
EXPLORATION AND INVENTORY OF ARACEAE AT MT. BAGALBAL, PHILIPPINES

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Abstract

This study investigated the taxonomy and distribution pattern of Araceae species at Mt. Bagalbal, Sitio Migtulod, Barangay Mt. Nebo, Valencia City Bukidnon, Philippines as well as their ecological and conservation status. Araceae are highly diverse in life form at Mt. Bagalbal which comprises of thirteen (13) species under three (3) subfamilies, with Monsteroideae having the greatest number of species, followed by Aroideae and Pothoideae as the lowest. The Araceae flora from Mt. Bagalbal's species distribution pattern revealed a distinct and unambiguous dispersal of the majority of the angiosperms. Out of thirteen (13) species collected, two (2) species were ecologically classified as both endemic and native in the Philippines, eight (8) species were native and one (1) species was naturalized. In terms of conservation status, one (1) species has no data because it was not identified, nine (9) species were data deficient (DD), one (1) is Least Concern (LC), one (1) is Near Threatened (NT) and one (1) is vulnerable (VU) and it is the *Alocasia zebrina*.

Keywords: araceae, conservation status, distribution pattern, ecological status.

INTRODUCTION

The Philippines is one of the world's 17 mega-diverse countries, containing two-thirds of the Earth's biodiversity and 70 to 80% of the world's plant and animal species due to its geographical isolation and diverse habitat. Many of the archipelago's islands are thought to have a very high level of endemism in terms of both land and animal species, with at least 25 genera of plants and 50% of terrestrial wildlife represented (Biodiversity Philippine Clearing House Mechanism, 2022). From 1997 to 2016, 170 species of wildlife flora have been discovered and the number is still increasing with studies conducted by the academe, researchers including the study on Araceae.

Araceae is a family of 144 genera and 3,645 published species, worldwide in distribution (Boyce & Croat, 2011; Croat, 1979). It is one of the most ecologically and structurally diverse family of monocots occupying a wide variety of habitats and display a notable diversity of life forms from geophytes, climbers, epiphytes, helophytes to free-floating aquatics (Croat, 1998; Grayum, 1990; Mayo et al., 1997; Medecilo & Madulid,

2013). In the Philippines, it is represented by 25 genera and ca.150 species, with *Alocasia* having the largest number of species (Medecilo & Madulid, 2013).

Members of the Araceae are highly diverse in life forms, leaf morphology, and inflorescence characteristics. Life forms range submerged or free-floating aquatics to terrestrial (sometimes tuberous), and to epiphytic or hemiepiphytic plants or climbers. Leaves range from simple and entire to compound and highly divided, and may be basal or produced from an aerial stem. The family Araceae is defined by bearing small flowers on a fleshy axis (spadix) subtended by a modified leaf (spathe). There is much variation on this theme.

The research of Araceae diversity in Mt. Bagalbal is subject which in general has not been studied critically. Mount Bagalbal in Sitio Migtulod, Barangay Mt. Nebo of Valencia City, Bukidnon, Philippines is one of the important conservation areas including to species of Araceae. However, the main threat to the long-term survival of many Araceae is the loss and reductions of quality natural habitats, especially in the rain forest regions of Asia.

Thus, this study assessed the different Araceae species present at Mt. Bagalbal, Sitio Migtulod, Barangay Mt. Nebo, Valencia City, Bukidnon, Philippines and to contribute important scientific data in monitoring the species diversity and conservation management in the area.

MATERIALS AND METHODS

A letter of request was sent to the local government unit of Mt. Nebo, Valencia City, for the approval of the fieldwork and submission of informed consent before the conduct of the study. An Entry Protocol from the City Government of Valencia, Bukidnon, Philippines, followed this. Likewise, meetings with the local guides were conducted.

The study was conducted in Mt. Bagalbal, Sitio Migtulod, Brgy. Mt. Nebo, Valencia City, Bukidnon, is approximately 7.9728, 124.9866, or 70 56' 27" N and 124 05' 14" E. The peak is 1 226 meters above sea level and consists of trees, shrubs, herbs, and weeds.

An inventory and assessment of the Araceae species was done through alpha taxonomy. This was done by using the floristic survey method wherein all the Araceae species seen or collected along the accessible trail and within 5 meters sideways from the main trail was listed down.

The collected specimens of Araceae species were placed in a plastic bag with field label data: species name, local name, abiotic environment, altitude, collection number and date of collection. These were pressed using newspaper and presser and then air dried and placed in cardboard and were properly labeled for herbarium specimens.

Identification of the specimens were based on taxonomic characters and identified using standard manuals, books, keys, checklist, monographs and related literature as well as consultation from a specialist on Araceae.

Coordinates were measured using Altimeter ® software and tallied during the collection of each liverwort sample. This information was then forwarded to the GeoMin of the College of Forestry, CMU for the mapping of the species distribution pattern of the araceae flora. Photographs were made from the actual observations in the field as

Ecological status of Araceae was determined using the published articles on Co’s Digital Flora of the Philippines (Pelsers et al., 2011-onwards) and it can be classified as endemic, native or naturalized.

Endemic are native species that only grow in one location in the world (Dempsey, 2023). Native plants are species that have originated and evolved in a local area over a long period of time. Species that are native are described in terms of their geographic origin (Dempsey, 2023). Naturalized are plants that have been able to persist in an ecosystem over time without human assistance (Dempsey, 2023).

Conservation status of Araceae was determined using the available online data on International Union of Conservation of Nature (IUCN,2023) and it can be classified as shown in Figure 1.

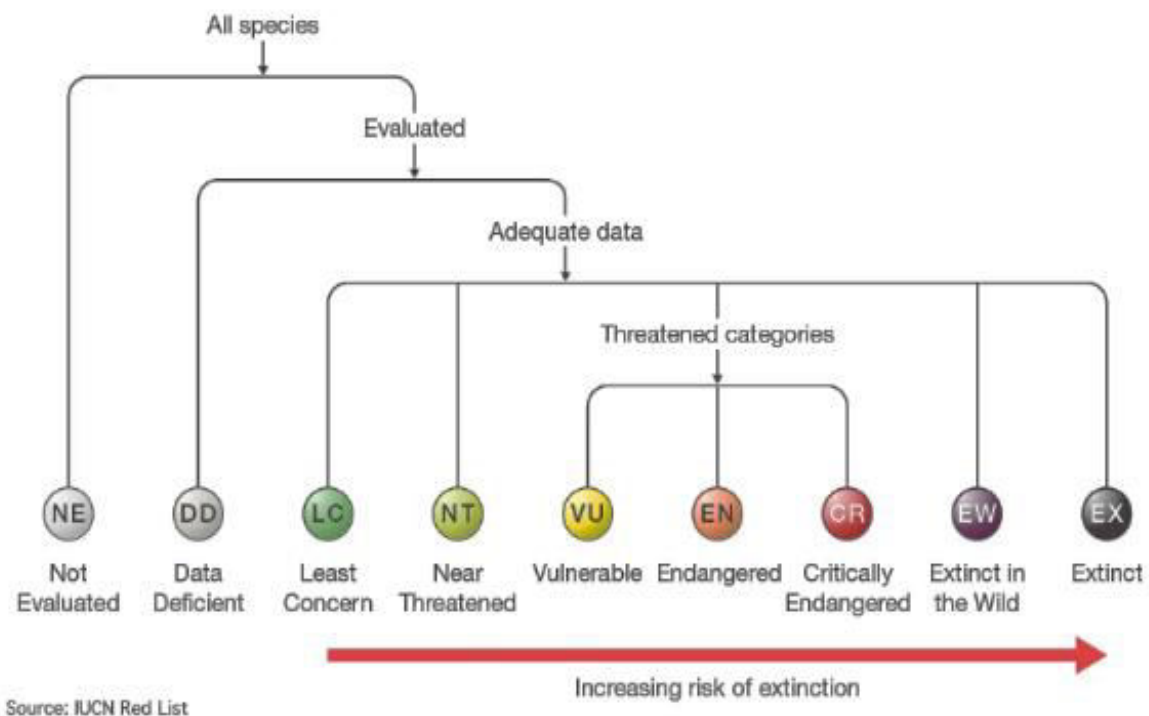


Figure 1. Structure of the IUCN Red List Categories

RESULTS AND DISCUSSION

Description, Identification and Classification of Araceae Species

Araceae is the third largest family of monocots and is divided into eight (8) sub-families, all of which had evolved before the K/T boundary (Cretaceous/Tertiary) and is one of the oldest members of the angiosperms (Croat, 2019; Hesse & Zetter, 2007; Nauheimer et al., 2012; Stevens, 2020).

Further, members of the Araceae are highly diverse in life forms, leaf morphology, and inflorescence characteristics. Life forms range submerged or free-floating aquatics to terrestrial (sometimes tuberous), and to epiphytic or hemiepiphytic plants or climbers (Nugroho & Santika, 2008). Leaves range from simple and entire to compound and highly divided, and may be basal or produced from an aerial stem. The family Araceae is defined by bearing small flowers on a fleshy axis (spadix) subtended by a modified leaf (spathe). There is much variation on this theme.

The description and identification of each sub-family, genera and species were done through proper visual observation of its morphological characteristics in their natural setting during the field sampling as well as during the preparation of the specimens for herbarium.

Co's Digital Flora of the Philippines of Pelsner et al. (2011 onwards), International Aroid Society (2020), Croat (2019) and other related literature were used for proper identification of the samples. All the samples collected were easily identified and verified by an Aroid Expert from Central Mindanao University.

The Araceae flora were systematically described using the morphological characteristics:

SUB-FAMILY AROIDEAE *Alocasia zebrina* Schott ex van Houtte



Figure 2. Morphology of *Alocasia zebrina* Schott ex van Houtte (A) Plant habit; (B) Juvenile; (C) Inflorescence; (D) Fruit; (E) Collected sample

Description: terrestrial herb with adventitious roots; zebra-striped pattern on petiole; arrow-shaped leaves are deep green, and have a showy, glossy texture.

Alocasia maquilingensis

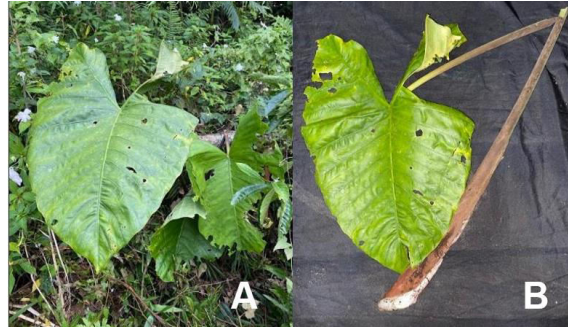


Figure 3. Morphology of *Alocasia maquilingensis*. (A) Plant habit; (B) Leaf

Description: broad green leaf blade, ovato-sagittate in shape, petiole is around 1-meter long and light purple to brown in color

Schismatoglottis calyptrata Zoll. & Mor.



Figure 4. Morphology of *Schismatoglottis calyptrata* Zoll. & Mor. (A) Plant habit; (B) Inflorescence; (C) Collected sample

Description: a stoloniferous herb; leaf blades are green in color (adaxial), pale green (abaxial) and cordate to sagittate in shape; inflorescence is a spadix and it white in color.

SUB-FAMILY MONSTEROIDEAE

Amydrium medium



Figure 5. Morphology of *Amydrium medium*. (A) Plant habit; (B) juvenile leaf structure

Description: hemiepiphyte plant with medium sized cordate (heart-shaped) leaves with fenestrations's (holes) and lobed (cuts); adaxial is dark green/evergreen and abaxial is glossy. Juvenile leaves have no holes and cuts.

Colocasia esculenta L. Schott

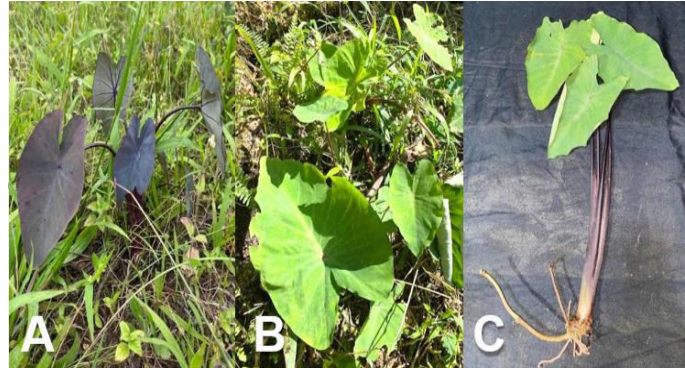


Figure 6. Morphology of *Colocasia esculenta* L. Schott. (A) Plant habit; (B) leaf structure; (C) Collected sample

Description: herbaceous with long thick and fleshy petiole varies from green to purple in color; lamina or leaf blade is large, purple and green in color, triangular or arrow-head in shape

Epipremnum pinnatum



Figure 7. Morphology of *Epipremnum pinnatum*. (A) Plant habit; (B) Spadix; (C) Collected sample

Description: hemiepiphytic with dark green adaxial, glossy light green abaxial, arrow-shaped leaf blade with entire margins; inflorescence is spadix with fruit and white in color.

Rhaphidophora elmeri



Figure 8. Morphology of *Rhaphidophora elmeri*. (A) Plant habit; (B) Collected sample

Description: juvenile plant with glossy green leaf blade; adxial is dark glossy green, abaxial is lighter glossy green.

Rhaphidophora korthalsaii



Figure 9. Morphology *Rhaphidophora korthalsaii* (A) Plant habit; (B) Collected sample

Description: hemiepiphyte plant, lanceolate with truncate base of leaf blade; slightly glossy to dark green adaxial leaf.

Rhaphidophora perkinsiae



Figure 10. Morphology *Rhaphidophora perkinsiae*. (A) Plant habit; (B) Spadix(C)Collected sample

Description: Epiphytic plant with glossy dark green adaxial, light green abaxial surface of ovate leaf blade; inflorescence is present; spadix with fruit is present.

Rhaphidophora sp.1



Figure 11. Morphology *Rhaphidophora sp.1*. (A) Plant habit; (B) Collected sample

Description: lanceolate leaf blade with light to dark green adaxial leaf, light green abaxial; flower and fruit are absent.

Scindapsus pictus



Figure 12. Morphology *Scindapsus pictus*. (A) Plant habit; (B) Collected sample

Description: climber with attractive leaves of green, variegated with silver blot; leathery feeling of ovate leaves.

Xanthosoma sagittifolium.



Figure 13. Morphology *Xanthosoma sagittifolium*. Plant habit

Description: herbaceous with around 1 meter long, fleshy petiole; dark green, sagittate (arrow shaped) lamina with distinctive leaf veins that starts the midrib and wavy margins.

SUB-FAMILY POTHOIDEAE
Pothoidium lobbianum Schott



Figure 14. Morphology *Pothoidium lobbianum* Schott. (A) Plant habit; (B) Collected Sample

Description: epiphytic with dark green unifoliate leaf blade arrange distichously; flattened petiole, resembling blade.

Mt. Bagalbal of Sitio Migtulod, Barangay Mt. Nebo, Valencia Bukidnon included 21 numbers of collections, 9 genera and 13 species of Araceae (Table 1 and 2). Those collections belong to 3 sub-families (Aroideae, Monsteroideae and Pothoideae). One species of Rhapsidophora was not identified completely up to species level because there was no inflorescence during the time of investigation.

Table 1. List of Number of Sub-family, Genera and Species of Araceae

Sub-family	Genera	Species
3	9	13

As shown in Table 2, the Araceae species collected at Mt. Bagalbal, revealed that subfamily Monsteroideae is the most species rich among the three subfamilies of Araceae with nine (9) species namely: *Amydrium medium* (Zoll. & Moritzi) Nicolson, *Colocasia esculenta* L. Schott, *Epipremnum pinnatum* (L.) Engl., *Rhaphidophora elmeri* Engl. & K. Krause, *Rhaphidophora korthalsaii* Schott, *Rhaphidophora perkinsiae* Engl., *Rhaphidophora sp.1*, *Scindapsus pictus* Hassk. and *Xanthosoma sagittifolium* (L.) Schott. This is followed by subfamily Aroideae with three (3) species, namely: *Alocasia zebrina* Schott, *Alocasia maquilingensis* Merr and *Schismatoglottis calyptrata* Zoll. & Mor. The subfamily Pothoideae has only one (1) species which is *Pothoidium lobbianum* Schott.

Table 2. The Araceae species collected at Mt. Bagalbal

Subfamily	Genera	Species	Elevation (masl)
<i>Aroideae</i>	<i>Alocasia</i>	<i>zebrina</i> Schott	1271 - 1313
<i>Aroideae</i>	<i>Alocasia</i>	<i>maquilingensis</i> Merr	1302
<i>Aroideae</i>	<i>Schismatoglottis</i>	<i>calyptrata</i> Zoll. & Mor.	1213 - 1253
<i>Monsteroideae</i>	<i>Amydrium</i>	<i>medium</i> (Zoll. & Moritzi) Nicolson	1304
<i>Monsteroideae</i>	<i>Colocasia</i>	<i>esculenta</i> (L.) Schott	1210, 1299
<i>Monsteroideae</i>	<i>Epipremnum</i>	<i>pinnatum</i> (L.) Engl.	1230 - 1253
<i>Monsteroideae</i>	<i>Rhaphidophora</i>	<i>elmeri</i> Engl. & K. Krause	1240 - 1304
<i>Monsteroideae</i>	<i>Rhaphidophora</i>	<i>korthalsaii</i> Schott	1247 - 1264
<i>Monsteroideae</i>	<i>Rhaphidophora</i>	<i>perkinsiae</i> Engl.	1313
<i>Monsteroideae</i>	<i>Rhaphidophora</i>	<i>sp.1</i>	1312
<i>Monsteroideae</i>	<i>Scindapsus</i>	<i>pictus</i> Hassk.	1293
<i>Monsteroideae</i>	<i>Xanthosoma</i>	<i>sagittifolium</i> (L.) Schott	1200
<i>Pothoideae</i>	<i>Pothoidium</i>	<i>lobbianum</i> Schott	1290

Aroids, generally love reasonable humidity, shady environment (Hilder, 2020). The Araceae species that can be found easily were *Schismatoglottis calyptrata* Zoll. & Mor. and *Alocasia zebrina*. These species can be found in Mt. Bagalbal which have many river flows. These species usually grow at tropical humid forest floor, limestone and river flows (Backer and Bakhuizen, 1965; Mayo et al., 1997; Tsukaya et al., 2004). *S. calyptrata* generally grows in lowland and lower mountain rain forest (Hay, 1996).

Araceae Species Distribution at Mt. Bagalbal

Araceae abundance is dependent on available water and atmospheric humidity. In the humid tropics, the Araceae are most diverse and have many variety of life forms as hemiepiphytes, epiphytes, geophytes, rheophytes, submerged or periodically submerged aquatics, helophytes and free floating aquatics, with flowering and fruiting varying by species and pollination and dispersal facilitated by wind, water, insects, animals and humans (Mayo et al., 1997).

In determining the species distribution, data that contains the species name of each of the collected specimens together with its respective coordinates – latitude and longitude – were used.

The distribution of Araceae species at Mt. Bagalbal was determined using the QGIS® application. Quantum Geographic Information System (QGIS) is an open-source software that was utilized to create, edit, visualize, analyze, and publish geospatial information such as that of species distribution. In the context of this research, QGIS from the Center of Geomatics Research and Extension in Mindanao (GeoMin) of the College of Forestry, Central Mindanao University, Philippines was utilized so that the quality and assurance of the data will be secured as it was confirmed by experts and qualified technicians.

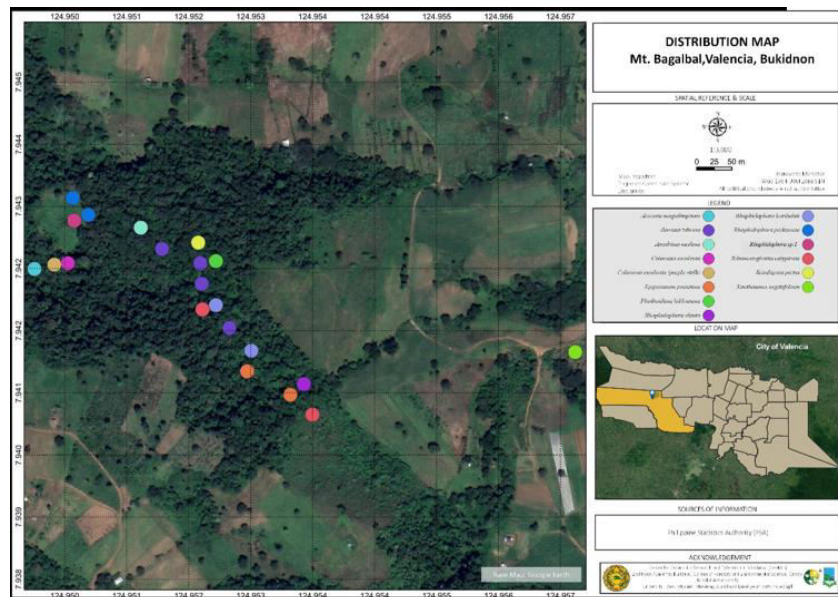


Figure 15. Species Distribution Pattern of Araceae species at Mt. Bagalbal

As observed from the data shown on Figure 15, the species distribution pattern of Araceae from Mt. Bagalbal showed a clear dispersal of the Aroids. *A. zebrina* were found to be inhabiting three different coordinates as well as *S. calytrata* and *C. esculenta*. *R.*

korthalsii, R. elmeri, R. perkinsiae were distributed in to two different and unique coordinates. Aroids that were limitedly distributed: P. lobbianum, A. medium, A. maquilingensis. and S. pictus

The entire Araceae collections were found between 1200 m to 1305 m above sea level. As observed during the collection, Araceae distribution decreases gradually with the increasing altitudes. This is consonant with the findings of Zulhazman (2020) and Sungkajanttranon et al. (2018). Sungkajanttranon et al. (2018) added that there are factors that can affect the distribution of Araceae, such as the percentage of sand, silt, and clay, soil pH, organic matter (OM), where the soil pH tended to decrease with increased elevation. In contrast, OM tended to increase with elevation.

Ecological and Conservation Status of Araceae species at Mt. Bagalba

The Araceae is one of the most botanically diverse families within the monocotyledons. Over 800 species of Araceae are of economic importance (ornamental, edible, medicinal). For example, about 10% of the world population consumes taro corms (rhizomes of *Colocasia esculenta* (L.) Schott), the most cultivated species of Araceae. It is a foodstuff and foodstock for animals (Pedralli, 2002). Most species of Araceae are ornamental plants the most important of which are from the genera *Anthurium* Schott, *Philodendron* Schott, *Dieffenbachia* Schott, *Monstera* Adams and *Zantedeschia* Spreng. (Pedralli, 2002).

In the Amazon region, many species of Araceae are used for medicinal purposes, including the treatment of malaria and associated fevers and the most important species are from the genus *Philodendron* Schott. Species of Araceae traditionally used for malaria, fevers, headaches and liver disorders are reviewed. Relevant literature that reveals the antimalarial potential of extracts and isolated compounds, including median inhibitory concentrations (IC₅₀) against *Plasmodium falciparum*, are also reviewed.

The determination of the conservation status of the Aroids is of prime importance to provide significant information for conservation and protection purposes. It would also be a great importance so that government agencies and non-government organization will plan safety measures to conserve these plants as well as the environment.

Conservation status of Araceae species was determined using the available data on International Union of Conservation of Nature (IUCN, 2023) and Co's Digital Flora of the Philippines of Pelsner et al. (2011 onwards) and articles of Croat (1997) as well as the DENR Administrative Order (2017).

As gleamed in Table 3, Araceae species were classified as to their ecological and conservation status. Out of 13 species, *A. zebrina*, *A. maquilingensis* and *R. emeri* were endemic and native in the Philippines. Eight (8) species were also native in the Philippines. While *X. sagittifolium* is a naturalized species in the Philippines.

In terms of conservation status, nine (9) species have data deficient (DD) and one (1) has no data because it was not identified. *Colocasia esculenta* is evaluated as least concern (LC) because the specific species is still plentiful in the wild. The near threatened (NT) species is *R. korthalsaii* Schott which is vulnerable to endangerment in the near future, but it does not currently qualify for the threatened status.

Most of the Philippine *Alocasia* species are of ornamental or of potential ornamental value and are presently threatened by over collection and habitat destruction (Medecilo & Madulid, 2013). There are several species of Philippine *Alocasia* that are restricted in their distribution and are known only from few natural calamities today. They are presently threatened in various degrees and in need of protection. However, they are not in the cites, whereas *A. zebrina* is included in the National List of Threatened Species of the Department of Environment and Natural Resources (DENR) and classified as vulnerable (VU).

Table 3. Ecological and conservation status of Araceae at Mt. Bagalbal

Species		Ecological Status	Conservation Status
<i>Alocasia</i>	<i>zebrina</i> Schott	Endemic, Native	VU
<i>Alocasia</i>	<i>maquilingensis</i> Merr	Endemic, Native	DD
<i>Schismatoglottis</i>	<i>calyptrata</i> Zoll. & Mor.	Native	DD
<i>Amydrium</i>	<i>medium</i> (Zoll. & Moritzi) Nicolson	Native	DD
<i>Colocasia</i>	<i>esculenta</i> (L.) Schott	Native	LC
<i>Epipremnum</i>	<i>pinnatum</i> (L.) Engl.	Native	DD
<i>Rhaphidophora</i>	<i>elmeri</i> Engl. & K. Krause	Endemic, Native	DD
<i>Rhaphidophora</i>	<i>korthalsaii</i> Schott	Native	NT
<i>Rhaphidophora</i>	<i>perkinsiae</i> Engl.	Native	DD
<i>Rhaphidophora</i>	<i>sp.1</i>	-	-
<i>Scindapsus</i>	<i>pictus</i> Hassk.	Native	DD
<i>Xanthosoma</i>	<i>sagittifolium</i> (L.) Schott	Naturalized	DD
<i>Pothodium</i>	<i>lobbianum</i> Schott	Native	DD

The plants that were classified as "vulnerable," "near threatened," and "least concern" suggest that these species face significant threats to their survival and are likely to become extinct soon. The population of these animals may be in danger due to habitat loss, excessive logging, climate change, or other factors. On the other side, 'data deficient' refers to species for whom there is not enough data to evaluate the state of their conservation. Due to the difficulty in identifying specific threats to these species and formulating an acceptable conservation status, this knowledge gap may hinder conservation efforts.

The data on the Araceae species' conservation condition at Mt. Bagalbal, Sitio Migtulod, Barangay Mt. Nebo, Valencia City, Bukidnon, Philippines, is alarming and

demands that the community and those who live nearby take prompt conservation and protection measures. Some species found in the area have conservation statuses of "vulnerable," "near threatened," and "least concern," which suggests that the area still has the capacity to support the delicate biology of these plants.

According to Zulhazman (2020), the main threat to the Araceae is the loss and reduction of quality in their natural habitats. Some species are highly adapted to specific environments and cannot survive under altered conditions. Thus, the removal of tropical forests may eliminate most of terrestrial, climber, and epiphyte species, since many of them require a shaded environment.

CONCLUSION

There were thirteen (13) species identified that belonged to three (3) subfamilies of Araceae. A total of nine (9) species under Monsteroideae, three (3) for Aroideae and only one (1) for Pothoideae.

The Araceae flora from Mt. Bagalbal's species distribution pattern revealed a distinct and unambiguous dispersal of the majority of the angiosperms. Three (3) species were found to be inhabiting three different coordinates. Three (3) species were distributed in to two different and unique coordinates. There were three (3) aroid species that were limitedly distributed.

Out of thirteen (13) species collected, two (2) species were ecologically classified as both endemic and native in the Philippines, eight (8) species were native and one (1) species was naturalized. In terms of conservation status, one (1) species has no data because it was not identified, nine (9) species were data deficient (DD), one (1) LC, one (1) NT and one (1) VU. It was evaluated as least concern (LC) because the specific species is still plentiful in the wild. The near threatened (NT) species is vulnerable to endangerment in the near future, but it does not currently qualify for the threatened status. Vulnerable (VU) species possess a very high risk of extinction as a result of rapid decrease in population.

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