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Inventory and assessment of carnivorous Pitcher Plants (Caryophyllales Nepenthaceae) in Mt. Kalindog, Kalabugao, Impasug-Ong, Bukidnon, Philippines

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ABSTRACT Kalabugao, an area nestled within the lush landscapes of Bukidnon, Philippines, boasts a diverse and rich ecosystem that provides an ideal habitat for pitcher plants to thrive. Despite that, very few studies have been conducted related to pitcher plants. The study assessed carnivorous pitcher plant species in Mt. Kalindog, Kalabugao, Impasug-ong, Bukidnon, Philippines. A total of 3 individual species belonging to 1 family and 1 genus were identified. Among the pitcher plants found, 1 has been discovered to be endangered. Two pitcher plants were found to be vulnerable. Due to the disturbance of the area, pitcher plant diversity and species richness were relatively low. Furthermore, conducting enhanced investigations and establishing additional sampling plots in various regions of Mt. Kalindog, Kalabugao, Impasug-Ong, and Bukidnon, Philippines, will help better understand the spatial distribution of pitcher plant species given the Mountain's significant potential as a healthy habitat for pitcher plants and promote conservation.

KEY WORDS Conservation status; diversity; pitcher plants; species.

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INTRODUCTION

Nepenthes L. (Caryophyllales Nepenthaceae) is a genus of wild carnivorous plant and is grown or crossed with other plants to create decorative hybrids. The species of this genus have the pitcher-shaped leaves that act as a passive pitfall trap; though not designed for photosynthetic assimilation, the traps are optimized for prey attraction, catch, digesting, and nutrient uptake (Pavlovič & Kocáb, 2021). They are usually found in woods, especially in the mountains, blooming in damp, nutrient-poor soils, such as sandy coastal marshes, pine barrens, and tropical areas (Wong et al., 2020). They rely on carnivory to get nutrients like phosphate and nitrogen. Certain pitcher plants also use animal excrement or leaf litter as a source of nutrients. Nepenthes are commonly referred to as monkey cups or tropical pitcher plants. There are over 140 species of *Nepenthes* distributed in the Old World's tropical regions, including Madagascar, Australia, India, Sri Lanka, South China, Indonesia, Malaysia, and the Philippines (Nuanlaong et al., 2017).

The past few decades have seen a rise in interest in understanding how various traditional or local knowledge systems could enhance current methods for better ecosystem management and conservation on a global scale (Guerrero-Gatica et al., 2020). The species may be more at risk of extinction as a result of several current challenges, both environmental

and anthropogenic. The Species Survival Commission of the International Union for the Conservation of Nature and Natural Resources (IUCN) has listed practically all *Nepenthes* species as endangered in the Philippines, and they are included on the country's list of threatened and endangered plant species (Alejandro et al., 2009). A more profound comprehension of the species' ecology and conservation requirements is needed to maintain the wild populations. For the species to be successfully secured at Botanic Gardens, a more profound comprehension of their needs in its natural habitat would be beneficial (Yudaputra et al., 2023).

According to Bittleston et al. (2018), carnivorous pitcher plants "pitchers" are exquisite examples of convergent evolution. In botany and conservation biology, the assessment of pitcher plant species in the study area has the potential to make a significant contribution. Unique and important to their environments, pitcher plants are important ecological entities.

Even though Bukidnon is known to have a varied range of biodiversity, very few studies have been conducted on pitcher plants. To understand the ecological significance and conservation needs of pitcher plants in the stay area, this study specifically aimed to assess pitcher plant species present in Mt. Kalindog, Kalabugao, Impasug-Ong, Bukidnon, Philippines, with the hope that the researchers could gain valuable insights on the ecology and conservation, preservation, protection, and control of these species, ultimately informing on effective conservation management practices and enhancing our understanding of biodiversity conservation.

MATERIAL AND METHODS

Research design

This study employed a descriptive research design to comprehensively assess the pitcher plant species in Mt. Kalindog, Kalabugao, Impasug-Ong, Bukidnon, Philippines. The descriptive research design allows researchers to delve deeply into the characteristics and ecological interactions of the studied pitcher plants. By employing the opportunistic transect walk method, researchers can systematically observe and document various aspects of the pitcher plant habitat, including species distribution, morphological features, and ecological associations. Furthermore, this research design enables researchers to capture the richness and complexity of pitcher plant ecosystems by incorporating qualitative insights from experts and local guides.

Entry protocol

Before conducting the research, the researchers asked for the approval of the barangay captain or a Prior Informed Consent Certificate (PICC). In addition, the researchers also secured issuance of a Wildlife Gratuitous Permit (WGP), in compliance with RA 9147 of 2001 and its Implementing Rules and Regulations-Joint DENRDA-PCSD Admin, R10 2015-19 was obtained from the Department of Environment and Natural Resources (DENR) Order No. 01, series of 2004 and in compliance with DAO No. 2004-55 to gather specimens for the herbarium for the identification purposes. In addition, a formal letter of request was given to the principal of IBED to seek permission to conduct the pitcher plant assessment outside of the school vicinity. The formal letter outlined the research's objectives, scope, and duration. Lastly, a letter was sent to the Center for Biodiversity Research and Extension in Mindanao (CEBREM) specifically requesting permission to use their time to aid the researchers in examining the types of pitcher plant species present in Mt. Kalindog, Kalabugao, Impasug-Ong, Bukidnon, Philippines.

Study area

This study was conducted in Kalabugao, Impasug-ong, Bukidnon, Philippines (Fig. 1), specifically on Mt. Kalindog, at approximately 8.4575°N latitude and 125.1576°E longitude, Mt. Kalindog is situated on the island of Mindanao, approximately 970 meters above sea level (m asl).

The area's climate is characterized by temperatures ranging from 61 °F to 88 °F throughout the year, with an average relative humidity of 84.12%, creating a consistently moist and temperate environment conducive to flourishing its unique flora and fauna.

Samples

Researchers collected pitcher plants following a

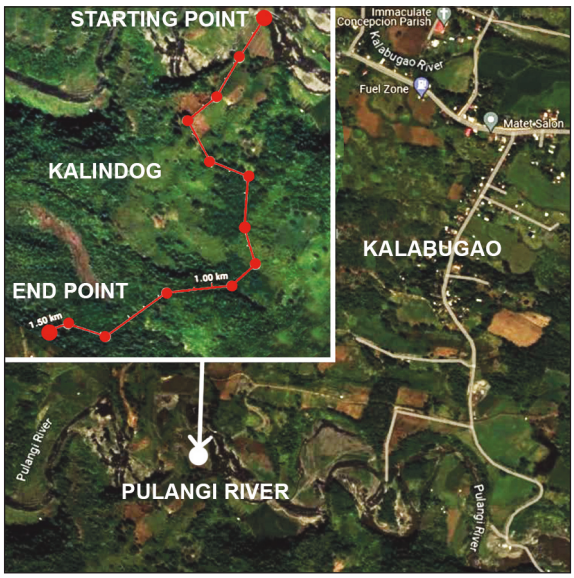

Figure 1. Study Site, Mt. Kalindog, Kalabugao, Impasug-ong, Bukidnon, Philippines.

similar procedure of Coritico & Amoroso (2017). This method involves systematically walking along predetermined paths or transects within the study area to observe and record data related to the pitcher plant species. This employed a method where the researchers could gather comprehensive information on pitcher plant distribution, abundance, and ecological characteristics in the specified location. While collecting the pitcher plant, researchers used apps to document the pitcher plant's location and coordinates. Using sharp scissors, researchers carefully collected specific pitcher plant samples, such as flowers, seeds, leaves, and pitcher's pitcher, without harming the entire plant to ensure its survival. Once the samples were collected, they were carefully put in a plastic bag that had been labeled, providing a safe and secure storage environment. In addition, researchers photographed the parts with a ruler for scale before initiating the drying method.

The collected samples of pitcher plant species were subsequently taken to the Center for Biodiversity Research and Extension in Mindanao (CEBREM) for thorough examination and final identification. Proper identification and classification of the collected pitcher plant species was done in consultation with plant experts, ensuring that every sample was accurately identified. Additionally, a Central Mindanao University (CMU) expert assisted all stages of the sampling process.

RESULTS AND DISCUSSION

Pitcher Plant species

An inventory and assessment of pitcher plant species from Mt. Kalindog, Kalabugao, Impasubong, and Bukidnon (Table 1) revealed three species collected belonging to the genus *Nepenthes* (family Nepenthaceae): *Nepenthes talaandig* Gronem, *Nepenthes truncata* Mcfarl, and *Nepenthes* aff. *merrilliana* Mcfarl.

These species have been found within the main study area, 200 meters away from the roadside, and 300 meters away from it for the whole area of the study.

The species of genus *Nepenthes* have highly specialized foliage, which resembles hollow, water-filled vessels or pitchers, allowing it to lure and catch arthropods and, on rarer occasions, frogs, rodents, and small birds (McPherson 2009; Cheek & Jebb 2013, 2014). Recent explorations in Mindanao and Luzon have increased the number of Nepenthes species found in the Philippines to 52 with the discovery of a new species from Mt. Hamiguitan characterized by ground and upper pitchers with fringed wings on the tendril (Amoroso et al., 2017). There are currently 183 recognized species of *Nepenthes* (POWO, 2023), and their pitcher morphology demonstrates an astounding diversity. About 600 known species of carnivores, including eudicotyledons and monocotyledons, fall into six different angiosperm subclasses (Ellison & Gotelli, 2001).

Diversity and richness of Pitcher Plant species

The diversity of pitcher plant species at the study site was determined using Shannon-Wiener's Diversity Index (Table 2). The result is 0.965, which indicates very low diversity. Margalef's Richness Index of Biodiversity was also used to determine the richness of pitcher plant species. The result is 0.9102, which indicates a low species richness. Such low diversity and species richness of pitcher plants are presumably due to the disturbances in the area.

Gronemeyer et al. (2014) study shows that there are 50 species of Philippine *Nepenthes* after recent discoveries in Mindanao and Luzon. Both domestic and international botanists have thoroughly studied the prominent mountains of Mindanao, but the cen-

Family	Genera	Species	Species Count	Collection no.
NEPENTHACEAE	*Nepenthes*	*N. talaandig* Gronem.	4	RAO 001
NEPENTHACEAE	*Nepenthes*	*N. truncata* Mcfarl.	4	RAO 002
NEPENTHACEAE	*Nepenthes*	*N. merrilliana* Mcfarl.	1	RAO 003

Table 1. List of identified species of Pitcher Plants in Mt. Kalindog, Kalabugao, Philippines.

No. of Species	Shannon W's Index	Margalef's Index
3	**0.965**	**0.9102**

Relative values	Shannon-Wiener Diversity Index (H')	Criteria for Margalef's Index Value	Richness Index values Category
Very High	3.50 and above	R < 2.5	Low species richness
High	3.00–3.49	2.5 > R < 4 R	Medium species richness
Moderate	2.50–2.99	> 4	High species richness
Low	2.0–2.49		
Very Low	1.99 and below		

Table 2. Diversity and richness of Pitcher Plant species in Mt. Kalindog, Kalabugao, Philippines.

tral cordillera, which is made up of the Pantaron, Tangkulan, and Tago ranges, has not been thoroughly studied. Only two locations in this region have been explored: Mt. Kiamo in the Tago Range and a tiny peak in the Pantaron Range near Barangay St. Peter in Malaybalay City, Bukidnon.

In addition, the study of Bauer et al. (2011) studied the trapping mechanisms of *Nepenthes* pitcher plants, revealing why evolution has led to speciation among them. These results shed light on trap diversity in *Nepenthes* and show how specialization to nutrient source initiates speciation and rapid diversification within this genus, thus demonstrating the complex relationship between morphology and evolutionary adaptation in carnivorous plant life.

Conservation status of Pitcher Plant species

IUCN Red lists (2024) and DENR-DAO (2017-11) determined the conservation status of pitcher plant species in the study site. The conservation status of *Nepenthes talaandig* is deemed Vulnerable, indicating it faces a high risk of extinction due to habitat loss and exploitation. *Nepenthes truncata*, on the other hand, is classified as endangered, suggesting it is at a heightened risk of extinction in the wild. Similarly, *N.* aff. *merrilliana* is also listed as Vulnerable, highlighting its vulnerability to threats such as habitat degradation and climate change.

In the study of Lagunday & Amoroso (2019), the endangered pitcher plant species result from habitat loss, legal poaching, and destruction of the environment. These plants are sensitive to environmental changes because they frequently have particular habitat needs. To preserve these intriguing plants and their environments, conservation efforts are essential. Particularly, in this study (Lagunday & Amoroso, 2019) was cited a kind of tropical pitcher plant indigenous to the Philippines called *N. cabanae* Lagunday et Amoroso, 2019 from central Mindanao; this species was assessed as Critically Endangered.

Moreover, the assessment of traditional and local knowledge has grown recently due to its vital responsibilities for improving conservation and management practices. Most tribal groups are un-

Figures 2–10. Collected Pitcher Plant species in Mt. Kalindog, Kalabugao, Impasug-ong, Bukidnon (Philippines). Figs. 2–5: *Nepenthes talaandig*. Fig. 6: *Nepenthes* aff. *merrilliana*. Figs. 7–10: *Nepenthes truncata*.

documented on these arguments, and traditional plant resources are unexplored. For example, Dapar & Victor (2022) conducted a study on the Manobo tribe, one of the most populated and diverse tribal communities in the Philippines, including the secluded Tigwahanon-Manobo community in Mt. Malimumu, San Fernando, Bukidnon which provided important eth-nobotanical information and conservation status of plants in this area.

Ecological importance of Pitcher Plant species

Pitcher plants contribute to ecosystem biodiversity by offering different ecological niches for var-

Pitcher Plant Species	Conservation Status
Nepenthes talaandig Gronem.	VULNERABLE
Nepenthes truncata Mcfarl.	ENDANGERED
Nepenthes aff. *merrilliana* Mcfarl.	VULNERABLE

Table 3. Conservation status of pitcher plant species found in Mt. Kalindog, Kalabugao.

ious microorganism groups. Their capacity to flourish in harsh settings demonstrates tenacity and adaptability of these plants. In addition, the Philippines is the main center of diversity of the genus *Nepenthes*, the largest genus of carnivorous plants. These species can trap and digest also small amphibians and even mammals (Gronemeyer et al., 2014).

Pitcher plants contribute to improving the environment in which they live and perform bioremediation. Certain organisms can flourish in contaminated or deteriorated surroundings, taking up heavy metals and other harmful substances from the ground or water. Pitcher plants may be used to clean up contaminated areas, restore ecosystems, and enhance environmental health by using their inherent detoxifying capabilities. This emphasizes their ability to help mitigate the effects of human activity on the environment and promote sustainable development. Low photosynthetic capacity, nitrogen efficiency, chlorophyll, and nitrogen concentration of *Nepenthes* pitchers were found, together with a set of important features. Dual use of leaves for photosynthesis and nutrient gain can decrease photosynthetic efficiency in carnivorous plants (Pavlovic et al., 2007).

To further improve local biodiversity, the pitcher plants microhabitats sustain various organism communities, such as bacteria, protozoa, and small invertebrates. In addition, certain pitcher plants produce lovely blooms that attract pollinators and aid in the growth of other plant species within their environments. Carnivorous plants that feed on insects, however, run the risk that increasing trapping effectiveness might reduce reproductive success by capturing pollinators. Such a pollinator–prey conflict might be essential in evolving trap features (Jürgens et al., 2015).

The distinctive roles pitcher plants serve in the nutrient cycle, biodiversity, and pest control make them ecologically significant. These carnivorous plants catch and consume insects to control insect populations and preserve ecological balance. They participate in the nutrient cycle by degrading the insects they catch and help other plants to access these vital nutrients (Saganová et al., 2018).

CONCLUSIONS

The results revealed a total of three (3) species overall that differ under one (1) family and one (1) genus. The species are *Nepenthes talaandig* Gronem., *Nepenthes truncata* Mcfarl., and *Nepenthes* aff. *merrilliana* Mcfarl. The most common pitcher plant found from different pitcher plant assessments was *Nepenthes talaandig* Gronem.

This study found the species in some habitats, such as soil and tree branches. All pitcher plants found were already on the records of pitcher plants in the Philippines, and no new species were found. Due to the disturbance of the area, pitcher plant diversity and species richness were relatively low. Among the pitcher plants found, one was discovered to be “Endangered”. Two pitcher plants found were “Vulnerable” (Table 3). Prior studies have clarified the crucial responsibilities pitcher plants play in the ecosystems in the area, including their involvement in attracting insects and cycling nutrients. The pitcher plants in Mt. Kalindog, Kalabugao, Impasug-ong, and Bukidnon, Philippines, play an essential ecological function in nutrient cycling, acting as natural pest controls and adapting to nutrient-poor settings. They sustain biodiversity, control pest populations, and give different species habitats. Pitcher plant preservation is essential to preserving biodiversity and the balance of ecosystems. For long-term ecological stability, pitcher plants and their habitats must be protected through conservation initiatives.

For all these reasons it is necessary to conclude with some recommendations.

It is recommended to undertake more regular, extensive, and comprehensive investigations to thoroughly examine all pitcher plant species in the area and maximize their exploitation, given the mountain’s significant potential as a healthy habitat for pitcher plants.

It is also suggested to conduct enhanced investigations and establish additional sampling plots in various regions of Mt. Kalindog, Kalabugao, Impasug-Ong, and Bukidnon, Philippines, to better understand the spatial distribution of pitcher plant species.

More studies are recommended about the biodiversity and conservation status of the pitcher plant species in Kalabugao, Impasug-ong, and Bukidnon due to some species of pitcher plants being extinct. Conservation initiatives are crucial for the long-term ecological stability of pitcher plants in the study area; these plants are vital for nutrient cycling, maintaining biodiversity, and strengthening ecosystem resilience.

It is recommended that conservation efforts should target habitat preservation and address threats like habitat destruction, pollution, and illegal harvesting.

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REFERENCES

Alejandro G.J.D., Madulid R.S. & Madulid D.A., 2009. The utility of internal transcribed spacer (NRDNA) sequence data for phylogenetic reconstruction in endemic Philippine *nepenthes* L. (Nepenthaceae). The Philippine Scientist, 45(0). https://doi.org/10.3860/psci.v45i0.994

Amoroso B., Lagunday E., Coritico P. & Colong D., 2017. *Nepenthes alfredoi* (Caryophyllales, Nepenthaceae) is a new species of pitcher plant from Mindanao, Philippines. Association of Systematic Biologists of the Philippines, 11(2). https://doi.org/10.26757/pjsb.2017b11018

Bauer U., Clemente C.J., Renner T. & Federle,W., 2011. Form follows function: morphological diversification and alternative trapping strategies in carnivorous *Nepenthes* pitcher plants. Journal of Evolutionary Biology, 25: 90–102. https://doi.org/10.1111/j.1420-9101.2011.02406.x

Bittleston L.S., Wolock C.J., Yahya B.E., Chan X.Y., Chan K.G., Pierce N.E. & Pringle A., 2018. Convergence between the microcosms of Southeast Asian and North American pitcher plants. eLife, 7. https://doi.org/10.7554/elife.36741

Britannica Encyclopaedia, 2024. Pitcher plant. Encyclopedia Britannica. https://www.britannica.com/plant/pitcher-plant

Cheek M. & Jebb M., 2013. Recircumscription of the *Nepenthes alata* group (Caryophyllales: Nepenthaceae), in the Philippines, with four new species. European Journal of Taxonomy. 69: 1–23.

Cheek M. & Jebb M., 2014. Expansion of the Nepenthes alata group (Nepenthaceae), Philippines, and descriptions of three new species. Blumea-Biodiversity, Evolution and Biogeography of Plants, 59: 144-145.

Coritico F. P. & Amoroso V.B., 2017. A rapid assessment of vascular plants in Mt. Kiamo, Mindanao, Philippines. Asian Journal of Biodiversity, 8. https://doi.org/10.7828/ajob.v8i1.998

Dapar M.L.G. & Victor A., 2022. Ethnobotanical study and conservation status of plants used by the Tigwahanon-Manobo in Mt. Malimu, San Fernando, Bukidnon, Philippines. Journal of Tropical Life Science, 12: 163–172. https://doi.org/10.11594/jtls.12.02.02

DENR - DAO, 2017. Department of Environment and Natural Resources Administrative Order, No. 2017-11. Updated National List of Threatened Philippine Plants and theirs categories.

Ellison A.M. & Gotelli N.J., 2001. Evolutionary ecology of carnivorous plants. Trends in Ecology and Evolution, 16: 623–629. https://doi.org/10.1016/s0169-5347(01)02269-8

Gronemeyer T., Coritico F.P., Wistuba A., Marwinski D., Gieray T., Micheler M., Mey F.S. & Amoroso V.B., 2014. Four New Species of *Nepenthes* L. (Nepenthaceae) from the Central Mountains of Mindanao, Philippines. Plants, 3: 284–303. https://doi.org/10.3390/plants3020284

Guerrero-Gatica M., Mujica M.I., Barceló M., Vio-Garay M.F., Gelcich S. & Armestó J.J., 2020. Traditional and Local Knowledge in Chile: Review of Experiences and Insights for Management and Sustainability. Sustainability, 12: 1767. https://doi.org/10.3390/su12051767

IUCN Red List of Threatened Species, 2024. https://www.iucnredlist.org/

Jürgens A., Witt T., Sciligo A.R. & El-Sayed A.M., 2015. The effect of trap color and trap-flower distance on prey and pollinator capture in carnivorous *Drosera* species. Functional Ecology, 29(8), 1026–1037. https://doi.org/10.1111/1365-2435.12408

Lagunday E. & Amoroso B., 2019. *Nepenthes cabanae* (Caryophyllales, Nepenthaceae), a new species of pitcher plant from central Mindanao, Philippines. Philippine Journal of Systematic Biology, 13: 39–45. https://doi.org/10.26757/pjsb2019a13005

McPherson S., 2009. Pitcher Plants of the Old World 1st ed.; Redfern Natural History, GB: Poole, UK.

Nuanlaong S., Nuanlaong T. & Suraninpong P., 2017. A new classification of Thailand's *Nepenthes* species by genetic analysis of AFLP markers. Wu-th. https://www.academia.edu/19798694/A_New_Classification_of_Thailand_s_*Nepenthes*_Species_by_Genetic_Analysis_of_AFLP_Markers?email_work_card=view-paper

Pavlovič A. & Kocáb O., 2021. Alternative oxidase (AOX) in the carnivorous pitcher plants of the genus *Nepenthes*: What is it good for? Annals of Botany, 129: 357–365. https://doi.org/10.1093/aob/mcab151

Pavlovič A., Masarovičová E. & Hudák J., 2007. Carnivorous syndrome in Asian pitcher plants of the genus *Nepenthes*. Annals of Botany, 100: 527–536. https://doi.org/10.1093/aob/mcm145

Saganová M., Bokor B., Stolárik T. & Pavlovič A., 2018. Regulation of enzyme activities in carnivorous pitcher plants of the genus *Nepenthes*. Planta, 248: 451–464. https://doi.org/10.1007/s00425-018-2917-7

Wong C., Ling Y.S., Wee J.L.S., Mujahid A. & Müller M., 2020. A comparative UHPLC-Q/TOF–MS-based eco-metabolomics approach reveals temperature adaptation of four *Nepenthes* species. Scientific Reports, 10(1). https://doi.org/10.1038/s41598-020-78873-3

Yudaputra A., Astuti I.P., Handayani T., Siregar H.M., Robiansyah I., Wang L., Rachmadiyanto A.N., Purnomo D.W., Kurniawan V., Isnaini Y., Damayanti F., Zulkarnaen R.N., Witono J.R., Fijridiyanto I.A., Yuzammi, Hidayat A., Siregar M., Munawaroh E., Wardhani F.A. & Cropper W.P., 2023. Comprehensive approaches for assessing extinction risk of endangered tropical pitcher plant *Nepenthes talangensis*. PLOS ONE, 18(8), e0289722. https://doi.org/10.1371/journal.pone.0289722