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Research Article

New records of Moss flora in Mt. Mayo range, Davao Oriental, Philippines

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ABSTRACT

Mosses are among the underexplored taxa in the Philippines, where habitat degradation continues to cause biodiversity loss. The province of Davao Oriental is known for its high species richness, rarity, and endemicity, although the majority are yet to be discovered. This study presents new records of moss flora in Mt. Mayo Range, Davao Oriental, Philippines. Alpha-taxonomy was used to assess, identify, calculate richness, and determine the conservation status of the documented species. Results revealed new records in the locality: 30 species, 17 genera, and 13 families. The local assessment revealed 18 abundant species, while 12 species are noted to be rare. In addition, three endemic species were recorded: *Ectropothecium ferruginuem* Jaeger, *Ectropothecium luzoniae* Jaeger, and *Thuidium benguetense* Broth. Ex Bartram. This study reports the first record of *E. luzoniae* in Mindanao, previously documented in the Luzon and Visayas region. Mosses were confined on the tree branches and trunks, whereas moss epiphytes thrived in decaying logs. This study provides baseline information on the previously undocumented moss diversity in the surveyed sites. Further explorations are needed to document more species and inform conservation decisions. Advancing moss conservation is also sought, especially among less-studied mountain regions in Mindanao, Philippines.

Key words: Conservation status, mosses, Mt. Mayo Range, Philippines, species richness

INTRODUCTION

Mosses are widely distributed globally and occupy a broad range of habitats. They rarely are isolated floral individuals but instead occur in populations or colonies in characteristic growth forms, such as mats, cushions, turfs, or wefts. Extensive morphological and anatomical diversification characterizes them in both gametophyte and sporophyte organization. Taxonomic surveys have been extra challenging over the years among moss flora. At present, only around 15,000 species have been described, although new species are continuously being explored (Sabovljević, Vujičić & Sabovljević, 2014; Azuelo, Sariana, & Pabualan, 2010).

Notably, mosses are biological indicators, especially in ecological health, microclimate regulation, and understory vegetation. They also provide food and habitat to many invertebrates, while many species have ethnomedical applications to indigenous communities in the Philippines (Azuelo et al., 2011; Azuelo et al., 2016; Bates, 2000).

However, unsustainable practices pose threats to the already dwindling moss diversity. Deforestation, conversion of forests to agricultural lands, rapidly changing cultivations, and overcollection are among the top factors affecting the species. Consequently, many species have become extinct before they are documented (Amoroso & Aspiras, 2010). Intensive explorations have been conducted in some parts of Bukidnon, Mindanao Island, but many regions remain data deficient (Azuelo, Sariana, & Pabualan, 2010; Lubos, 2010; Tan et al., 2015; Tan et al., 2017). This report underscores the urgency of taxonomic assessment and diversity surveys, especially in unexplored biogeographical regions in the Philippines.

The researchers undertook the first taxonomic survey and assessment in Mt. Mayo Range, Davao Oriental, Philippines. The province is known for its rich biodiversity; however, no moss records have been established. This study aims to document species, determine the species richness, and ascertain the conservation status of moss flora in the surveyed sites.

MATERIALS AND METHODS

Study Area

The range is divided into several mountain sites, Mt. Magyubo-Yubo, Mt. Kasiling-Dako, and Mt. Tindok. The moss species were collected at the cloud montane forest situated at Mt. Magyubo-Yubo at 1,350 meters above sea level (masl).

Field Sampling

The inventory and assessment of moss species were done through a transect walk or alpha taxonomy within a montane forest. One-shot sampling was conducted on

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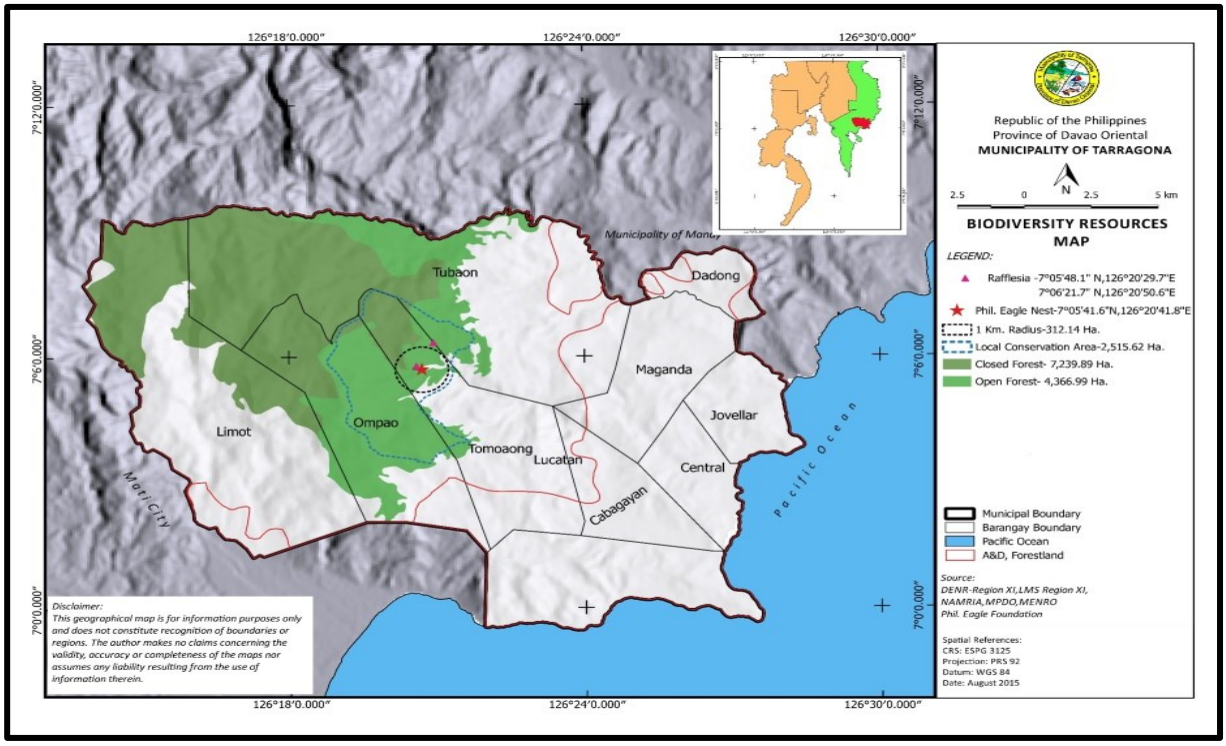

Figure 1. Biodiversity Resources Map of Mt. Mayo Range, Davao Oriental, Philippines. (Source: LGU Tarragona)

December 2018. Specimens were collected randomly along the transect line within the surveyed sites. Also, a handheld global positioning system (GPS) was used to record the spatial locations of the collected samples, and the microhabitats were recorded properly (Azuelo & Puno, 2018).

Preservation of Specimen

In collecting bryophytes and preparation for herbarium specimens, the guide from Shevock et al. (2014) was utilized. The moss samples were placed directly into a small folded paper packet with field label data: altitude, collection-number, date of collection, and the ecology and associated habitats. Three (3) patches of samples were collected. The collected specimens of mosses were then air-dried and placed in packets (envelope) and appropriately labeled for herbarium vouchers.

Identification of Moss Species and Species Richness

The collected specimens were identified, classified, and morphologically described through their respective diagnostic characteristics, such as habit, habitat, leaf arrangement, stem structure, sporophyte characters, and rhizoids (Yamaguchi, 1993). The identification was made using dichotomous keys from books, scientific articles, and species comparisons from an herbarium in the Central Mindanao University (CMU). Further examinations were done through light microscopy. The final species identification was verified by an expert Bryologist. Species richness was derived based on the total number of species that were documented in the surveyed sites.

Conservation Status

The conservation status of the documented moss species was based on the categorization of the International Union for Conservation of Nature (IUCN) (2021). Categories include rare, widespread, endemic, threatened, or endangered. A systematic review of scientific journals was also conducted to establish local conservation assessments.

Ethics

A clearance from the Municipal Environmental Resources Office (MENRO) and the Mayor's Permit from the Municipality of Tarragona was secured before the conduct of the study. An Entry Protocol followed with the Barangay Officials at Barangay Ompao, Tarragona, Davao Oriental. Likewise, meetings with the local guides were conducted to inform them of the study in Mt. Mayo forest. The Department of Environment and Natural Resources (DENR) issued a Gratuitous Permit for this study.

RESULTS AND DISCUSSION

Taxonomic Survey of Moss Species

This study recorded 13 families, 17 genera, and 30 moss species. Table 1 shows 18 abundant and 12 rare species. In terms of status, three (3) endemic species were found in the study area, namely: *Ectropothecium ferruginuem* (C. Müll.) Jaeg., *Ectropothecium luzoniae* (C. Müll.) Jaeg., and *Thuidium benguetense* Broth. Ex Bartr. These three endemic species are new records in Davao Oriental (Azuelo et al., 2010). Also, *E. luzoniae* is a new distribution record in Mindanao. Previous assessments of Linis (2014) documented *E. luzoniae* in Luzon and Visayas floral regions only. Previous explorations in Mindanao revealed the diversity of the genus *Ectropothecium,* excluding the *luzoniae* species (Azuelo et al., 2018, 2016, 2011, & 2010; Lubos, 2007, & 2010; & Tan et al., 2000; Shevock & Yorong, 2018). Several moss diversity assessments have been carried out on Camiguin Island, but *E. luzoniae* was not

Table 1. Summary of Moss Species Collected in Mt. Mayo Range, Davao Oriental, Philippines.

Family	Scientific Name	Local Assessment	Status
Calymperaceae	*Syrrhopodon tristichus* Nees ex Schwaegr.	Abundant	NRL, W
Dicranaceae	*Dicranaloma blumii* (Nees) Par.	Abundant	NRL, W
	Dicranaloma braunii (C. Müll. Ex Dozy & Molk)	Abundant	NRL, W
Fissidentaceae	*Fissidins nobilis* (Griff)	Rare	NRL, W
Hypnaceae	*Ectropothecium falciforme* (Doz & Molk) Jaeg.	Rare	NRL, W
	Ectropothecium ferruginuem (C. Müll.) Jaeg.	Rare	NRL, E
	Ectropothecium luzoniae (C. Müll.) Jaeg.	Rare	NRL, E
	Isopterygium minutirameum (C. Müll.) Jaeg.	Abundant	NRL, W
	Vesicularia reticulata (Dozy & Molk) Broth.	Abundant	NRL, W
Hypnodendraceae	*Hypnodenron dendroides* (Brid.)	Abundant	NRL, W
	Hypnodendron diversifolium Broth. & Geh	Abundant	NRL, W
Leucobryaceae	*Leucobryum javense* (Brid.)	Abundant	NRL, W
	Leucobryum scalare C. Müll. Ex Fleisch	Abundant	NRL, W
Meteoriaceae	*Barbella flagellifera* (Card.)	Rare	NRL, W
	Meteorium miquelianum (C. Müll.) ex Fleisch	Rare	NRL, W
Pterobryaceae	*Pterobryopsis crassicaulis* (C. Müll.)	Abundant	NRL, W
	Pterobryopsis gedenensis Fleisch	Abundant	NRL, W
Racopilaceae	*Racopilum johannis-wenkleri* Broth	Rare	NRL, W
	Racopilum spectabile Reinw. & Hornsch	Rare	NRL, W
Rhizogoniaceae	*Pyrrhobryum latifolium* (Bosch & Lac.) Mitt	Abundant	NRL, W
	Pyrrhobryum spiniforme (Hedw.) Mitt.	Abundant	NRL, W
Spiridentaceae	Spiridens *reinwardtii* Nees	Rare	NRL, W
Sematophyllaceae	*Acroporium hamulatum* (Fleisch.) Fleisch	Abundant	NRL, W
	Acroporium johannis-wenkleri Broth.	Abundant	NRL, W
	Acroporium stramineum (Reinw. & Hornsch.) M. Fleisch	Abundant	NRL, W
	Trismegistia calderensis (Sull.) Broth	Abundant	NRL, W
	Trismegistia panduriformis (C. Wright) Broth.	Abundant	NRL, W
Thuidiaceae	*Thuidium benguetense* Broth. Ex Bartr.	Rare	NRL, E
	Thuidium cymbifolium (Dozy & Molk.)	Rare	NRL, W
	Thuidium prystocalyx (Müll. Hal.)	Rare	NRL, W

Note: NRL–New Record in terms of Locality, R–Rare, W–Widespread, E–Endemic

previously documented (Lubos, 2018; Lubos, 2015). Tadiosa and Lubos (2019) emphasized the need to conduct more moss diversity assessments to discover new species records. However, species identification has always been extra challenging due to limitations in morphological techniques. All 30 species were new taxonomic records in the locality. More scientific explorations are needed to establish a databank of moss species. There is also a growing demand to re-assess moss diversity through molecular technologies, especially in species identification.

Species Richness

The moss floral species in the Mt. Mayo Range were identified, collected, and recorded through alpha

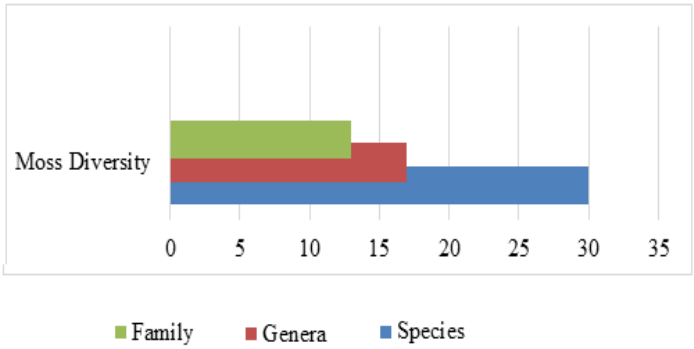

Figure 2. Diversity of Moss Species in Mt. Mayo Range, Davao Oriental, Philippines

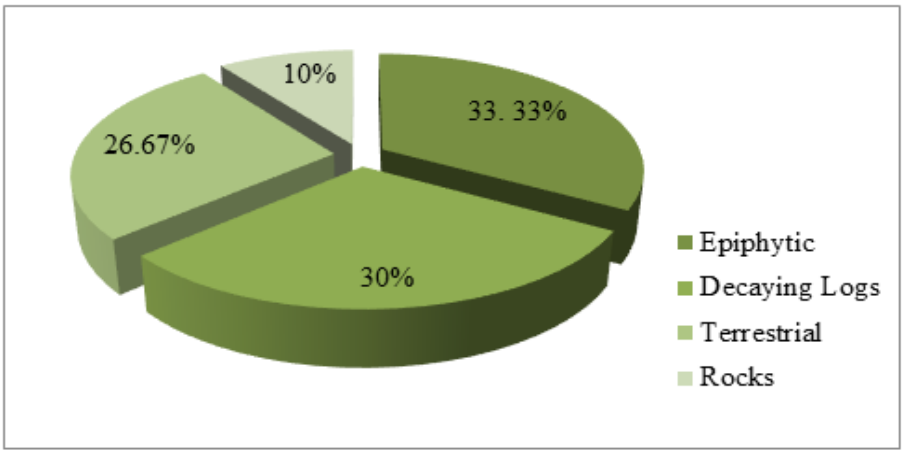

Figure 3. Habitats of Moss Species in Mt. Mayo Range, Davao Oriental, Philippines.

taxonomy (transect walk) established from lower montane to upper montane forests. Table 1 shows the number of families, genera, and species of moss collected in the surveyed sites, accounting for 13 families, 17 genera, and 30 species. The results of this study support Balanay et al. (2016) and Azuelo et al. (2010) that bryofloral species are widely distributed in the Mindanao mountains, notably the moisture-loving species. New records of moss flora were documented in a high-elevation mountain range in the Philippines. This reveals the importance of favorable climate conditions and land use intensity in moss diversity.

The collected moss species in Mt. Magyubo-Yubo, Mayo Range, Ompao, Tarragona, Davao Oriental are presented in Table 1. Hypnaceae and Symatophyllaceae are the most species-rich among the 13 families. Both families have five identified species found in the lower and upper montane forests. Hypnaceae include the following species: *Ectropothecium falciforme* (Doz & Molk) Jaeg., *Ectropothecium ferruginuem* (C. Müll.) Jaeg., *Ectropothecium luzoniae* (C. Müll.) Jaeg., *Isopterygium minutirameum* (C. Müll.) Jaeg., *Vesicularia reticulata* (Dozy & Molk) Broth. On the other hand, Symatophyllaceae has the following species: *Acroporium hamulatum* (Fleisch.) Fleisch, *Acroporium johannis-wenkleri* Broth., *Acroporium stramineum* (Reinw & Hornsch.) Fleisch, *Trismegistia calderensis* (Sull.) Broth, and *Trismegistia panduriformis* (C. Wright) Broth. It is estimated that many moss species remain undocumented in the study areas, prompting bryologists to conduct further assessments.

Habitat Use

Figure 3 shows the habitat of the documented moss species. As reflected, 33.33% of the documented mosses are epiphytic, inhabiting tree branches, trunks, and bases. Also, 30 % thrived in decaying logs, 26.7 % in soil or terrestrial habitats, and 10% on the rocks. The result of this study is consistent with the previous survey of Azuelo et al. (2010) on the diversity and ecological status of bryophytes in Mt. Kitanglad, Bukidnon, which revealed that many species were epiphytic or found on tree trunks and branches. This finding emphasizes that bryophyte assemblages are influenced by the vegetation structure and ecological conditions (Azuelo et al., 2016; Sales et al., 2016; Toro Manriquez et al., 2020). Habitat data are essential in designing conservation measures for mosses. Further studies must be conducted to integrate vegetation, canopy characteristics, and other geographical data (Sun et al., 2013; Toro Manriquez et al., 2020). There is a need to design holistic forest management strategies to ensure effective moss conservation. This presents an extra challenge for Philippine conservationists as anthropogenic pressures continuously threaten forest resources.

Conservation of Moss Flora

The diversity of moss flora is highly dependent on specific environmental conditions. Mezaka et al. (2021) reported that forest stand age and area impact Latvia's diversity of epiphytic mosses. It was also documented that land use intensification reduces bryophyte diversity (Buzhdygan et al., 2020; Boch et al., 2018). Forest and landscape use are rapidly changing with the increasing threats of deforestation in the Philippines. Forest cover in the Mt. Mayo Range was significantly reduced for agricultural production. Consequently, the diversity of moss flora has been adversely impacted, with many species getting extinct without scientific documentation. Taxonomic surveys are of paramount importance to establish baselines on moss flora in understudied regions in the country. Establishing a herbarium would also ensure that moss specimens are preserved in a controlled facility. Lastly, utilizing contextualized learning materials on moss diversity, especially in primary and higher education institutions, could significantly improve conservation education programs.

CONCLUSION

A total of 13 families, 17 genera, and 30 species of mosses were documented in Mt. Mayo Range, Davao Oriental, Philippines.The present study reports insufficient data on the overall moss diversity. However, the dearth of surveys emphasizes the importance of this pioneering work as a potential ground for further scie ntific explorations. The families Hypnaceae and Symatophyllaceae are the most species-rich among the 13 families. Also, species data on the local assessment revealed 18 abundant and 12 rare species. Three are endemic species, namely, *Ectropothecium ferruginuem* (C. Müll.) Jaeg., *Ectropothecium luzoniae* (C. Müll.) Jaeg. and *Thuidium benguetense* Broth. Ex Bartr. Thirty were found as new records in the locality, and 27 species were widespread. This study revealed that 33.33% of the mosses are found in tree branches, trunks, and base

or epiphytic, 30 % thrived in decaying logs, 26.7 % inhabited soil, and 10% were confined in soil and on the rocks. This new record underscores the importance of bryological studies, specifically on mosses, in the Philippines, where habitat degradation is pacing faster than conservation initiatives.

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