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Bryophytes Flora in Forest Patch of President Roxas, Cotabato, Philippines

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A B S T R A C T

This study was conducted to document bryophyte species in a forest patch of Pres Roxas, Cotabato, Philippines. A modified belt transect method was employed and 3 transect lines were established along the human-established trail. A total of 18 species of mosses and liverworts were identified. These species were classified under 11 families, and 14 genera. Nine (9) species of bryophytes were identified from both transect 1 and 2 while in transect 3, only 5 species thrived. Of the 18 species identified, *Thiudium benguetense* is found in the 3 transect lines established. Two (2) were identified endemic to the Philippines *Ecthropothecium ferrugineum* and *Thiudium benguetense.* Moreover, similarity index showed that 86% are discordant species and each transect line harbors unique species of bryophytes. It is recommended that intervention in the protection and conservation of the remaining flora community of the mountain ecosystem must be employed given that community is dependent on the water coming from it.

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INTRODUCTION

Bryophytes like other plant groups are playing important role in our environment. They can contribute to increasing forest species and biomass, enriching ecosystems such as in oil formation, nitrogen cycling, water retention, plant colonization, seed germination, seedling growth, and forest restoration (Quin et al., 2013). Moreover, bryophytes keep soil and surrounding areas wet, which helps other plants thrive. Due to their small size and poikilohydric water and nutrition strategy, bryophytes are fundamentally different from vascular plants. Their existence and reproduction depend on the external environment (He, 2016).

Various research was already conducted looking into the bryophytes flora of the Philippines (Tan & Iwatsuki; 1991, Tan et al., 2000; 2015; Linis & Tan, 2008; Shevock and Yorong, 2018). However, bryological knowledge in our country is still limited. Bryophyte research in the Philippines is mostly done in protected areas (Azuelo et al., 2010;2016; Shevock & Yorong 2018), parks or landscapes (Carreon et al., 2016; Salvador-Membreve et al., 2019), urban areas (Sabovljevic & Sabovljevic, 2009; Angeles et al., 2020). On the other hand, the study on bryophyte flora in a forest patch is not well documented. As a good indicator of the real condition of a certain environment, bryophytes are the best species to be used as an indicator of disturbances. Exploring their presence in a forest patch, it can be a good basis for making strategies for the rehabilitation and conservation of the disturbed ecosystem such as forest patches. Thus, this study was conducted to document the bryophyte flora in the forest patch of President Roxas, Cotabato, Philippines.

THEORETICAL REVIEW

Bryophytes Natural Adaptation

Bryophytes are seedless plants outside specific water-attending tissues and it does not have a real vascular order (xylem and phloem) that authorizes bureaucracy to attract water and nutrients up from the ground at some meaningful distance. This omission of specific tissues for moving water and disappeared bread during the whole of the animal limits terrestrial forms to being very short plants, because the only habit to move essences through the plant physique is by absorption and spread from the surface liquid. Lacking this specific order distinguishes bryophytes from ferns and blooming plants. On the other hand, bryophytes do not have ancestries but have rhizoids, which are approximately natural, occasionally multicellular filaments of thin-secure containers that length from the photosynthetic tissue into the soil or added substrate. They anchor the plant rather and in a few cases aid water and mineral rude answer (Cocking, D., 2001).

Many studies have identified the characteristics that determine bryophyte distribution and richness. Most bryophytes grow on tree trunks, decomposing logs, litter-covered wet rocks, and dirt. The species richness trend may be due to vegetation type altitudinal zonation. Hence, bryophyte diversity varies across the landscape (Stieperaere, 1997) *Acroporium, Aerobryopsis, Aerobryidium, Calyptothecium, Clastobryopsis, Dawsonia, Dicranoloma, Ectropothecium, Fissidens, Hypnodendron Leucobryum,*

Macromitrium, Meteorium, Neckera, Orthodontium, Pogonatum, Pyrrhobryum, Rhodob, Rhodobryum, Macromitrium, Meteorium, Neckera, Orthodontium, Pogonatum, Pyrrhobryum (Azuelo, 2009). The species similarity between vegetation types shows that bryophytes species may be attributed to moss and liverwort life adaptations, that light intensity, temperature, and humidity vary vertically, and that both forests had an equally low temperature and cool environment that allows mosses and liverworts of various morphological forms and structures (Del Rosario, 1986).

Bryophytes benefit humans and animals. Worms and snails consume them. They reduce soil erosion and settlement. Mosses on rocks decompose rocks into dirt (Nahm, 2005 and Samulde, 2012).

Bryophytes support many plants worldwide. They are vital to wetland, mountain, and tundra biodiversity. Bryophytes form massive mixed communities that shape temperate forests' ecosystems. They're essential for iron ore formation. Bryophytes gather minerals from through-fall, canopy leaching, and precipitation. Hence, bryophytes protect soil nutrients from leaching (Saxena & Harinder, 2004).

Ecological Uses

Bryophytes are useful to additional living belongings, containing us. They are meat for a few mammals such as worms and snails. They likewise help hold the soil working to hold it from being bathed continuously. Some mosses that persist in rocks cause them to decay to form soil (Samulde, 2012).

In addition, forest species diversity and biomass are dominated by bryophytes. They also shape ecosystems through forming soil, nitrogen biogeochemical cycling, water retention, plant colonization, seed germination, seedling growth, and forest restoration (Sun, 2013). By absorbing and storing water, bryophytes regulate relative humidity. They often indicate habitat health. Pollution or other changes in water, soil, or air quality affect bryophyte growth (Krosnick & Elizabeth, 2006). President Roxas' North Cotabato town has several bryophytes.

METHODOLOGY

Study Area

President Roxas, Cotabato is located at 7° 09'16"N 125° 03'21"E. The area is surrounded by diverse plant species such as old trees, shrubs, ferns, and bryophytes. The reservation area has a total of 100 hectares of which 5 hectares were claimed by the Pres. Roxas LGU. The area is the source of drinking and household purposes of the community.

Figure 1. Map showing the study area.

Field Sampling Method and collection of specimens.

A modified belt transect method (Alcala, 2019) was used. This was done by randomly stretching a 100-meter string along the trail. Three line transects were established, each extending 1 meter on both sides from the line segments. For every transect, 5 quadrats measuring 1mx1m were randomly established. Sample specimens of bryophyte were collected for further examination in the laboratory. The collection procedure of Del Rosario (1967) was followed. The bryophytes were scraped from their substrate using a knife and were placed in transparent cellophane in order to retain their moisture to prolong viability. During collection, pertinent data was also noted such as substrate and exact locality of data.

Species Identification

The bryophytes specimen was photo-documented and pre identified in situ. The morphology and diagnostic characters of the stem, leaves, breach were noted. In the pre-identification, the works of Bartram (1939) and Tan and Iwatsuki (1991) were used. Specimens were sent to Central Mindanao University and identity for confirmation by a local expert.

RESULTS AND DISCUSSION

There were 18 species of bryophytes identified from the forest patch of President Roxas. There were eight families of mosses and three families of liverworts identified which comprises 11 genera and 14 species for mosses and 3 genera and 4 species for liverworts. Of these families of bryophytes, Hypanaceae has the most species identified (5 species) coming from 3 genera followed by Bartramiaceae with 2 species and 1 genus, Sematophyllaceae with 2 species and 2 genera and the rest has only 1 species under 1 genus (Table 1).

Table 1. List of bryophytes species identified from the forest patch of President Roxas, Cotabato Philippines.

Family	Species	Transect 1	Transect 2	Transect 3
Moss				
Bartramiaceae	*Bartramia aprica*	-	+	-

	Bartramia stricta	-	+	-
Bryaceae	*Bryum apiculatum*	-	-	+
Calymperaceae	*Mithyridium repens*	+	-	-
Hypnaceae	*Ecthropothecium ferrugineum*	+	-	-
	Isopterygium bancanum	-	-	+
	Isopterygium minutirameum	+	+	-
	Vesicularia dubyana Brotherus	+	+	-
	Vesicularia reticulata Brotherus	-	+	-
Polytrichaceae	*Polytrichum sp*	-	+	-
Pottiaceae	*Hyophila involuta*	+	-	-
Sematophyllaceae	*Acanthorrhynchium papillatum*	-	-	+
	Trichosteleum singapurense	+	-	-
Thuidiaceae	*Thuidium benguetense*	+	+	+
Liverworts				
Geocalycaceae	*Heteroscyphus zollingeri*	-	+	-
Marchantiaceae	*Marchantia polymorpha L.*	-	-	+
Plagiochilaceae	P*lagiochila javanica* (Sw.)	+	-	-
	Plagiochila junghuhniana sp.	+	+	-

Legend:
(+) Presence
(-) Absence

Two (2) species were identified as endemic to the Philippines. These species are *Thiudium benguetense* and *Ecthropothecium ferrugineum* (Fig 2).

A B

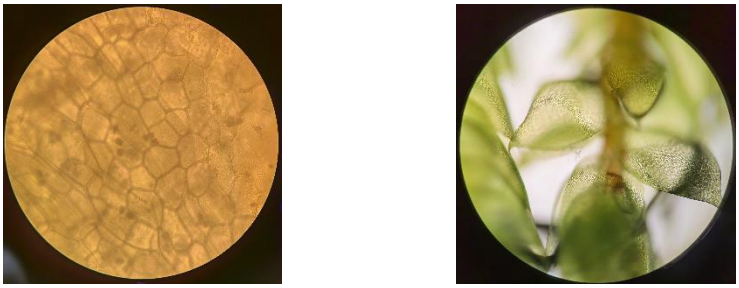
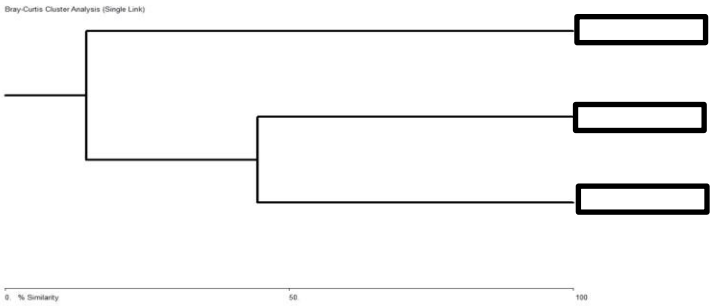


Figure 2. Endemic species of Bryophytes. A. *Thiudium benguetense.* B. *Ecthropothecium ferrugineum*

Similarity index showed that 86% are discordant species (Fig 3) which means that each transects lines harbors unique species of bryophytes. *Thuidium benguetense* was found present in all transect lines. Meanwhile, *Isopterygium minutirameum, Vesicularia dubyana Brotherus* and *Plagiochila junghuhniana* were found in transects one and two.



DISCUSSION

The study identified 18 species of both mosses and liverworts. This low species richness of bryophytes in the area is an indicator that the said mountain ecosystem is under disturbance. According to Halling ack & Hodgets (2000) that these cryptogams are abundant in moist areas and their variation often matches with habitat diversity. Some of the identified disturbances affecting its species richness are deforestation, forest conversion to agricultural lands, the rapid change in cultivation practices and overcollection (Canakan et al., 2022).

Among the 11 families of bryophytes identified, Hypnaceae has the highest number of species recorded. This is a big family of pleurocarps, including about 60 genera, distributed worldwide in many kinds of substrates and one of the most diverse moss family (Qin, 2013). In general, pleurocarps have creeping shoot systems with significant lateral branching (Stotler, 1996). It is possible to identify pleurocarpous mosses (mosses that create carpets) by their widespread branching and lateral sporophyte positioning (Saxena, 2004). As stated by (Ignatov et al., 1997; Ireland & Buck, 2009) this species occur on calcareous rocks and in terrestrial settings. Tropical, subtropical, and temperate regions of the planet all contain it. It has up to 35 species that are spread out around the globe. Because of its characteristic scale-like leaves, it is simple to identify.

Moreover, *Thuidium benguetense* was discovered on all transect lines and this may be due to the favorable conditions observed in the area. *Thuidium benguetense* was identified as an uncommon species in the Mt. Rayo Range, Davao Oriental, in research by Canakan et al. (2022). Azuelo et al. (2010), mentioned in their study that *Thuidium benguetense* preferred unique to extreme microhabitats like decomposed logs and different substrates.

With two genera and two species, the Sematophyllaceae and Bartramiaceae families were found to be the second most frequent in the sampling area. *Acanthorrhynchium papillatum* and *Trichosteleum singapurense*, both members of the family Sematophyllacea, were thriving in transects three and one, respectively. Although members of the Sematophyllaceae family can be found in temperate climates, however, it is in the tropics and subtropics where they are most diverse and growing as epiphytes on stems and branches (Ramsay, 2012). *Bartramia aprica* and other members of the Bartramiaceae family were both discovered in transect 2.

It's interesting that two Plagiochilaceae species were collected and named. The family is rarely reported, according to Seregar et al. (2018) because it usually inhabits places such as the upper highland forest. The family Pottiacea, Bryaceae, Polytrichaceae, Plagiochilaceae Geocalycaceae and Marchantiaceae were found to be the least abundant in the area with one genus and one species found. The Pottiacea family is rather uncommon and is usually found on fairly dry and sandy soil (So, M. L. and Zhu,R.L, 1996).

Liverworts do not normally live on the ground because of their morphological traits; they are thalloid and have succulent flat leaves that perish when exposed to high moisture content environments. Liverworts, unlike mosses, are not trampling resistant. Additionally, liverworts preferred to grow higher on the trunk; hornworts, on the other hand, are the least diverse bryophyte group, with only 200-250 species globally. Despite their modest taxonomic diversity, the group has not been documented globally which explains why mosses and just two families of liverworts were gathered in the area.

As observed with distribution of the bryophytes present in the study area, the abiotic factors of the three transects have minimal difference in all line transects established. Transects 1 and 2 have been found to have an equal number of species present. This means that the abiotic factors of the study area are most favorable to the moss species. Local assessment revealed that the distribution of bryophytes species varies by environmental change (Lubos, 2000; Azuelo & Sariana, 2005). Meanwhile, transect 3 shows the least number of species identified among the 3 transects. This result attributes to the higher temperature and humidity of the transect 3 compared to the other two transects as ideally, they grow well in areas where temperatures range from 22°C to 28°C, and their response is dependent on a moist and cool environment for their survival. Furthermore, bryophytes often inhabit wet regions like rivers and woodlands because they are so reliant on water for both their life and reproduction. But nonetheless, some bryophytes can endure in environments with little or no rainfall. This explains the uniqueness of the three transect lines on bryophytes species documented as exhibited by the cluster analysis.

The results show that the most prevalent bryophytes in the study area are moss species. They naturally grow on stone walls, pavement edges, and even city sidewalk cracks. They inhabit rock outcrops, colonize disturbed, nutrient-poor sand and gravel settings, and dwell on rock outcrops. Colonies formed by pioneer mosses serve as a foundation for the development of larger plants and the production of soil by trapping seeds and holding water.

The results of this study also support the findings of Saxena (2004), which found that many moss species have widespread and, in some cases, worldwide distributions, suggesting that they are among the most adaptable taxa on Earth. Because of their trample-resistant structure and capacity for regeneration, mosses are typically ground-dwelling bryophytes.

The research area had the least number of liverworts, though. Due to their thalloid anatomical structure, succulent flat leaves, and tendency to decompose in environments with high moisture content, liverworts typically do not inhabit ground habitats. Moreover, liverworts are not trample-resistant like mosses. Mosses were more numerous than liverwort in the research region because mosses have less developed sporophytes than liverworts, which is another reason why liverworts prefer to grow higher up the trunk.

CONCLUSION

The low species richness of bryophytes in the sampling area is an indicator of disturbances. The presence of the endemic species implies that the forest patch in Pres Roxas could be a good habitat for bryophytes thus it is important to protect and conserve the remaining forest given that it is the source of water for the lowland community.

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