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Species Richness, Distribution, and Status of Mosses in Selected Mountains in Mindanao, Philippines

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Abstract **-** The paper determined the species richness, distribution, and status of mosses in selected mountains in Mindanao, Philippines. Field collections of mosses were conducted in Mt. Kalatungan, Bukidnon Province ,Mt. Matutum, South Cotabato Province , and Mt. Malambo, Davao Province at 10 meters on each side of the trails using alpha-taxonomy method. The mosses were collected, classified, and identified. Its status were also assessed. The study revealed 137 species, 87 genera and 33 families of mosses. Of the 137 species, 109 were found in Mt. Kalatungan , 59 in Mt. Matutum. and 20 in Mt. Malambo. Assessment of status of the species revealed 7 species as Philippine record, 37 new to Mindanao, 1 collected only twice, 29 widespread, 12 rare species, and all species collected were new record in terms of locality. Mt. Kalatungan had the highest species richness, followed by Mt. Matutum, and Mt. Malambo had the least number of species. Based on the findings, with the alarming rate of degradation of the mountains which 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. Some species are epiphytes on tree trunks or branches of live trees while others are on rotten logs, rock surfaces, moist stones along the stream banks and some grow well on soil. Hence, the identified habitats of new records in the Philippines, new to Mindanao , new in terms of locality, widespread , and rare species of mosses should be protected through a strict implementation of the forest laws by concerned authorities.

Keywords - Mosses, species richness, distribution, status, Mindanao Island, Philippines.

INTRODUCTION

The large and diverse Philippine moss flora has a modern checklist (Tan and Iwatsuki, 1991). The history and progress of Philippine bryology were reviewed and summarized by Tan (1992) who discussed in detail the floristic composition and affinity of the archipelagic moss flora (see also Tan, 1984). In Tan's publications, Mindanao was cited as an important island, albeit with a still incompletely known flora, which may hold critically the key to a better understanding of the origin and evolution of the entire Philippine moss flora. In recent years, the Island of Mindanao has been postulated to have a different geological origin and plate tectonic history from the rest of the islands forming the Philippine archipelago (Hall, 1998). As such, this second largest southern island of the country may harbor important floristic and bryogeographical information that needs to be documented before the local forests become completely decimated. To date, Mindanao Island has a total of 187 genera and 314 species of mosses (cf. Tan and Iwatsuki 1991), 50 of which are known only from this island. The rest are found also in Luzon and the Visayas Islands. Among the 50 species of Philippine mosses known from Mindanao, 4% are widespread in the tropics, 60% are Malesian taxa, 21% have an Australasian link, 10% have a Bornean link, and only 6% have a continental Asiatic connection. Clearly, the moss flora of Mindanao has a strong southern and Australasian influence compared to other large islands in the country (Tan ,1998). The main objective of this paper is to determine the species richness, distribution, and status of mosses in selected mountains in Mindanao, Philippines.

MATERIALS AND METHODS

Survey and Collection

Survey of mosses was conducted in Mt. Kalatungan, Bukidnon Province, Mt. Matutum, Tupi, South Cotabato Province, and Mt. Malambo, Datu Salumay, Davao Province. Representative specimens of mosses were collected at 10 m on each side of the trail from base to the upper portion of the three selected areas using alpha- taxonomy method.

Classification and Identification

The specimens collected were classified and identified using the taxonomic keys of Bartram (1939). Morphological characters of the leaf (leaf arrangement, midrib, base, apex, margin, cells, shape) and sporophyte (size, shape, texture of capsule and seta, number of teeth) were used to identify the species.

Photographs

A camera was used for documentation. Stereomicroscope, trinocular microscope and dissecting microscope were also used to identify and classify the species of mosses.

Preparation of Herbarium specimens

The collected specimens of mosses were placed in a plastic bag or ziplock, labelled with the following data: collection number, name of collector, altitude, name of the mountain, date of collection, and associated habitats. This was then air-dried and placed in a standard packets and properly labeled for herbarium vouchers.

Assessment of Conservation Status

A New Annotated Checklist of Iwatsuki and Tan (1991**),** print scientific journals and on-line journals were used to determine the status of the collected specimens. Assessment of conservation status of the species, whether new record in the Philippines, new in Mindanao, new in terms of locality, rare, and widespread was made.

RESULTS AND DISCUSSION

Species Richness and Distribution

A total of 137 species, 87 genera and 33 families of mosses were found in the three selected mountains in Mindanao, Philippines (Figs. 1 and 2, p. 87 and Table 1 p. 76).

Mt. Kalatungan (Fig. 3 p. 87) showed the highest species composition with 109 species , followed by Mt. Matutum (Fig. 4 p. 88) with 53 species, and Mt. Malambo (Fig. 5 p. 88) with only 20 species of mosses (Table 1).

Table 1. Checklist of family, genera, and species of mosses on the selected mountains in Mindanao, Philippines

	Family / Genera / Species	KALATUNGAN	MALAMBO	MATUTUM	STATUS
	Fissidentaceae				
	Fissidens Hedw.				
1	*Fissidens oblongifolius* Hook. f. & Wils.	/	x	x	NRL,NRM
2	*Fissidens nobilis* Griff.	/	x	/	NRL,W
	Dicranaceae				
	Campylopodium (C. Mull.) Besch.				
3	*Campylopodium medium* (Duby) Giese & Frahm	/	x	x	NRL,NRM
	Campylopus Brid.				
4	*Campylopus ericoides* (Griff.) Jaeg	x	/	/	NRL,NRM
5	*Campyopus umbellatus* (Arnott) Par.	/	x	x	NRL,W
	Dicranella (C. Mull.) Besch.				
6	*Dicranella setifera* (Mitt.) Jaeg	/	x	x	NRL,R,NRM
	Dicranoloma (Ren.) Ren.				
7	*Dicranoloma billarderi* cf. (Brid. ex anon.) Par.	/	/	x	NRL
8	*Dicranoloma blumii* (Nees)Par.	/	x	x	NRL,W
9	*Dicranoloma brevisetum var. brevisetum* (Dozyy & Molk) Par.	x	x	/	NRL
10	*Dicranoloma brevisetum var. samoanum* (Broth.) Tan & Kop.	/	x	x	NRL,W
11	*Dicranoloma reflexum* (C. Mull.) Ren.	/	x	x	NRL,NRM
	Holomitrium Brid. Nom. Cons				
12	*Holomitrium cylindraceum* (P. Beauv.) Wijk & Marg.	/	x	/	NRL,NRM
	Leucoloma Brid.Nom. Cons				
13	*Leucoloma molle* (C. Mull.) Mitt.	/	/	/	NRL
	Trematodon Michx.				

Table 1 continued

14	*Trematodon longicolis* Michx.	/	x	x	NRL,NRM
	Leucobryaceae				
	Cladopodanthus Dozy & Molk.				
15	*Cladopodanthus speciosus* (Dozy & Molk.) Fleisch.	/	x	x	NRL,NRM
	Leucobyum Hampe				
16	*Leucobryum aduncum* Dozy & Molk.	/	x	x	NRL,NRM
17	*Leucobyum boninense* Sull. & Lesq.	/	x	x	NRP,NRL,R
18	*Leucobryum chlorophyllum* C. Mull.	/	x	x	NRL,NRM
19	*Leucobyum javense* (Brid.) Mitt.	/	/	/	NRL
20	*Leucobyum sanctum* (Brid.) Hampe	x	/	x	NRL
	Leucophanes Brid.				
21	*Leucophanes glaucum* (Schwaegr.) Mitt.	/	x	/	NRL
22	*Leucophanes angustifolium* Ren. & Card.	/	x	/	NRL
	Octoblepharum Hedw.				
23	*Octoblepharum albidum* Hedw.	/	x	x	NRL
	Calymperaceae				
	Calymperes Sw. in Web.				
24	*Calymperes serratum* A. Br. ex C. Mull.	/	x	/	NRL
	Exostratum Ellis				
25	*Exostratum blumei* (Ness ex Hampe) Ellis	/	x	x	NRL
26	*Exostratum sullivantii* (Dozy & Molk.) Ellis	/	x	x	NRL,NRM
	Syrrhopodon Schwaegr.				
27	*Syrrhopodon gardneri* (Hook.) Schwaegr.	/	x	x	NRL,NRM
28	*Syrrhopodon japonicus* (Besch.) Broth.	/	x	x	NRL,NRM
	Pottiaceae				
	Barbula Hedw. Nom. Cons				
29	*Barbula obscuriretis* Dix.	/	x	x	NRL,NRM
	Hyophila				
30	*Hyophila involuta* (Hook.) Jaeg.	/	x	x	NRL,W

Table 1 continued

31	*Hyophila rosea* Williams	/	/	x	NRL,NRM
	Pseudosymblepharis Broth.				
32	*Pseudosymblepharis angustata* (Mitt.) Hilp.	x	x	/	NRL,R,NRM
	Weissia Hedw.				
33	*Weissia controversa* Hedw.	/	x	x	NRL,R
	Funariaceae				
	Funaria Hedw.				
34	*Funaria hygrometrica var. calvescens* (Schwaegr.) Mont.	/	x	x	NRL,W
	Splachnaceae				
	Tayloria Hook.				
35	*Tayloria indica* Mitt.	/	x	x	NRL
	Bryaceae				
	Brachymenium Schwaegr.				
36	*Brachymenium nepalense* Hook.	/	x	/	NRL,W
	Bryum Hedw.				
37	*Bryum apiculatum* Schwaegr.	/	x	x	NRL
38	*Bryum sahyadrense* Card. & Dix.	/	x	x	NRL
	Rhodobryum Hampe.				
39	*Rhodobryum aubertii* (Schwaegr) Thir.	x	/	x	NRL
40	*Rhodobryum giganteum* (Schwaegr.) Par.	/	x	x	NRL
	Mniaceae				
	Orthomnion Wills.				
41	*Orthomnion elimbatum* (Nog.) T. Kop.	/	x	x	NRL,R,NRM
	Plagiomnium Kop.				
42	*Plagiomnium integrum* (Bosch. & Lac.) T.Kop.	/	x	x	NRL,NRM
	Rhizogoniaceae				
	Hymenodon Hook.F. & Wils.				
43	*Hymenodon angustifolius* Lac.	x	x	/	NRL
	Pyrrhobryum Mitt.				

Table 1 continued

44	*Pyrrhobryum latifolium* (Bosch. & Lac.) T. Mitt.	/	x	x	NRL
45	*Pyrrhobryum spiniforme* (Hedw.) Mitt.	/	x	/	NRL,W
	Rhizogonium Brid.				
46	*Rhizogonium graeffeenum* (C. Mull.) Jaeg.	x	/	x	NRL
	Hypnodendraceae				
	Hypnodendron (C. Mull.) Lindb. Ex Mitt.				
47	*Hypnodendron auricomum* Broth. & Geh.	/	x	x	NRP,NRL,R
48	*Hypnodendron dendroides* (Brid.) Touw	/	x	/	NRL,W
49	*Hypnodendron diversifolium* Broth. & Geh.	/	x	x	NRL
50	*Hypnodendron reinwardtii ssp.caducifolium* (Herz.) Touw	x	/	x	NRL,W
51	*Hypnodendron subspinervium* (C. Mull.) Jaeg. *ssp arborescens* (Mitt.) Touw	/	x	/	NRL
	Bartramiaceae				
	Philonitis Brid.				
52	*Philonitis calomicra* Broth.	x	x	/	NRL
53	*Philonitis mollis* (Dozy & Molk.) Mitt.	/	x	x	NRL,NRM
54	*Philonitis runcinata* C. Mull. Ex aongstr	x	x	/	NRL
55	*Philonitis thwaitesii* Mitt.	x	x	/	NRL,NRM
	Spiridentaceae				
	Spiridens Nees				
56	*Spiridens reinwardtii* Nees	/	x	x	NRL,W
	Erpodiaceae				
57	*Erpodium biseriatum* (Aust.) Aust.	/	x	x	NRL, R,2 C
	Orthotrichaceae				
	Macromitrium Brid.				
58	*Macromitrium blumei* Nees ex Schwaegr.	/	x	x	NRL
59	*Macromitrium longicaule* C. Mull.	/	x	/	NRL
60	*Macromitrium salakanum* C. Mull.	/	x	/	NRL
61	*Macromitrium ochraceum* (Dozy & Molk.) C. Mull.	/	x	x	NRL

Table 1 continued

	Racopilum P. Beauv.				
62	*Racopilum johannis-winkleri* Broth.	/	x	/	NRL
63	*Racopilum spectabile* Reinw. & Hornsch.	/	/	/	NRL,W
	Cyrtopodaceae				
	Bescherellia Duby				
64	*Bescherellia philippinensis* (C.Mull.) Fleisch.	/	x	/	NRL,R
	Pronodontaceae				
	Neolindbergia Fleish.				
65	*Neolindbergia cladomniodes* Akiyama	x	x	/	NRP,NRL,R
	Pterobryaceae				
	Calyptothecium Mitt.				
66	*Calyptothecium recurvulum* (Broth ex C. Mull.) Broth.	x	x	/	NRL
	Garovaglia Endi.				
67	*Garovaglia bauerlenii* (Geh.) Par.	/	x	x	NRP,NRL,R
68	*Garovaglia elegans* (Dozy & Molk.) Hampe ex Bosch & Lac.	/	/	/	NRL,W
69	*Garovaglia luzonensis var. zwickeyi* (Bartr.) During	/	x	x	NRL
	Pterobryopsis Fleisch.				
70	*Pterobryopsis gedehensis* Fleisch.	/	x	/	NRL
	Symphysodon				
71	*Symphysodon neckeroides var. neckeroides* Dozy & Molk	/	x	x	NRL
	Symphysodontella Fleisch.				
72	*Symphysodontella attenuatula* Fleisch.	/	x	/	NRL
73	*Symphysodontella subulata* Broth.	/	x	x	NRL
74	*Symphysodontella parvifolia* Bart.	/	x	/	NRP,NRL,R
	Trachyloma Brid.				
75	*Trachyloma indicum* Mitt.	/	x	x	NRL,W
	Meteoriaceae				
	Aerobryidium Fleisch.				
76	*Aerobryidium crispifolium* (Broth.& Geh.) Fleisch. ex Broth.	/	x	x	NRL,NRM

Table 1 continued

77	*Aerobryidium filamentosum* (Hook.) Fleisch.	/	x	x	NRL
	Aerobryopsis Fleisch.				
78	*Aerobryopsis wallichi* (Brid.) Fleisch.	x	x	/	NRL,W
	Aerobryum Dozy & Molk.				
79	*Aerobryum speciosum* (Dozy & Molk.) Dozy & Molk.	/	x	x	NRL
	Barbella Fleisch. Ex. Broth.				
80	*Barbella cubensis* (Mitt.) Broth.	/	x	x	NRL
	Floribundaria Fleisch.				
81	*Floribundaria floribunda* (Dozy & Molk.) Fleisch.	/	x	/	NRL,W
	Meteoriopsis Fleisch. Ex Broth				
82	*Meteoriopsis squarrosa* (Hook.) Fleisch.	/	x	x	NRL
	Meteonium (Brid.) Dozy & Broth.				
83	*Meteonium subpolytrichum*(Brid.) Dozy & Broth.	/	x	x	NRL,NRM
	Papillaria (C. Mull.) C. Mull.				
84	*Papillaria fuscencens* (Hook) Jaeg.	/	x	x	NRL
85	*Papillaria leuconeura* (C. Mull.) Jaeg.	/	x	x	NRL,NRM
	Phyllogoniaceae				
	Cryptogonium (C. Mull.) Mull. On F. Mull.				
86	*Cryptogonium phylogonioides* (Sull.) Isov.	/	x	x	NRL
	Neckeraceae				
	Himantocladium (Mitt.) Fleisch.				
87	*Himantocladium cyclophyllum* (C. Mull.) Fleisch.	/	x	x	NRL,W
88	*Himantocladium plumula* (Ness.) Fleisch.	x	x	/	NRL
	Homaliodendron Fleisch.				
89	*Homaliodendron flabellatum* (Sm.) Fleisch.	/	x	/	NRL,W
	Neckera Hedw. Nom. Cons.				
90	*Neckera warburgii* Broth.	/	x	x	NRL
	Neckeropsis Reichardt				
91	*Neckeropsis lepineana* (Mont.) Fleisch.	/	x	/	NRL,W

Table 1 continued

	Pinnatella Felisch.				
92	*Pinnatella mariei* (Besch.) Broth.	/	x	x	NRL
93	*Pinnatella alopecuroides* (Hook.) Fleisch.	/	x	x	NRL
	Lembophyllaceae				
	Neobarbella Nog.				
94	*Neobarbella comes* (Griff.) Nog.	/	x	x	NRL,NRM
	Hookeriaceae				
	Calliscostella (C. Mull.) Mitt.,nom.cons				
95	*Calliscostella papillata* (Mont.) Mitt.	x	x	/	NRL,W
	Calyptrochaeta Desv.				
96	*Calyptrochaeta parviretis* cf. (Fleisch.) Iwats., Tan & Touw	x	x	/	NRL
97	*Calyptrochaeta remotifolia* (C. Mull.) Iwats., Tan & Touw	/	x	x	NRL
	Chaetomitriopsis Fleisch.				
98	*Chaetomitriopsis glaucocarpa* (Reinw.) Fleisch.	/	x	x	NRL
	Chaetomitrium Dozy & Molk				
99	*Chaetomitrium warburgii* Broth in Warb	/	x	x	NRL
	Cyclodictyon Mitt.				
100	*Cyclodictyon blumeanum* (C. Mull.) O. Kuntze	x	x	/	NRL,W
	Distichophyllum Dozy & Molk.				
101	*Distichophyllum tortile* Dozy & Molk.ex. Bosch & Lac.	/	x	x	NRL,NRM
	Leucomiaceae				
	Leucomium Mitt.				
102	*Leucomium strumosum* (Horsch.) Mitt.	/	x	x	NRL
	Hypopterygiaceae				
	Lopidium Hook. F. & Wils.				
103	*Lopidium struthiopteris* (Brid.) Fleisch.	/	x	/	NRL
	Thuidiaceae				
	Pelekium				

Table 1 continued

104	*Pelekium* velatum Mitt.	/	x	x	NRL,W
	Thuidium Schimp in B.S.G.				
105	*Thuidium cymbifolium* (Dozy & Molk.) Dozy & Molk.	/	x	x	NRL,W
106	*Thiudium glaucinum* (Mitt.) Bosch. & Lac.	x	x	/	NRL
	Brachytheciaceae				
	Eurrhynchium Schimp. In B.S.G.				
107	*Eurrhynchium vagans* (Jaeg.) Bartr.	/	x	/	NRL,NRM
	Palamocladium C. Mull.				
108	*Palamocladium nilgheriense* (Mont.) C. Mull.	/	x	x	NRL
	Homalothecium Schimp.				
109	*Homalothecium appressifolium* (Williams) Broth.	/	x	/	NRL,NRM
	Rhynchostegium B.S.G.				
110	*Rhynchostegium celebicum* (Lac.) Jaeg.	/	x	/	NRL
	Entodontaceae				
	Entodon C. Mull.				
111	*Entodon plicatus* C. Mull.	/	x	x	NRL
	Erythrodontium Hampe				
112	*Erythrodontium julaceum* C. Mull.	/	x	x	NRL,W
	Sematophyllaceae				
	Acroporium Mitt.				
113	*Acroporium ramicola* (Hampe) Broth.	/	x	/	NRP,NRL
114	*Acroporium stramineum* (Reinw. & Horsch.) Fleisch.	x	/	x	NRL
115	*Acroporium strepsiphyllum* (Mont.) B.C. Tan	x	/	x	NRL
	Meiotheciella B.C. Tan, (Mont) B.C.Tan				
116	*Meiotheciella papillosa* (Broth in ther) B.C. Tan, Schof & Ramsay, comb.nov.	/	x	x	NRP,NRL,R
	Meiothecium Mitt.				
117	*Meiothecium microcarpum* (Hook.) Mitt.	/	x	x	NRL
	Radulina Buck & Tan				
118	*Radulina hamata* (Dozy & Molk) Buck & Tan	x	/	x	NRL,W

Table 1 continued

	Rhaphidostichum Fleisch.				
119	*Rhaphidostichum piliferum* (Broth.) Broth.	x	/	x	NRL,NRM
	Sematophyllum Mitt.				
120	*Sematophyllum subpinnatum* (Hook.) Mitt.	/	x	x	NRL
	Trichosteleum				
121	*Trichosteleum ruficaule* (Thwaits & Mitt.) Tan	/	x	/	NRL
	Trimegistia (C. Mull.) C. Mull.				
122	*Trimegistia calderensis* (Sull.) Broth.	x	x	/	NRL
	Hypnaceae				
	Ectropothecium Mitt.				
123	*Ectropothecium dealbatum* (Reinw. & Hornsch.) Jaeg.	/	x	x	NRL,W
124	*Ectropothecium falciforme* (Dozy & Molk.) Jaeg.	x	/	x	NRL
125	*Ectropothecium ferrugineum* (C. Mull.) Jaeg.	x	x	/	NRL
126	*Ectropothecium ichnotocladum* (C. Mull.) Jaeg.	/	x	/	NRL
127	*Ectropothecium monumentorum* cf. (Duby) cf.Jaeg.	/	x	x	NRL,W
128	*Ectropothecium penzigianum* Fleisch.	/	x	x	NRL,NRM
129	*Ectropothecium striatulum* Dix. Ex Bartr.	/	x	x	NRL,NRM
	Ctenidium (Schimp.) Mitt.				
130	*Ctenidium luzonense*cf. Broth.	/	x	x	NRL
	Vasicularia (C. Mull.)C. Mull.				
131	*Vasicularia reticulata* (Dozy & Molk.) Broth.	x	x	/	NRL,W
	Buxbaumiaceae				
	Diphyscium Mohr.				
132	*Diphyscium involutum* Mitt.	/	x	x	NRL,NRM
	Polytrichaceae				
	Dawsonia R. Br.				
133	*Dawsonia longifolia* (Brush & Schimp Zant var. superba (Grev.) Zant	/	x	x	NRL, R
	Pogonatum P. Beauv.				

Table 1 continued

134	*Pogonatum camusii* (Ther) Touw.	/	/	x	NRL
135	*Pogonatum cirratum ssp.cirratum* (Sw.) Brid.	/	/	x	NRL,NRM
136	*Pogonatum microphyllum* (Dozy & Molk.) Dozy & Molk.	/	x	/	NRL,NRM
137	*Pogonatum neesii* (C. Mull.) Dozy.	x	x	/	NRL,W
	TOTAL	109	20	53	

Legend: x - absent
/ - present
NRP - New record in the Philippines
NRM - New record in Mindanao
NRL - New Record in terms of Locality
R - Rare
2 C - 2nd collection in the Philippines
W- Widespread

Table 2. Number of family, genera, and species of mosses in the three selected mountains in Mindanao, Philippines

MOUNTAIN	FAMILY	GENERA	SPECIES
Kalatungan	32	76	109
Matutum	24	44	53
Malambo	12	17	20

This study confirmed the report and observation of Tan (1992,1994,1998) and Tan, Lubos, and Schwarz (2000) that mosses grow best in moist forest with high altitude. Mt. Kalatungan has the highest altitude compared to Mt. Matutum and Mt. Malambo.

Assessment

The three mountains revealed that there are 7 new records of mosses in the Philippines, 37 new to Mindanao, 137 new records in terms of locality, 12 rare species, 1 collected twice, and 29 widespread species (Table 3).

Table 3. Status of mosses in three selected mountains in Mindanao, Philippines.

Status	**Kalatungan**	**Matutum**	**Malambo**
1. New Record in the Philippines (NRP) (reported by Tan, Lubos, and Schwarz,2000)	**6**	**1**	**0**
2. New record in Mindanao (NRM)	**33**	**8**	**0**
3. New record in terms of locality (NRL)	**109**	**53**	**20**
4. Rare (R)	**11**	**3**	**0**
5. 2nd collection (2C)	**1**	**0**	**0**
7. Widespread (W)	**21**	**13**	**4**

Fig. 1. Philippine Map

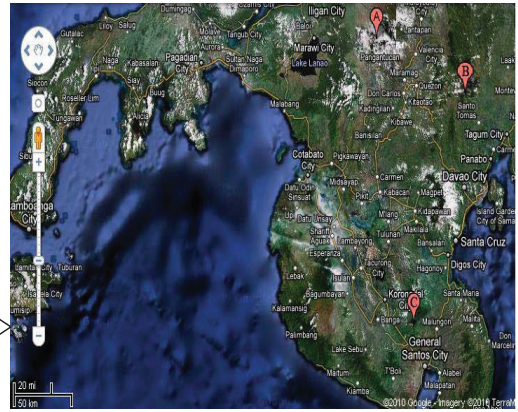

Fig. 2. Mindanao Map

Fig. 3. Mt. Kalatungan, Bukidnon Province with highest elevation of 2,824 masl

Fig. 4. Mt. Matutum, South Cotabato Province with highest elevation of 2,286 masl.

Fig. 5. Mt. Malambo, Salumay, Davao Province with highest elevation of 1,278 masl.

CONCLUSION

The study found that there are new records of mosses found in Mindanao, particularly in Mt. Kalatungan in Bukidnon, Mt. Matutum in South Cotabato and Mt. Malambo in Salumay, Davao Province.

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