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Ethnomedicinal Properties and Distribution of Macrolichens in Mt. Apo Natural Park, Davao, Philippines

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ABSTRACT

The distribution of epiphytic macrolichens in the montane forest of Mt. Apo Natural Park was investigated. The overall objective of the study was to determine the species richness, composition, taxonomy and ecology of the macrolichen species; recognize their medicinal properties and identify the conservation status of the species as rare, endemic and endangered. Transect method and 8 randomly quadrat plots were sampled in a 20 x 20 m plot in a 12 hectares of the montane forest identified as lower and upper montane. Taxonomic treatments of the collected macrolichens species were performed in the field and in the laboratory. The curren study revealed 117 macrolichens species belonging to 19 genera and 9 families. Comparison of the taxa were based upon observable characters such as the notable growth forms and mirohabitats distribution of species that

are closely epiphytic on tree trunks is represented by family Lobariaceae. Local assessment further revealed 2 critically endangered lichens species namely: *Lobaria retigera* (Bory) Trevisan and *Pseudocyphellaria aurata* (Ach.) and 1 species nearly threatened, *Usnea* sp. Of the collected species, 8 macrolichens were noted to have ethnobotanically recorded with medicinal properties. The macrolichens distributions in the park suggests that environmental and ecological interactions within and among the species play an important role in the dynamics of the forest ecosystem. It is therefore recommended that a stronger effort in the documentation and its floristic analysis on their occurrence to ensure their survival and diversity.

Keywords: conservation status, ethnobotany, floristic, taxonomic characters

INTRODUCTION

In most tropical montane forest epiphytic lichen communities are widespread in any forested habitats where they usually constitute an important component of the total biodiversity. In fact, it can give indirect information on their environmental continuity and status of conservation.

Recent reports were on lichen-dominated vegetation which comprises 8% of the terrestrial surface of the earth and they are found in a diverse range of habitats (Meijer and Donohoe, 2006). There have been concerns for the long-term relationships of the lichens in the protected natural park, but due to drastic climate change, it does alter its species richness in regions of the montane forests. So far, no taxonomic studies have been reflected in scientific literatures about the present diversity status of the nonvascular groups in Mt. Apo.

The floristic studies noted that diversity of lichens can be explained in terms of large number of different habitats found on large green old forest growth. Likewise, the diversity of its assemblages was assessed through species richness and species distribution-range type growth forms and life strategies (Stevanovic and Svetlana, 2006).

Lichens are a symbiosis between a fungus known as mycobiont, and a photosynthetic organism, either a green alga or cyanobacteria. They have a wide range of substrates, both natural and man-made, and obtain their required nutrients and water directly from the atmosphere. They have a variety of growth forms, the main morpho-types namely: crustose, foliose and fruticose. The crustose are "crust-like" and are tightly attached to or embedded in their

substrate, have no cortex and colonize and persist on rocks and trees, often in extensive patches. They consisted about 75% of all lichens on earth. The foliose are leaf-like in both appearance and structure and adhere to the substrate loosely; and the fruticose which are shrub-like or branched appearance with no, distinct top and bottom and are often round in cross-section.

Mount Apo is a large solfataric, potential-active stratovolcano in Mindanao. The altitude is 2,945 meters (9,692 ft.). It is the highest mountain in the country and is located between Davao City and Davao Del Sur province in Region XI and Cotabato province in Region XII.

Generally, the lichens absorb most of its mineral nutrients from the air and rainfall. They can withstand to great extremes in temperature and had a slow growth which could possibly be attributed to their slow rate of photosynthesis.

The species are extremely sensitive to environmental stress, especially concerning atmospheric pollution, eutrophication, and climate change (Nimis et al, 2002). Thus lichen diversity is an excellent indicator of pollution by phototoxic gaseous substances and respond relatively fast to a deterioration in air quality. The diversity, density and growth-forms of lichens appeared to vary in different areas of the montane with lichens in some areas being both larger in size and more abundant, and the variety of species seemed to differ.

OBJECTIVES OF THE STUDY

The overall objective of this study was to determine the species richness, and composition of the macrolichens in the park; and to recognize the species with medicinal properties and species identified as rare, endemic and endangered.

MATERIALS AND METHODS

Entry Protocol

A permit clearance was secured before the conduct of the research from the PAMB, DENR, Makilala, North Cotabato.

Study Area

The study site was conducted on the montane forest section of Mt. Apo Natural Park, passing through the Barangay of New Israeltrail to Makalangit (06º 56 N and 125º 13 E), Makilala, North Cotabato. The local climate is cool and humid, with the mean daily temperature ranging from 17ºC and 19ºC for the

month of February, 2015; and the temperature ranges from 16ºC to 17ºC during the conduct of the field sampling. The forest is simply section into lower and upper montane and dominated by 20 – 30 m tall trees. The montane elevation ranges from 1500 to 2010 masl. Its understory vegetation is characterized by tree ferns, shrubs, herbs, vines and palm trees. The canopy and subcanopy branches showed distinct and rich vascular and non-vascular epiphytes including orchids, ferns, vines, bryophytes and lichen species. Generally, the forest landscape appears undisturbed with old growth forest on the forest floor and the persistent ground-level cloud or fog development are usually observed.

Field Sampling

The collection of macrolichens at the field work was carried out employing a transect walk and a quadrat of eight (8) sampled plots with 20x20 meters each. The total area sampled is about 12 hectares. A GPS was used to give the exact geographical locations of the study area (Figure 1).

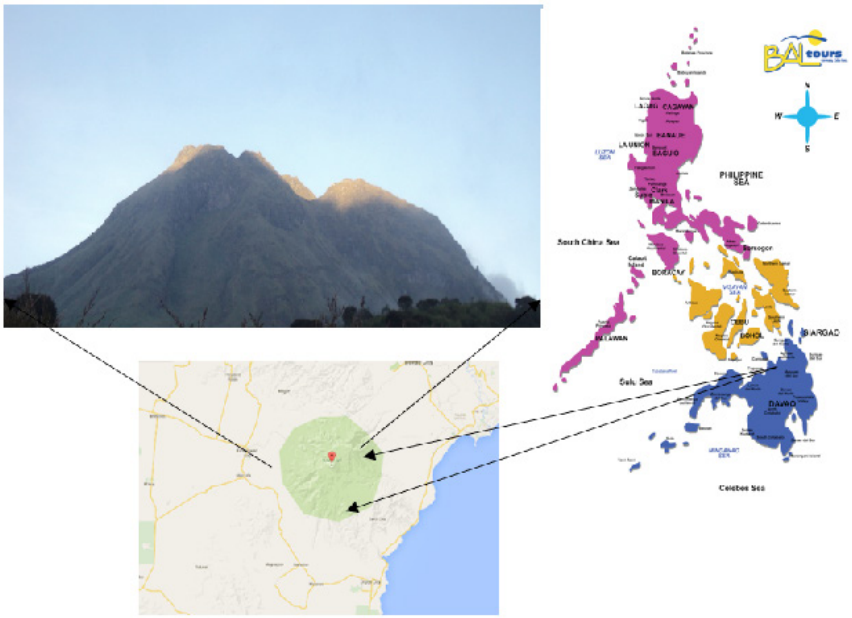

Figure 1. The location study site in Mt. Apo Natural Park.

The macrolichens were sampled randomly in all microhabitats within the plots and along the trail and outside plots. Each species of macrolichens was

assessed by noting their habitat preferences. These serves as their substratum confined at tree trunks, soil, logs, rocks, twigs, branches, litter, exposed roots and on upper leaf surfaces. The voucher specimens were placed in their individual packet and properly labelled with detailed and accurate information.

Species Nomenclature

Identification of the specimens was based on taxonomic characters and microscopy examinations was done on those specimens that exhibited unique characters using field lens and dissecting microscopes. Some standard manuals, books, keys, checklist, monographs, photo images from an internet sources, herbaria and related literatures were used. The growth forms, photobiont and reproductive strategies were taken into account to detect the morphology structures of the lichen species. The species identification was referred to an expert, a Lichenologist based in the Philippines.

Vouchers of specimens were deposited at the Science Laboratory Room of the College of Education, Central Mindanao University. Database was made for all the macrolichens collected for future examination and research. Likewise, photodocumentation was performed in the field and in the laboratory.

More importantly, a checklist of the macrolichens in the form of Information Education and Communication (IEC) materials were prepared for accessibility of profile of the species. The nomenclature, ecology and the distribution of the lichen species was organized in the data.

Assessment of Conservation Status

An assessment of conservation status of lichen species as to its endemicity, threatened or endangered was also employed using existing literature from the International Union for Conservation of Nature (IUCN) Red List. More importantly, local assessment on the macrolichens species was carried out as to its medicinal and potential properties was given preference based on literature.

Data Analysis

Descriptive statistics were used to describe such as frequency counts, and percentage distribution of species in different microhabitats of the forest. Comparison of the random quadrat plots as to species richness and life forms of lichens was employed.

RESULTS AND DISCUSSION

Species Richness

The present investigation revealed a collection 305 Macrolichens specimens with 117 species belonging to 19 genera and 9 families (Table 1). There are 2 quadrat plots with the macrolichens with the highest number of species is Q5 (26) and the least is Q7 (10) (Figure. 1).

Table 1

Number of families, genera, and species of Macrolichens collected in Mt. Apo Natural Park

	Family	Genera	Species
MACROLICHENS	9	19	117

Similarly, the most species – rich among the macrolichen species is represented by the families of Lobariaceae and Parmeliaceae followed by Collemataceae, Peltigeraceae, Physiaceae, Gyalectaceae, Cladoniaceae, Coccocarpiaceae and the least species is represented by Dictyonemaceae (Table 2; Figure 2). There are species under study belonging to unidentified species. These group of species need further verifications on their distinct morphology characters.

Table 2

List of Macrolichens family collected in Mt. Apo Natural Park

LICHENS	Foliose	Genera	Species	
	COCCOCARPIACEAE	1	2	
	COLLEMATACEAE	2	7	
	DICTYONEMACEAE	1	1	
	GYALECTACEAE	1	5	
	LOBARIACEAE	3	35	
	PARMELIACEAE	6	35	
	PELTIGERACEAE	1	7	
	PHYSCIACEAE	3	7	
		18		99
	Fruticose			
	CLADONIACEAE	1	5	
	1	1		5
	UNIDENTIFIED SP.			13
Total	9	19	117	

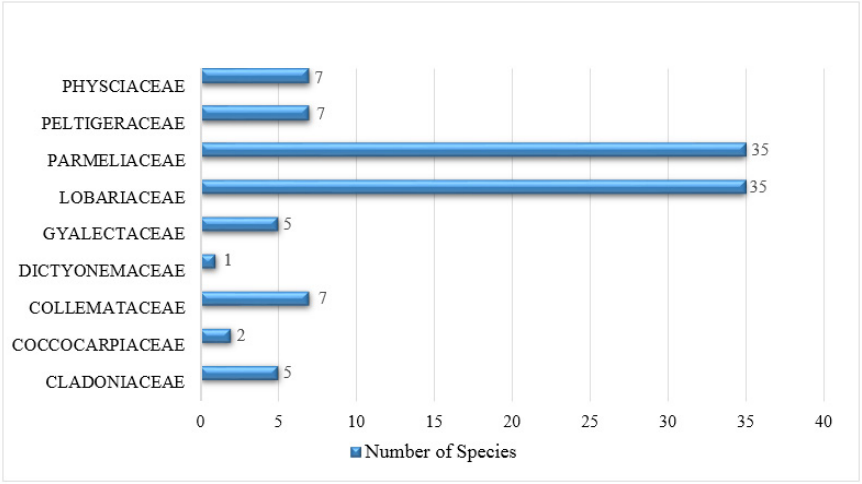

Figure 2. The number of the Macrolichens species for each family.

An assessment of the macrolichens and their distribution for each quadrat plot is reflected in the study. As noted, the epiphytic floral species exhibited were closely linked to their habitats on the landscape. It appears that one should consider the pattern of species diversity and assessing each to include its potential habitats in an ecosystem (Newsmaster et al., 2003). The data indicated that the macrolichens were found in close association with their substrate similarity. The study presents similar findings with Vitt & Belland (1997) that species richness is closely related to microhabitat diversity.

Further results indicated that generally epiphytic macrolichens are growing on trees, decayed litter and logs, fallen branches, twigs and rocks, soil and surface leaves. The data results reflect that several macrolichens species were present in all the quadrat plots while others were not confined to some quadrat plots. This explains that species are substrate specific for some may occur temporarily available to small microhabitats such as on decayed logs, and leaves. However, the microclimate of the prevailing area of the species is significant thus species of lichens grow on almost tree trunk and in all substrates which might be attributed for its most favourable climate (Krishnappa, 2013).

In the study area, lichen cover was relatively low in some quadrat plots in the higher elevations than in the lower elevations of the montane forests. The data findings may be due to the effects of light that are probably having a direct effect on lichen growth. According to Lucking (1998) that lichen communities

differ completely between gaps and understory, which have dramatic differences in light and nutrient availability.

Species Composition

A comparison of the species per quadrat plot is presented with microhabitats/ substratum. As shown, the distribution of macrolichens differ in their microhabitats in each plot. At the montane, fallen branch, trunks and logs are the richest habitats for macrolichens in the montane forest.

According to Holtz et al. (2002) the understorey or forest floor plays a much more important role as habitat for nonvascular plants. Thus, the difference in terms of species richness and microhabitat differentiation of the species correlate with differences in climate and forest composition.

For the macrolichens, a total of 32 species under 13 genera and 8 families were collected along the transect walk and outside plot. The largest family belongs to Lobariaceae (10) and the least is represented by family Dictyonemaceae and Gyalectaceae with single species. Five of the species are fruticose and 24 species are foliose. It is noted that the lichens collected are moisture dependent and shade-adapted. The presence of Lobariaceae and Collemataceae in the transect walk indicated that the two families are more frequent in humid forests (Balaji and Hariharan, 2013). More importantly, the total number of macrolichens has been shown to be strongly associated with moisture and vegetation types (Dynesius, 2006).

The lichen taxa were found in both low and high montane forest and exhibited unique features with respect to growth forms and substratum preference. Some examples of the macrolichens are examined during the study is presented in Table 3. As gleaned on the data, visual assessment such as color, size and shape and reproductive structures such as apothecia structured forms differs among the macrolichens. It was found out that more prevalent are the foliose lichen during the time of collection and displayed 82% for the foliose and 18% for the fruticose.

As presented, the identified quadrats for the upper montane (Q1 – Q4) depicting 68 species and the lower montane (Q5 – Q8) with 77 macrolichens species. Each quadrat is about 200 meters from each other. In the present study, the upper montane forest showed low species number than the lower montane forest. The present study area is characterized by a difference in heights or elevation, microclimate structure, particularly in moisture (humidity) which is about 91%, light availability and the exposure of the species between canopy

of trees. These findings obtained similar results with the study conducted by Gehrig-Downie et al (2013), that the high species in the lowland forest may be due to their complex architecture of the area and its epiphytic diversity coincided with the high moisture level. As observed, the lower montane showed daily occurrences of low temperature thus causing high relative humidity.

Microhabitats

The distribution of macrolichens species showed that the most species-rich microhabitats are on trunk (28%), followed by fallen branch (21%), fallen twigs (19%), fallen logs (16%), twigs (6%), branch and decayed log (5%) respectively. These findings show remarkably distinct for macrolichens and appeared differently due to differences in structural characters between the forest floor habitat and those on epiphytic on tree trunks (Plae 1 & Plate 2).

During the field work there was a low temperature range (16 – 18) degrees Celsius and humidity (90-91 %) percent. As noted, the distribution and species composition appeared to show correlated with humidity and light regimes in determining the composition of the lichens communities.

The type and number of microhabitats are important predictors of the number and type of species present. In fact, important habitat for lichens include large rotten logs, large trees were consistently higher in old-growth compared to young forest in both the Interior Cedar-Hemlock Zone (Arsenault, 2000).

Medicinal Value: An Ethnobotanical Perspective

Based from the literature search, a total of 8 species were noted with medicinal properties namely: *Cladonia bellidiflora*(Ach.) *Schaerer, Lobaria pulmonaria* (L.) Hoffm., *Parmotrema reticulatum* (Taylor) M. Choisy, *Parmotrema tinctorum* (Nyl.) Hale, *Peltigera canina*(L.) Willd., *Usnea articulata* L. Hoffm., *Usnea hirta*(L.) F.H. Wigg.and *Usnea longissima* Ach. Both species exhibited antimicrobial activity, antipyretic, diuretic, antiseptic, antihypertensive, anticancer and healing effects (Table 4).

Table 4

List of Macrolichens with medicinal uses

LICHENS	Medicinal Uses	Active Components
1. *Cladonia bellidiflora* (Ach.) Schaerer	Treatment for eye disease when mixed with mother's milk (Garibaldi, 1999). Red ends dipped in mother's milk and applied to sore eyes (Turner, 2004)	Glyceraldehyde-3-phosphate dehydrogenase
2. *Lobaria pulmonaria* (L.) Hoffm.	Applied to cuts as antiseptic and healing agent (Guarrera et al., 2008). Used for indigestion, malnutrition in children, abdominal distension, ascarid infestation, burns and scalds, edema due to kidney inflammation, local swelling, reducing inflammation, relieving pain, and severe aching of skin. Drink decoction or apply powder to affected area (Hu et al., 1980; Wang and Qian, 2013).	Stictic acid, constictic acid, and norstictic acid
3. *Parmotrema reticulatum* (Taylor) M. Choisy	Tea drunk to relieve discomfort from kidney disorder or venereal disease. The tea is commonly prepared in late afternoon and left for one night before being drunk (Pennington, 1969).	Catechin, purpurin, tannic acid and reserpine
4. *Parmotrema tinctorum* (Nyl.) Hale	Used for blurred vision, bleeding from uterus, bleeding from external injuries, sore and swelling, chronic dermatitis, and localized swelling. Drink decoction or apply powdered lichen to affected area (Wang and Qian, 2013).	Lecanoric acid
5. *Peltigera canina* (L.) Willd.	Used for rabies and jaundice in India (Biswas, 1956) and China (Wang and Qian, 2013). Tonic and medicine for liver complaints (Subramanian and Ramakrishnan, 1964).	Tenuiorin, erbosterol, mannitol, linoleic acid and sterol
6. *Usnea articulata* L. Hoffm.	Treatment for stomachache. A handful is chewed fresh and the juice swallowed, it is bitter but relieves the pain after a while (Kokwaro, 1976). Used for wounds and skin bruises (Brooker et al., 1987).	Fumarprotocetraric acid
7. *Usnea hirta* (L.) F.H. Wigg.	Used for heal wounds and to prevent hair loss (Willemet, 1787).	Hirtusneanoside
8. *Usnea longissima* Ach.	For treating cancer, tuberculosis, and ulcers (Yazici and Aslan, 2003; Odabasoglu et al., 2006). Used to heal bone fractures. Washed, air dried, soaked overnight in salted water, and placed over affected part (Sharma, 1997).	Evernic, diffractaic, barbatic, and 4-O-demethylbarbati acids

CONCLUSIONS

Based on the findings of the study, the following conclusions are derived: The montane forest have shown high diversity of macrolichens species and with great diversification of their microhabitats. A total taxa of 117 macrolichen species with 19 genera and 9 families. The lower montane exhibited high species richness since the forest is characterized by mixed tall trees and closed canopy and high humidity. The macrolichens is closely related to large and varied microhabitats than in the upper montane characterized with scattered trees and restricted habitats, thus both species show remarkably distinct and diverse in their morphology structures. The most family-rich macrolichens species are Lobariaceae and Parmeliaceae and the least family is Dictyonemaceae. The macrolichens distribution are closely epiphytic on tree trunks represented by Lobariaceae and the least is Parmeliaceae on decayed log and on the tree branch represented by the families Coccocarpiaceae, and Gyalectaceae. Local assessment of status of macrolichens, twenty-five (25) species are rare, two (2) critically endangered namely: *Lobaria retigera* (Bory) Trevisan and *Pseudocyphellaria aurata* (Ach.) and one (1) species is near threatened and 3 species are least concern namely: *Usnea filipendula Stirt*., *Usnea flammea* Stirt and *Usnea flagilescens* Hav. ex Lynge. Some species of macrolichens were ethnobotanically recorded with medicinal properties.

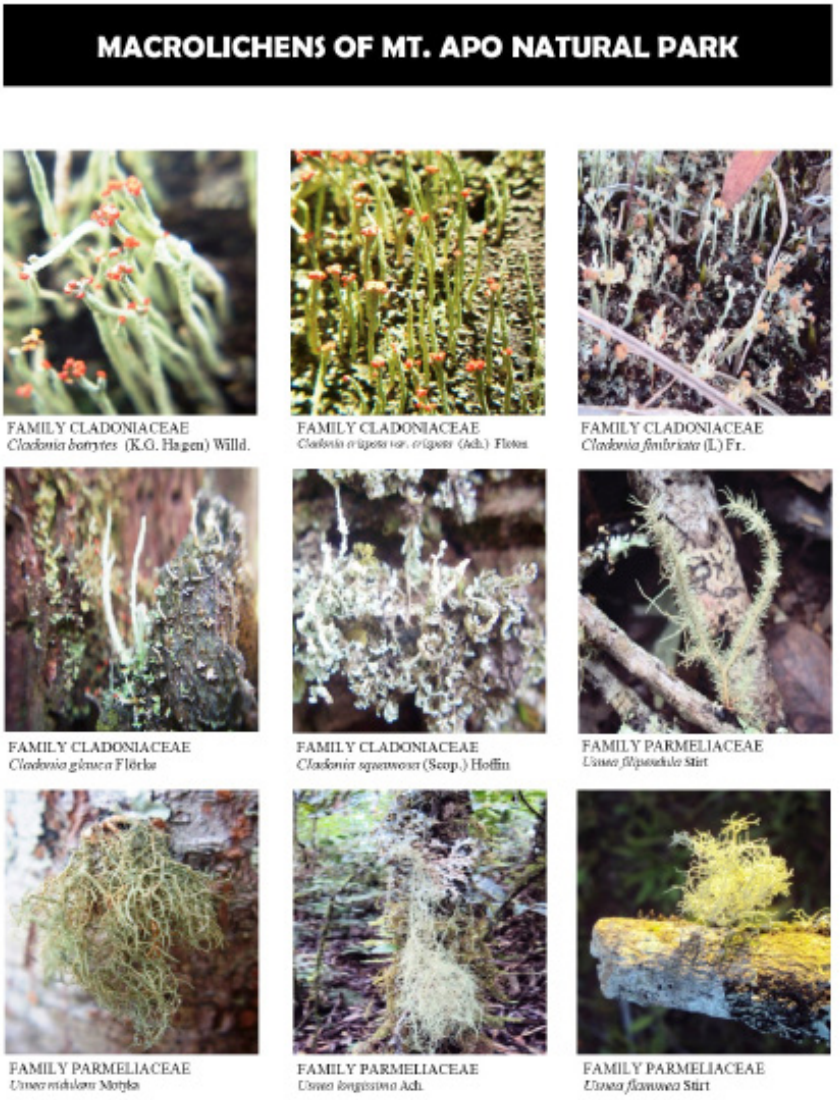

Plate 1. Some macrolichens species of Mt. Apo Natural Park

Plate 2. Some macrolichens species of Mt. Apo Natural Park

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