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## **Inventory of Epiphytic Moss Flora in the Montane Forest of Mt. Kasiling Dako, Tarragona, Davao Oriental**

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### **Abstract**

Mosses have been found to be good indicators of environmental conditions. Their significant in the environment helps to evaluate and assess the effect of environmental changes on the ecosystem. This study aims to determine the record status of the collected species of mosses found in Mt. Kasiling Dako, Tomoang, Tarragona, Davao Oriental, Philippines. The said station has an approximate elevation of 392.6 meters or 1,388.0 feet above mean sea level (masl). The inventory of the moss floral species was done through a transect walk (Alpha Taxonomy) which covers 200 meters following the trail of the forest. The choice of the area conducted through a purposive sampling method in which all mosses was examined and investigated. Twenty – one species of mosses was identified, classified, and described based on their life forms and habitat. Of the 21 specimens collected, eleven locally assessed as abundant while ten found rare. Based on the habitat preference of the mosses, nine preferred tree trunk, five preferred rocks, three for tree base, and two for both tree log and clay. Thus, these protected areas need to be preserved in order to ensure mosses' growth and abundance. This furtherly recommend the conduct of morphological examination and find a standardized method of measuring status record of the moss floral species.

**Keywords:** Species richness; flora; epiphytes; taxonomic characters; Philippines.

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## **1. Introduction**

Many urban areas in Mindanao regions face environmental problems such as pollution and the heat effect on island. With the extent of assessing atmospheric changes organisms (bio indicators) their responds to environmental changes indicates the health condition of the ecosystem. Largest record of bio indicators has appealed considerable attention due to extreme changes of atmospheric conditions. Bryophytes are one such group of plants known to be sensitive to environmental changes, in particular to atmospheric conditions. Their significant in the environment helps to evaluate and assess the effect of environmental changes on the ecosystem. Bryophytes form a significant component in many forest ecosystems. They represent a large portion of forest biodiversity. Mosses are small, low-growing plants that constitute the phylum Bryophytes. Bryophytes have neither true stem, leaves nor roots, nor a vascular system [1]. They are divided into three separate phyla: Bryophytes (mosses) the most numbered with 15,000 species worldwide; Haptophyte (liverworts) with 6,500 species and Anthoceroophyta (hornworts) with approximately 100 species [7]. Further, since bryophytes lack a proper cuticle or roots, the uptake of water is mainly from the ambient humidity. Therefore, more than any other organism, bryophytes are highly sensitive to climate change. In addition, mosses have been found to be good indicators of environmental conditions. Some bryophytes specifically mosses grow only in a narrow and specific pH range. Their presence can be used as an indicator of soil pH. Bryophytes envelope the forest floor and tree trunks and aid in moisture conservation. Consequently, mosses are important but sometimes overlooked group of plants (European Commission, 2010). Additionally, bryophyte collection and inventory efforts have historically received much less attention in Mindanao as compared to Luzon. The number of mosses reported by [5] for these two island masses is in stark contrast with 613 mosses documented for Luzon but only 333 species for Mindanao [8]. For this reason, the study will be conducted to determine the inventory of mosses in local levels. Monitoring of air pollution using bio indicators is emerging as a potentially effective and more economical alternative performing by direct ambient air measurements. This is especially relevant for monitoring large areas [2]. The usefulness of mosses in determining trace- and heavy-metal concentrations in different geographical areas has been discussed and demonstrated in several studies [6]. Moreover, many European countries have used mosses since the beginning of 1960s in national and multinational surveys of atmospheric-metal deposition [3]. In practice, controlling anthropogenic air pollutants is a very complex problem where sources and emissions have to be managed and monitored, and economic aspects have to be integrated [10]. Most air pollution studies in India are based on atmospheric aerosols collected on particulate matter filters. This active method gives an idea of trace element atmospheric pollution only during the sampling time. It requires long-term sampling at a large number of sampling sites. The measurements require sophisticated technical equipment that is expensive. There is lack of sufficiently sensitive and inexpensive techniques that permit the simultaneous measurement of many air contaminants [11]. In India, it is difficult to use air samplers in remote areas due to lack of electricity. Biomonitoring is the one and only solution. In this paper, we discuss the usefulness of biomonitoring as a technique used to investigate trace element atmospheric pollution. It includes the principles, possibilities, and suggested strategies to develop such approaches. Mindanao is the southernmost island of the Philippines. At 104,630 km<sup>2</sup>, Mindanao is only slightly smaller than the island of Luzon to the north at 109,965 km<sup>2</sup>. However, bryophyte collection and inventory efforts have historically received much less attention in Mindanao as compared to Luzon. The number of mosses reported by

[5] for these two island masses is in stark contrast with 613 mosses documented for Luzon but only 333 species for Mindanao. The state of under collection of the moss diversity in Mindanao is shown further by the outcome of a recently held joint month-long expedition conducted in April to May of 2014 by botanists of Central Mindanao University (CMUH) in the Philippines and the California Academy of Sciences (CAS) in United States. According to [13,14] the annihilation of the mountains is basically caused by human activities such as land clearing, slash and burn method for expanding crop plantation, urbanization, firewood consumption, over collection of moss plant materials of horticulture, landscaping and other commercial purposes. Thus, this study suggested the Department on the strong implementation of environmental policies especially in plants (Bryophytes) conservation. Providing individual with opportunities to be involved in any of the planned environmental programs such as orientations, seminars, symposiums on about environmental conservations and awareness. Then, actively participates to any community outreach program sponsored by the national, provincial and local government relating to any environmental concerns.

### ***1.1. Objective of the Study***

The main objective of the study is to determine the record status of the collected species of mosses found in the mountain sites, Kasiling Dako, Tarragona, Mati, Philippines. Specifically, it aimed to:

1. Determine the species of moss inhabiting the area;
2. Collect, identify, and describe the moss species based on taxonomic characters; and
3. Assess the conservation status of the moss species whether endemic, rare, and widespread.

### ***1.2. Significance of the Study***

The result from the study would offer scientific knowledge on the status of mosses in Mt. Kasiling Dako, Davao Oriental. This will also ascertain the conservation and protection of the mosses including their microhabitats. Significantly, outcomes of this endeavor will provide baseline information that will guide environmentalists, Local Government Unit (LGU), experts, taxonomist, science teachers (biology) and students on what local actions are needed in order to conserve the moss species. Studying the morphological structures of the moss flora would provide scientific knowledge on composition, distribution and diversity. The findings of the study will provide scientific information on moss flora species as to its ecology and habitat identification. Furthermore, results and findings of the study will help other people realize and gain had better understand of the importance of preserving or conserving the area.

### ***1.3. Scope and Limitation***

The study only focused on the inventory and assessments of moss flora collected in Mt. Kasiling Dako, Tarragona, Davao Oriental by transect walking. The taxonomic characters were used to identify and describe the moss flora in the site. Local assessment and IUCN website were utilized to determine the conservation status of the moss species whether endemic, rare, and widespread. The following morphological structures namely: leaf margins, leaf shape, leaf apex, leaf arrangement, cell shape and its costa were validated through the website [www.tropicos.org](http://www.tropicos.org).

## 2. Methodology

### 2.1. Orientation and Organization of the Study

In the conduct of the study, a letter of permit was secured at the MENRO (Municipal Environmental and Natural Resources Officer) and CENRO (City Environmental and Natural Resources Officer) and the presentation of the research proposal at Barangay Tomoaong, Taragona. This was followed by an Entry Protocol with the Barangay Officials at Barangay Tomoaong, Taragona, Davao Oriental. Likewise, meetings with the local guides and researchers was conducted with the information for 5 – 6 days study in Mt. Mayo forest field sampling.

### 2.2. Location of the Study Site

The research site was conducted at Mt. Kasiling Dako, Tomoaong, Tarragona, Davao Oriental, Philippines. Tomoaong is situated at approximately 7.0118, 126.3776, in the island of Mindanao. Tomoaong is a barangay in the municipality of Tarragona, in the province of Davao Oriental. Its population as determined by the 2015 Census was 2,388. This represented 9.11% of the total population of Tarragona. The site has an elevation at these coordinates is estimated at 392.6 meters or 1,388.0 feet above mean sea level. Its latitudinal and longitudinal position is at 7°02'42.00" North and 126°26'52.80" East. An altimeter was used to give the exact geographical location of the study site. A location map (GPS) was used to establish the actual site of the research area.



**Figure 1:** Map of Barangay Tomoaong, Taragona, Mati City, Davao Oriental

### 2.3. Establishments of the Study

The conduct of inventory and assessment of the moss was done by Alpha Taxonomy or transect walk in the site. This was done by listing all the mosses seen or collected along the trail. All the species seen were collected and the corresponding habitats were deposited at the science laboratory room in Montevista National High School main campus. The choice of the vegetation within the sites was executed according to the subjective sampling method. The sampling sites will be set-up on the northern and eastern part of the forests for reasons of sunlight intensity, which was considered an important factor for assessing the populations of species of mosses.

#### **2.4. Collection of Specimens**

The study site was favorable for the moss flora on its species perpetuation because of its elevation having favorable climatic condition and of the same time due to its preferable temperature. Representative specimens of moss were collected 200 meters on each side of the trail from the base to the upper portion of the selected area through alpha taxonomy inventory of the species of moss flora.

#### **2.5. Equipment and Materials**

During the collection of the specimens, the following equipment and materials were used such as field lens, field note, knife, camera, pencil and pen, plastic bags, cutters, marker, and cellular phones. While during the microscopy examination, the following were used: dissecting set, dissecting microscope, binocular microscope, and glass slides, with cover slips, blades, and beaker, syringe, and medicine droppers.



**Figure 2:** Equipment and materials used in the study

#### **2.6. Identification and Description of Moss Species**

A field floristic inventory of the moss flora in Mt. Kasiling Dako, Tarragona, Davao Oriental was conducted. The mosses specimens collected were identified and described morphologically by their diagnostic characters such as leaf margins, leaf shape, leaf apex, leaf base, cell shape, leaf base, and costa. Identification was compared using the existing herbaria present in Central Mindanao University, Musuan, Maramag, Valecia City, Bukindnon. Each of the species treated in this study was described individually with respect to its economic value in the genus. The specimens were identified by the researcher and confirmed by Dr. Andrea G. Azuelo, a bryologist who was based at Central Mindanao University.

#### **2.7. Preparation of Herbarium Specimens**

The collected specimens of mosses were placed in a plastic bag or zip lock, labelled with the following data: collection number, corresponding altitude, date of collection, associated habitats and name of the researcher. This was then air-dried and place in a standard pocket for herbarium vouchers.

#### **2.8. Assessment of Conservation Status of Mosses Species**

Assessment of conservation status of mosses revealed whether they are found to be rare, widespread, endemic, vulnerable, threatened or endangered, critically endangered and last concern. This was assessed using the International Union of Conservation of Nature and used from scientific journals and websites. Also, the Species Richness, Distribution, and Status of Mosses in Selected Mountains in Mindanao, Philippines journals by <sup>[8]</sup> was used.

### ***2.9. Photographs and Documentation***

Photographs were taken during the collection process at the actual site to show the natural habitats of the moss flora. In addition, photomicrograph was done to capture the taxonomic characteristic details of the specimens. This was then used for identification of the mosses in Mt. Kasiling Dako, Tomoaong, Tarragona, Mati City, Davao Oriental. Photograph and documentation serve and visual data for comparison of an existing herbaria plant identification and classification.

## **3. Results and Discussion**

### ***3.1. Location and Topography of the Study Area***

The location of the study was conducted at Mt. Kasiling Dako, Tomoaong, Tarragona, Mati City, Davao Oriental. Tomoaong is situated at approximately 7.0118, 126.3776, in the island of Mindanao. Tomoaong is a barangay in the municipality of Tarragona, in the province of Davao Oriental, which has an approximate elevation of 392.6 meters or 1,388.0 feet above mean sea level. As observed, the place is cloud montane forest, which is a perfect area for moss species collection. Moreover, moss species was favorable for its perpetuation because of its climatic condition and cold temperature. Furthermore, its latitudinal and longitudinal position is at 7°02'42.00" North and 126°26'52.80" East (Philippine Standard Geographic Code, 2012). The preliminary assessment of moss flora in Mt. Kasiling Dako, Tomoaong, Tarragona, Mati City, Davao Oriental was done through a transect walk. The collected moss was described according to its taxonomic characters such as leaf margin, leaf shape, leaf apex, leaf base, cell shape, Costa, and its habit with the use of a microscope and field lens.

### ***3.2. Moss Species Richness in Mt. Kasiling Dako***

**Table 1** below shows the species collected in Mt. Kasiling Dako with their families, genera, and species. As reflected on the table, there were thirteen (13) families, nineteen (19) genera, and twenty - one (21) species. The epiphytic species of moss collected has varied in terms of number and its terms to its family. Moreover, the sample species were lesser compared to the result conducted by [1,8] in selected mountains in Mindanao. The result of the study showed that as we go higher to the mountain with favorable climatic condition and good soil content, a high percentage diversity of epiphytic moss species could be recorded. Since, the site was firstly introduced to community for study, the Municipal Environmental and Natural Resources Officer and City Environmental and Natural Resources Officer furtherly opened the study site to any study on biodiversity to generate knowledge leading to formulation of various plans and programs on about the importance of environmental conservation.

**Table 1:** Summary of the number of epiphytic moss families, genera and species collected in Mt. Kasling Dako, Tomoaong, Tarragona, Davao Oriental.

Sample	Family	Genera	Species
Mosses	13	19	21

**3.3. Moss Species: Collection, Identification and Description**

The moss species collected and identified in Mt. Kasiling Dako, Tomoaong, Tarragona, Davao Oriental is presented in table 2. Based on the table, study revealed that, the family Sematophyllaceae has the most species among the 13 families with three (3) identified species which were found in the lower and upper montane of Mt. Kasiling Dako, Tomoaong, Tarragona, Davao Oriental namely: *Acroporium hyalinum* (Reinw. Ex Schwager.) Mitt; *Trismegistia rigida* (Mitt.) Broth; and *Sematophyllum luzonense* (Broth.). Family Calymperaceae follows this with two (2) recorded species, namely: *Syrrhopodon tristichus* Nees. in Seem; *Leucophanes angustifolium* (Mitt.) Schwager. The family Dicranaceae has also two (2) species namely: *Dicranaloma blumii* (Nees) Par. and *Leucoloma mole* (C. Mull) Mitt. The family Hypnaceae has *Ectropothecium falciforme* (Dozy & Molk.) Jaeg. and *Isopterygium minuteranium* (C. Mull.) Mitt. The same with the family Hypnodendraceae has *Hypnodendron dendroides* (Brid.); and *Hypnodendron vittense* Mitt. In Seem as recorded species. The family Meteoraceae also has two (2) species recorded namely: *Isopterygium saxense* Williams and *Barbella comes* (Griff.) Broth. Family Thuidaceae as the last family having two (2) recorded species among the thirteen (13) families such as *Thuidium* sp. and *Thuidium cymbifolium* (Doz. & Molk.).

**Table 2:** Summary of collected and identified moss species in Mt. Kasiling Dako, Tarragona, Davao Oriental

FAMILY	GENERA	SPECIES
BRYACEAE	Rhodobryum	aurbertii (Schwaegr.)
CALYMPERACEAE	Syrrhopodon	tristichus Nees. In Seem
	Leucophanes	angustifolium (Mitt.) Schwaegr.
DICRANACEAE	Dicranaloma	blumii (Nees) Par.
	Leucoloma	mole (C. Mull) Mitt.
HYPNACEAE	Ectropothecium	falciforme (Dozy & Molk.) Jaeg
	Isopterygium	minuteranium (C. Mull.) Mitt.
HYPNODENDRACEAE	Hypnodendron	dendroides (Brid.) Touw
	Hypnodendron	vittense Mitt. In Seem
LEUCOBRYACEAE	Leucobryum	arfakianum C. Mull ex Geh.
METEORACEAE	Isopterygium	saxense Williams
	Barbella	comes (Griff.) Broth.
RHIZOGONIACEAE	Pyrrhobryum	latifolium (Bosch. & Lac) Mitt.
RHACOPILACEAE	Rhacopilum	spectabile Reinw. and Hornsch.
SEMATOPHYLLACEAE	Acroporium	hyalinum (Reinw. Ex Schwaegr.) Mitt.
	Trismegistia	rigida (Mitt.) Broth
	Sematophyllum	sp.
THUIDIACEAE	Thuidium	sp.
	Thuidium	cymbifolium (Doz. & Molk.)
POLYTRICHACEAE	Pogonatum	microphyllum (Doz. & Molk.)
FISSIDENTACEAE	Fissidens	braunii (C.M.) Doz. & Molk.

Then six (6) of the recorded thirteen (13) families has one species namely *Rhodobryum aurbertii* (Schwaegr.) for Bryaceae; *Leucobryum arfakianum* C. Mull ex Geh. for Leucobryaceae; *Pyrrhobryum latifolium* (Bosch. & Lac) Mitt for Rhizogoniaceae. *Rhacopilum spectabile* Reinw. and Hornsch for Rhacopilaceae. Then, *Pogonatum microphyllum* (Doz. & Molk.) for Polytrichaceae and for the family Fissidentaceae it has *Fissidens braunii* (C.M.) Doz. & Molk. as species recorded. Of these, thirteen (13) epiphytic moss species, one (1) was still unidentified but were properly described according to its morphological characters.

### 3.4. Assessment

**Table 3:** Local assessment of the moss floral species found in the lower and upper montane of Mt. Kasiling Dako, Tomoaong, Tarragona, Davao Oriental.

Species Name	Local Assessment	Habitat	Status
<i>Rhodobryum aurbertii</i> (Schwaegr.)	Rare	Rock	NRL
<i>Syrrhopodon tristichus</i> Nees. In Seem	Abundant	Clay	NRL
<i>Leucophanes angustifolium</i> (Mitt.) Schwaegr.	Rare	Tree base	NRL
<i>Dicranaloma blumii</i> (Nees) Par.	Abundant	Tree trunk	NRL
<i>Leucoloma mole</i> (C. Mull) Mitt.	Abundant	Tree trunk	NRL
<i>Ectropothecium falciforme</i> (Dozy & Molk.) Jaeg	Abundant	Tree log	NRL
<i>Isopterygium minuteranium</i> (C. Mull.) Mitt.	Rare	Rock	NRL
<i>Hypnodendron dendroides</i> (Brid.) Touw	Abundant	Tree trunk	NRL
<i>Hypnodendron vittense</i> Mitt. In Seem	Abundant	Tree trunk	NRL
<i>Leucobryum arfakianum</i> C. Mull ex Geh.	Rare	Tree trunk	NRL
<i>Isopterygium saxense</i> Williams	Rare	Tree trunk	NRL
<i>Barbella comes</i> (Griff.) Broth.	Rare	Rock	NRL
<i>Pyrrhobryum latifolium</i> (Bosch. & Lac) Mitt.	Abundant	Tree base	NRL
<i>Rhacopilum spectabile</i> Reinw. and Hornsch.	Abundant	Tree log	NRL
<i>Acroporium hyalinum</i> (Reinw. Ex Schwaegr.) Mitt.	Abundant	Tree base	NRL
<i>Trismegistia rigida</i> (Mitt.) Broth	Abundant	Tree trunk	NRL
<i>Sematophyllum luzonense</i> (Broth.)	Abundant	Tree trunk	NRL
<i>Thuidium</i> sp.	Rare	Rock	NRL
<i>Thuidium microphyllum</i> (Doz. & Molk.)	Rare	Rock	NRL
<i>Pogonatum microphyllum</i> (Doz. & Molk.)	Rare	Clay	NRL
<i>Fissidens braunii</i> (C.M.) Doz. & Molk.	Rare	Tree trunk	NRL

Note: NRL (New Records in terms of locality)

The present status of the moss floral species found in Mt. Kasiling Dako, Tomoaong, Tarragon, Davao Oriental was determined using the method of <sup>[1]</sup> by which the abundance and rarity of the species was done through counting techniques of the patches of their microhabitats. Five (5) and above clumps were considered abundant species; while, four (4) and below are considered rare species in the area where the specimen were collected.

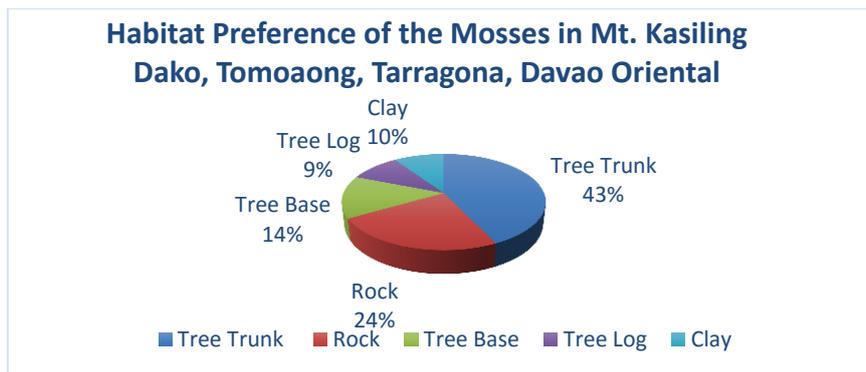
### 3.5. Habitat Preferences

The distribution of the mosses found in Mt. Kasiling Dako, Tomoaong, Tarragona, Davao Oriental was identified in terms of their specific microhabitat. Five (6) microhabitats were identified namely tree trunk, tree base, tree log, tree bark, rock and clay.

**Table 4**

Tree trunk	Rock	Tree base	Tree log	Clay
9	5	3	2	2

**Figure 3** showed that the preferences of the most flora species in Mt. Kasiling Dako, Tomoaong, Tarragona, Davao Oriental. As per data, figure revealed 43 % of the mosses found on tree trunk, 24% preferred rocks in the lower and upper montane of Tomoaong, Tarragona, Davao Oriental. In addition, 14 % of the moss preferred on tree base, 10% of them preferred clay. Moreover, 9% of the species recorded preferred on tree log.



**Figure 3:** Percentage of the preference of mosses in Mt. Kasiling Dako, Tomoaong, Tarragona, Davao Oriental.

### 3.6. Photomicrograph of the collected moss: Taxonomy

The following are the photomicrographs performed the collected epiphytic moss species in Mt. Kasiling Dako with their corresponding taxonomic characters. The following morphological features namely: leaf margin, leaf apex, leaf shape, leaf base, cell shape, and its costa. The specimens were collected at Mt. Kasling Dako, Tomoaong, Tarragona, Davao Oriental on December 27 – 31, 2018. Further, the taxonomic keys of [10] were used in the collection and identification of moss species. Then, Dr. Andrea G. Azuelo, Ph.D. confirmed the samples, which was compared from the existing herbaria at Central Mindanao University. The following are the plates of the moss floral species found in Mt. Kasling Dako, Tomoaong, Tarragona, Davao Oriental in the lower and upper montane. The taxonomic characters stipulated were based on the results of the observed morphological structures of the mosses through microscopy examination. Furthermore, the taxonomic character includes the leaf arrangement, shape, base, apex, margin, and costa.

### 4. Conclusions

The study found out that based on the local assessment of the status of the mosses in the montane forest of Mt. Kasiling Dako, Tomoaong, Tarragona, Davao Oriental. Eleven (11) species of moss collected were determined as “abundant” and ten (10) species as “rare” including the unidentified species. Thus, this study furtherly showed that some parts of the specified area were protected by some human activities for commercial purposes. It also showed that there were portion in the lower montane of the forest were utilized by the residence for crop plantation. With this, species of moss were vulnerable for some human activities and it might be one of the

reasons of moss species diversity loss, Thus, these protected areas furtherly suggested the Government of Davao Oriental the need to be preserved and protect the place in order to ensure mosses' growth and abundance. For us to protect our ecosystem, we must also protect and preserve several bio indicators. Protecting species of moss is putting our concern and care to our environment.

## **5. Recommendation**

Findings of the study revealed that in Mindanao particularly in the city of Davao Oriental, species of mosses were not totally introduced both global and international. In addition, these eventually enlightens and triggers researchers mind to conduct any study on bryophytes species. Greater inventory efforts are needed for bryofloral species in the total area of Tarragona Mountains and establishment of sampling plots to determine the species diversity in the area. Nevertheless, conservation measures and strict implementation of policies and guidelines for the protection of both flora in the area. Moreover, conduct further anatomical examination of the moss floral species such as the cross section of leaf and other organs of the plant. Furthermore, find a standard method of measuring the local assessments of the conservation status of the mosses.

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