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Mosses from the Molawin-Dampalit Subwatershed, Mt. Makiling Forest Reserve, the Philippines

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ABSTRACT

Despite being important components of natural ecosystems, mosses are often not included in forest inventories, assessment, and monitoring particularly in the Philippine setting. In view of this, we aimed to document and revisit the moss flora of Mt. Makiling Forest Reserve which is regarded as one of the most biologically explored areas in the country. A collection of mosses from the Molawin-Dampalit Subwatershed of the Mt. Makiling Forest Reserve yielded a total of 27 species, one (1) subspecies, and one (1) variety in 22 genera and 10 families. These represent 12.16% of the species, 22% of the genera, and 31.25% of the families reported for the mountain. The most represented families are Neckeraceae (5 species) and Calymperaceae and Pylaisiadelphaceae (3 species each). *Syrrhopodon aristifolius* Mitt. is hereby reported as new record for Luzon Island. With this, the importance and need for continued studies on the mosses is highlighted especially in underexplored portions of Mt. Makiling and should be ultimately geared towards a revised checklist of the mosses for the mountain.

Keywords: mosses, bryophytes, Mt. Makiling, Philippines.

INTRODUCTION

Mount Makiling Forest Reserve and ASEAN Heritage Park (MMFR) is the subject of our recent studies which aimed to update the moss flora of the mountain and its vicinity (Alcala *et al*., 2020). As one of the most biologically known areas in the Philippines, the mountain had been subject to numerous bryological studies in the past (*e.g*. Tan, 1982; Tixier, 1972) –resulting to 213 species, three (3) subspecies, nine (9) varieties), and one (1) forma in 96 genera and 31 families of mosses known for the area. Our recent study on mosses collected in the Greater Sipit Subwatershed yielded 36 species and one (1) subspecies, of which 10 species, one (1) genus, and one (1) family are newly recorded for the mountain (Alcala *et al*., 2020). In addition to this, only a handful of studies have been conducted in the MMFR recently (*e.g*. Magcale-Macandog *et al*., 2022); hence, the need to revisit and explore other areas in the mountain became apparent.

Despite being important components of natural ecosystems (Hallingbäck and Tan, 2010), bryophytes in general are not included in the recommended guidelines of the Department of Environment and Natural Resources of the Philippines (see DENR–BMB and GIZ, 2017). The inclusion of bryophytes in forest inventories, assessment, and monitoring in the Philippines is particularly important in order to provide baseline information and monitor bryophyte richness in a particular area. An example of this is presented by Sastre-De Jesus and Tan (1995) who discussed how human activities reduced the number of mosses of Mt. Santo Tomas in Benguet from 175 species to only 80 species. With this, revisiting biologically explored areas may provide up-to-date information on the bryophyte species richness of an area; in this case for Mt. Makiling.

In this report, we present the second part of our research which focused on the collections made in the Molawin-Dampalit Subwatershed along the northeastern slope of the mountain. This covers the area along the Mariang Makiling Trail which traverses from the University of the Philippines Los Baños campus up to the summit at Peak 2 (1,090 m asl). This trail is characterized by an access road up to around 500 m asl at Agila Base and is frequently used by locals and tourists alike. Also presented here are information on the substrate, habitat, and intra-Philippine distribution of each species.

MATERIALS AND METHODS

The methodologies followed in this research are presented in detail by Alcala *et al*. (2020). The elevation and geographical location of the plots were determined using a Global Navigation Satellite System (GNSS) receiver (Table 1; Fig. 1). Voucher specimens were examined and identified in the Department of Forest Biological Sciences, College of Forestry and Natural Resources, University of the Philippines Los Baños and were deposited at CAHUP. Information on the intra-Philippine distribution of species were consulted primarily from Tan and Iwatsuki (1991) and the works of Azuelo *et al*. (2015), Linis (2009, 2010, 2014, 2018, 2019, 2021), Linis and Tan (2013), Lubos (2007), Shevock and Yorong (2018), Tan *et al*. (2000), Tan (1996), Tan and Shevock (2014), Tan et al. (2015), and Tan *et al*. (2017).

Table 1. Collection sites within the Molawin-Dampalit Subwatershed, Mt. Makiling.

No.	Site Description	Collection Date
1	Tropical lowland evergreen rainforest at 300 m elevation; WGS 84. Lat/Long: 14º08.52' N, 121º13.82' E	13 February 2016
2	Tropical lowland evergreen rainforest at 400 m elevation; WGS 84. Lat/Long: 14º08.16' N, 121º13.75' E	13 February 2016
3	Tropical lowland evergreen rainforest at 500 m elevation; WGS 84. Lat/Long: 14º07.77' N, 121º12.66' E	13 February 2016
4	Tropical lowland evergreen rainforest at 600 m elevation; WGS 84. Lat/Long: 14º08.03' N, 121º12.48' E	13 February 2016
5	Tropical lowland evergreen rainforest at 700 m elevation; WGS 84. Lat/Long: 14º08.31' N, 121º12.32' E	13 February 2016
6	Tropical lower montane rainforest at 800 m elevation; WGS 84. Lat/Long: 14º08.35' N, 121º11.94' E	13 February 2016
7	Tropical upper montane rainforest at 900 m elevation; WGS 84. Lat/Long: 14º08.28' N, 121º11.81' E	13 February 2016
8	Tropical upper montane rainforest at 1,000 m elevation; WGS 84. Lat/Long: 14º08.17' N, 121º11.74' E	13 February 2016

RESULTS AND DISCUSSION

Enumeration of Taxa

A total of 27 species, one (1) subspecies, and one (1) variety in 22 genera and 10 families were recorded in the Molawin-Dampalit Subwatershed of Mt. Makiling Forest Reserve and ASEAN Heritage Park. The list is presented in alphabetical order for ease of reference –with each species annotated by locality (see Table 1), voucher specimen number, substrate and habitat information, and intra-Philippine distribution. An asterisk (*) indicates a new record for Mt. Makiling and vicinity. Nomenclature follows Tan and Iwatsuki (1991) and Brinda and Atwood (2022, continuously updated), adjusted following recent nomenclatural changes.

Acroporium hermaphroditum (Müll. Hal.) M. Fleisch. [Sematophyllaceae] – SITE 8: A.A. Alcala 91. Epiphytic in tropical upper montane rainforest. Intra-Philippine Distribution: Batan, Luzon, Mindoro, Camiguin, and Mindanao (Linis, 2009; Tan and Iwatsuki, 1991).

Acroporium secundum (Reinw. & Hornsch.) M. Fleisch. [Sematophyllaceae] – SITE 7: A.A. Alcala 83. SITE 8: A.A. Alcala 93. Epiphytic or epixylic in tropical upper montane rainforest. Intra-Philippine Distribution: Luzon, Mindoro, Palawan, Negros, Camiguin, and Mindanao (Linis, 2009, 2010, 2014; Tan and Iwatsuki, 1991).

Barbella compressiramea (Renauld & Cardot) M. Fleisch. [Meteoriaceae] – SITE 3: A.A. Alcala 56.

Figure 1. Collection sites in the Molawin-Dampalit Subwatershed: the tropical lowland evergreen rainforest from 300 m to 700 m asl (A-E); the tropical lower montane rainforest at 800 m asl (F); and the tropical upper montane rainforest at 900 m to 1000 m asl (G-I).

Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Luzon (Linis, 2019; Tan and Iwatsuki, 1991).

Caduciella mariei (Besch.) Enroth [Neckeraceae] – SITE 1: A,A. Alcala 50. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Luzon, Catanduanes, Palawan, and Mindanao (Linis, 2014; Lubos, 2010 as *Pinnatella mariei*; Tan and Iwatsuki, 1991 as *Pinnatella mariei*).

Circulifolium exiguum (Bosch & Sande Lac.) S. Olsson, Enroth & D. Quandt [Neckeraceae] – SITE 3: A.A. Alcala 57. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Batan, Luzon, Catanduanes, Mindoro, and Mindanao (Linis, 2014; Tan and Iwatsuki, 1991 as *Homaliodendron exiguum*).

Claopodium prionophyllum (Müll. Hal.) Broth. [Leskeaceae] – SITE 5: A.A. Alcala 75. On rocks in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Widespread (Tan and Iwatsuki, 1991).

Dendro-hypnum reinwardtii subsp. *caducifolium* (Herzog) N.E. Bell, A.E. Newton & D. Quandt [Hypnodendraceae] – SITE 8: A.A. Alcala 86. Epiphytic in tropical upper montane rainforest. Intra-Philippine Distribution: Widespread (Tan and Iwatsuki, 1991 as *Hypnodendron reinwardtii* subsp. *caducifolium*).

Exostratum blumei (Nees ex Hampe) L.T. Ellis [Calymperaceae] – SITE 5: A.A. Alcala 72 & 74. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Batan, Luzon, Catanduanes, Negros, Cebu, Camiguin, and Mindanao (Linis, 2010; Tan and Iwatsuki, 1991).

Fissidens braunii (Müll. Hal.) Dozy & Molk. [Fissidentaceae] – SITE 3: A.A. Alcala 63. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Batan, Luzon, Lubang, and Mindanao (Tan and Iwatsuki, 1991).

Fissidens crispulus Brid. [Fissidentaceae] – SITE 6: A.A. Alcala 77. Epixylic in tropical lower montane rainforest. Intra-Philippine Distribution: Widespread (Tan and Iwatsuki, 1991 as *F. zippelianus*).

Fissidens crispulus var. *robinsonii* (Broth.) Z. Iwats. & Z.H. Li [Fissidentaceae] – SITE 1: A.A. Alcala 49.

SITE 3: A.A. Alcala 64. SITE 4: A.A. Alcala 66. On rocks or soil in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Luzon, Palawan, Panay, and Mindanao (Linis, 2019 as *F. robinsonii*; Tan, 1996 *F. zippelianus* var. *robinsonii*; Tan and Iwatsuki, 1991 as *F. zippelianus* var. *robinsonii*).

Himantocladium plumula (Nees) M. Fleisch. [Neckeraceae] – SITE 3: A.A. Alcala 58. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Luzon, Mindoro, Samar, and Mindanao (Tan and Iwatsuki, 1991).

Homaliodendron flabellatum (Sm.) M. Fleisch. [Neckeraceae] – SITE 8: A.A. Alcala 87. Epiphytic in tropical upper montane rainforest. Intra-Philippine Distribution: Widespread (Tan and Iwatsuki, 1991).

Isopterygium albescens (Hook.) A. Jaeger [Pylaisiadelphaceae] – SITE 2: A.A. Alcala 53. SITE 4: A.A. Alcala 67, 68, & 69. Epiphytic or on soil in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Widespread (Linis, 2009 as *I. minutirameum*, 2010, 2014; Tan, 1996 as *I. minutirameum*; Tan and Iwatsuki, 1991).

Leucobryum bowringii Mitt. [Leucobryaceae] – SITE 7: A.A. Alcala 79 & 80a. SITE 8: A.A. Alcala 88, 89, & 90. Epiphytic or epixylic in tropical upper montane rainforest. Intra-Philippine Distribution: Batan, Luzon, Catanduanes, Mindoro, Sibuyan, Negros, and Panay (Linis, 2009, 2014; Tan and Iwatsuki, 1991).

Leucobryum sanctum (Nees ex Schwägr.) Hampe [Leucobryaceae] – SITE 7: A.A. Alcala 80b. Epiphytic in tropical upper montane rainforest. Intra-Philippine Distribution: Widespread (Tan and Iwatsuki, 1991).

Leucoloma molle (Müll. Hal.) Mitt. [Dicranaceae] – SITE 7: A.A.Alcala 84 & 85. Epiphytic in tropical upper montane rainforest. Intra-Philippine Distribution: Batan, Luzon, Catanduanes, Mindoro, Palawan, Negros, Camiguin, and Mindanao (Linis, 2009, 2010, 2014; Tan, 1996; Tan and Iwatsuki, 1991).

Leucophanes octoblepharioides Brid. [Calymperaceae] – SITE 3: A.A. Alcala 59 & 60. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Batan, Luzon, Catanduanes, Mindoro, Palawan, Panay, Camiguin, and Mindanao (Linis, 2009, 2010, 2014; Tan, 1996; Tan and Iwatsuki, 1991).

Neckeromnion lepineanum (Mont.) S. Olsson, Enroth, Huttunen & D. Quandt [Neckeraceae] – SITE 2: A.A. Alcala 52. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Widespread (Tan and Iwatsuki, 1991 as *Neckeropsis lepineana*).

Pelekium bifarium (Bosch. & Sande. Lac.) M. Fleisch. [Thuidiaceae] – SITE 6: A.A. Alcala 76. SITE 7: A.A. Alcala 81. Epiphytic or epixylic in tropical lower and tropical upper montane rainforest. Intra-Philippine Distribution: Luzon, Mindoro, Palawan, and Panay (Linis, 2009 as *Aequatoriella bifaria*; Tan, 1996 as *Lorentzia bifaria*; Tan and Iwatsuki, 1991 as *L. bifaria*).

Pelekium velatum Mitt. [Thuidiaceae] – SITE 2: A.A. Alcala 51. SITE 4: A.A. Alcala 65. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Widespread (Tan and Iwatsuki, 1991 as *Lorentzia velata*).

Pyrrhobryum spiniforme (Hedw.) Mitt. [Rhizogoniaceae] – SITE 5: A.A. Alcala 71. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Widespread (Tan and Iwatsuki, 1991).

Rhaphidostichum luzonense (Broth.) Broth. [Sematophyllaceae] – SITE 8: A.A. Alcala 92. Epiphytic in tropical upper montane rainforest. Intra-Philippine Distribution: Luzon and Mindanao (Shevock and Yorong, 2018; Tan and Iwatsuki, 1991).

Rhynchostegiella menadensis (Sande Lac.) E.B. Bartram [Brachytheciaceae] – SITE 2: A.A. Alcala 54 & 55. SITE 3: A.A. Alcala 61. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Luzon, Palawan, and Mindanao (Shevock and Yorong, 2018; Tan, 1996; Tan and Iwatsuki, 1991).

Rhynchostegium celebicum (Sande Lac.) A. Jaeger [Brachytheciaceae] – SITE 6: A.A. Alcala 78. Epiphytic in tropical lower montane rainforest. Intra-Philippine Distribution: Luzon, Mindoro, and Mindanao (Linis, 2009; Tan and Iwatsuki, 1991).

**Syrrhopodon aristifolius* Mitt. [Calymperaceae] – SITE 5: A.A. Alcala 73. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Heretofore known only from Mindoro and Mindanao (Ellis and Tan, 1999; Tan and Iwatsuki, 1991).

Taxithelium instratum (Brid.) Broth. [Pylaisiadelphaceae] – SITE 3: A.A. Alcala 62. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Widespread (Tan and Iwatsuki, 1991).

Taxithelium lindbergii (A. Jaeger) Renauld & Cardot

[Pylaisiadelphaceae] – SITE 4: A.A. Alcala 70. Epiphytic in tropical lowland evergreen rainforest. Intra-Philippine Distribution: Luzon, Mindoro, Camiguin, and Mindanao (Câmara, 2011; Linis, 2019; Tan and Iwatsuki, 1991 as *Taxithelium alare*).

DISCUSSION

Restating, a total of 27 species, one (1) subspecies, and one (1) variety in 22 genera and 10 families were found in the Molawin-Dampalit Subwatershed of the Mt. Makiling Forest Reserve (Table 2). These represent 12.16% of the species, 22% of the genera, and 31.25% of the families reported for the mountain and its vicinity. The most represented families are Neckeraceae with five (5) species and Calymperaceae, Pylaisiadelphaceae, and Sematophyllaceae each with three (3) species. Among genera, *Acroporium*, *Fissidens*, *Leucobryum*, *Pelekium*, and *Taxithelium* are represented each with two (2) species.

Table 2. Summary of mosses found in the Molawin-Dampalit Subwatershed, Mt. Makiling Forest Reserve.

Families	Genera	Species and subspecies
Brachytheciaceae	two (2)	two (2) species
Calymperaceae	three (3)	three (3) species
Dicranaceae	one (1)	one (1) species
Fissidentaceae	one (1)	two (2) species and one (1) variety
Hypnodendraceae	one (1)	one (1) species and subspecies
Leskeaceae	one (1)	one (1) species
Leucobryaceae	one (1)	two (2) species
Meteoriaceae	one (1)	one (1) species
Neckeraceae	five (5)	five (5) species
Pylaisiadelphaceae	two (2)	three (3) species
Rhizogoniaceae	one (1)	one (1) species
Sematophyllaceae	two (2)	three (3) species
Thuidiaceae	one (1)	two (2) species
Total	22 genera	27 species, one (1) subspecies, and one (1) variety

Among the species recorded in the Molawin-Dampalit Subwatershed, the presence of *Syrrhopodon aristifolius* is noteworthy and is the first record of this species in Luzon Island. This Indo-Pacific species have been previously recorded from Mindoro and Mindanao and is distinguished from other species of Calymperaceae by its linear and bristle-like leaves, poorly defined extent of the hyaline lamina, and the polystratose and usually

entire margins above leaf base (Ellis and Tan, 1999).

In light of recent studies on the moss flora of Mt. Makiling (*i.e*. Alcala *et al*., 2020; Magcale-Macandog *et al*., 2022), it is apparent that further explorations on the least studied areas of the forest reserve will likely provide more information on the local moss flora and their distribution. Magcale-Macandog *et al*. (2022) found 24 species of mosses belonging to 19 families thriving in the northeastern slope of the mountain. In addition, they found out that species composition of plots sampled varied along an elevational gradient –forming three (3) clusters, of which high elevation areas (900 to 1000 m asl) form a distinct assemblage. To complement this, we include *Acroporium hermaphroditum*, *A. secundum*, *Leucobryum bowringii*, *Leucoloma molle*, and *Rhaphidostichum luzonense* as elements that characterize the high elevation areas of Mt. Makiling. Similarly, *Caduciella mariei*, *Circulifolium exiguum*, *Himantocladium plumula*, *Isopterygium albescens*, *Neckeromnion lepineanum*, and *Syrrhopodon aristifolius* are among the species found along the lower elevation of the northeastern slope of the mountain. Given these, we emphasize the need to conduct additional fieldworks within the forest reserve (*e.g*. in the Cambantoc Subwatershed and Crater Area) to gather additional data on the moss flora and its distribution which would provide essential information for a revised checklist of the mosses to be realized.

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