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Botanical data for the conservation of the Victoria-Anepahan Mountain Range, Palawan, Philippines

Jaybie S. Arzaga^{1,2,*} and Maria Celeste N. Banaticla-Hilario¹

¹Plant Biology Division, Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines Los Baños

²Department of Biology, College of Sciences, Palawan State University

*Corresponding Author: jsarzaga@up.edu.ph

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ABSTRACT

The Victoria-Anepahan Mountain Range (VAMR) in Palawan, Philippines, is a botanically significant yet threatened mountain range that harbors a rich diversity of plant species. This paper reviewed the botanical studies conducted in VAMR, collated published species data and produced a consolidated and updated species list of plants in VAMR. Analysis of temporal and spatial distribution of botanical studies showed that research activities have been sporadic, with periods of high activity followed by gaps. The dominant focus has been on new species discovery, accounting for over 70% of the studies. In contrast, floristic surveys and ethnobotanical studies have been relatively limited. Consolidation of data from 18 studies resulted in a list comprised of 255 species representing 187 genera and 93 families. The findings revealed a significant number of endemic plant species (91), many of which are assessed as threatened (51). Critical knowledge gaps were identified, such as the lack of comprehensive floristic surveys in specific areas in VAMR, and insufficient species threat assessments. The geographical coverage of plant species discovery efforts has been limited in the municipality of Narra, while other areas within the larger VAMR, such as Aborlan, Quezon, and Puerto Princesa City, remain underexplored. Additionally, ethnobotanical research has been confined to only two Tagbanua communities, leaving out valuable traditional ecological knowledge from other areas in the region. Addressing these gaps by expanding the geographical and taxonomic scope of botanical and ethnobotanical studies could deepen the understanding of the mountain range's unique plant biodiversity and its traditional uses.

Keywords: biodiversity, conservation, ethnobotany, floristic survey, Tagbanua

INTRODUCTION

The Philippines is widely recognized as a global biodiversity hotspot, known for its exceptional levels of diversity. However, despite this overall biodiversity richness, the country also contains distinct regions that can be considered global plant diversity

darkspots. An area is considered a biodiversity darkspot when it possesses high levels of endemism and significant biodiversity, yet remains poorly studied or neglected by conservation efforts, leading to potential unknown losses of life. Palawan is an actual "darkspot" in the biodiversity landscape of the country. Palawan is the fifth-largest island (>11,000 square



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kilometers land area) in the Philippine archipelago (Fidenci and Castillo 2009), and the largest island in the Philippine province of the same name, situated between 7°47' and 12°22' north latitude and 117°00' and 119°51' east longitude. Palawan is renowned as the Philippines' last ecological frontier because it still has vast forests, rich marine life, and high levels of biodiversity compared to more developed and exploited regions. It is also acknowledged as one of the country's most diverse and abundant island (Sandalo and Baltazar 1997), home to a remarkable estimated tally of 3,000-3,500 flowering species, many of which are exclusive to it (Madulid 2002). Recognizing its immense ecological value, Palawan was designated as a biosphere reserve within the Philippines through United Nations Educational, Scientific and Cultural Organization's Man and Biosphere Reserve Program in 1990, underscoring its significant role in global biodiversity preservation (Diesmos and Palomar 2004).

Palawan holds a unique phytogeographical significance, occupying a distinct and secluded position, and acting as a connecting bridge between Luzon and Mindoro in the north and Borneo in the south. Its isolation from the main island chain of the Philippine archipelago presents compelling opportunities for conducting comprehensive

biodiversity studies. However, in spite of the reported high endemism, many areas are not yet explored, making it a biodiversity darkspot as mentioned earlier. Additionally, despite the popularity of Palawan's natural attractions, its biodiversity is currently experiencing threats such as illegal and unregulated logging, conversion of land for different purposes, and mining operations (Arriola et al. 2017; Sopsop and Buot 2009; Cruz et al. 2007).

The Victoria-Anepahan Mountain Range (VAMR) rises as one of the prominent ecologically significant areas in Palawan (Reyes 2019) (Figure 1). It measures about 210,000 ha and extends to Aborlan, Narra, and Quezon municipalities, and Puerto Princesa City. It is known to be a biodiversity hotspot exhibiting 41.18% endemism rate in its plant and animal species. Moreover, 31% of the species of the mountain range need conservation and protections efforts for these critical species are identified as high priority (Maclang 2023). This mountain range is also known to have the largest ultramafic forest in Palawan, hosting unique plant communities as well as rich wildlife diversity (Magdayao 2021). The VAMR is truly an important habitat for a great number of species maintaining the rich biodiversity of the greater Palawan biogeographic region (Tandang et al. 2020).

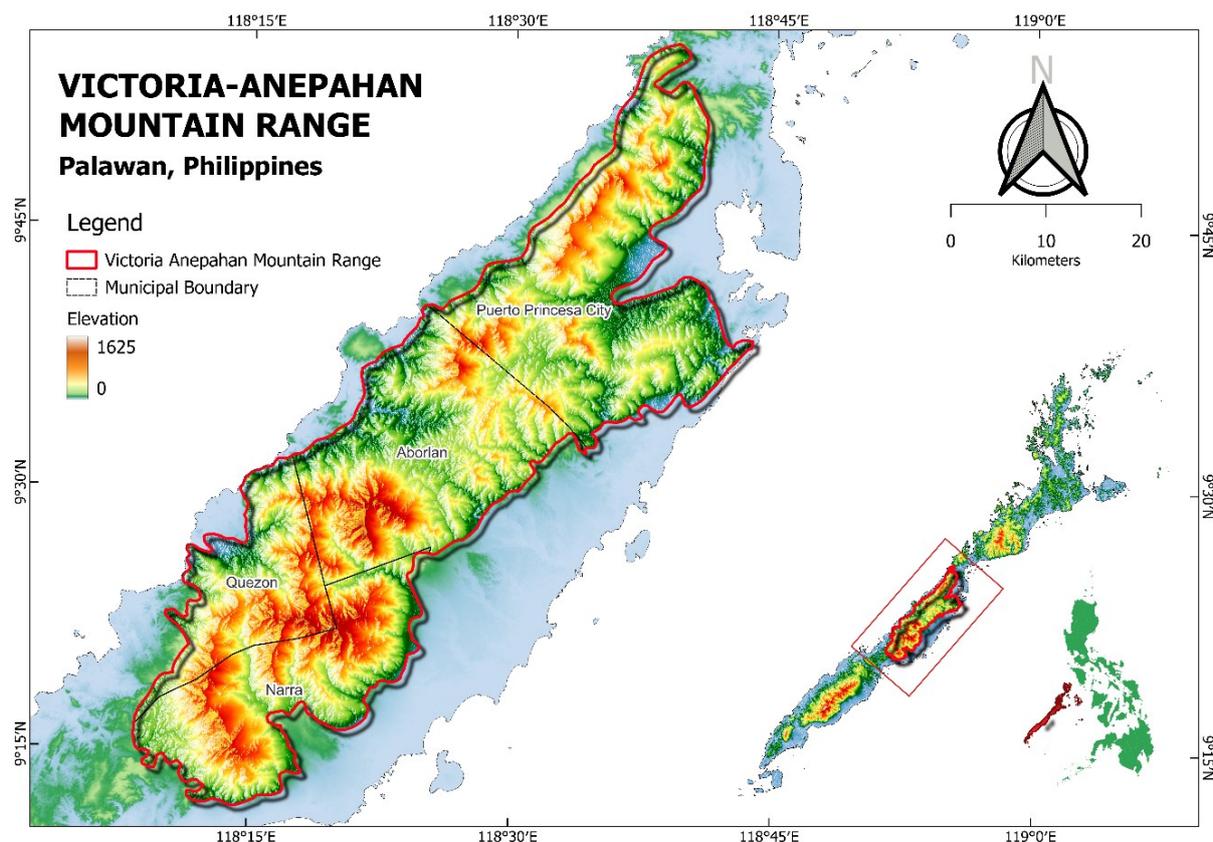


Figure 1. Map of the Victoria-Anepahan Mountain Range (VAMR).

Currently, the majority of the natural areas covered by VAMR is not yet a protected area (PA). It is very alarming given the fact that this mountain range is home to a wide range of flora and fauna that are endemic and threatened (Maclang 2023). In addition to that, it also serves as an essential watershed that gives water supply to the communities surrounding it (Magdayao 2021). Given its remarkable biodiversity and vulnerability to surrounding threats, VAMR is in dire need of a PA status. Being a PA would give it legal recognition that would enforce regulations leading to a decreased degree of unsustainable exploitation of VAMR, safeguarding its natural resources (Maclang 2023). A PA status would support sustainable practices in resources extraction, encourage responsible ecotourism, and push more efforts for conservation (Magdayao 2021).

The Palawan Council for Sustainable Development (PCSD) is now initiating an inter-local government unit agreement that involves the municipalities of Aborlan, Narra, and Quezon, and the city of Puerto Princesa City to jointly manage VAMR (Maclang 2023). The information about the diversity of plants and other biodiversity aspects are important in supporting this initiative of PCSD. Conducted comprehensive floristic studies in VAMR can give details about the diversity and distribution of plant species which can help in identifying the presence of endemic and endangered species that need measures for conservation. Biodiversity data from existing studies can also show the unique vegetation profile and ecological significance of VAMR. This supports the call for coordinated management initiatives.

This paper aimed to assess the current state of plant biodiversity and research in VAMR based on existing literature. The research objectives were to: 1) document and review the botanical studies conducted in VAMR; 2) synthesize published species data and produce a consolidated list of plant species with their updated information, and 3) identify botanical research gaps that need to be addressed for the effective protection and conservation of plant biodiversity in VAMR.

THE REVIEW PROCESS

A systematic review of published literature was performed in this study. Google Scholar and Science Direct were utilized in conducting a comprehensive literature search to investigate the floristic studies conducted at VAMR. Keywords “Victoria-Anepahan Mountain Range” and “Flora” were used, and the search results were critically reviewed. There were 54 searched articles of which 18 were given preference for they specifically addressed the desired aspects of the study.

The databases used in checking the updated and accepted names of species and their families were the Royal Botanic Gardens, Kew’s Plants of the World Online (<https://powo.science.kew.org>) and Co’s Digital Flora of the Philippines (CDFP) (Pelsner et al. 2011 onwards). The Global Biodiversity Information Facility (<https://www.gbif.org>) was used to obtain species distribution data. Co’s Digital Flora of the Philippines (CDFP) (Pelsner et al. 2011 onwards) was also employed to further confirm the distribution of species at the country level. The conservation status of species was assessed using the International Union for Conservation of Nature (IUCN) Red List for global status and the Department of Environment and Natural Resources (DAO-2017-11) for national classification. Furthermore, the Botanic Gardens Conservation International (BGCI 2024) ThreatSearch tool was employed to gather supplementary data on species conservation.

EXPLORATIONS IN VAMR

The rich plant life and hidden botanical wonders of the VAMR in Palawan, Philippines, are brought to light through the indispensable work of botanical explorations. The work of researchers and botanists has greatly advanced knowledge of the mountain range’s plant life and highlighted its ecological value. Botanical studies conducted in the VAMR covers three primary areas: vegetation surveys and analyses, ethnobotany, and new species discovery.

As shown in Figure 2, botanical studies in VAMR have occurred sporadically over the 25-year period from 1999 to 2024. The earliest study was recorded in 1999, followed by a single study in 2003, 2004, and 2009. Research activity slightly increased in 2010 and 2011, with two studies conducted in each of these years. A similar level of activity was observed in 2016. The highest number of studies was recorded in 2020, with three published works. In the remaining years, most activity was limited to one study per year, including 2013, 2018, 2021, 2023, and 2024. There were also several years when no botanical studies were reported, specifically from 2000 to 2002, 2005 to 2008, 2012, 2014 to 2015, 2017, 2019, and 2022. It can be gleaned that the occurrence of research activities at VAMR have been inconsistent, with periods of high activity followed by gaps where no studies were conducted. The reasons for this fluctuation could be due to factors such as funding availability, changes in research priorities, or other institutional or external influences.

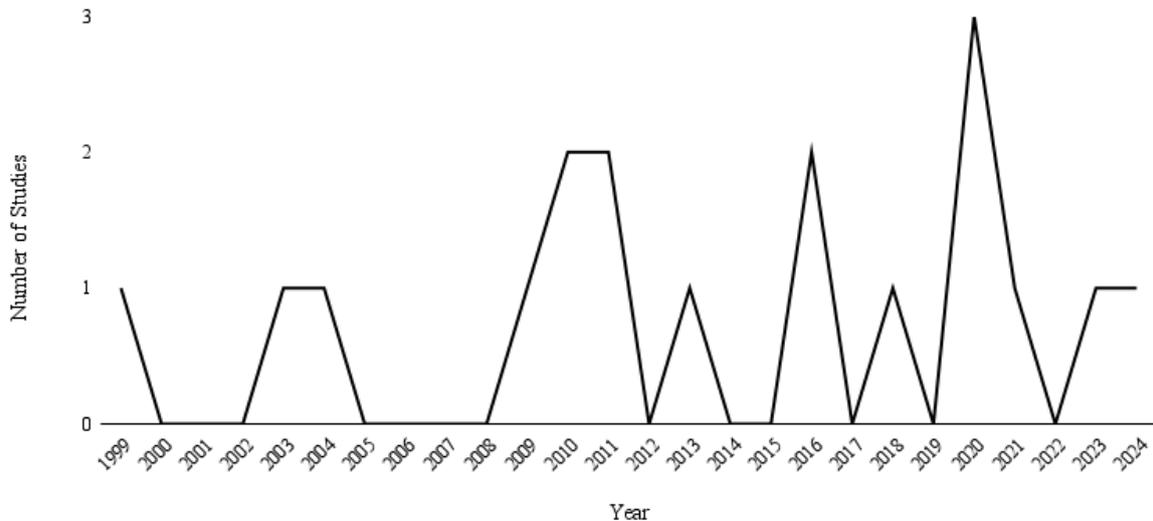


Figure 2. Number of studies conducted at Victoria-Anepahan Mountain Range (VAMR).

There were 18 botanical studies conducted at VAMR across the past 25 years. The majority of these studies (72.20%) were focused on new species discovery (Figure 3). It means that a significant portion of VAMR's research efforts has been directed towards the identification, documentation, and taxonomic analysis of previously unknown plant species. In contrast, 16.7% are floristic surveys. These types of surveys aimed to comprehensively document and analyze the plant species found in a specific area or ecosystem. The third category of studies was ethnobotany, which examined the traditional knowledge and uses of plants by indigenous or local communities, had the lowest proportion at 11.1% (Figure 3). While discovery and documentation of novel species significantly enrich biodiversity data and reinforce the ecological importance of VAMR as an area of high endemism, the other aspects of botanical research should also be tended to. Conducting more floristic surveys and ethnobotanical studies could provide a more holistic understanding of plant life and its interactions with human communities at VAMR.

The distribution of studies conducted within the Victoria-Anepahan Mountain Range indicates that the majority of the research activities have been concentrated in the municipality of Narra (Figure 4). Nine studies focusing on new species discovery and ethnobotany have been conducted in this area. This municipality, occupying a large portion of the mountain range, has been a prime location for researchers to focus their efforts. Additionally, the municipality of Aborlan has been the site of notable research activities, with five studies conducted focusing on discovery of new species, floristic surveys and ethnobotanical investigations. Its position within the central zone of the VAMR renders Aborlan a suitable and accessible area for scientific studies.

Similarly, Puerto Princesa City, the capital and only city in the province, had four documented studies for a floristic survey and new species discovery. However, there is a complete absence of research activity in the municipality of Quezon. The absence of research in the Quezon area of the VAMR indicates that it may not have been prioritized by researchers. A possible reason for this is that only a limited portion of Quezon lies within the VAMR boundary. This municipality is, in fact, also situated within the bounds of Mt. Mantalingahan Protected Landscape, a separate key biodiversity area in Palawan. Consequently, researchers may have focused on core VAMR areas located in Narra, Aborlan and Puerto Princesa City where the mountain range occupies a larger portion.

The first type of botanical exploration—vegetation surveys and analyses—was carried out by Sopsop and Buot (2013) and Beijnen and Jose (2020), who documented patterns in plant species richness, diversity, and distribution within particular sites of the VAMR. The study by Sopsop and Buot (2013) was focused on evaluating forest types and plant species across the Aborlan Guba System, within an elevation range of 150–760 meters above sea level (masl). In total, 324 plant species were observed, and four distinct vegetation zones were delineated based on species dominance. Each zone was named according to the dominant tree species present within its specific elevation range. The forest types identified were *Artocarpus-Ganophyllum* forest (Zone I), *Koordersiodendron-Litsea* forest (Zone IIA), *Pouteria-Ficus-Neonauclea-Quercus-Syzygium-Tristaniopsis* forest (Zone IIB), *Swintonia-Agathis-Magnolia* forest (Zone III), and *Pinus* forest (Zone IV) (Sopsop and Buot 2013). The dissertation conducted by Sopsop (2010) reported that her vegetation survey conducted in Aborlan Guba System had identified 324

species across 89 families and 192 known genera, of which some were undetermined. Meanwhile, Beijnen and Jose (2020) conducted a vegetation survey at the threatened riverine lowland forest ecosystem in the Talakaigan Watershed, which is also situated in Aborlan, Palawan. They identified a total of 22 plant species from 17 genera and 11 families. The small

number of plant species recorded in their study may not fully reflect the complete picture of the biodiversity of the riverine lowland forests of the study site. One possible reason is the limited sections of the area they investigated due to accessibility challenges, such as the remote and inaccessible nature of some areas.

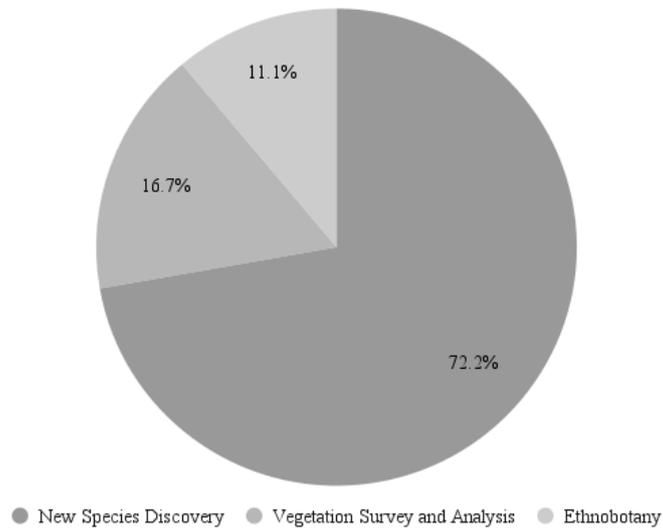


Figure 3. Types of studies in Victoria-Anepahan Mountain Range (VAMR).

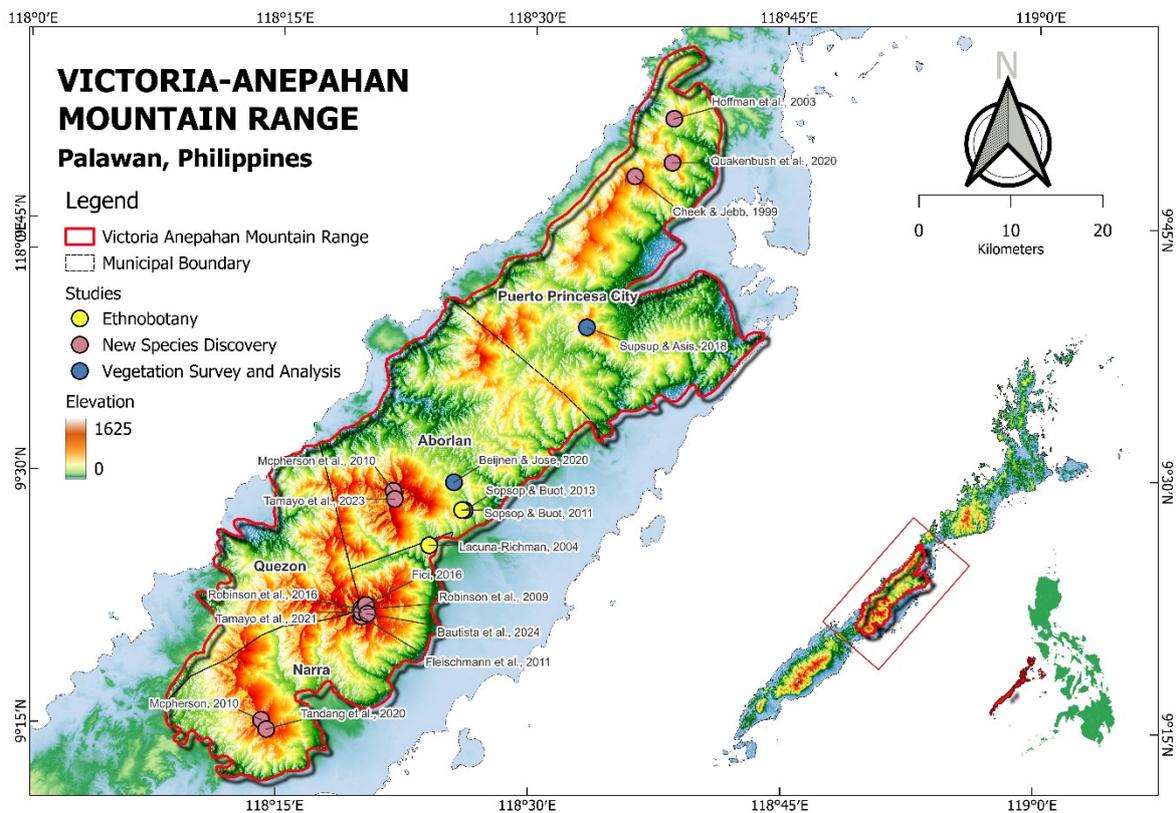


Figure 4. Distribution map of Victoria-Anepahan Mountain Range (VAMR) botanical studies (Blue: Vegetation survey and analyses; Yellow: Ethnobotany; Violet: New Species Discovery).

Aside from the vegetation surveys and analyses conducted by Sopsop and Buot (2013) and Beijnen and Jose (2020), Supsup and Asis (2018) also identified plant species and the important habitats for endemic and threatened species in the northern part of the Victoria-Anepahan Mountain Range, Puerto Princesa City, Palawan. They conducted a rapid assessment of vegetation covering the barangays of Bacungan, Simpocan, Bagong Bayan, Napsan, Montible, Iwahig, and Irawan. During the assessment, they collected geographic coordinates of different habitat types, such as cultivated areas, mangroves, secondary growth, and pristine forests, to be used as reference points for supervised vegetation analysis. Through this, they identified 12 plant species, and provided information on their conservation status, distribution, habitat, and number of records.

Since the aforementioned studies focused on a few specific locations, their findings may not be directly applicable to other areas in VAMR with different environmental conditions and forest types. Figure 4 reveals that the mentioned vegetation studies are limited to the specific areas in Aborlan and Puerto Princesa. While these botanical surveys have contributed to a better understanding of the local flora, there is still a need to further examine the other unexplored areas in VAMR. A more complete assessment of the VAMR's botanical richness and diversity can be achieved by extending surveys to cover additional areas like in Narra and Quezon.

The second type of botanical explorations in VAMR involves ethnobotanical studies. Various indigenous ethnolinguistic groups reside in the province of Palawan. Among these groups are the Pala'wan, Tau't Bato, Molbog, Batak, Agutaynen, Cuyonon, and Tagbanua (Acero 2020). The Tagbanua, often referred to as the intermediate indigenous group

of Palawan, apply this label to themselves and are likewise recognized as such by other local communities. The Tagbanua have traditionally sustained their livelihood through the local practice of subsistence slash-and-burn agriculture, known in Filipino as “kaingin”, cultivating rice and other crops (Dressler 2005). However, modifications to this traditional farming practice have occurred in response to changing land-use policies, including restrictions on logging and forest conversion, alongside growing population demands (Acero 2020). Harvesting forest products remains the chief livelihood activity providing cash income for the Tagbanua.

The utilization of plants by the Tagbanua people in the VAMR has been documented in two ethnobotanical studies. Lacuna-Richman (2004) conducted her study in Sitio Boong, Barangay Dumanguena, Narra, Palawan, while Sopsop and Buot (2011) focused their research on the Aborlan Guba System in Aborlan, Palawan. Figure 5 compares the number of plant species utilized for different purposes, drawing on data from Lacuna-Richman (2004) and Sopsop and Buot (2011). It can be discerned that Lacuna-Richman (2004) mainly reported food plants and species used in house construction while Sopsop and Buot (2011) were able to document other purposes such as medicinal, ornamental, as sources of water and fuel, and for farming and harvesting. It should be noted that in the study Lacuna-Richman (2004), participants did not disclose their medicinal plants due to concerns about biopiracy and the loss of intellectual rights over traditional knowledge. The threat of bioprospectors has led to a reluctance to share information about medicinal plants with non-tribal members (Lacuna-Richman 2004). This connotes the importance of respecting indigenous communities' rights and knowledge when engaging with traditional plant resources.

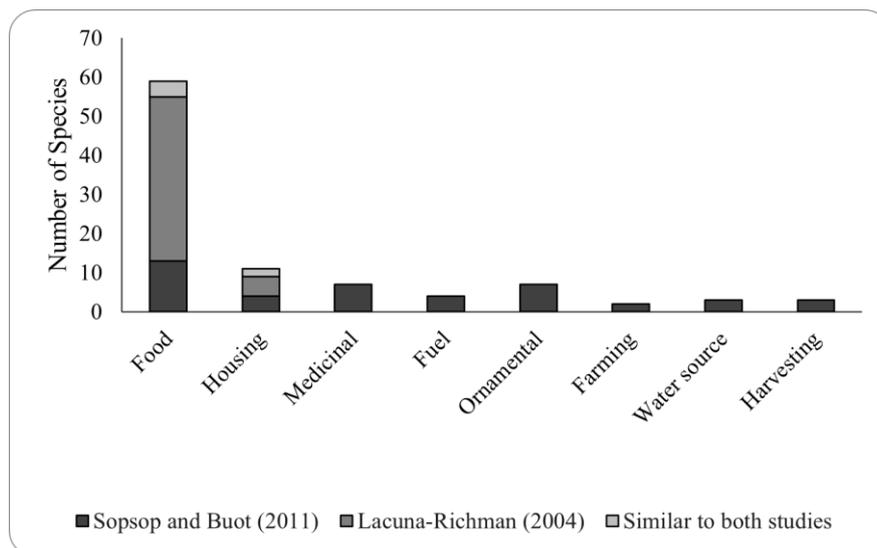


Figure 5. Comparison of plant use data of Tagbanua communities obtained from the ethnobotanical studies of Lacuna-Richman (2004) and Sopsop and Buot (2011).

Interestingly, the two studies shared four common edible plant species and two common plant species used for traditional house-building, highlighting some consistencies in the Tagbanua's reliance on locally available resources. Nevertheless, there are more species that are unique to each study. The differences in the findings between the two studies reflect the localized variation in Tagbanua traditional ecological knowledge and plant resource utilization across the VAMR. These studies show the Tagbanua's deep understanding and sustainable use of the diverse plant life in their forest environment, which is crucial to preserve and promote for the continuation of their cultural practices.

The studies conducted by Lacuna-Richman (2004) and Sopsop and Buot (2011) demonstrate the abundant plant diversity and indigenous knowledge possessed by the Tagbanua communities residing in VAMR. The Tagbanua people have deep knowledge of and reliance on the local environment for food, housing, medicine, fuel, ornamentation, farm implements, and alternative water sources. Although the aforementioned studies offer ideas about the utilization of plant resources by the Tagbanua community within certain parts of the mountain range, there is a necessity for additional research to thoroughly document the entirety of plant diversity, traditional knowledge, and cultural practices among Tagbanua communities in various other areas of VAMR. Moreover, considering the vital role forest resources play in the lives of the Tagbanua people, prioritizing sustainable forest management is essential. Key actions include supporting sustainable resource use, protecting indigenous knowledge on plant utilization, and ensuring community participation in management decisions. Protecting and conserving plant species with cultural, ecological, and economic value to the Tagbanua should be a key priority in conservation strategies for VAMR.

The third type of botanical exploration in VAMR is the discovery of novel species and records. The identification of new species and an additional distribution record in VAMR reveals the mountain range's ecological richness and botanical uniqueness. A total of 15 new species and record from 11 different genera and eight families have been discovered and officially documented over the past 25 years (Cheek and Jebb 1999; Hoffmann et al. 2003; Robinson et al. 2009; McPherson 2010; McPherson et al. 2010; Fleischmann et al. 2011; Fici 2016; Robinson et al. 2016; Quakenbush et al. 2020; Tandang et al. 2020; Tamayo et al. 2021; Tamayo et al. 2023; Bautista et al. 2024).

Table 1 provides a list of new plant species and records belonging to several botanical families, including Capparaceae, Droseraceae, Ericaceae, Euphorbiaceae, Melastomataceae, Nepenthaceae, Orchidaceae, and Rubiaceae. The families with the

largest number of species represented are Orchidaceae and Nepenthaceae, with four (4) species each. Most of these species were observed in the municipality of Narra, Palawan, as indicated by the violet points in Figure 4. It can be gleaned that the municipality of Narra has been a focus of new species discoveries. Most of the newly discovered plant species were found in the ultramafic peak of Mt. Victoria in Narra.

There were three new species and one new distribution record under the family Orchidaceae. The terrestrial orchids *Stigmatodactylus dalagangpalawanicum* A.S.Rob. and *Stigmatodactylus aquamarinus* A.S.Rob. & Gironella were discovered growing in the upper montane forest of Mt. Victoria in Narra (Robinson et al. 2016) as well as *Corybas circinatus* Tandang & R.Bustam. which was found in the mid-montane forest Mt. Victoria and Sultan Peak in Narra at 331 masl (Tandang et al. 2020). A new distribution record was reported for *Cryptostylis carinata* J.J.Sm., found in an upland swamp overlying ultramafic rock in Mt. Victoria, Narra (Robinson et al. 2016).

The two new species of Nepenthaceae found in Narra were *Nepenthes attenboroughii* A.S.Rob., S.McPherson & V.B.Heinrich found in the summit region of Mt. Victoria and *Nepenthes palawanensis* S.McPherson, Cervancia, Chi.C.Lee, Jaunzems, Mey & A.S.Rob. found in the summit ridge of Sultan Peak, each with its specific habitat preferences. The *N. attenboroughii* flourishes in open, exposed habitats characterized by low-growing upper montane scrub. It was found by Robinsons et al. (2009) at an elevation of 1,650 masl. The *N. palawanensis* is another species from the Nepenthaceae family which is found in a low-growing upper montane scrub and has not been documented in forested or shaded areas, just like *N. attenboroughii*. Its elevation ranges from 1,100 to 1,236 masl (McPherson 2010). Meanwhile, *Nepenthes leonardoii* S.McPherson, Bourke, Cervancia, Jaunzems & A.S.Rob. was documented in Mt. Shumkat. According to the literature, Mt. Shumkat is also located in Narra, Palawan; however, based on the National Mapping and Resource Information Authority data used in creating Figure 4, the mountain falls within the jurisdiction of Aborlan. This discrepancy may be attributed to the authors' jump off point in Narra, while the actual collection site of the species was already within Aborlan. This species has a different habitat preference as it occurs in upper montane forests but in shaded areas and thrives in open scrub on ridges and summit zones. It was recorded at an elevation of 1,490 masl (McPherson et al. 2010). *Nepenthes philippinensis* Macfarl. found on Mt. Pulgar in Puerto Princesa City thrived on ultramafic soils in lower elevations of 25-250 masl (Cheek and Jebb 1999).

These literatures about new plant species discoveries show the richness and endemic nature of plants that thrive in the montane and ultramafic

ecosystems. The distribution elevation of the discovered species ranges from as low as 25-250 masl like the *N. philippinensis* to as high as 1,700 masl like the *Vaccinium exiguum* M.N.Tamayo, R.Bustam. & P.W.Fritsch, reflecting the plants' adaptations to diverse montane environments. There were restricted occurrences of species like the *Drosera ultramafica* A.Fleischm., A.S.Rob. & S.McPherson, *Rhododendron astrophorum* M.N.Tamayo, Y.P.Ang & A.S.Rob., and *Nepenthes* species that were found in ultramafic and montane forest habits, which shows that these areas are critical centers of endemism shaped by the distinctive soil composition and microclimates that support rapid diversification (De Castro et al. 2020). There were also several species that were restricted in particular peaks of VAMR in Narra, Palawan, such as the *Nepenthes* and *Stigmatodactylus* orchids. It

emphasizes the high level of localized endemism and the likelihood that these species are adapted to narrowly defined environmental conditions. According to Galey et al. (2017), montane and ultramafic environments can serve as engines of evolution where the combination of unique physical and biological conditions promotes the rise of narrowly adapted and endemic plant species. The adaptability and the diversity of montane ecosystems are supported by the wide altitudinal ranges occupied by some of the newly discovered plant organisms. It supports the idea that there should be a high conservation priority to be given to the montane and ultramafic habitats of VAMR. These environments act as biodiversity hotspots and give an opportunity to study the ecological and evolutionary forces behind species diversification.

Table 1. Newly described species and record from the Victoria-Anepahan Mountain Range, with details on family, species, habitat and ecology, elevation, and source.

Family	Species	Habitat and Ecology	Elevation (masl)	Source
Capparaceae	<i>Capparis tagbanuorum</i> Fici	known from a single locality in Mt. Victoria, in forest habitats along a stream valley; ultramafic soils	490-590	Fici 2016
Droseraceae	<i>Drosera ultramafica</i> A.Fleischm., A.S.Rob. & S.McPherson	growing on high montane forest, on ultramafic soils	1680	Fleischmann et al. 2011
Ericaceae	<i>Rhododendron astrophorum</i> M.N.Tamayo, Y.P.Ang & A.S.Rob.	found as an epiphyte on the larger limbs of shrubs and small trees from mid-montane ultramafic forest	1100-1477	Tamayo et al. 2023
	<i>Vaccinium exiguum</i> M.N.Tamayo, R.Bustam. & P.W.Fritsch	known from a single individual from a single location at the exposed ultramafic forest summit of Mt. Victoria	1700	Tamayo et al. 2021
Euphorbiaceae	<i>Phyllanthus balgooyi</i> Petra Hoffm. & A.J.M.Baker	growing as isolated individuals, restricted to ultramafic substrates in scrub or very stunted open forest	150-200	Hoffmann et al. 2003
Melastomataceae	<i>Medinilla ultramaficola</i> Quakenbush, Y.P.Ang & R.Bustam.	found on exposed ultramafic ridges	150-1010	Quakenbush et al. 2020
Nepenthaceae	<i>Nepenthes attenboroughii</i> A.S.Rob., S.Mc Pherson & V.B.Heinrich	exposed, open areas of low growing upper montane scrub; not known from forest or shaded habitat	1650	Robinson et al. 2009
	<i>Nepenthes leonardoi</i> S.McPherson, Bourke, Cervancia, Jaunzems & A.S.Rob.	growing in upper mountain forest, often in shade, as well as in open scrub in ridge top and summit areas	1490	McPherson et al. 2010

Family	Species	Habitat and Ecology	Elevation (masl)	Source
	<i>Nepenthes palawanensis</i> S.McPherson, Cervancia, Chi.C.Lee, Jaunzems, Mey & A.S.Rob.	areas of low growing upper montane scrub; not known from forest or shaded habitat.	1100-1236	McPherson 2010
	<i>Nepenthes philippinensis</i> Macfarl.	scrub on ultramafic soils	25-520	Cheek and Jebb 1999
Orchidaceae	<i>Corybas circinatus</i> Tandang & R.Bustam.	skeletal, humic soils overlying mafic rocks; stunted, mid-montane trees close to the waterfall camp	331	Tandang et al. 2020
	<i>Cryptostylis carinata</i> J.J.Sm. (new record)	upland swamp overlying ultramafic rock	1459	Robinson et al. 2016
	<i>Stigmatodactylus aquamarinus</i> A.S.Rob. & Gironella	growing terrestrially in moss pads overlying matted tree roots or steeply inclined ultramafic rock, generally occurring singly beneath closed canopy forest of upper montane trees 4–6 m tall or climbing bamboo; or in ultramafic rubble in open summit scrub, sheltered by large boulders	1460	Robinson et al. 2016
	<i>Stigmatodactylus dalagangpalawanicum</i> A.S.Rob.	growing terrestrially in humus layer overlying ultramafic rock in upper montane, closed canopy forest below summit scrub zone	1600	Robinson et al. 2016
Rubiaceae	<i>Psychotria pendens</i> M.Bautista & R.Bustam.	growing in moist, shady lowland and mid-elevation forest areas	500	Bautista et al. 2024
Total Number of Species	15			

UPDATED SPECIES LIST

The comprehensive updated species list compiled from 18 botanical studies in the VAMR gives a snapshot of the rich plant diversity in the region. Spanning 93 families, 187 genera, and a total of 255 species, the list offers important insights into the taxonomic breadth and composition of the local flora. There were 56 species that were previously documented under outdated taxonomic names. These 56 species have been cross-checked and updated to their current nomenclature. Geographically, the list includes 196 species that are already known to occur in Palawan, while 58 species have not yet been recorded in the province (as per Pelsner et al. 2011 onwards) but are on the list.

The comprehensive species list provides the geographic distribution and endemism levels of the documented plant diversity (Figure 6). Over 164 (64.3%) of the 255 species were categorized as non-endemic, indicating they have a wider distribution

beyond the Philippine archipelago. However, a substantial proportion, accounting for over 35.7% (91 species) of the total, are Endemic to the Philippines, emphasizing the unique and irreplaceable nature of the plant life in this region. Of the 91 Philippine endemic species, 24 were restricted to Palawan, underscoring the exceptional level of localized endemism within VAMR. These 24 Palawan-endemic species represent a distinct and highly specialized component of the regional flora, warranting targeted conservation efforts to protect them from any threats. While the majority of the species have a broader area distribution, the substantial proportion of endemic Philippine species, and the even more specialized Palawan-endemic subset, emphasizes the unique and irreplaceable nature of this flora.

The species list includes data on the conservation status of the documented plant species, as assessed under both the global International Union for Conservation of Nature and the national DAO 2017-11 framework in the Philippines. From the IUCN

assessment, 28 species were classified as critically endangered, endangered or vulnerable, indicating they face a risk of extinction worldwide (Figure 7). An additional 12 species were categorized as Near Threatened, meaning they are close to qualifying for a threatened status. However, a significant portion (98 species) has not yet been evaluated by IUCN, leaving their global conservation status unknown. Conversely, the national classification under DAO 2017-11 presents a more alarming scenario for plant conservation in the Philippines. There were 51 species identified as critically endangered, endangered, and vulnerable. It indicates that these species are under alarming threats and are at risk of extinction in the Philippines. There were also 14 species that fall under the classification other threatened species in DAO 2017-11 which means that there is a pressing need for conservation actions. The results of conservation status evaluation of plant species in the IUCN and DAO 2017-11 point out a need for critical and focused protection strategies for the threatened plant species of VAMR. Prioritizing both the protection of these threatened species and the conservation of the VAMR's unique natural heritage is essential. The conservation status of the 98 unevaluated species must also be assessed to give a more accurate estimate of the extent of threatened species.

The BGCI ThreatSearch database (BGCI 2024) was used to evaluate the conservation status of species lacking IUCN or DAO 2017-11 assessments. Among the 24 species with available data, 15 were identified as threatened, one as possibly threatened, seven as not threatened, and one as data deficient (Figure 8). These threatened species should also be assessed by IUCN and DAO 2017-11 to confirm their

status and attract attention from conservation professionals and authorities. The BGCI database serves as a valuable alternative tool for assessing species not classified under IUCN or DAO 2017-11, enhancing our understanding of biodiversity and the risks faced by these species.

DATA GAPS AND OTHER OPPORTUNITIES

Based on the existing body of knowledge about the flora of VAMR, there are several significant research gaps identified. A major research gap pertains to the narrow geographic and taxonomic scope of previous botanical research efforts. While new plant species have been found across two peaks in the municipality of Narra, there is significant potential for discovering additional undescribed species in other areas and peaks within the larger VAMR, such as in the municipalities of Aborlan and Quezon, and the city of Puerto Princesa. Even in the case of the Puerto Princesa City area, where a rapid assessment has been done by Supsup and Asis (2018), a more comprehensive botanical survey of the mountain regions could uncover additional plant diversity and distribution patterns. Expanding the geographical scope of plant species surveys and exploration to these other uncharted regions will reveal the actual plant diversity in VAMR. Moreover, the existing data points out that the available literature has primarily focused on the discovery of new plant species. It is essential to broaden the research scope to encompass more extensive botanical and ethnobotanical studies in order to better understand the plant biodiversity, traditional knowledge, and resource use within the VAMR.

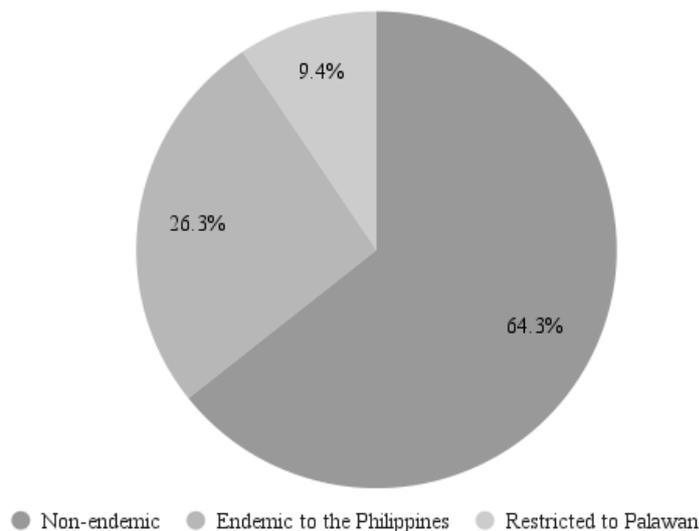


Figure 6. Endemism of Victoria-Anepahan Mountain Range's Flora.

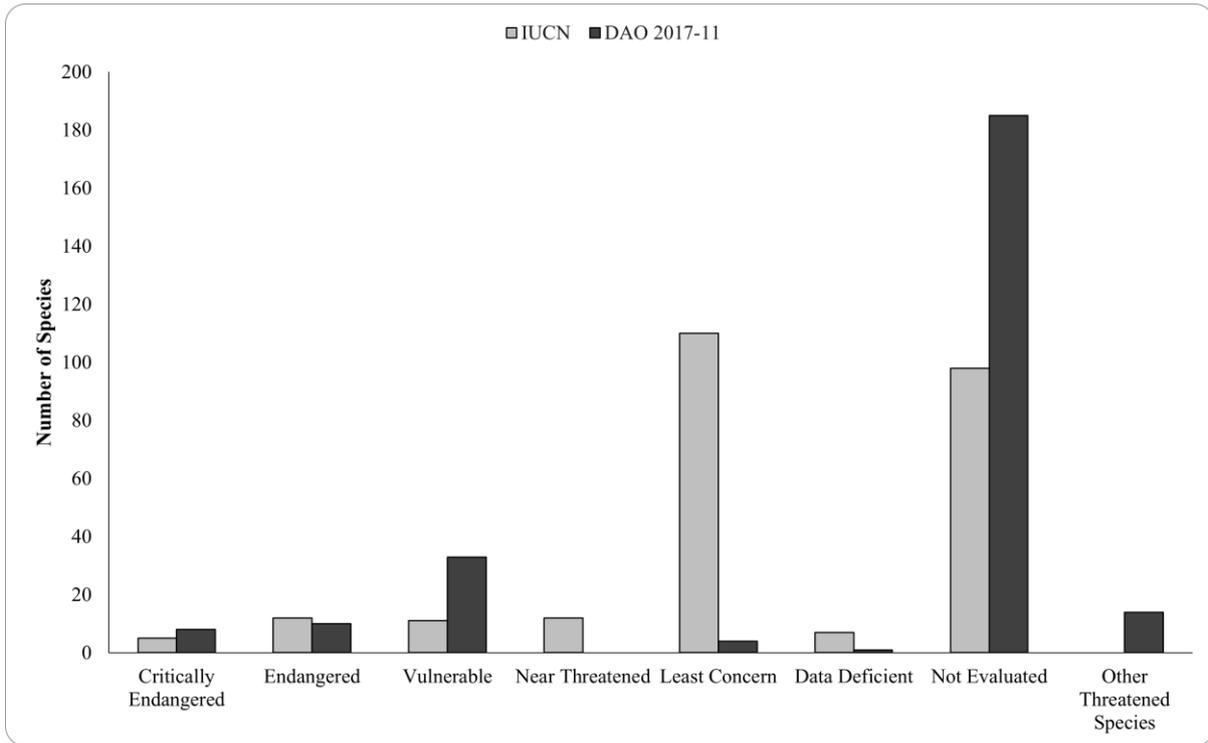


Figure 7. International Union for Conservation of Nature and Department of Environment and Natural Resources Administrative Order 2017-11 conservation status of Victoria-Anepahan Mountain Range’s Flora.

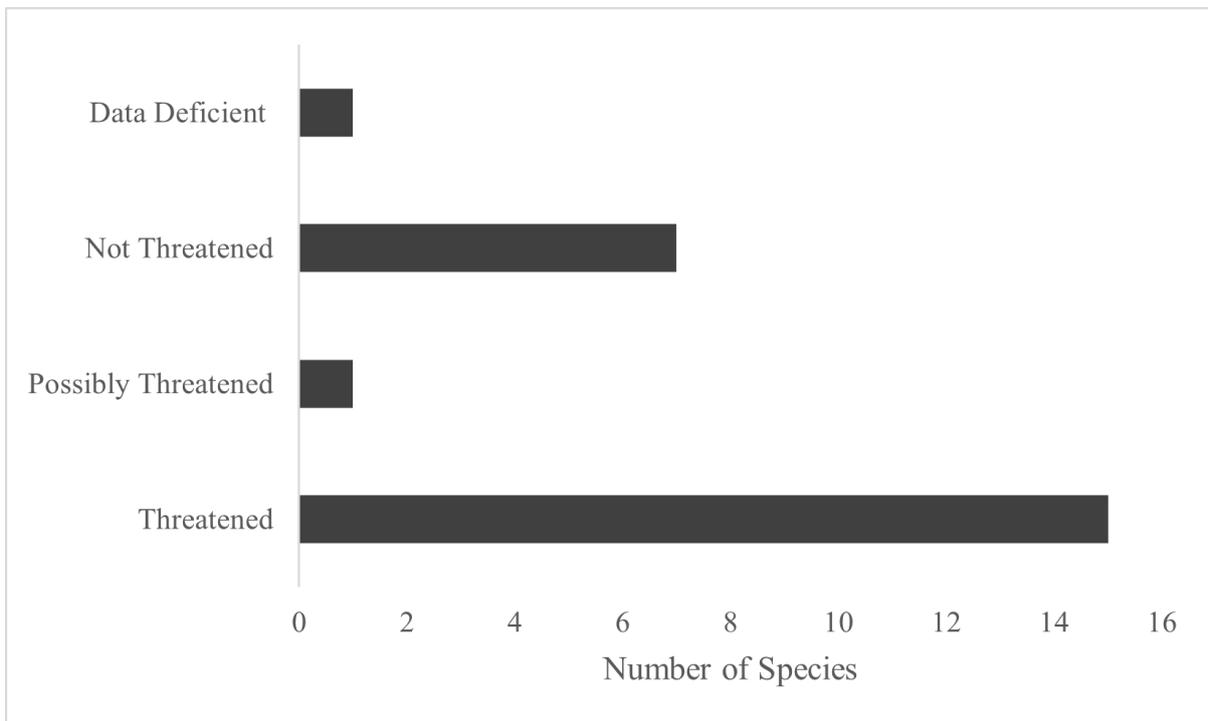


Figure 8. Conservation status of plant species in the Victoria-Anepahan Mountain Range according to Botanic Gardens and Plant Conservation ThreatSearch.

Botanical surveys in VAMR have largely concentrated on the angiosperms. It is also noteworthy that the recently discovered plant species in VAMR are mainly shrubs and herbs. These studies have not thoroughly included bryophytes and other understory plants. Understory vegetation should also be studied as they are key components of forest ecosystems contributing to ecological balance and function. They can reflect the condition of their environment and can also support the wildlife by giving them nourishment and habitat. More comprehensive floristic surveys should be conducted and should include understory vegetation within the different forest types in VAMR. Understory vegetations are often underrepresented in botanical studies even though they hold valuable information about the environmental state and conservation needs of a particular site. They are highly responsive to environmental shifts and can function as bioindicators of habitat quality, microclimate, and levels of disturbance (Deng et al. 2023).

The limited ethnobotanical research conducted in the mountain range is another identified data gap. There are only two Tagbanua communities that were investigated, one located in Narra and the other in Aborlan. There are other Tagbanua communities that remain unexplored and hold potential for investigating ethnobotanical knowledge and traditional plant use. Other communities situated in other sitios and barangays within VAMR, such as those in Puerto Princesa City (Barangays Napsan, Simpocan, and Bagong Bayan), can also provide ethnobotanical data and reveal a fuller picture of traditional knowledge and plant resource utilization in the VAMR. Conducting ethnobotanical studies in VAMR beyond the Tagbanua communities that have already been the focus of previous studies is truly important. Each community may have distinct traditional ecological knowledge and practices related to plant utilization. Other Tagbanua settlements may reveal new information that can possibly lead to the identification of medicinal and culturally important species.

The analysis of the phytochemical properties of medicinal plants utilized by the Tagbanua people should be conducted, especially for those species that have not yet been subjected to scientific study. According to Recuenco et al. (2020), scientific validation through phytochemical studies can reinforce claims of traditional plant use. The exploration of the active compounds, modes of action, and therapeutic potential of medicinal plants allows researchers to deepen scientific understanding of their efficacy while promoting the preservation and continued practice of traditional knowledge. Furthermore, there are occurrences of the migration of tribe members to lowland areas or urban centers. This poses a risk of eroding the traditional ecological knowledge of the Tagbanua communities in VAMR. According to Abdullah and Khan (2023), migration and

displacement from their traditional lands and practices can result in the erosion of important information about the mountain's plant diversity, medicinal uses, and sustainable resource management practices. Hence, there is a greater need to conduct more ethnobotanical studies. There should be collaboration with the Tagbanua people to document and preserve their traditional knowledge. This is vital to the preservation of valuable traditional ecological knowledge.

The absence of extensive floral explorations in ultramafic forests presents an opportunity for future botanical studies. Results of this study show that ultramafic forests are home to many newly discovered species. Ultramafic forests are those that grow on soils derived from ultramafic rocks, such as serpentinite, and are known to harbor unique and specialized plant communities adapted to the challenging environmental conditions associated with these substrates (Galey et al. 2017). According to De Castro et al. (2020), ultramafic environments are often characterized by high levels of endemism, as plants evolve unique adaptations to cope with the harsh soil conditions. The ultramafic forests of VAMR could be a home to more endemic flora. Investigating the VAMR's ultramafic habitats may reveal significant biodiversity. It can contribute to both species' discovery and a more profound and comprehensive understanding of plant community structure. There are still many ultramafic peaks in VAMR that are unexplored. These habitats tend to be patchy and geographically limited, where each mountain or peak may host unique assemblages of plant species. Conducting more botanical studies to other ultramafic zones of VAMR may offer deeper understanding of the plant diversity associated with these specialized habitats. Ultramafic forests are often seen as delicate and ecologically vulnerable habitats due to their narrow distribution and the unique adaptations of their flora. There should be more efforts to protect the ultramafic habitats of the VAMR to maintain the rare and unique plant biodiversity they harbor.

Expand geographic and taxonomic coverage in future botanical studies, conduct more ethnobotanical studies, and focus more on the ultramafic habitats can contribute to a deeper understanding of plant diversity, traditional ecological knowledge, and conservation needs within VAMR. This will ultimately inform a more effective management, protection, and conservation of the Victoria-Anepahan Mountain Range in the island of Palawan, Philippines.

The VAMR harbors exceptional plant diversity and endemism, emphasizing its importance as a key biodiversity area in Palawan. However, research efforts over the past 25 years have been uneven, with heavy emphasis on species discovery in select habitats while large geographic, taxonomic, and ethnobotanical gaps remain. The high number of

threatened and potentially at-risk species highlights the urgent need for expanded surveys, comprehensive assessments, and conservation actions. Strengthening research in understudied areas, integrating traditional ecological knowledge of the Tagbanua people, and prioritizing ultramafic forests are essential for building a more complete understanding of VAMR's flora and ensuring its long-term conservation.

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There are no human or animal subjects in this article and informed consent is not applicable.

DECLARATION OF COMPETING INTEREST

The authors declare that there are no competing interests among the authors.

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