tasa – tasa". Furthermore, the binomial naming assumes that the study specimen code PPS1-Pitcher Plant Species No.1 in three (3) selected areas in Bucas Grande Island was given a taxon name: *Nepenthes mirabilis* (Lour.) Druce. The study specimen code PPS2-Pitcher Plant Species No.2 was given a taxon name: *Nepenthes merrilliana* (Macfarlane). However, there are several variances or variety of N. *mirabilis* which are not covered in this study.

Habitat and Conservation Status

The *Nepenthes mirabilis* and *Nepenthes merrilliana* species were observed at the range from 460 ft – 706 ft above sea level. *N. mirabilis* were observed at the swampy and river vicinity as well as in watershed area in Bucas Grande Island, Socorro. The *Nepenthes merrilliana* is observed in the wide river vicinity and watershed area of Bucas Grande Island. It has the same observation with the other references that these two species thrive in less nutrients soil and endemic in the Philippines. It has been recorded from Mindanao, the Surigao Province, including Dinagat Island of Caraga Region (Aribal and Buot Jr., 2009). Moreover, the *N. merrilliana* is categorized as vulnerable species (IUCN 2018) while *N. mirabilis* as least concern by IUCN ver 3.1. in the year 2018.

Findings

1. There are two (2) types of pitcher plant species identified in Bucas Grande Island, Socorro. Both are carnivorous plant species with the taxon names; *Nepenthes mirabilis* and *Nepenthes merrilliana*.

2. Both species displayed two distinct ornamental parts, climbing stem and basal rosette and each ornamental part accompanied by upper and lower pitcher cup respectively. Further, the upper and lower pitcher cup of both *N. mirabilis* and *N. merrilliana* have lid and undergo morphosis. *N. mirabilis* has a hip structure present in midway to lower half portion of the upper pitcher cup with about 13cm width x 9cm length, lower to the third or quarter in lower winged pitcher cup with about 18cm width x 11cm length. The lower leaves have fimbriate margin as its key character.

On the other hand, *N. merrilliana* has the upper pitcher cup body with about 18cm width x 17cm length having a wide peristome narrowing or forming funnel like shape to the lower portion in the digestive zone of the pitcher body to the tendrils. It has winged lower pitcher cup have with a wide mouth and from the peristome to the digestive zone is a globose pitcher body with 27cm width x 26cm length long. The leaf shape is long attenuate-spathulate as its key character. The systematic classification is the same except for species level. Kingdom Plantae, Division Tracheophyta, Class Magnoliopsida, Order Nepenthales, Family Nepenthaceae and Genus: Nepenthes.

3. Both species are endemic in Philippines. However, *Nepenthes mirabilis* is categorized as least concern species in 2018 by IUCN ver 3.1 while *Nepenthes merrilliana* is categorized as vulnerable species by IUCN 2018.

Conclusion

Based on the data gathered, coupled with series of verifications, the researchers came to a conclusion that the Pitcher plant species inBucas Grande Island, Socorro, Surigao del Norte two taxa; *Nepenthes mirabilis* and *Nepenthes merrilliana,* both are carnivorous pitcher plant species endemic to this country. However, only the *N. merrilliana* is categorized as vulnerable species which needs a careful monitoring and relevant conservation measures.

Recommendations

1. Further similar research study in other barangays in Bucas Grande Island, Socorro, Surigao del Norte is recommended to explore and identify any other existing species present within the locality.
2. Inquilines characterization and DNA bar coding for the Pitcher Plant Species: *Nepenthes mirabilis* and *Nepenthes merrilliana* for genetic based classification.
3. Since the result of the study categorized one species found to be a vulnerable species, it is recommended to the LGU to formulate ordinances for the conservation measures and for appropriate implementation of policies in relation to the protection of pitcher plant species.

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