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RESEARCH ARTICLE

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Biogeography of Mindoro mosses

V.C. Linis[1]

Key words

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Mindoro
mosses
The Philippines

Abstract The moss flora of Mindoro Island was updated based on the 2004–2006 expeditions conducted by the author. The island's moss flora now consists of 282 species in 128 genera and 39 families, which is higher than Palawan but far less than those of Luzon and Mindanao. Generally, the flora is most abundant in the eastern rainy part of the island, especially along mid-elevations on the east-facing slope of the central mountain range in the transition zone between montane and mossy forests. Moss diversity is also greater in riverine forests than in inland forests at low elevations. Only three moss taxa, *Rhaccocarpus alpinus*, *Dicranoloma daymannianum* and *Distichophyllum noguchianum*, have their Philippine range restricted to the island. *Distichophyllum noguchianum* is a Philippine endemic. Floristically, the Mindoro moss flora is identified more with Luzon within the Philippine archipelago, while its sharing of other widespread Malesian taxa reinforced its role as an integral component of the Malesian flora. Reports of taxa with Australasian affinity show growing evidence for a Gondwanan influence on the island moss flora, although a tenuous one. Likewise, the presence of moss taxa such as *Acroporium johannes-winkleri*, *Cryptogonium phyllogonioides* and *Glyptothecium sciuroides* in Mindoro, reinforce the important role of Palawan as link in the exchange of biota between Mindoro, Borneo and Peninsular Malaysia during the Pleistocene. Finally, the importance of the island in enriching the Philippine flora and the necessity to protect its remaining forests are discussed.

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INTRODUCTION

Geological history of Mindoro Island

The island of Mindoro is the seventh largest island in the Philippines with an area of 10 244 km^2 (Fig. 1). It is found southwest of Luzon Island and northeast of Palawan island between 12°9' and 13°54' NL and 120°1' and 121°15' EL (Fund for Assistance to Private Education 1975). A mountain range along its central axis divides the island into an eastern and western half. Situated along this range are two of the island's highest peaks: Mt Halcon standing at 2 597 m is found in the northeast portion of the island, and Mt Baco located in the south-central portion of the island stands at 2 498 m. The climate of the island is tropically wet (National Geographic Society 1999). The eastern half of the island is generally rainy throughout the year with an annual rainfall of 2 500 mm. The western half of the island, on the other hand, has a marked dry season during the months of November up to February (Collins et al. 1991).

Mindoro's mountainous interior, despite its varied physiogeographic attributes, is known to consist mainly of metamorphic rocks of continental crust origin uplifted since Mid-Eocene (Fernandez 1982). Calcareous and volcanic rocks are not extensive and are mostly confined to small areas near and along the island's coasts. Geologically, Mindoro is interesting, because it was part of the Tertiary micro-continent, the North Palawan Block. Together with north-eastern Panay and Palawan, the Block was reported to have been positioned near the coast of China, forming part of the continuous continental shelf (Southeast Eurasian Margin) with Hainan and Taiwan during the Eocene some 50 million years ago (Holloway 1982). Because of the opening of the South China Sea in the Oligocene, Mindoro, north-eastern Panay and Palawan were pushed to their present day positions in the Philippine archipelago. The arrival of the North Palawan Block from its pre-drift position to its present day position in the Philippines has been postulated to be in the mid- to late Pliocene (Hall 1996, 1998). Others such as Hamilton (1981) included only the south-western part of Mindoro Island in the North Palawan Block giving its northern portion a separate origin. However, Aurelio (2001) has suggested that this portion could have been formed by the collision of the North Palawan microcontinental plate and the Philippine Mobile Belt.

Tan et al. (1988) reported that the above events in Mindoro have strongly influenced the evolution of modern Philippine biota. First, the resulting island chains between Borneo and Luzon provided the necessary land bridge habitats for the two-way migration of plants and animals between the two large islands. Secondly, the drifting of the ancient North Palawan Block across the South China Sea might have carried with it some continental Asiatic plants and animals that have been incorporated into the Philippine biota.

Bryological history of Mindoro Island

The earliest report on Mindoro mosses was published by Brotherus in 1907. He listed thirty-two species of mosses from a collection made by Merrill during his ascent of Mt Halcon on November 1906. The following years, Bartlett, Ramos and Edaño also collected mosses from the island, mainly on Mt Halcon and the vicinities of Puerto Galera. Bartram (1939) included their collections in his publication of the Philippine moss flora. He described about 81 species of mosses in 56 genera and 25 families from the island.

Fifty years later Tan & Iwatsuki (1991) produced a new checklist of Philippine mosses representing the outcome of their renewed and exhaustive review of Philippine moss literature up to the end of 1990. In this checklist, the number of moss taxa from Mindoro increased to 121 species in 72 genera and 28 families. Tan & Mandia (2001) further increased the number to 140 species in 82 genera and 32 families based on a small collection made by the second author.

[1] Philippine National Herbarium, National Museum, P. Burgos Avenue corner Taft Avenue, Manila 1000, The Philippines.

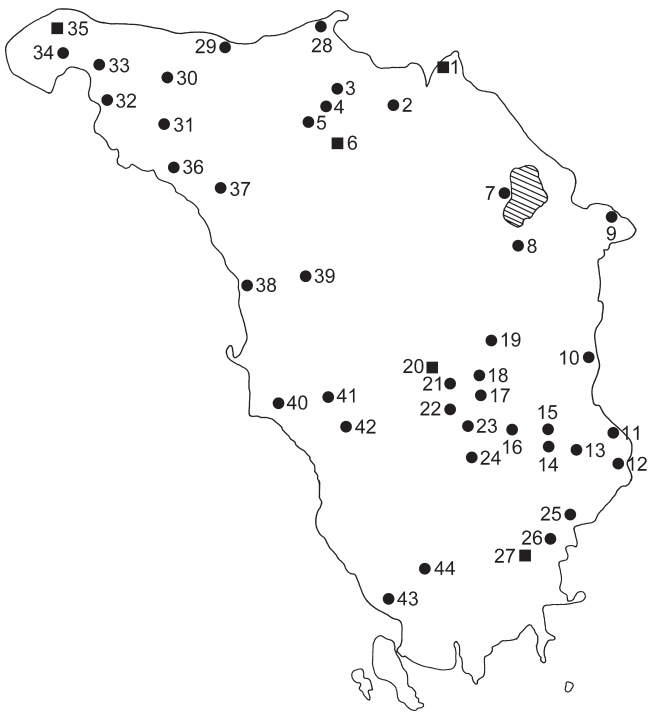

Fig. 1 Map of Mindoro Island showing collection localities.

Between 2003 and 2006, the author organized four expeditions to study the moss diversity of Mindoro Island. During these expeditions a large number of mosses were collected from different localities (Table 1, Fig. 1), which resulted in the discovery of species not yet reported from the island. At present we accept 282 species of mosses for Mindoro island, which is still far less than Luzon and Mindanao, but considerably higher than that of Palawan. Perhaps this low number of moss species of Mindoro compared to Luzon and Mindanao clearly indicates our limited knowledge for Mindoro's moss flora.

MATERIAL AND METHODS

Published information (Brotherus 1907, Bartram 1939, Tan & Iwatsuki 1991, Tan & Mandia 2001) and the unpublished data from the 2004 to 2006 collections of Mindoro mosses were used by the author to assign each individual species to a specific distribution pattern within Malesia and nearby regions as well as within the Philippines.

Voucher specimens of the collections made by the author are deposited at the Philippine National Herbarium (PNH) in Manila, with some duplicates sent to the National University of Singapore's Herbarium of the Raffles Museum of Biodiversity Research (SINU) in Singapore.

Table 1 List of collection localities in Mindoro Island.

Locality No.	Description
1	Agricultural land close to shoreline near Calapan City, alt. sea level to 100 m, 13°24' N, 121°10' E
2	Mixed agricultural and settlement area within Baco municipality, alt. 100–200 m, 13°17' N, 121°07' E
3	In second-growth lowland forest on slope facing north, alt. 200–800 m, 13°18' N, 121°02' E
4	In second-growth lowland forest on slope facing north, alt. 800–1200 m, 13°18' N, 121°01' E
5	In montane forest at Dulungan Ridge, alt. 1200–1800 m, 13°18' N, 121°57' E
6	Heath forest on summit of Mt Halcon, alt. 1800–2597 m, 13°15' N, 121°59' E
7	Shoreline of Lake Naujan, alt. 30 m, 13°10' N, 121°18' E
8	Agricultural surroundings alongside road, alt. 580 m, 13°04' N, 121°18' E
9	In second-growth lowland forest at Dumali Peak, alt. 650 m, 13°06' N, 121°30' E
10	Estuarine area facing east, alt. sea level to 2 m, 12°50' N, 121°28' E
11	Low beach forest mixed with settlements facing east, alt. 5–10 m, 12°42' N, 121°30' E
12	Agricultural area with Bongabong municipality, alt. 10–20 m, 12°39' N, 121°32' E
13	Along Bongabong river, alt. 20–50 m, 12°39' N, 121°26' E
14	Limestone cliff alongside road, alt. 50–200 m, 12°43' N, 121°22' E
15	Mixed grassland and agricultural developments along Bongabong River, alt. 100–300 m, 12°42' N, 121°21' E
16	Surrounding secondary lowland forest of So. Balite, alt. 200–400 m, 13°02' N, 121°55' E
17	In lowland forest along the middle reaches of Bongabong River, alt. 400–800 m, 12°49' N, 121°15' E
18	In lowland forest, alt. 800–1500 m, 12°52' N, 121°15' E
19	In montane forest, alt. 1500–2300 m, 12°55' N, 121°15' E
20	Low scrub and well-developed mossy forest on north side of the Mt Baco's summit, alt. 2300–2498 m, 12°50' N, 121°09' E
21	In lowland forest along Batangan River, alt. 500–1500 m, 12°48' N, 121°12' E
22	In montane forest, alt. 1500–1750 m, 12°46' N, 121°11' E
23	In montane forest, alt. 1500–1800 m, 12°44' N, 121°13' E
24	In lowland forest, alt. 700–1500 m, 12°40' N, 121°14' E
25	Along trail close to coastline facing east, alt. 1–5 m, 12°31' N, 121°25' E
26	On low scrub and grassland over limestone hills, alt. 1000–1200 m, 12°30' N, 121°23' E
27	In lowland forest at Knob Peak, alt. 700–1400 m, 12°29' N, 121°19' E
28	In secondary lowland forest along cliff facing the coast, alt. 500–600 m, 13°31' N, 120°56' E
29	In low scrub and secondary forest along coast facing east, alt. 1–5 m, 13°26' N, 120°43' E
30	In secondary forest along Creek close to Falls, alt. 500–600 m, 13°24' N, 120°40' E
31	In agricultural surroundings near Mamburao municipality, alt. 50 m, 13°19' N, 120°37' E
32	In secondary lowland forest along road facing west, alt. 100 m, 13°20' N, 120°30' E
33	In secondary lowland forest along dry creek, alt. 250 m, 13°26' N, 120°30' E
34	In secondary lowland forest along south slope of Mt Calavite, alt. 200 m, 13°25' N, 120°25' E
35	In montane forest surrounding the abandoned transmitter station at peak of Mt Calavite, alt. 200–1800 m, 13°28' N, 120°23' E
36	In agricultural area over limestone within Mamburao municipality, alt. 20 m, 13°13' N, 120°23' E
37	In mixed grassland and secondary lowland forest along slope facing west, alt. 670 m, 13°11' N, 120°44' E
38	On gravel and boulders alongside small creek, alt. 25 m, 13°01' N, 120°46' E
39	In secondary lowland forest, Brgy. Poypoy, Calintaan, alt. 80–150 m, 13°01' N, 120°54' E
40	In mixed agricultural and secondary lowland forest, alt. 500–600 m, 12°46' N, 120°50' E
41	On limestones alongside creek in secondary lowland forest, alt. 730 m, 12°45' N, 120°56' E
42	In lowland forest, alt. 600–700 m, 12°42' N, 120°59' E
43	In agricultural surrounding near San Jose City, alt. 20 m, 12°21' N, 121°03' E
44	In poor secondary lowland forest and grassland over limestone, alt. 900 m, 12°26' N, 121°08' E

Kroeber's index [%K = C * (A+B)/ 2AB * 50; A = number of taxa in first area, B = in second area, C number of shared taxa] was used for computing the percentage of similarity between pairs of areas, at the generic and species levels. However, for floristic comparisons of moss floras within the Philippine archipelago, the efforts were limited to the first six largest islands, because these are the only ones with adequate bryological information (Tan & Robinson 1990, Touw 1991, Yamaguchi 1993, Tan 1993, 1994, 1996, Tan & Lin 1995, Tan et al. 2000, Tan & Mandia 2001, Touw 2001, Linis 2004, Linis & Tan in print).

A detailed analysis of the similarity of Mindoro mosses with nearby islands and regions is also presented in this paper. This was demonstrated using a phenetic dendrogram based on Jaccard's Coefficient of Similarity and UPGMA (Unweighted Pair-Group Mathematical Average) with the Multi-Variate Statistical Package v3.0.

Table 2 Number of moss taxa reported from all large islands within the Philippines.

Islands	Genera	Species
Luzon	218	613
Mindanao	141	333
Palawan	94	219
Mindoro	128	282
Panay	68	130
Negros	89	161
Samar	53	92
Leyte	53	83
Cebu	52	82
Bohol	48	75
Sibuyan	52	82
Camiguin	50	82
Biliran	48	74
Sulu archipelagoes	54	88

RESULTS AND DISCUSSION

Diversity of mosses of Mindoro

The majority of the previous moss records from Mindoro Island came from Mt Halcon and Puerto Galera. Also, many collections were made from a few high peaks: Mt Halcon, Mt Baco and Mt Calavite. Vast areas of the island still have received little or no bryological investigation. Important areas like Mt Baco and adjoining areas as well as the entire southern and western areas of the island, consisting mostly of limestones, have no moss record at all. It is crucial therefore that Mt Baco, which has a national park status, and other relevant areas of the island worthy for bryological investigations are included in this study.

From the new collections made in 2004 to 2006, the total number of mosses known in the island has been increased to 282 species in 128 genera and 39 families (see Appendix). Worth mentioning are the 142 new records gathered for the island. Among these new records are *Braunfelsia edentula, Cryptogonium phyllogonioides, Entodon rubicundus, Fissidens wichurae, Haplohymenium pseudotriste, Hymenodon angustifolius, Leucobryum bowringii, Macromitrium ochraceum, Papillaria leuconeura, Philonotis bartramnioides, Pogonatum subtortile, Syrrhopodon ciliatus, Taxiphyllum arcuatum* and *Wijkia hornschuchii*. Previous records of these taxa confined themselves to, either Luzon, some islands in the Visayas, or Mindanao. Thus, their findings in Mindoro have significantly extended their local ranges inside the country.

Also, the mosses of Mindoro are observed to be most abundant in the eastern rainy part of the island, along the eastern side of the central mountain range. One reason for their occurrence is that the evergreen lowland forests of the eastern slope are generally wetter compared to the drier, semi-deciduous forests found west of the range. Therefore, it is not surprising that forests along the eastern slope support moss genera like *Distichophyllum*, *Garovaglia*, *Hypnodendron*, *Hypopterygium*, *Plagiomnium* and other wet loving mosses. Another reason for the lower number of moss taxa on the western part of the island could be the prevalence of grasslands due to perennial fires and frequent burning of forests used for the expansion of pasturelands (Development Alternatives 1992). Due to these two factors, genera of semi-dry and anthropogenic habitats like *Entodon*, *Gymnostomum*, *Hyophila*, *Pseudosymblepharis* abound.

As of today, three moss taxa, namely *Dicranoloma daymannianum, Distichophyllum noguchianum* and *Rhaccocarpus alpinus* have their Philippine range restricted to Mindoro.

Generally speaking, moss species in Mindoro are highest in diversity at mid-elevations on the east-facing slope of the central mountain range in the transition zone between montane and the mossy forests, while the number and diversity decreases towards the western side of the island, where grasslands and burnt landscapes become the main topographical feature. At lower elevations, moss diversity is also greater in riverine forests than in inland forests.

Floristic affinity of Mindoro moss flora intra-Philippines

The richness of mosses in different large islands of the Philippines is shown in Table 2. In counting the number of moss taxa for each island a conservative approach is adopted so that the resulting floristic affinities are not exaggerated.

By comparison, the Mindoro moss flora with 282 moss taxa ranks third in terms of species number after the moss floras of Luzon and Mindanao. This is followed by Panay and Negros, each with 130 and 161 moss taxa, respectively.

Table 3 shows the comparative floristic affinity of Mindoro with that of Luzon, Palawan, Panay, Negros and Mindanao. It is apparent from Table 3 that the composition of the Mindoro moss flora resembles that of Luzon most closely at the generic and species levels. The similarity is followed closely by the moss floras of Negros and Palawan; both islands are geographically located near Mindoro.

Table 3 Kroeber's index of taxon similarity (%K) between the moss floras of Mindoro and that of Luzon, Palawan, Panay, Negros and Mindanao (unshared: Mindoro/other island).

	Luzon		Palawan		Panay		Negros		Mindanao	
	shared	unshared	shared	unshared	shared	unshared	shared	unshared	shared	unshared
128 genera	123	95/5	79	15/49	64	4/64	77	12/51	97	44/31
%K genera	81.63		72.88		72.06		73.34		72.23	
282 species	261	351/19	153	67/129	110	20/171	128	33/153	188	145/93
%K species	67.56		62.06		61.81		62.45		61.56	

Tan & Iwatsuki (1991) already mentioned the strong Luzon connection of the Mindoro moss flora, even though Mindoro was then still incompletely known. Merrill (1928) also observed the same botanical affinity among the phanerogam floras of these two islands.

Between Mindoro and Luzon most of the unshared taxa are species that grow at high altitude (over 2 500 m), mostly in Northern Luzon. These taxa belong to the widespread, continental Asiatic and Himalayan genera, like *Atrichum, Ceratodon*, *Dendrocyathophorum* and *Grimmia* or the Malesian endemic and Australasian genera that reached Mindoro but not Luzon, such as *Cryptogonium* and *Rhaccocarpus.* The remaining unshared taxa either belong to local endemics that evolved separately in the two islands or the species are still undercollected.

It is unlikely that Negros came second in terms of degree of floristic similarity with Mindoro both at the generic and species levels. However, a large part of this island is still bryologically under-explored, thus the floristic affinity with Mindoro remains inconclusive. Much more collecting has to be done in this Visayan Island.

On the other hand, Palawan, where the local forests belong to the semi-dry and seasonally deciduous type of rainforests, harbours a less richer moss flora when compared to Mindoro. Some of the Mindoro taxa that are apparently absent in Palawan are the wet-loving mosses belonging to genera like *Daltonia, Distichophyllum*, *Hymenodon* and *Neolinbergia*, including a handful of genera that have successfully reached Mindoro from Luzon but not yet Palawan. The handful of Palawan mosses not found in Mindoro Island is obviously xeric or drought-tolerant. The other unshared taxa represent the South and East Malesian taxa that apparently failed to reach Mindoro from Palawan, such as *Clastrobryum asperrimum* and *Horikawaea redfearnii* and the rest is likely to be an undercollection artefact.

Panay, despite its geographical proximity to Mindoro, came fourth in terms of degree of floristic similarity with Mindoro. Like Negros, however, a large part of this island is underexplored bryologically; hence its overall picture of floristic similarity with Mindoro remains inconclusive at present.

As expected, Mindanao came fifth in terms of floristic resemblance with the moss flora of Mindoro. The most obvious factors accounting for this relatively weak similarity are their different geological histories and distinct climatic conditions. There are several genera present in Mindanao that are absent in Mindoro. These are mostly the South Malesian and Australasian genera that reached only Mindanao in the Philippines such as *Bryobrothera*, *Dawsonia*, *Ectropotheciopsis*, *Leskeodon* and *Meiotheciella*. Other taxa are of limited ranges in Luzon and Mindoro but failed to reach other southern islands in the Philippine archipelago.

Affinity of Mindoro moss flora extra-Philippines

A UPGMA dendrogram (Fig. 2) demonstrates the overall floristic distances between Mindoro and nearby islands and countries outside the Philippines. The highest similarity is with the Malay Peninsula, Java, Sumatra, Borneo and the Lesser Sunda Islands. This shows the Mindoro moss flora to be an integral component of the (West) Malesian flora.

As to be expected, Sulawesi, New Guinea, Indochina, Mainland China, Taiwan and Mongolia came increasingly less close in floristic resemblance with Mindoro (Fig. 2). This similarity/dissimilarity between the Philippines and other areas can be explained in two ways. The taxa shared with other areas in the Philippines but not Mindoro are the widespread temperate East Asiatic mosses, including the Himalayan taxa, some of which have successfully penetrated the northern highlands of Luzon, but failed to reach the rest of the Philippines to the south. Second, there are taxa of southern affinity that were unable to reach Mindoro, but were able to penetrate only Mindanao in the southern Philippines.

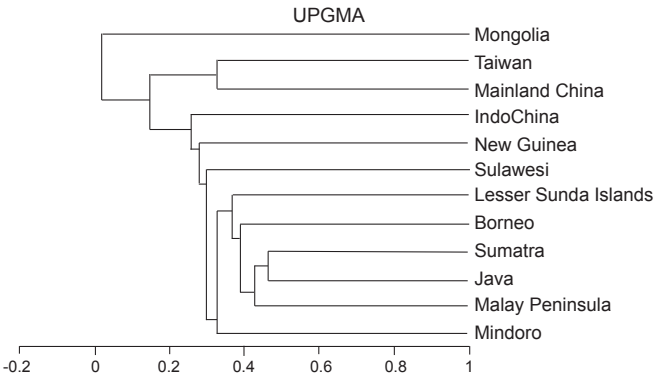

Fig. 2 Phenetic tree demonstrating Mindoro moss overall floristic distance / similarity with neighbouring islands and regions outside Philippines.

There is little evidence of floristic influence from the Southern Hemisphere or Australasia on the Mindoro moss flora. Only *Rhaccocarpus alpinus* was collected from Mindoro showing the Gondwanan influence in the island's moss flora albeit a tenuous one (Tan & Mandia 2001). The Mindoro record of this moss taxon also foretells the likely presence of this species in Palawan, for the species is also known from Sumatra, Borneo, and Sulawesi to New Guinea (Koponen & Norris 1986). *Rhaccocarpus alpinus* most likely reached Mindoro via a Borneo / Palawan route.

Only one endemic species, *Distichophyllum noguchianum*, has been reported from Mindoro. Another taxon, *Neolinbergia* sp., was recently collected by the author from the island and appears endemic too. However, the endemic status of these two taxa has not been subjected to detailed evaluation and may become redundant.

A moss flora resembling that of Mindoro Island is expected for adjacent smaller islands like Sibuyan. A close bryological affinity between these two islands is apparent, but needs further substantiation by extensive collecting.

CONCLUSION

Floristically, the Mindoro moss flora has the highest resemblance with Luzon. Its strong relationship with Malesian areas show it to be an integral component of the Malesian flora. Reports of taxa with Australasian affinity show a growing evidence of the Gondwanan influence in the island though a tenuous one.

Until recently, two new records of moss taxa: *Rhaccocarpus alpinus* and *Dicranoloma daymannianum* were collected from Mindoro. These noteworthy discoveries demonstrate the role of the island as an important dispersal link within the Philippine flora. Seen in this light the conservation of the remaining forests of Mindoro has become more urgent if only to save these and future novelties.

It is sad, however, that despite the increase of threats to Mindoro's forests only a number of nature reserves have been established in the island since 1936. All have been proven to be less than effective (Heaney & Regalado 1998). Other important sites worth conserving like Mt Halcon, Mt Calavite, Mt Malasimbo and intervening areas in the north and Pointed Peak with its immediate vicinities in the south remain unprotected.

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Appendix A new checklist of Mindoro mosses alphabetically arranged by family, genus and species. (Note: numbers after species name indicates collection localities as defined in Table 1 and shown in Fig. 1).

Bartramiaceae
- *Breutelia arundinifolia* (Duby) M.Fleisch. 5, 6
- *Philonotis bartramnioides* (Griff.) Griffin & W.R.Buck 5, 6, 18, 21
- *Philonotis hastata* (Duby) Wijk & Marg. 1, 2, 3, 17, 21, 24, 35, 39

Brachytheciaceae
- *Aerobryum speciosum* (Dozy & Molk.) Dozy & Molk. 18
- *Brachythecium buchanani* (Hook.) A.Jaeger 35
- *Homalothecium laevisetum* Sande Lac. 18
- *Oxyrrhynchium asperisetum* (Müll.Hal.) Broth. 6, 19
- *Oxyrrhynchium vagans* (A.Jaeger) Ignatov & Huttunen 4, 5, 21
- *Remyella brachypoda* (M.Fleisch.) Ignatov & Huttunen 4, 5
- *Rhynchostegiella mindorensis* (Broth.) Broth. 5
- *Rhynchostegium celebicum* (Sande Lac.) A.Jaeger 19

Bruchiaceae
- *Trematodon longicollis* Michx. 20, 35, 39

Bryaceae
- *Brachymenium nepalense* Hook. in Schwägr. 17, 24
- *Bryum apiculatum* Schwägr. 3
- *Bryum billardieri* Schwägr. 35
- *Bryum capillare* Hedw. 35
- *Bryum clavatum* (Schimp.) Müll.Hal. 2, 35
- *Bryum coronatum* Schwägr. 1, 7, 8, 11, 12, 14, 25, 26, 28, 40, 41, 44
- *Bryum cryophilum* Mårtensson 4
- *Bryum neelgheriense* Mont. in Müll.Hal. 4
- *Bryum paradoxum* Schwägr. 2, 3, 5, 27, 28, 30, 32, 33, 34, 35, 37, 38, 39
- *Pohlia nutans* (Hedw.) Lindb. 35
- *Rhodobryum giganteum* (Schwägr.) Paris 5, 6

Calymperaceae
- *Calymperes boulayi* Besch. 1, 2, 3, 9, 10, 11, 12, 28
- *Calymperes erosum* Müll.Hal. 15
- *Calymperes graeffeanum* Müll.Hal. 18, 28
- *Calymperes mollucense* Schwägr. 30, 32, 33, 34, 37, 39
- *Calymperes porrectum* Mitt. 3, 17, 24
- *Calymperes serratum* A.Br. ex Müll.Hal. 35
- *Calymperes taitense* (Sull.) Mitt. 17, 18, 27, 28, 29, 30, 32, 33, 34, 35, 36, 37, 39
- *Calymperes tenerum* Müll.Hal. 1, 2, 3, 9, 12, 13, 14, 15, 26, 31, 42
- *Mitthyridium fasciculatum* (Hook. & Grev.) H.Rob. 17, 18, 24
- *Mithyridium flavum* (Müll.Hal.) H.Rob. 4, 5
- *Mithyridium wallisii* (Müll.Hal.) H.Rob. 3
- *Syrrhopodon albovaginatus* Schwägr. 3
- *Syrrhopodon aristifolius* Mitt. 28
- *Syrrhopodon ciliatus* (Hook.) Schwägr. 3
- *Syrrhopodon confertus* Sande Lac. 35
- *Syrrhopodon croceus* Mitt. 4
- *Syrrhopodon involutus* Schwägr. 3
- *Syrrhopodon japonicus* (Besch.) Broth. 35
- *Syrrhopodon muelleri* (Dozy & Molk.) Sande Lac. 23
- *Syrrhopodon spiculosus* Hook. & Grev. 3, 4, 18, 19
- *Syrrhopodon tjibodensis* M.Fleisch. 35
- *Syrrhopodon tristichus* Nees ex Schwägr. 3, 5, 19

Daltoniaceae
- *Acrophyllum javense* (Dixon ex J.Froehl.) Z.Iwats., B.C.Tan & Touw 6
- *Calyptrochaeta microblasta* (Broth.) B.C.Tan & H.Rob. 19
- *Calyptrochaeta parviretis* (M.Fleisch.) Z.Iwats., B.C.Tan & Touw 18, 19
- *Calyptrochaeta remotifolia* (Müll.Hal.) Z.Iwats., B.C.Tan & Touw 3
- *Daltonia angustifolia* Dozy & Molk. 6
- *Daltonia armata* E.B.Bartram 35
- *Distichophyllum cuspidatum* (Dozy & Molk.) Dozy & Molk. 3, 4
- *Distichophyllum mittenii* Bosch & Sande Lac. 19
- *Distichophyllum nigricaule* Mitt. ex Bosch & Sande Lac. 35
- *Distichophyllum noguchianum* B.C.Tan 6
- *Distichophyllum osterwaldii* M.Fleisch. 23, 35

Dicranaceae
- *Braunfelsia dicranoides* (Dozy & Molk.) Broth. 5
- *Braunfelsia edentula* (Mitt.) Wijk. & Marg. 5, 23
- *Campylopodium medium* (Duby) Giese & Frahm 19, 26, 27, 35
- *Campylopus comosus* (Reinw. & Hornsch.) Bosch & Sande Lac. 3, 4, 5, 22, 35
- *Campylopus ericoides* (Griff.) A.Jaeger 4, 35
- *Campylopus exasperatus* (Nees & Blume) Brid. 5
- *Campylopus hermitrichus* (Müll.Hal.) 6
- *Campylopus laxitextus* Sande Lac. 19
- *Campylopus umbellatus* (Arn.) Paris 4, 5, 6, 18, 27, 35

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Dicranoloma billarderi (Brid.) Paris 19, 20
Dicranoloma blumii (Nees) Paris 4, 5, 6, 19, 20
Dicranoloma braunii (Müll.Hal. ex Dozy & Molk.) Paris 4, 5, 18, 19, 35
Dicranoloma brevisetum (Dozy & Molk.) Paris var. *samoanum* (Broth.) B.C.Tan & T.J.Kop. 5, 6
Dicranoloma daymannianum E.B.Bartram 6
Holomitrium cylindraceum (P.Beauv.) Wijk & Marg. 23
Leptotrichella brasiliensis (Duby) Ochyra 35
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Fissidentaceae
Fissidens ceylonensis Dozy & Molk. 2, 13, 29, 30, 32, 33, 34, 37, 39
Fissidens crenulatus Mitt. *elmeri* (Broth.) Z.Iwats. & Suzuki 2
Fissidens crispulus Brid. var. *crispulus* 1, 2, 3, 4, 8, 17, 18, 22, 24, 26, 30, 32, 33, 34, 35, 39, 40, 41, 42, 44
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Fissidens gymnogynus Besch. 6
Fissidens nobilis Griff. 3, 4, 6, 35
Fissidens oblongiflorus Hook.f. & Wilson 28
Fissidens wichurae Broth. & M.Fleisch. 23
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Grimmiaceae
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Hedwigiaceae
Rhaccocarpus alpinus (Wright) Paris 6

Hylocomiaceae
Macrothamnium javense M.Fleisch. 6
Macrothamnium macrocarpum (Reinw. & Hornsch.) M.Fleisch. 5

Hypnaceae
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Ectropotheciella distichophylla (Hampe) M.Fleisch. 5, 6, 17, 22, 24
Ectropothecium buitenzorgii (Bél.) Mitt. 4, 19
Ectropothecium dealbatum (Reinw. & Hornsch.) A.Jaeger *1*8, 35
Ectropothecium elegantipinnatum (Müll.Hal.) A.Jaeger 4
Ectropothecium falciforme (Dozy & Molk.) A.Jaeger 4, 5
Ectropothecium ferrugineum (Müll.Hal.) A.Jaeger 3, 17, 21, 24
Ectropothecium luzoniae (Müll.Hal.) A.Jaeger 3, 4
Ectropothecium monumentorum (Duby) A.Jaeger 4, 5
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Hypnodendron fusco-mucronatum (Müll.Hal.) A.Jaeger 18, 35
Hypnodendron milnei Mitt. in Seem. ssp. *korthalsii* (Bosch & Sande Lac. ex Paris) Touw 3, 5, 6, 18
Hypnodendron reinwardtii ssp. *caducifolium* (Herzog) Touw 3, 4, 6, 18, 19, 20, 23, 35
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Hypopterygium tamarisci (Sw.) Brid. ex Müll.Hal. 18, 19
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Lopidium struthiopteris (Brid.) M.Fleisch. 18, 19, 21, 35

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Leucrobryum aduncum Dozy & Molk. 3, 22, 23, 27
Leucobryum arkafianum Müll.Hal. ex Geh. 5
Leucobryum bowringii Mitt. 19, 20, 23, 27, 35
Leucobryum chlorophyllosum Müll.Hal. 4, 19, 20
Leucobryum javense (Brid.) Mitt. 3, 4, 5, 6, 18, 19, 20, 23, 24
Leucobryum juniperoideum (Brid.) Müll.Hal. 18, 19, 20
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Schistomitrium mucronifolium (Müll.Hal.) M.Fleisch. 35
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Aerobryopsis crispifolia (Broth. & Geh.) Menzel 18
Aerobryopsis subdivergens (Broth.) Broth. ssp. *scariosa* (E.B.Bartram) Nog. 4, 5, 6, 19, 23
Aerobryopsis wallichii (Brid.) M.Fleisch. 18, 21, 27, 35
Barbela convolvens (Mitt.) Broth. 19, 20
Barbela elongata Williams 18, 19, 23, 35
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Floribundaria floribunda (Dozy & Molk.) M.Fleisch. 18, 19, 20, 27, 35
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Meteoriopsis reclinata (Müll.Hal.) M.Fleisch. ex Broth. 21, 35
Meteorium polytrichum Dozy & Molk. 17, 19, 20, 24
Meteorium subpolytrichum (Besch.) Broth. 19, 20
Papillaria leuconeura (Müll.Hal.) A.Jaeger 19, 20
Trachycladiella sparsa (Mitt.) Menzel 19, 20

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Himantocladium plumula (Nees) M.Fleisch. 28
Homaliodendron exiguum (Bosch & Sande Lac.) M.Fleisch. 19, 35
Homaliodendron flabellatum (Sm.) M.Fleisch. 4, 19, 35
Homaliodendron microdendron (Mont.) M.Fleisch. 19
Neckeropsis andamana (Müll.Hal.) M.Fleisch. 18
Neckeropsis exserta (Hook. ex Schwägr.) Broth. 27, 30, 32, 33, 34, 35, 37, 40
Neckeropsis gracilenta (Bosch & Sande Lac.) M.Fleisch. 18
Neckeropsis lepineana (Mont.) M.Fleisch. 17, 19, 21, 24, 27
Pinnatella alopecuroides (Hook.) M.Fleisch. 18
Pinnatella ambigua (Bosch & Sande Lac.) M.Fleisch. 17, 18, 21, 24
Pinnatella kuehliana (Bosch & Sande Lac.) M.Fleisch. 18
Pinnatella mucronata (Bosch & Sande Lac.) M.Fleisch. 17, 18, 24

Orthotrichaceae
Groutiella tomentosa (Hornsch.) Wijk & Marg. 2, 17, 18, 19, 21, 23, 24, 26, 27, 34, 35, 41, 42
Macromitrium angustifolium Dozy & Molk. 19
Macromitrium blumei Nees ex Schwägr. 4
Macromitrium cuspidatum Hampe 28
Macromitrium fasciculare Mitt. 5
Macromitrium foxworthyii Broth. 18, 23
Macromitrium microstomum (Hook. & Grev.) Schwägr. 19, 22, 35
Macromitrium mindorense Broth. 5
Macromitrium ochraceum (Dozy & Molk.) Müll.Hal. 19, 20
Macromitrium orthostichum Nees ex Schwägr. 18
Macromitrium salakanum Müll.Hal. 19, 20
Macromitrium subtile Schwägr. ssp. *subuligerum* (Bosch & Sande Lac.) M.Fleisch. 3, 17, 19, 21, 22, 27
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Cryptogonium phyllogonioides (Sull.) Isov. 18

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Actinodontium rhaphidostegum (Müll.Hal.) Bosch & Sande Lac. 3, 4, 19, 35
Callicostella papillata (Mont.) Mitt. 3, 22
Cyclodictyon blumeanum (Müll.Hal.) Kuntze 32, 34
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Pogonatum cirratum (Sw.) Brid. 4, 5, 6, 18, 19, 20
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Barbula indica (Hook.) Spreng. 1, 26
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Hydrogonium pseudoehrenbergii (M.Fleisch.) P.C.Chen 17, 18
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Neolinbergia sp. M.Fleisch. 19
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Calyptothecium urvilleanum (Müll.Hal.) Broth. 17
Oedicladium rufescens (Reinw. & Hornsch.) Mitt. 18, 22
Pterobryella longifrons (Müll.Hal.) A.Jaeger 18, 19, 20, 22
Pterobryopsis crassicaulis (Müll.Hal.) M.Fleisch. 19, 20, 22, 23, 35
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Symphysodontella attenuatula M.Fleisch. 19, 20, 22
Symphysodontella cylindracea (Mont.) M.Fleisch. 28
Symphysodontella subulata Broth. 28
Trachyloma indicum Mitt. 5, 6
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Garovaglia elegans (Dozy & Molk.) Hampe ex Bosch & Sande Lac. 4, 6, 18, 34, 35
Glyphothecium sciuroides (Hook.) Hampe 18, 24, 35
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Racopilum spectabile Reinw. & Hornsch. 4, 18, 21, 32, 34, 35
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Hymenodon angustifolius Sande Lac. 19, 20
Pyrrhobryum spiniforme (Hedw.) Mitt. 3, 5, 18, 19, 32, 35
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Accanthorrynchium papillatum (Harv.) M.Fleisch. 3
Acroporium diminutum (Brid.) M.Fleisch. 4, 5, 6, 20
Acroporium hermaphroditum (C Müll.) M.Fleisch. 5, 6
Acroporium johannis-winkleri Broth. 6
Acroporium lamprophyllum Mitt. 5
Acroporium secundum (Reinw. & Hornsch.) M.Fleisch. 4, 5, 6, 20, 22, 23, 32, 34, 35
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Acroporium stramineum (Reinw. & Hornsch.) M.Fleisch. 34, 35
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Meiothecium attenuatum Broth. 18
Meiothecium hamatum (Müll.Hal.) Broth. 3, 4
Meiothecium microcarpum (Hook.) Mitt. 3
Radulina hamata (Dozy & Molk.) W.R.Buck & B.C.Tan 3, 4, 5, 19, 20, 30, 32, 33, 35, 37, 39, 40
Rhaphidostichum piliferum (Broth.) Broth. 3
Sematophyllum microcladioides (Broth.) Broth. 22
Taxithelium alare Broth. 3, 5, 23
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Taxithelium instratum (Brid.) Broth. 18
Taxithelium kerianum (Broth.) Broth. 5
Taxithelium nepalense (Schwägr.) Broth. 1, 26, 27, 29, 30, 32, 33, 34, 35, 36, 37, 39, 40, 41, 43
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Trismegistia korthalsii (Dozy & Molk.) Broth. 4, 5, 6
Trismegistia panduriformis (C.Wright) Broth. 6
Trismegistia rigida (Mitt.) Broth. 3, 5, 18, 19, 27
Warburgiella bistrumosa (Müll.Hal.) M.Fleisch. 4, 5
Warburgiella cuppressinoides Müll.Hal. ex Broth. 4
Warburgiella philippinensis (Williams) Broth. 5
Wijkia hornschuchii (Dozy & Molk.) Crum 5, 6
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Sphagnum junhuhnianum Dozy & Molk. 5, 6
Sphagnum sericeum Müll.Hal. 6
Spiridentaceae
Spiridens reinwardtii Nees 5, 17, 18, 19, 24
Splachnobryaceae
Splachnobryum obtusum (Brid.) Müll.Hal. 18
Stereophyllaceae
Entodontopsis anceps (Bosch. & Sande Lac.) W.R.Buck & Ireland 1, 8, 27, 30, 32, 33, 34, 35, 37, 39, 41, 42, 43
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Claopodium prionophyllum Broth. 18, 19, 21, 35
Haplohymenium pseudotriste (Müll.Hal.) Broth. 18
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Pelekium gratum (P.Beauv.) Touw 17, 18, 24, 30, 32, 33, 35, 39
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