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Mosses from the Greater Sipit Subwatershed, Mt. Makiling Forest Reserve, the Philippines

Ailene A. Alcala^{1*}, Manuel L. Castillo², Pastor L. Malabrigo Jr.², Eugene L. R. Logatoc¹, Bonifacio O. Pasion^{3, 4}, Ramil S. Alcala⁵

¹Institute of Biological Sciences, University of the Philippines Los Baños, 4031 Los Baños, Laguna, Philippines

²Department of Forest Biological Sciences, College of Forestry and Natural Resources, University of the Philippines Los Baños, 4031 Los Baños, Laguna, Philippines

³Center for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menglun, Mengla, Yunnan 666303, China

⁴Institute of Biology, University of the Philippines Diliman, 1101 Diliman, Quezon City, Philippines

⁵Citicore Renewable Energy Corp., San Miguel Ave., Ortigas Center, Pasig City, Philippines

Corresponding author: aaalcala1@up.edu.ph

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ABSTRACT

The mosses of the Greater Sipit Subwatershed of the Mt. Makiling Forest Reserve, based on a collection carried out along an elevational gradient from 300 m asl to 1,000 m asl, consists of 36 species and one (1) subspecies distributed in 24 genera and 17 families. These represent 16.14% of the species, 25% of the genera, and 50% of the families reported for the mountain. The most represented families are Calymperaceae (7 species), Fissidentaceae (5 species), and Hypnaceae (4 species). Epiphytic (18 species and 1 subspecies) and saxicolous (15 species) taxa make up the majority of the collection. Ten (10) species are added to the moss flora of Mt. Makiling and vicinity namely *Calymperes afzelii*, *C. erosum*, *Campylopus savannarum*, *Dicranoloma assimile*, *Fissidens polypodioides*, *F. taxifolius*, *Mitthyridium flavum*, *Oedocladium rufescens*, *Pelekium contortulum*, and *Sematophyllum tristiculum*.

Key words: Mosses, bryophytes, Mt. Makiling, Philippines.

INTRODUCTION

Mount Makiling (1,090 m elev.) is an inactive volcano located in the southern portion of Luzon Island; the summit is located at 14°13.62' N, 121°19.57' E. The upper portion of the mountain is designated as the Mt. Makiling Forest Reserve

(MMFR), a state-owned reserve under the control and administration of the University of the Philippines Los Baños (UPLB). Straddling the boundaries of the Laguna and Batangas provinces, the forest reserve covers an area of 4,244.37 hectares and is divided into four (4) subwatersheds namely Molawin-Dampalit, Cambantoc, Greater Sipit, and Tigbi. Designated as a

forest reserve as early as 1910, MMFR serves as a living research and training laboratory of UPLB, a geothermal resource, an ecotourism site, and an important water source of neighboring communities (Lapitan et al. 2010). In 2013, the MMFR was designated as an ASEAN Heritage Park for its scientific and cultural importance.

Looking into the mosses, Tan and Iwatsuki (1991) enumerated approximately 700 species in 228 genera and 55 families known to occur in the Philippines. Out of these, 213 species, three (3) subspecies, nine (9) varieties, and one (1) forma distributed in 96 genera and 31 families were recorded in Mt. Makiling (Penecilla 1980; Tan 1982; Tan and Iwatsuki 1991; Tixier, 1972). Mount Makiling and its environs are regarded as one of the most biologically known areas in the Philippines and have been subject to biodiversity studies in the past (Lapitan et al. 2010). It is apparent, however, that no recent studies on

mosses have been conducted in the MMFR. In view of this, the present paper aimed to identify and provide information on the moss species found along an elevational gradient in the Greater Sipit Subwatershed, together with information on their substrate preferences and geographical distribution.

MATERIAL AND METHODS

Fieldwork was conducted in different vegetation types along the southwestern slope of Mt. Makiling, particularly along the trail to Peak 3 in the Greater Sipit Subwatershed. Prior to the collection, a reconnaissance survey was conducted in the study area to identify and layout potential sampling plots. A Global Navigation Satellite System (GNSS) receiver was used to determine the elevation and geographical location of the plots (Table 1).

Table 1. Collection sites within the Greater Sipit Subwatershed, Mt. Makiling.

No.	Site Description	Collection Date
1	Tropical lowland evergreen rainforest at 300 m elevation; WGS 84. Lat/Long: 14°11.13' N, 121°18.68' E	5 July 2015
2	Tropical lowland evergreen rainforest at 400 m elevation; WGS 84. Lat/Long: 14°11.74' N, 121°18.59' E	5 July 2015
3	Tropical lowland evergreen rainforest at 500 m elevation; WGS 84. Lat/Long: 14°12.01' N, 121°18.51' E	5 July 2015
4	Tropical lowland evergreen rainforest at 600 m elevation; WGS 84. Lat/Long: 14°12.08' N, 121°18.31' E	5 July 2015
5	Wooded grassland at 700 m elevation; WGS 84. Lat/Long: 14°12.29' N, 121°18.43' E	5 July 2015
6	Tropical lower montane rainforest at 800 m elevation; WGS 84. Lat/Long: 14°12.49' N, 121°18.46' E	4 July 2015
7	Tropical upper montane rainforest at 900 m elevation; WGS 84. Lat/Long: 14°13.17' N, 121°18.45' E	4 July 2015
8	Tropical upper montane rainforest at 1,000 m elevation; WGS 84. Lat/Long: 14°13.31' N, 121°18.46' E	4 July 2015

Following the Modified Belt Transect Method, elevational transect plots were laid out in a left to right manner parallel to the existing trail (as transect line) at 100 m elevation interval from 300 m asl to 1,000 m asl (Fig. 1). The lower elevation limit was set at 300 m asl since areas below this elevation are mostly occupied by agricultural and residential lands. A total of sixteen (16) sampling plots measuring 10 m × 10 m were established. Voucher specimens were collected from all available microhabitats within each plot and were then prepared and preserved following standard procedures (Glime, 2013; Shevock et al., 2014).

Examination and identification of collections were done in the Department of Forest Biological Sciences, College of Forestry and Natural Resources,

University of the Philippines Los Baños. Species identifications were confirmed through comparison with species descriptions and illustrations from floras and monographs and with authentically named specimens deposited at the Botanical Herbarium of the UPLB Museum of Natural History (CAHUP). Information on the geographical distribution of species were consulted from published literature, mainly by Tan and Iwatsuki (1991) and the works of Azuelo et al. (2015), Linis (2009, 2010, 2014, 2018), 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). All voucher specimens were deposited at CAHUP.

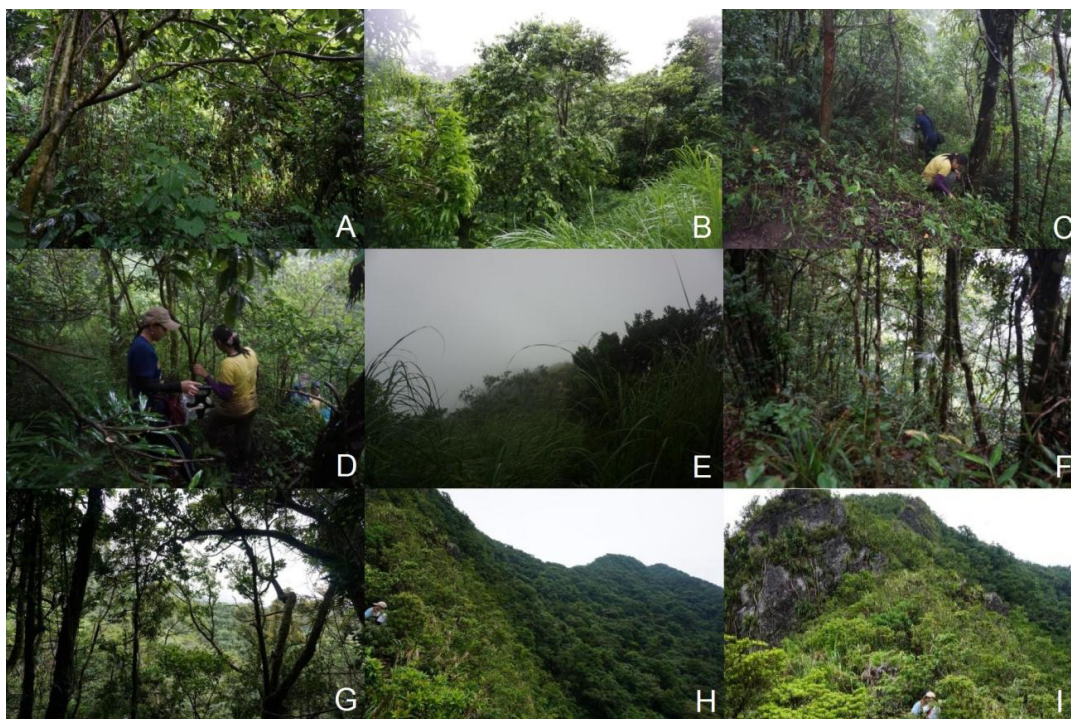


Fig. 1. Collection sites in the Greater Sipit Subwatershed: the tropical lowland evergreen rainforest from 300 m to 600 m asl (A-D); a wooded grassland at 700 m asl (E); the tropical lower montane rainforest at 800 m asl (F); and the tropical upper montane rainforest at 900 m to 1000 m asl (G-I).

RESULTS AND DISCUSSION

Enumeration of Taxa

Presented in this list are a total of 36 species and one (1) subspecies in 24 genera and 17 families known to occur in the Greater Sipit Subwatershed of Mt. Makiling Forest Reserve and ASEAN Heritage Park. Nomenclature mainly follows Tan and Iwatsuki (1991), updated following recent nomenclatural changes. Each species is annotated by locality (see Table 3), voucher specimen number, substrate and habitat information, and intra-Philippine distribution. Species marked with an asterisk (*) indicates a new record for Mt. Makiling and vicinity. The list of species is presented in alphabetical order for ease of reference.

Acroporium pungens (Hedw.) Broth. [Sematophyllaceae] – SITE 8: AAAAlcala 36 *pro parte*, 39, 44, 47. Epiphytic in tropical upper montane rainforest. Recorded in the Philippines from Luzon, Mindoro, Panay, Camiguin, and Mindanao (Linis, 2009, 2010; Shevock and Yorong, 2018; Tan and Iwatsuki, 1991 as *Acroporium sigmatodontium*).

Bryum coronatum Schwägr. [Bryaceae] – SITE 5: AAAAlcala 23. Growing on soil in wooded grassland. Widespread in the Philippines (Tan and Iwatsuki, 1991).

**Calymperes afzelii* Sw. [Calymperaceae] – SITE 1: AAAAlcala 01. On rocks in tropical lowland evergreen

rainforest. Previously known in the Philippines from Luzon, Balabac, and Palawan (Linis, 2014; Ellis and Tan, 1999).

**Calymperes erosum* Müll. Hal. [Calymperaceae] – SITE 5: AAAAlcala 24. On rocks in wooded grassland. Previously recorded in the Philippines from Luzon, Mindoro, Balabac, Culion, and Palawan (Ellis and Tan, 1999; Linis, 2009; Tan, 1996).

Calymperes serratum A. Braun ex Müll. Hal. [Calymperaceae] – SITE 7: AAAAlcala 34a. Epiphytic in tropical upper montane rainforest. Recorded in the Philippines from Luzon, Mindoro, Negros, and Mindanao (Ellis and Tan, 1999; Linis, 2009; Tan and Iwatsuki, 1991).

Calymperes tahitense (Sull.) Mitt. [Calymperaceae] – SITE 5: AAAAlcala 20. On rocks in wooded grassland. Widespread in the Philippines (Ellis and Tan, 1999; Tan and Iwatsuki, 1991).

Calymperes tenerum Müll. Hal. [Calymperaceae] – SITE 2: AAAAlcala 10. Epiphytic in tropical lowland evergreen rainforest. Widespread in the Philippines (Ellis and Tan, 1999; Tan and Iwatsuki, 1991).

**Campylopus savannarum* (Müll. Hal.) Mitt. [Dicranaceae] – SITE 8: AAAAlcala 45. On rocks in tropical upper montane rainforest. Previously known in the Philippines from Luzon and previously recorded in Laguna without specific locality information (Tan and Iwatsuki, 1991).

Claopodium prionophyllum (Müll. Hal.) Broth. [Leskeaceae] – SITE 5: AAAlcala 21. SITE 6: AAAlcala 28a. On rocks in wooded grassland and tropical lower montane rainforest. Widespread in the Philippines (Tan and Iwatsuki, 1991).

**Dicranoloma assimile* (Hampe) Paris [Dicranaceae] – SITE 7: AAAlcala 35a. Epiphytic in tropical upper montane rainforest. Recorded in the Philippines from Luzon, Mindoro, Camiguin, and Mindanao (Linis, 2009, 2010; Tan and Iwatsuki, 1991).

Ectropothecium buitenzorgii (Bél.) Mitt. [Hypnaceae] – SITE 6: AAAlcala 26a. SITE 8: AAAlcala 36 pro parte. Epiphytic in tropical lower and tropical upper montane rainforests. Widespread in the Philippines (Tan and Iwatsuki, 1991).

Ectropothecium ichnotocladum (Müll. Hal.) A. Jaeger [Hypnaceae] – SITE 8: AAAlcala 38. Epiphytic in tropical upper montane rainforest. Widespread in the Philippines (Tan and Iwatsuki, 1991).

Entodontopsis anceps (Bosch & Sande Lac.) W.R. Buck & R.R. Ireland [Stereophyllaceae] – SITE 1: AAAlcala 04, 06. SITE 2: AAAlcala 11a. On rocks in tropical lowland evergreen rainforest. Recorded in the Philippines from Luzon and Mindoro (Linis, 2009; Tan and Iwatsuki, 1991 as *Stereophyllum anceps*).

Fissidens hollianus Dozy & Molk. [Fissidentaceae] – SITE 1: AAAlcala 02. On rocks in tropical lowland evergreen rainforest. Recorded in the Philippines from Luzon and Palawan (Tan, 1996; Tan and Iwatsuki, 1991).

Fissidens javanicus Dozy & Molk. [Fissidentaceae] – SITE 7: AAAlcala 34b. Epiphytic in upper montane rainforest. Recorded in the Philippines from Luzon (Tan and Iwatsuki, 1991).

**Fissidens polypodioides* Hedw. [Fissidentaceae] – SITE 3: AAAlcala 13b. On rocks in tropical lowland evergreen rainforest. Previously recorded in the Philippines from Luzon and Mindanao (Linis, 2014 as *Fissidens areolatus*; Shevock and Yorong, 2018; Tan and Iwatsuki, 1991 as *F. areolatus*).

**Fissidens taxifolius* Hedw. [Fissidentaceae] – SITE 8: AAAlcala 37. Epiphytic in tropical upper montane rainforest. Previously recorded in the Philippines from Luzon, Negros, and Mindanao (Shevock and Yorong, 2018; Tan and Iwatsuki, 1991).

Fissidens zollingeri Dozy & Molk. [Fissidentaceae] – SITE 2: AAAlcala 09. On soil in tropical lowland evergreen rainforest. Recorded in the Philippines from Batan, Luzon, Mindoro, Palawan, and Negros (Linis, 2009; Tan, 1996; Tan and Iwatsuki, 1991).

Homaliodendron flabellatum (Sm.) M. Fleisch. [Neckeraceae] – SITE 7: AAAlcala 33. Epiphytic in

tropical upper montane rainforest. Widespread in the Philippines (Tan and Iwatsuki, 1991).

Hyophila involuta (Hook.) A. Jaeger [Pottiaceae] – SITE 1: AAAlcala 03. On rocks in tropical lowland evergreen rainforest. Widespread in the Philippines (Tan and Iwatsuki, 1991).

Hypnodendron reinwardtii subsp. *caducifolium* (Herzog) A. Touw [Hypnodendraceae] – SITE 8: AAAlcala 43. Epiphytic in tropical upper montane rainforest. Widespread in the Philippines (Tan and Iwatsuki, 1991).

Isopterygium bancanum (Sande Lac.) A. Jaeger [Pylaisiadelphaceae] – SITE 1: AAAlcala 07. SITE 4: AAAlcala 18. On rocks in tropical lowland evergreen rainforest. Recorded in the Philippines from Batan, Luzon, Mindoro, and Palawan (Linis, 2009; Tan, 1996; Tan and Iwatsuki, 1991).

Isopterygium minutirameum (Müll. Hal.) A. Jaeger [Pylaisiadelphaceae] – SITE 1: AAAlcala 05. On rocks in tropical lowland evergreen rainforest. Recorded in the Philippines from Batan, Luzon, Polillo, Lubang, Mindoro, Palawan, and Camiguin (Linis, 2009, 2010; Tan, 1996; Tan and Iwatsuki, 1991).

Leucobryum bowringii Mitt. [Leucobryaceae] – SITE 8: AAAlcala 42, 46. Epiphytic in tropical upper montane rainforest. Recorded in the Philippines from Batan, Luzon, Mindoro, Sibuyan, Negros, and Panay (Linis, 2009; Tan and Iwatsuki, 1991).

Leucoloma molle (Müll. Hal.) Mitt. [Dicranaceae] – SITE 8: AAAlcala 40, 43 pro parte. SITE 6: AAAlcala 27a. Epiphytic in tropical lower and tropical upper montane rainforests. Recorded in the Philippines from Batan, Luzon, Mindoro, Palawan, Negros, Camiguin, and Mindanao (Linis, 2009, 2010; Tan, 1996; Tan and Iwatsuki, 1991).

Leucophanes octoblepharioides Brid. [Calymperaceae] – SITE 2: AAAlcala 08. SITE 4: AAAlcala 17. SITE 6: AAAlcala 26b. Epiphytic in tropical lowland evergreen and tropical lower montane rainforests. Recorded in the Philippines from Luzon, Mindoro, Palawan, Panay, Camiguin and Mindanao (Linis, 2009, 2010; Tan, 1996; Tan and Iwatsuki, 1991).

**Mitthyridium flavum* (Müll. Hal.) H. Rob. [Calymperaceae] – SITE 6: AAAlcala 26c. Epiphytic in tropical lower montane rainforest. Widespread in the Philippines (Ellis and Tan, 1999; Tan and Iwatsuki, 1991).

**Oediacidium rufescens* (Reinw. & Hornsch.) Mitt. [Myuriaceae] – SITE 6: AAAlcala 30, 31a, 32. Epiphytic in tropical lower montane rainforest. Previously recorded in the Philippines from Luzon,

Mindoro, Negros, Palawan, and Mindanao (Linis, 2009; Tan and Iwatsuki, 1991; Tan and Shevock, 2014).

Pelekium bifarium (Bosch. & Sande. Lac.) M. Fleisch. [Thuidiaceae] – SITE 5: *AAAAlcala 19*. SITE 7: *AAAAlcala 35b*. Epiphytic and on rocks in wooded grassland and tropical upper montane rainforest. Recorded in the Philippines from Luzon, Mindoro, Palawan, and Panay (Linis, 2009 as *Aequatoriella bifaria*; Tan, 1996 as *Lorentzia bifaria*; Tan and Iwatsuki, 1991 as *L. bifaria*).

**Pelekium contortulum* (Mitt.) A. Touw [Thuidiaceae] – SITE 2: *AAAAlcala 11b*. On rocks in tropical lowland evergreen rainforest. Previously recorded in the Philippines from Luzon and Mindoro (Linis, 2009, 2019; Tan and Iwatsuki, 1991 as *Thuidium benguetense*).

Pelekium investe A. Touw [Thuidiaceae] – SITE 3: *AAAAlcala 12b, 13c*. On rocks in tropical lowland evergreen rainforest. Recorded in the Philippines from Luzon, Lubang, Mindoro, Palawan, Panay, Camiguin, and Mindanao (Linis, 2009, 2010, 2014; Tan, 1996 as *Thuidium investe*; Tan and Iwatsuki, 1991 as *T. investe*).

Pterobryopsis crassicaulis (Müll. Hal.) M. Fleisch. [Pterobryaceae] – SITE 6: *AAAAlcala 27b, 29a*. Epiphytic in tropical lower montane rainforest. Recorded in the Philippines from Luzon, Mindoro, Palawan, Panay, Negros, Samar, Camiguin, and Mindanao (Linis, 2009, 2010; Tan, 1996; Tan *et al.*, 2015; Tan and Iwatsuki, 1991)

**Sematophyllum tristiculum* (Mitt.) M. Fleisch. [Sematophyllaceae] – SITE 5: *AAAAlcala 22, 25*. Epiphytic in wooded grassland. Previously recorded

in the Philippines from Luzon and Mindanao (Tan and Iwatsuki, 1991).

Taxiphyllum taxirameum (Mitt.) M. Fleisch. [Hypnaceae] – SITE 3: *AAAAlcala 15*. Epiphytic in tropical lowland evergreen rainforest. Recorded in the Philippines from Luzon, Panay, and Mindanao (Linis, 2014; Tan and Iwatsuki, 1991; Tan and Shevock, 2014).

Trachythecium micropyxis (Broth.) E.B. Bartram [Symphyodontaceae] – SITE 3: *AAAAlcala 12a, 13a, 16*. On rocks in tropical lowland evergreen rainforest. Recorded in the Philippines from Luzon, Mindoro, Palawan, Camiguin, and Mindanao (Linis, 2009, 2010; Tan and Iwatsuki, 1991).

Vesicularia montagnei (Schimp.) Broth [Hypnaceae] – SITE 3: *AAAAlcala 14*. On rocks in tropical lowland evergreen rainforest. Widespread in the Philippines (Tan and Iwatsuki, 1991).

Species Richness and Composition

Restating, a total of 36 species and one (1) subspecies in 24 genera and 17 families were found in the Greater Sipit Subwatershed of the Mt. Makiling Forest Reserve (Table 2). These represent 16.14% of the species, 25% of the genera, and 50% of the families reported for the area. The most represented families are Calymperaceae (7 species), Fissidentaceae (5 species), and Hypnaceae (4 species). Among the genera, the most represented are *Calymperes* and *Fissidens* each with five (5) species followed by *Pelekium* with three (3) species. Looking into the substrate preferences of the species, epiphytes (18 species and 1 subspecies) and saxicoles (15 species) make up the majority of the collection (Fig. 2).

Table 2. Summary of mosses found in the Greater Sipit Subwatershed, Mt. Makiling Forest Reserve

Families	Genera	Species and subspecies
Bryaceae	one (1)	one (1) species
Calymperaceae	three (3)	seven (7) species
Dicranaceae	three (3)	three (3) species
Fissidentaceae	one (1)	five (5) species
Hypnaceae	three (3)	four (4) species
Hypnodendraceae	one (1)	one (1) species and subspecies
Leskeaceae	one (1)	one (1) species
Leucobryaceae	one (1)	one (1) species
Myuriaceae	one (1)	one (1) species
Neckeraceae	one (1)	one (1) species
Pottiaceae	one (1)	one (1) species
Pterobryaceae	one (1)	one (1) species
Pylaisiadelphaceae	one (1)	two (2) species
Sematophyllaceae	two (2)	two (2) species
Stereophyllaceae	one (1)	one (1) species
Symphyodontaceae	one (1)	one (1) species
Thuidiaceae	one (1)	three (3) species
Total	24 genera	36 species and one (1) subspecies

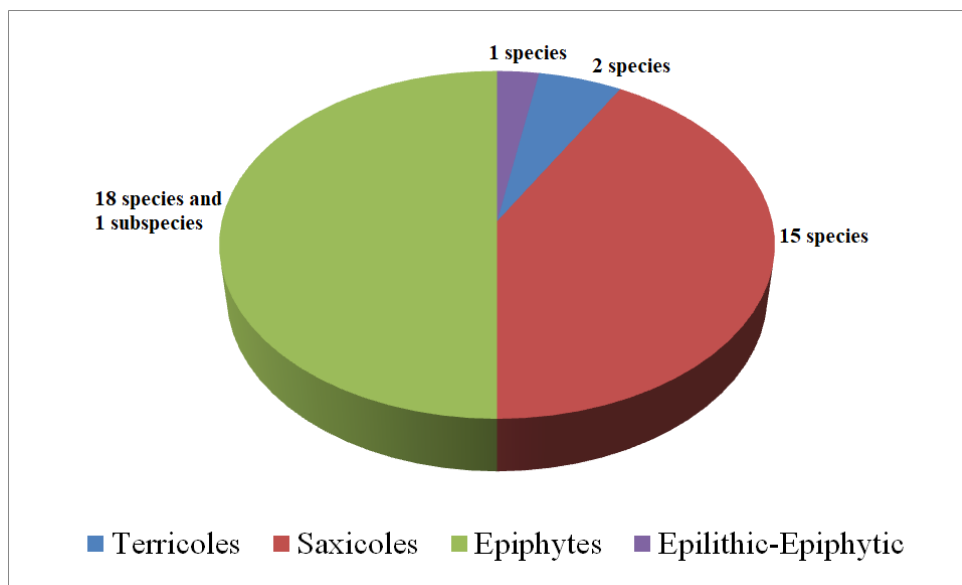


Fig. 2. Substrate preferences of mosses found in Greater Sipit Subwatershed, Mt. Makiling Forest Reserve.

Out of the 36 species and one (1) subspecies, ten (10) species are newly recorded for Mt. Makiling and vicinity namely *Calymperes afzelii*, *C. erosum*, *Campylopus savannarum*, *Dicranoloma assimile*, *Fissidens polypodioides*, *F. taxifolius*, *Mitthyridium flavum*, *Oedocladium rufescens*, *Pelekium contortulum*, and *Sematophyllum tristiculum*. With these additions, it is apparent that Mt. Makiling may harbour still undocumented species. Thus, additional explorations in the least explored areas of the mountain will definitely increase the number of mosses and will provide a better insight on the distribution of mosses in the forest reserve.

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