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SPECIES INVENTORY AND NEW DISTRIBUTION RECORDS OF MACROLICHENS IN MT. MAYO RANGE, DAVAO ORIENTAL, PHILIPPINES

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Abstract
Macrolichens are of global study interest because of their capacity to indicate ecological health. They serve as valuable indicators of the impacts of biodiversity loss and climate change across various ecosystems. However, lichenological studies in the Philippines are sporadic, especially in Mindanao, where there are limited human and financial resources for biodiversity research. The present study provides the first-ever species inventory of macrolichens in a biodiversity hotspot, the Mt. Mayo Range in Davao Oriental, Mindanao Island, Philippines. The quadrat and alpha taxonomy methods were conducted in montane and dipterocarp forests at an elevation range of 740 to 1,290 meters above sea level (m.a.s.l.) in 2022. Fifty-nine macrolichen species, belonging to 17 genera and 8 families, were documented. Many of these species are foliose and thrive on tree bark. Of the documented species, five are new records for the Philippines: *Leptogium milligranum* Sierk, *Lobaria spathulata* (Inumaru) Yoshim, *Sticta diversa* (Stirt.) Zahlbr., *Peltigera pruinosa* (Gyeln.) Inumaru, and *Polyblastidium propaguliferum* (Vain.) Kalb. The highest Shannon diversity index is recorded in the montane forests (H'=3.18), followed by the dipterocarp (H'=2.90), and the lower dipterocarp forests (H'=2.78). The Sørensen similarity index also reveals high species overlap (C_s=0.52) between the montane and dipterocarp forests. This paper highlights the importance of recognizing Mt. Mayo as a protected landscape and a crucial habitat for macrolichens. Community education and engagement of local and indigenous communities must be undertaken to inform conservation goals. The establishment of a local herbarium is deemed necessary to preserve macrolichens for education, research, and conservation purposes.

Keywords*:* biodiversity, Eastern Mindanao Biodiversity Corridor, lichens, Southeast Asia, taxonomy.

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INTRODUCTION

Macrolichens are a distinctive group of lichens, characterized by their large and easily visible thalli. They are symbiotic organisms consisting of fungi, photosynthetic cyanobacteria, or green algae, along with associated bacterial communities. This mutualistic association enables the fungi to obtain photosynthetic products and organic nitrogen from their photoautotrophic partners (Rascio & La Rocca 2013). Macrolichens are well-adapted to extreme environmental conditions, such as high altitudes, prolonged droughts, and nutrient-poor substrates. They commonly thrive in various substrates, including soil, rocks, tree bark, and the leaves of vascular plants. Their prominent size and complex forms (e.g., foliose and fruticose) distinguish them from smaller, crust-like lichens. These resilient organisms play a crucial role in ecosystem stability and serve as bioindicators of environmental pollution (Shukla et al. 2013, Perlmutter et al. 2018).

Globally, approximately 25,000 species of lichens have been identified (Chapman 2009). Despite the vast diversity of lichens in tropical regions, limited information is known about them in the Philippines (Azuelo & Puno 2018, Paguirigan et al. 2020). The Philippine lichen diversity remains underexplored and is considered among the poorest known in the world in terms of taxonomy and systematics (Bawingan et al. 2017, Paguirigan et al. 2020). Paguirigan et al. (2020) provided a comprehensive checklist of 1,234 validated species in the country, many of which belong to the genera *Graphis, Usnea, Porina, Leptogium,* and *Parmotrema*. It is important to acknowledge that many of these species may be undergoing silent extinction due to increasing anthropogenic threats that heavily impact their natural habitats.

The Mt. Mayo Range is one of the few remaining intact forests within the Eastern Mindanao Biodiversity Corridor (EMBC). It is characterized by rough terrain and steep slopes towering up to around 1,727 meters above sea level (m.a.s.l.). Being a biodiversity-rich area, it serves as a bioecological sanctuary for rare, unique, and threatened fauna and flora. Currently, this mountain range is not included in the legislated national protected areas in the Philippines, making its protection, conservation, and management extra challenging. Additionally, this region remains highly unexplored, presenting a great potential for scientific discoveries and necessitating an intensified environmental conservation effort (Canakan et al. 2022). There is a need to expand the biological collection and documentation of macrolichens to pursue appropriate conservation undertakings (Bawingan et al. 2017, Dela Tina-Picaza & Picaza 2023).

This study presents the first comprehensive list of macrolichen species found in the Mt. Mayo Range, Davao Oriental, Mindanao Island, Philippines, along with data about their distribution, diversity, and microhabitat preferences. The paper also reports new distribution records of macrolichens within the country, underscoring the importance of the mountain range as a biodiversity hotspot. The findings serve as a valuable baseline for assessing the ecological value of Mt. Mayo Range and contribute to an improved understanding of its hidden biodiversity. This information is critical for informing biodiversity monitoring, environmental planning, and conservation initiatives aimed at preserving the remaining biological frontiers of the Philippines.

MATERIALS AND METHODS

Sampling stations

Figure 1 illustrates the research stations located in the Mt. Mayo Range, in Barangay Ompao, Tarragona, Davao Oriental. Renowned among local hikers for its picturesque scenery, the mountain stands taller than the Mt. Hamiguitan Range Wildlife Sanctuary, a UNESCO World Heritage Site in the same province. It is home to the charismatic *Rafflesia mira* Fernando & Ong, 2005, and *Pithecophaga jefferyi* Ogilvie-Grant, 1896. The peak rises to an elevation of around 1,727 m.a.s.l., characterized by rugged terrain and very steep slopes. It serves as a headwater of significant river systems, providing clean and high-quality freshwater that sustains a rich diversity of aquatic life.
Station 1 is located at an altitude of at least 1,274 m.a.s.l. with an average ground temperature of 22°C to 24°C. This montane forest is characterized by several species of mosses, ferns, epiphytes, and hardwood trees. Numerous macrolichens in this area were found in litter, dead logs, fallen twigs, dried leaves, and humus-rich soil. This station is characterized by steep slopes, limited sunlight exposure, and frequent cloud cover or mist, creating a microclimate conducive to lichen growth.
Station 2 is located at an elevation of at least 981 m.a.s.l. The recorded average temperature ranges from 25°C to 27°C. This dipterocarp forest is characterized by vertically prominent hardwood trees, shrubs, ferns, and grasses. Some species of bryophytes and lichens are documented on large rocks and moist soil. Dead logs, litter, fallen twigs, and freshly cut trees are also observed at the station. There is enough sunlight to support the rich biodiversity in the area.

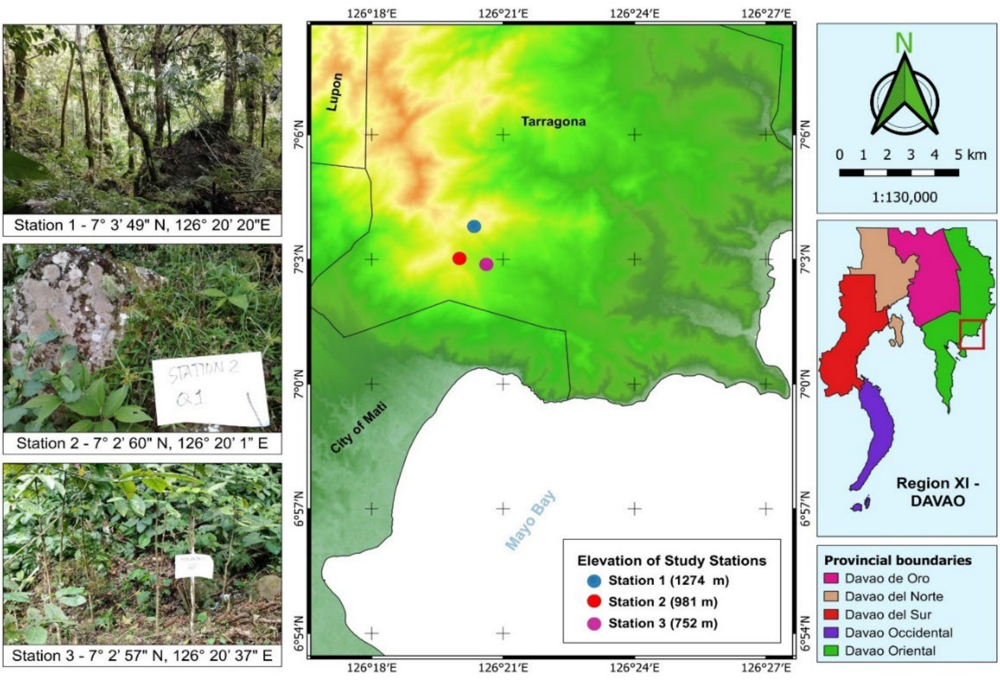

Figure 1. Study sampling stations: Station 1 (Montane Forest), Station 2 (Dipterocarp Forest), and Station 3 (Lower Dipterocarp Forest) in the Mt. Mayo Range, Davao Oriental, Philippines. Image courtesy: Maria Fe M. Dumaran.

Station 3, located within a lowland dipterocarp forest at an elevation of at least 752 m.a.s.l., is characterized by a warm and stable temperature averaging around 28°C throughout the day. The area features a mixture of native tall hardwood species alongside cultivated coffee and cacao trees. Several species of macrolichens, mosses, and ferns are observed thriving on rocks and soil. Macrolichens are also found colonizing forest floor materials, including litter, dead logs, fallen twigs, and dried leaves. The forest canopy allows sufficient sunlight to reach the ground, supporting a diverse understory.

Entry protocol

The researchers coordinated with the Municipal Environment and Natural Resources Office (MENRO) of the Local Government Unit of Tarragona in the Province of Davao Oriental. The Local Chief Executive issued a permit, allowing the research team to implement this project in the identified study stations. A Wildlife Gratuitous Permit (WGP No. XI-2021-16) was also secured from the Department of Environment and Natural Resources Regional Office XI (DENR XI). This project underwent the scrutiny of the Graduate School of the Bukidnon State University prior to implementation. The project design and methods were approved by the dissertation panel.

Quadrat method and alpha taxonomy

The inventory and assessment of macrolichens were conducted using the quadrat method combined with alpha-taxonomic sampling across different forest vegetation types. Sample species were collected and recorded along established trails following the methodology of Azuelo (2010). In each sampling location, a 20 m x 20 m plot was established, subdivided using a calibrated rope into 5 m x 5 m quadrats for systematic sampling (Amoroso and Aspiras, 2011). Lichen specimens were collected from various microhabitats, including tree bases (up to 1.5 meters above ground), decaying logs, fallen branches, dried leaves, rocks, and soil.

A handheld Global Positioning System (GPS) device was used to record the elevational data of each sampling station. The researchers employed a purposive sampling method in the selection of sampling stations, which were strategically located on the northern and eastern slopes of the Mt. Mayo Range. These orientations were chosen due to their exposure to varying sunlight intensities, a factor considered influential in the distribution and abundance of lichen species (Sales et al. 2016).

Collection and preparation of herbarium specimens

Macrolichens, being readily visible in the field, were collected and identified based on morphological features. A 10x magnification hand lens was utilized in examining the characteristics of macrolichen species. For specimens growing on rock surfaces, a hammer and beveled-edge chisel were used to collect samples along with their substrates. Macrolichens were typically collected with their substrate intact to preserve structural features essential for identification. Only specimens loosely attached to the substrate were scraped off directly. A minimum of two thalli per species was collected to ensure sufficient material for both microscopic and chemical analyses. Special care was undertaken to preserve the integrity of the thalli, particularly the margins, which are critical for morphological assessment.

Field materials included polyethylene packets (i.e., 6 in x 12 in), rubber bands, labeling stickers, plant press, blotting papers, nylon ropes, collecting bags, a handheld GPS device, a field notebook, and writing tools. Collected specimens were initially placed in labeled polyethylene packets and secured with rubber bands. These packets were then transferred to larger collection bags for transport. To prevent fungal contamination and discoloration of thalli, specimens were later transferred to blotting papers. Species collected from wet barks were placed in paper packets to prevent curling and preserve their form for herbarium mounting.

Herbarium packets were prepared using thick, white, or brown paper. The packets measured approximately 7 in x 5 in, with a 3.5-inch flap for affixing the label. Labels included information, such as the family and species name, locality, altitude, GPS coordinates, collection date, reference number, name of the collector, substrate type, and other notable field remarks. The name of the identifier and the date of identification were added later in the laboratory.

Dried specimens were mounted on thick paperboards, around 6.5 in x 4.5 in, slightly smaller than the herbarium packets. Each board was labeled with the same reference number as the packet to ensure consistency, then inserted into the herbarium packets. Only specimens of a single species were placed in each packet for easy reference. Completed packets were then organized in rectangular boxes and stored in wooden cupboards. All specimens were deposited at the Bukidnon State University - Botanical Gardens and Herbarium. Duplicates were also retained by the lead author.

Species identification

Species identification commenced with categorizing the collected lichen specimens based on their growth forms (i.e., foliose and fruticose) and the types of fruiting bodies present (i.e., apothecia, perithecia, or sterile forms). The identification process primarily relied on morphological, anatomical, and chemical characteristics, following the guidelines outlined by Nayaka (2014). Philippine macrolichen taxonomic keys from various published sources were also referenced, including the works by Bawingan et al. (2017), Fajardo and Bawingan (2019), Joshi et al. (2018), and Paguirigan et al. (2020). These references were essential in ensuring accurate species identification, especially since morphoanatomical traits vary significantly across genera and groups.

Further analysis involved microscopic examination and chemical spot tests to detect unique lichen substances. These tests included the K test, which uses a 10% aqueous solution of potassium hydroxide (KOH) or, alternatively, sodium hydroxide (NaOH). The C test was also employed using a 5.25% sodium hypochlorite solution or undiluted household bleach. Lastly, the researchers conducted the P test, which used an ethanolic solution of para-phenylenediamine prepared by dissolving a few crystals in 70 to 95% ethanol. These reagents were used to induce chemical reactions critical for distinguishing between closely related lichen species.

The collected specimens were pre-identified by the researchers and were confirmed by experts from Central Mindanao University, Bukidnon State University, and St. Louis University. A certification from the Lichenological and Bryological Society of the Philippines was obtained to ascertain the accuracy of species identification.

Data analysis

Species diversity and the similarity indices were analysed for the macrolichen species collected in the study areas. The species diversity was computed using the Shannon-Wiener Diversity Index (H'), accounting for both the abundance and evenness of species within each study station. On the other hand, the Sørensen Similarity Index (C_s) was calculated to evaluate the overlaps in species composition between different stations. This index emphasizes the number of species common between study stations, providing insights into the degree of similarity in macrolichen assemblages. The researchers also performed a t-test, determining the significant differences in the species diversity values. These statistical analyses were undertaken using the open-source PAleontological STatistics (PAST) tool (Hammer, Harper & Ryan, 2001). Graphical representations were used to illustrate species composition, altitudinal distribution, and microhabitat preferences. The Alluvial

Diagram was generated through RAWGraphs 2.0, an open-source analytical tool. The maps were prepared using QGIS, and images were enhanced using CorelDRAW 2024.

RESULTS

Macrolichen species in Mt. Mayo Range

In the Mt. Mayo Range, a collection of 59 macrolichens species was recorded, representing 8 families and 17 genera (Appendix 1). The family Parmeliaceae exhibited the highest species count, totaling 25 species (42.37%). Following closely, Lobariaceae and Physciaceae each comprised 12 species (20.33%), while Collemataceae, Pannariaceae, and Coccocarpiaceae contributed 4 (6.77%), 3 (5.08%), and 2 species (3.38%), respectively. Peltigeraceae was represented by a single species (1.69%).

Figure 2. New records of macrolichens in the Philippines documented in Mt. Mayo Range, Davao Oriental: (A) *Polyblastidium propaguliferum* (Vain.) Kalb, (B) *Peltigera pruinosa* (Gyeln.) Inumaru, (C) *Lobaria spathulata* (Inumaru) Yoshim, (D) *Sticta diversa* (Stirt.) Zahlbr., and (E) *Leptogium milligranum* Sierk. Image Courtesy: Maria Fe M. Dumaran.

Sixteen species were collected from lower elevation areas, ranging from 740 to 850 m.a.s.l., while 46 species were collected from 870 m.a.s.l. and above. Interestingly, some species were found in both lower and upper montane elevations. These six species are *Leptogium milligranum* Sierk (Collemataceae), *Sticta marginifera* Mont. (Lobariaceae), *Physma byrsaeum* Mull. Arg (Pannariaceae), *Usnea himalayana* C. Bab., *Usnea* cf. *subfloridana* (Parmeliaceae), and *Polyblastidium japonicum* (M. Sato) Kalb.

In the upper elevation (870 to 1290 m.a.s.l.), the majority of the macrolichens collected were *Usnea* spp. and *Parmotrema* spp. from the family Parmeliaceae, which accounted for 43% of the species. The genus *Pseudocyphellaria* of the ^^family Lobariaceae accounted for 22%, followed by the genus *Heterodermia* and *Polyblastidium* of the family Physciaceae at 15%. Three species were collected in the family Collemataceae and Pannariaceae (7%), two species in Ramalinaceae (4%), and only one species in Peltigeraceae (2%).

The present study also introduces new country records of macrolichens (Fig. 2), indicating that these species have not been previously documented in the Philippines. The newly recorded macrolichens include *Polyblastidium propaguliferum* (Vain.) Kalb, *Peltigera pruinosa* (Gyeln.) Inumaru, *Lobaria spathulata* (Inumaru) Yoshim, *Sticta diversa* (Stirt.) Zahlbr., and *Leptogium milligranum* Sierk. These records contribute to the expanding knowledge of lichen diversity in the Philippines, underscoring the critical need for intensified research and conservation initiatives.

Growth forms and substrates of macrolichens

Figure 3 illustrates that the majority of macrolichens collected in the sampling areas are foliose (69.49%), followed by fruticose (27.12%). One macrolichen species exhibits a squamulose growth form, particularly the *Phyllopsora* sp., while the *Lepidocollema* cf. *marianum* (Fr.) P.M. Jørg. has a foliose to squamulose growth form. Meanwhile, the substrates indicate the microhabitat preferences of macrolichens. Most of the macrolichens are from tree barks (64.41%), rocks, twigs, fallen twigs, and decaying logs. Some macrolichens are found in more than one substrate, such as the *Crocodia aurata* (Ach.) Link, *Lobaria hartmannii* (Müll.Arg.) Zahlbr., *Lobaria meridionalis* Vain., *Pseudocyphellaria argyracea* (Delise) Vain, which were collected from tree bark and twigs. A few species were collected from decaying logs, including the *Parmotrema* aff. *Robustum, Parmotrema subsumptum* (Nyl.) Hale, and *Sticta marginifera* Mont.

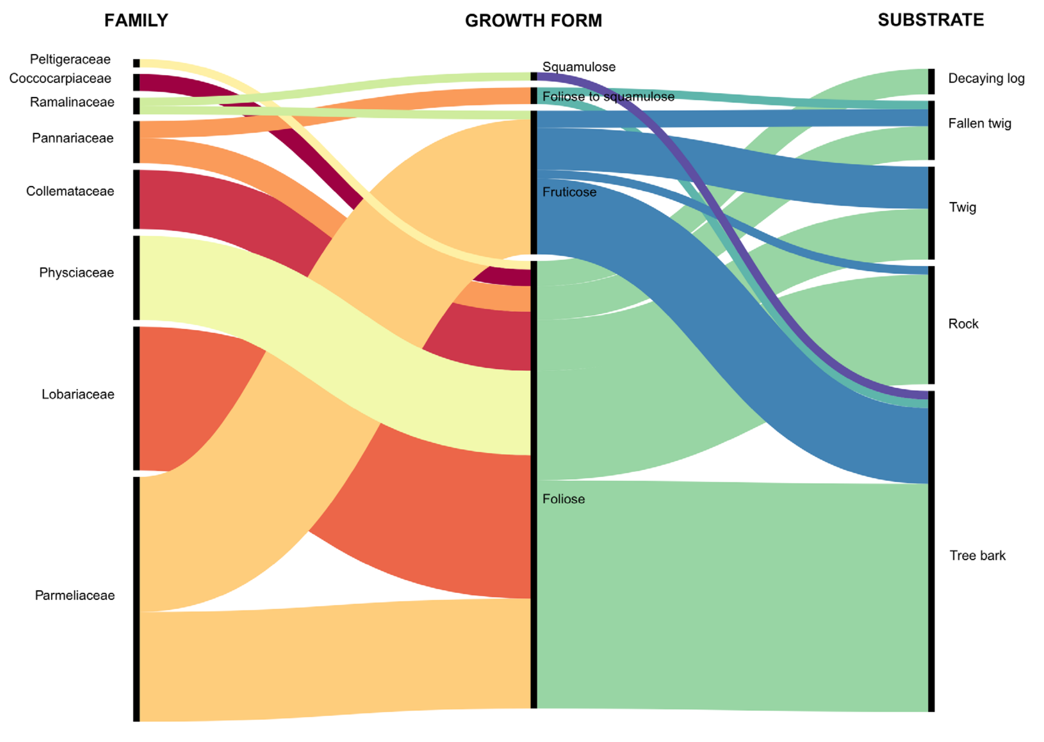

Figure 3. Growth forms and substrates of macrolichens in Mt. Mayo, Davao Oriental, Philippines.

Lichen diversity and similarity indices

Stations 1 and 2 recorded the highest similarity index at 52.17%, indicating a high degree of overlap between the species present at these areas. This is followed by Stations 2 and 3 with a similarity index of 21.05%. In contrast, Stations 1 and 3 exhibit the lowest index of similarity at 4.76%. Furthermore, the recorded species diversity is highest in Station 1 with a diversity index of 3.18, indicating a rich variety of species. Station 2 follows closely with a diversity index of 2.90, while Station 3 has a slightly lower diversity index of 2.78. There are no significant differences in the macrolichen species diversity in different elevations based on the computed p-values (Tab. 1).

Table 1. Diversity and similarity indices of macrolichens in Mt. Mayo Range, Davao Oriental, Philippines.

Stations	Common Species	Number of Species		Index	Percentage Similarity	Diversity t-test	p-value
		N1	N2	Similarity			
1 and 2	12	25	21	0.52	52.17%	-1.03	0.3
1 and 3	1	25	17	0.05	4.76%	-0.99	0.3
2 and 3	4	21	17	0.21	21.05%	-0.06	0.9

DISCUSSION

The study findings reveal that the forest vegetation and altitude in the Mt. Mayo Range support a rich diversity of macrolichens, particularly from the family Parmeliaceae, which includes *Usnea* spp. The study areas are relatively forested, keeping temperatures low and creating ideal conditions for both foliose and fruticose lichens. As Giordani and Brunialti (2015) noted, lichen physiology is interlinked with macro- and microclimatic factors, such as relative humidity and precipitation. In this study, the majority of the macrolichens collected are foliose (69.49%), characterized by leaf-like structures, while 27.12% are fruticose, including 15 *Usnea* spp. and a *Ramalina* sp. The data also indicate that macrolichen species composition varies across different elevational ranges, as reflected by the differing similarity indices (Tab. 1).

The documented macrolichens grow on several substrates, including tree trunks, decaying logs, fallen branches, twigs, and rocks. These microhabitats are typically characterized by adequate moisture and sufficient sunlight exposure, which pertains to the conditions favouring lichen colonisation. This result emphasizes the importance of protecting the forest ecosystems of Mt. Mayo Range, as this creates a microclimate essential for the survival of macrolichens. Azuelo and Puno (2018) similarly identified fallen branches, tree bark, and decaying logs as the commonly inhabited substrates for lichens. Fruticose lichens were found to be more diverse at higher altitudes, as reported in the studies by Galinato et al. (2017) and Robison et al. (2022). The occurrence of *Usnea* spp. at the sampling stations may be influenced by elevation-related factors, particularly the increased humidity, which provides the moisture needed for lichen growth (Santiago et al. 2021).

The abundance of foliose lichens, such as the *Coccocarpia* spp., *Parmotrema* spp., *Lobaria* spp., and *Physcia* spp., among others, can be attributed to the pristine air quality and high humidity at the Mt. Mayo Range. High elevation sampling stations host the most diverse lichen communities, while lower altitudes were dominated by species from families such as Lobariaceae and Pannariaceae, with rocky soil and partially shaded, dry-air environments. This finding was supported by Borge and Ellis (2024), stating that sunlight exposure and hydration promote lichen growth and diversity. Also, the type and number of microhabitats, such as large trees and decaying logs, are significant predictors of lichen diversity (Azuelo & Puno 2018). According to Vicol (2016), lichen species presence is strongly related to both macrohabitat factors, like elevation and host trees, and microhabitat features, such as moss cover.

Table 1 shows the similarity and diversity indices of macrolichens across sampling stations. The highest similarity index of 0.52 was found between Stations 1 and 2, while the lowest was between Stations 1 and 3 (C_s=0.05). These indices provide insights into the mechanisms driving the community assembly of macrolichens. The similarity in species composition between the montane and dipterocarp forests, particularly in the Parmeliaceae family, suggests that altitude and temperature play significant roles in shaping species distribution. The average temperature during sampling was 25°C, with 90% relative humidity, conditions that favour foliose lichen growth (Abas & Din 2021). Environmental factors such as temperature, light intensity, and humidity are reported to be essential for the growth and distribution of lichens (Khastini et al. 2019). Lichen diversity in tropical regions is most abundant at higher elevations, such as montane forests and mountain ecosystems (Chongbang et al. 2018). It was also documented that lichen diversity and distribution are influenced by environmental factors and forest structure (Sevgi et al. 2019; Abas & Din, 2020, Abas & Din 2021).

Many macrolichen species, such as *Parmotrema mellissii,* are sensitive to air pollution and are typically found in pristine environments (Abas & Din 2020, Abas & Din 2021). In this study, both Stations 1 and 2 are dominated by *Parmotrema* spp. and *Usnea* spp., while *Peltigera pruinosa* is found at Station 1 with a 2% coverage. As previously reported by Zúñiga et al. (2017), species under the genus *Peltigera* are primarily terrestrial or moss-dwelling, rarely growing on rocks or tree bark. Families with cyanobacteria as photobionts, such as Collemataceae and Lobariaceae, were more common in humid forests (Balaji & Hariharan 2013).

While there is no significant difference in the species diversity across the three sampling stations, it can be deduced that the Mt. Mayo Range provides a favourable environment for the growth and diversity of macrolichens across different elevational gradients. Despite the differences in elevation, there was no significant variation in species composition across the sampling stations, indicating that macrolichens are common throughout the area. In this paper, the highest species diversity was observed at Station 1 (H'=3.18), followed by Station 2 (H'=2.90), and Station 3 (H'=2.78), based on the Shannon-Weiner Index. These diversity index values suggest that macrolichens are well-adapted to the topographic conditions within the Mt. Mayo Range.

Meanwhile, new records of five macrolichen species in the Mt. Mayo Range are reported for the first time in the Philippines. These species are: *Polyblastidium propaguliferum* (Vain.) Kalb, *Peltigera pruinosa* (Gyeln.) Inumaru, *Lobaria spathulata* (Inumaru) Yoshim, *Sticta diversa* (Stirt.) Zahlbr., and *Leptogium milligranum* Sierk. The discovery of these previously undocumented macrolichens adds to the known biodiversity of the Philippines, particularly in the understudied Mindanao island. In addition, a few macrolichens could not be identified to the species level, including *Usnea* spp., *Phyllopsora* sp., and *Ramalina* sp. Some could only be identified as "aff.", or affinis (similar to), and "cf.", or confer (compare with), such as the *Parmotrema* aff. *elacinulatum* and *Usnea* cf. *articulata* (L.) Hoffmm, indicating varying degrees of uncertainty level in species identification. Further taxonomic works are needed to better understand macrolichen diversity and ecology in the study locale. These findings highlight Mt. Mayo Range as a biodiversity hotspot, serving as an important habitat for rare and ecologically important species. Consequently, this new scientific data serves as a critical baseline for further ecological studies and conservation planning. Species listings such as this are pivotal to combat silent extinction, especially in light of land use changes due to mining and timber poaching in the locality.

To effectively conserve the macrolichens, it is pivotal to designate protected areas and conservation zones that safeguard their natural habitats within the Mt. Mayo Range. This could involve designating forested areas as off-limits to humans and enforcing policy frameworks to minimize anthropogenic disturbances. Additionally, conducting regular monitoring and research activities, such as population surveys, ecological studies, and habitat assessments, could provide valuable data to assess the population trends of macrolichens. This information can inform conservation strategies and help identify potential threats to lichen communities, allowing for proactive intervention (Taer et al. 2023).

Furthermore, raising public awareness about the ecological significance of macrolichens and the fragile ecosystems they inhabit is essential. Educational initiatives, interpretive signages, and outreach programs could build engagement with local communities, hikers, and visitors, promoting responsible behaviours and reducing human impact on biodiversity (Marschall et al. 2017, Tumbaga et al. 2021, Gayo et al. 2024). Promoting regenerative futures practices in forest management practices is also crucial, as it will help restore denuded forests and ensure the preservation of suitable habitats for biodiversity (Ponce & Villegas 2022). This could involve implementing forest management practices that consider the conservation needs of macrolichens and prioritize the maintenance of their habitats.

Lastly, collaborating with local authorities, conservation organizations, and research institutions to develop and implement tailored conservation strategies is also paramount (Canakan et al. 2022). This collaborative approach can facilitate the exchange of expertise, resources, and knowledge, leading to effective conservation measures that address the specific needs of macrolichen species. By integrating multi-stakeholder perspectives into conservation goals, the preservation and long-term sustainability of the rich macrolichen diversity in the Mt. Mayo Range could be ascertained.

CONCLUSIONS

The findings of this study reveal that the Mt. Mayo Range in Davao Oriental, Mindanao Island, Philippines, harbours a remarkably rich diversity of macrolichen species. A total of 59 species is documented, belonging to 17 genera and 8 families. Notably, five species are newly recorded in the Philippines, underscoring the presence of previously undocumented macrolichen diversity and reinforcing the scientific importance of this biodiversity corridor.

This diversity reflects the unique ecological value of Mt. Mayo Range and positions it as a critical habitat for macrolichens. The results emphasize the urgent need to recognize Mt. Mayo Range as a protected landscape to ensure the long-term survival and sustainability of the diverse macrolichen species inhabiting the area. Conservation measures are imperative, especially in light of increasing environmental pressures and habitat degradation induced by anthropogenic activities.

Moreover, the discovery of new national records underscores the potential for further scientific exploration in the area, documenting not only the macrolichen diversity but also other wild fauna and flora. This calls for expanded research efforts and collaborative undertakings at the local and international levels. Also, the study emphasizes the necessity of engaging local and indigenous communities through community education and public awareness programs. This effort is critical to promote the ecological value of the

Mt. Mayo Range and champion multi-stakeholder support for conservation.
The establishment of a local herbarium is strongly recommended to support ongoing research and conservation efforts. This facility would serve as a valuable repository for macrolichens and other plant specimens. The primary goal is to preserve specimens for educational, scientific study, and biodiversity monitoring in the country.

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Appendix 1. List of macrolichen species in Mt. Mayo Range, Davao Oriental, Philippines. *Note: (+) present, (-) absent, *new records in the Philippines.*

Family	Species Name	Elevational Distribution (m.a.s.l.)		Growth Form	Substrate
		740-850	870-1290		
COCCOCARPIACEAE	*Coccocarpia erythroxyli* (Sprengel) Swinscow & Krog	+	-	Foliose	Tree bark
	Coccocarpia glaucina Kremp	+	-	Foliose	Tree bark
COLLEMATACEAE	*Leptogium azureum* Mont	-	+	Foliose	Tree bark
	Leptogium cyanescens (Pers.) Körb	+	-	Foliose	Tree bark, rock
	**Leptogium milligranum* Sierk	+	+	Foliose	Tree bark
	Leptogium phyllocarpum (Pers.) Mont.	-	+	Foliose	Tree bark
	Crocodia aurata (Ach.) Link	-	+	Foliose	Tree bark, twig
LOBARIACEAE	*Lobaria hartmannii* (Müll.Arg.) Zahlbr.	-	+	Foliose	Tree bark, twig
	Lobaria meridionalis Vain	-	+	Foliose	Tree bark, twig
	**Lobaria spathulata* (Inumaru) Yoshim	-	+	Foliose	Tree bark
	Pseudocyphellaria argyracea (Delise) Vain	-	+	Foliose	Tree bark, twig
	Pseudocyphellaria cf. *gilva*	-	+	Foliose	Tree bark
	Pseudocyphellaria desfontainii (Delisw) Vain.	-	+	Foliose	Rock, fallen twig
	Pseudocyphellaria multifida (Nyl.) D.J.Galloway & P.James	-	+	Foliose	Tree bark
	Pseudocyphellaria neglecta (Müll.Arg.) H.Magn	-	+	Foliose	Tree bark
	Pseudocyphellae aff. *neglecta*	-	+	Foliose	Tree bark
	**Sticta diversa* (Stirt.) Zahlbr.	-	+	Foliose	Tree bark, fallen twig
	Sticta marginifera Mont.	+	-	Foliose	Tree bark, decaying log
PANNARIACEA	*Physma byrsaeum* Müll.Arg.	+	+	Foliose	Tree bark, rock

	Lepidocollema cf. *marianum* (Fr.) P.M. Jørg.	-	+	Foliose to squamulose	Tree bark, fallen twig
	Lepidocollema sp.	-	+	Foliose	Tree bark
PARMELIA-CEAE	*Parmotrema cristiferum* (Taylor) Hale	-	+	Foliose	Tree bark, twig
	Parmotrema aff. *elacinulatum*	-	+	Foliose	Tree bark
	Parmotrema grayanum (Hue) Hale	-	+	Foliose	Tree bark
	Parmotrema aff. *melanothrix*	-	+	Foliose	Fallen twig
	Parmotrema aff. *robustum*	-		Foliose	Decaying log, rock
	Parmotrema subsumptum (Nyl.) Hale	-	+	Foliose	Decaying log
	Parmotrema aff. *erhizinosum*	-	+	Foliose	Fallen twig
	Parmotrema cf. *zollingeri*	+	-	Foliose	Tree bark
	Parmotrema mellissii (C.W. Dodge) Hale	-	+	Foliose	Tree bark
	Relicina (Relicinopsis) sp.	-	+	Foliose	Tree bark, twig
	Usnea aciculifera Vain.	-	+	Fruticose	Twig
	Usnea cf. *articulata* (L.) Hoffm.	-	+	Fruticose	Tree bark
	Usnea baileyi (Stirt.) Zahlbr.	-	+	Fruticose	Tree bark
	Usnea ceratina Ach.	+	+	Fruticose	Tree bark
	Usnea diffracta Vain.	-	+	Fruticose	Fallen twig
	Usnea cf. *fuscorubens*	+	-	Fruticose	Twig
	Usnea cf. *hesperina*	-	+	Fruticose	Tree bark
	Usnea himalayana C.Bab.	+	+	Fruticose	Tree bark
	Usnea cf. *pangiana*	-	+	Fruticose	Tree bark
	Usnea rubicunda Stirt.	+	+	Fruticose	Tree bark
	Usnea cf. *shimadae*	-	+	Fruticose	Rock
	Usnea cf. *subfloridana*	+	+	Fruticose	Tree bark
	Usnea sp. 1/*Usnea* cf. *bismolliuscula*	+	-	Fruticose	Tree bark, twig
	Usnea sp. 2	-	+	Fruticose	Twig
	Usnea sp. 3	-		Fruticose	Twig
PELTIGERA-CEAE	**Peltigera pruinosa* (Gyeln.) Inumaru		+	Foliose	Rock
PHYSCIA-CEAE	*Heterodermia diademata* (Taylor) D.D. Awasthi	-	+	Foliose	Rock
	Heterodermia aff. *comosa* (Eschw.) Follmann & Redón	-	+	Foliose	Rock

	Heterodermia flabellata (Fée) D. D. Awasthi	+	-	Foliose	Rock
	Heterodermia galactophylla (Tuck.) W.L. Culb.	-	+	Foliose	Rock
	Heterodermia koyana (Kurok.) Elix	-	+	Foliose	Rock
	Leucodermia boryi (Fée) Kalb	-	+	Foliose	Tree bark
	Physcia sorediosa (Vain.) Lynge	+	-	Foliose	Rock
	Polyblastidium hypoleucum (Ach.) Kalb	-	+	Foliose	Rock
	Polyblastidium japonicum (M.Sâto) Kalb	-	+	Foliose	Tree bark
	**Polyblastidium propaguliferum* (Vain.) Kalb	+	-	Foliose	Rock
RAMALINA-CEAE	*Phyllopsora* sp.	-	+	Squamulose	Tree bark
	Ramalina sp.	-	+	Fruticose	Fallen twig