Diversity of Bryophytes of Terengganu and Their Ecological Roles in the Environment

Gaik Ee Lee, Ahmad Damanhuri, and Nik Norhazrina

Abstract The diversity of bryophytes of Terengganu and their ecological roles in the environment is reviewed. Thus far, there are 257 taxa of bryophytes are recorded for Terengganu. A total of three species of mosses viz. *Mastopoma perundulatum* (Dixon) Horik. & Ando in Kira & Umesao, *Sematophyllum subhumile* (Müll. Hal.) M.Fleisch., and *Trismegistia complanatula* (Müll. Hal.) Müll. Hal. are reported for the first time for Peninsular Malaysia while 11 other taxa are new additions to the bryoflora of Terengganu.

Keywords Bryophytes · Mosses · Liverworts · Terengganu

Introduction

Bryophytes are a group of non-vascular plants including mosses (Bryophyta), liverworts (Marchantiophyta) and hornworts (Anthocerotophyta), known to be the second largest group among all land plants, surpassed only by the flowering plants (Magnoliophyta), with 450,000 species (Pimm and Joppa 2015). The bryophytes comprised 15,000 (Gradstein et al. 2001) to 25,000 species (Crum 2001) and they are most abundant in tropical rainforests. Unfortunately they have been frequently ignored and also extremely under-collected. They abound in wet, mountainous forest where they often grow luxuriantly in loose mats and patches, or tightly appressed to substrates such as rocks, leaves or bark of trees, and also some are found growing in pendulous festoons or hanging down loosely from tree branches.

Malaysian bryophytes have been collected since the nineteenth century and, to date, there are 2227 species and infraspecific taxa of bryophytes known to occur in

G. E. Lee (✉)
School of Marine and Environmental Sciences, Universiti Malaysia Terengganu, Kuala Nerus, Terengganu, Malaysia
e-mail: gaik.ee@umt.edu.my

A. Damanhuri · N. Norhazrina
School of Environmental and Natural Resource Sciences, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia

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M. T. Abdullah et al. (eds.), *Greater Kenyir Landscapes*,
https://doi.org/10.1007/978-3-319-92264-5_5

Malaysia (Cheah and Yong 2016; Pócs and Lee 2016; Sukkharak 2014; Furuki et al. 2013; Yong et al. 2013; Katagiri et al. 2012; Chuah-Petiot 2011; Suleiman et al. 2006). The first record of mosses in Terengganu was published by Dixon (1926), where he reported nine taxa which were collected in Kuala Berang, Kuala Telumong (or Kuala Telemong) and Kuala Terengganu, and subsequently Mohamed and Tan (1988), in their checklist of mosses of Peninsular Malaya and Singapore, enumerated 64 species, one subspecies, and one variety of mosses in 42 genera and 20 families in Terengganu. Recently, a new checklist of mosses with updated nomenclatures, synonymy, taxonomic bibliography, and distribution records in Peninsular Malaysia and Singapore has been produced in the framework of the project called The Flora of Peninsular Malaysia. The revised moss checklist recorded 174 taxa of mosses for Terengganu and this represents 31% of the 558 taxa reported for Peninsular Malaysia (Yong et al. 2013). Meanwhile, the first record of liverworts in Terengganu was reported by Yamada (1979) from Kuala Berang i.e. *Radula retroflexa* Taylor and followed by Inoue (1984) who listed one species i.e. *Plagiochila arbuscula* (Brid. ex Lehm. & Lindenb.) Lindenb. Some species of mosses, based on specimens collected in various localities in Terengganu, were also reported in various revisions and monographic studies of mosses (Mohamed and Robinson 1991; Iwatsuki and Mohamed1987; Frahm and Mohamed 1987; Miller and Manuel 1982; Eddy 1977; Johnson 1964). Since then, neither a comprehensive floristic nor taxonomic study on collection of bryophytes from Terengganu has been carried out until the third millennium, particularly the works of Damanhuri et al. (2006, 2008, 2011, 2014). Thus far, the bryophyte flora of Terengganu comprises 255 taxa of mosses, two species of liverworts, and none for hornwort.

The taxa of bryophytes reported in this paper are entirely based on the literatures on bryophytes reported for Terengganu starting from Dixon (1926). Further explanation regarding the specimens collected during the various scientific expeditions and also the deposition of specimens were recorded in Damanhuri et al. (2006, 2008, 2011, 2014). Distribution and references of all the bryophyte taxa reported for Terengganu are summarised in Table 1. Major collection localities are shown in Fig. 1 and listed in the Appendix 1.

Previous work on bryophytes in Terengganu are very scanty and comprehensive study is lacking except that of Damanhuri et al. (2006, 2008, 2011, 2014), in which most of the moss collections were made during scientific expeditions (Gunung Mandi Angin, Bukit Bauk, Gunung Gagau, Gunung Tebu) organised by the Forestry Department of Peninsular Malaysia. In those series of papers, three taxa of mosses are reported as new additions to the moss flora of Peninsular Malaysia viz. *Rhynchostegiella menadensis* (Sande Lac.) E.B.Bartram, *Schistomitrium robustum* Dozy & Molk., and *Syrrhopodon perarmatus* Broth. in Broth & Watts. The species *R. menadensis* was found growing on a tree trunk in Gunung Mandi Angin and hitherto only recorded in China, Indonesia and the Philippines (Liu et al. 2010). *Syrrhopodon perarmatus* occurs in temperate Australasia, Papua New Guinea and Pacific Islands (Fiji, Vanuatu), while *S. robustum* is endemic to Malesia (Eddy 1990).

Table 1 Summary of the number of taxa of mosses and liverworts collected at various localities in Terengganu

Locality	Total taxa (mosses)	Total taxa (liverworts)	References
Kuala Berang, K. Telumong, K. Terengganu	9 taxa	1 species	Dixon (1926) and Yamada (1979)
Terengganu	–	1 species	Inoue (1984)
Terengganu	64 species, 1 subspecies, 1 variety	–	Mohamed and Tan (1988)
Lata Payung Recreational Forest	81 species, 3 subspecies	–	Yushana (2005)[a]
Gunung Mandi Angin	139 species, 1 subspecies, 3 varieties	–	Damanhuri et al. (2006)
Bukit Bauk Urban Forest	67 species, 1 variety	–	Damanhuri et al. (2008)
Gunung Gagau	97 species, 6 subspecies, 17 varieties	–	Damanhuri et al. (2011)
Terengganu	174 taxa		Yong et al. (2013)
Lata Tembakah Recreational Forest	66 species, 3 subspecies, 10 varieties	–	Aishah (2013)[a]
Gunung Tebu	100 species, 7 subspecies, 20 varieties	–	Damanhuri et al. (2014)
Jeram Tanduk Forest Reserve	60 species, 3 subspecies, 15 varieties	–	Syazwana (2016)[a]
Tembat Permanent Forest Reserve	72 species, 3 subspecies, 6 varieties	–	Nurulhuda (2016)[a]

[a]Unpublished data from thesis

In this paper, an additional 81 taxa are added to the latest moss checklist of Terengganu and out of these, another three species were reported which are new to Peninsular Malaysia i.e. *Mastopoma perundulatum* (Dixon) Horik. & Ando in Kira & Umesao, *Sematophyllum subhumile* (Müll. Hal.) M.Fleisch., and *Trismegistia complanatula* (Müll. Hal.) Müll. Hal. and another 11 are new records for Terengganu, based on the unpublished theses by Yushana (2005), Aishah (2013), Nurulhuda (2016) and Syazwana (2016). Moreover, Terengganu is also the second locality for ten rare species of mosses (see Appendix 1 for the list of rare species of mosses), where all of these species were previously reported only from Pahang except one from Kedah (*Clastobryum caudatum*) (Yong et al. 2013). For the liverwort species, *R. retroflexa*, is only known to occur in Terengganu in Peninsular Malaysia and in Mt. Kinabalu in Sabah (Yamada 1979). *Radula retroflexa* is exclusively a rupicolous species. It was collected on rocks and rarely on tree trunks and branches (Yamada 1979) and this species is probably under-collected due to little fieldwork being done in Peninsular Malaysia.

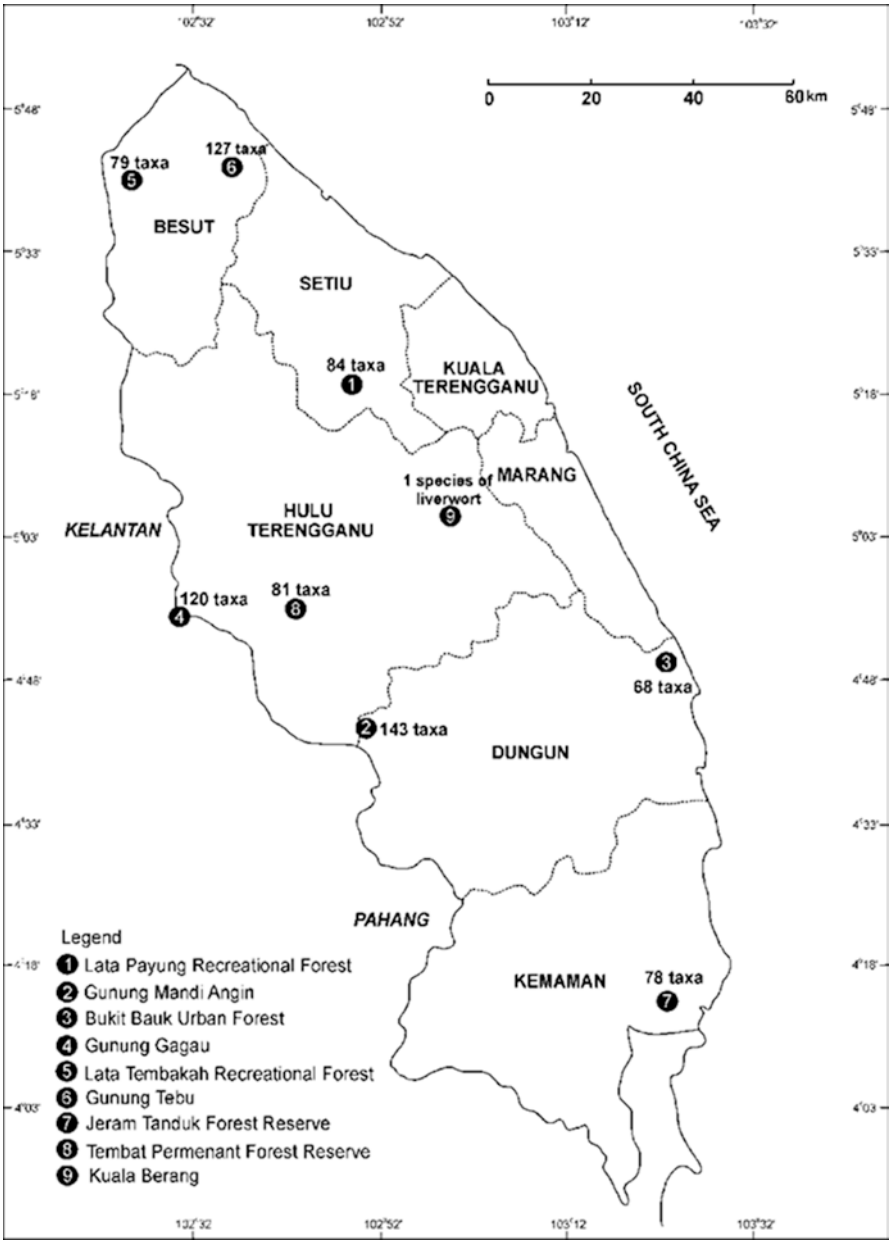

Fig. 1 Map of Terengganu showing the major collection localities and the number of taxa reported for the districts of Terengganu

The Ecological Role of Bryophytes: Water Retention and Environmental Indicators

Many bryophytes species have a higher and more effective water retention capacity as compared to many other plant groups (Proctor 2008). Bryophytes are able to hold a huge quantity of water during heavy rainfall and then gradually release the water from wet to dry area over a much longer period, and can, therefore, enhance and regulate the water flow in a forest or elsewhere. The exceptional water storage ability in bryophytes are due to its unique structure, for example the moss species, *Sphagnum* where the tissues contain empty and specialized water-holding hyaline cells which has incredible ability to absorb 20 or more times their own dry weight in water (Glime 2015; Nichols 1918). This sponge-like characteristic of *Sphagnum* (e.g., three species of *Sphagnum* in Gunung Gagau) definitely play an important and active role in the protection of slopes, banks, and steep hillsides against erosion by monitoring the destructive effects of heavy rainfalls and regulating the rhythm of waterway (Pócs 1980).

Besides, bryophytes are very sensitive to natural fluctuations in relative humidity, climate change and forest fragmentation, and therefore, many bryophytes are very restricted to specific forest microclimates. For example the epiphyllous liverworts, they have been pointed out particularly sensitive to environmental changes and have been assessed as possible indicators of forest ecological conditions (Daniels and Kariyappa 2007; Frego 2007; Pócs 1996).

Conclusion

A total of 257 taxa of bryophytes are recorded for Terengganu. Of these, six species of mosses viz. *Mastopoma perundulatum* (Dixon) Horik. & Ando in Kira & Umesao, *Rhynchostegiella menadensis* (Sande Lac.) E.B.Bartram, *Sematophyllum subhumile* (Müll. Hal.) M.Fleisch., *Schistomitrium robustum* Dozy & Molk., *Syrrhopodon perarmatus* E.B.Bartram, *Trismegistia complanatula* (Müll. Hal.) Müll. Hal. and one species of liverwort i.e. *Radula retroflexa* Taylor are reported to occur only in Terengganu. While ten rare species of mosses previously recorded only in Pahang or Kedah were also found in Terengganu, thus making the latter state the second reported locality in Peninsular Malaysia. In the present paper, a total of three species are reported for the first time for Peninsular Malaysia while 11 other taxa are new additions to the bryoflora of Terengganu. Terengganu harbours quite a number of new records and localities for Malaysian bryophytes as mentioned above and with further exploration and fieldwork it is expected many new discoveries will certainly be made in the future. Therefore, an urgent effort should be undertaken to collect and study the bryophytes, especially the liverworts and hornworts, in Terengganu before the microhabitats of these tiny plants are destroyed. Of special interest is the Kenyir tropical rainforest in Terengganu where bryophytes flourish particularly well

in such moist and humid forest and different bryophyte species can be found on tree trunks, bases, branches, twigs, or leaves, or on fallen and rotten logs in various stages of the undisturbed forest.

Acknowledgements We thank the editors for comments and inviting us to contribute our knowledge in this book. Financial support from the grants FRGS/1/2017/STG03/02/2 and GGPM-2017-090 to N. Norhazrina is gratefully acknowledged.

Appendix 1

Species Checklist and new additions to the bryoflora of Peninsular Malaysia and the state of Terengganu are indicated by "**" and "*" respectively. Rare species of mosses are marked with®. Major collection localities are represented in numbers: Lata Payung Recreational Forest (1), Gunung Mandi Angin (2), Bukit Bauk Urban Forest (3), Gunung Gagau (4), Lata Tembakah Recreational Forest (5), Gunung Tebu (6), Jeram Tanduk Forest Reserve (7), Tembat Permanent Forest Reserve (8). Name of taxa are arranged alphabetically.

No.	Name of taxa of mosses	Locality
1	*Acanthorrhynchium papillatum* (Harv.) M.Fleisch.	1, 2, 3, 4, 5, 6, 7, 8
2	*Acroporium adspersum* (Hampe) Broth.	4, 6
3	*Acroporium condensatum* Müll. Hal. ex E.B.Bartram	4, 6
4	*Acroporium convolutum* (Sande Lac.) M.Fleisch. var. *convolutum*	1, 2, 3, 4
5	*Acroporium convolutum* var. *elatum* (Dixon) B.C.Tan	2
6	*Acroporium diminutum* (Brid.) M.Fleisch.	1, 2, 3, 4, 6, 7
7	*Acroporium downii* (Dixon) Broth.	1, 2
8	*Acroporium joannis-winkleri* Broth.	1, 2, 4, 6
9	*Acroporium lamprophyllum* Mitt.	1, 2, 3, 4, 5, 6, 7, 8
10	*Acroporium macroturgidum* Dixon	4
11	*Acroporium pungens* (Hedw.) Broth.	4
12	*Acroporium rigens* (Broth. ex Dixon) Dixon	4, 5, 6
13	*Acroporium rufum* (Reinw. & Hornsch.) M.Fleisch.	2, 4
14	*Acroporium secundum* (Reinw. & Hornsch.) M.Fleisch.	2, 4
15	*Acroporium stramineum* (Reinw. & Horsch.) M.Fleisch. var. *stramineum*	2, 4, 6
16	*Acroporium stramineum* var. *hamulatum* (M.Fleisch.) B.C.Tan	2, 4
17	*Acroporium strepsiphyllum* (Mont.) B.C.Tan	1, 2, 4, 6
18	*Aequatoriella bifaria* (Bosch & Sande Lac.) Touw	2, 3, 8
19	*Aerobryidium aureonitens* (Hook. ex Schwägr.) Broth.	1, 2, 4, 5, 6, 7, 8
20	*Aerobryidium crispifolium* (Broth. & Geh.) M.Fleisch. in Broth.	4, 6
21	*Aerobryopsis leptosigmata* (Müll. Hal. ex Broth. & Geh.) M.Fleisch.	2
22	*Aerobryopsis longissima* (Dozy & Molk.) M.Fleisch	5, 6, 7, 8
23	**Aerobryopsis subleptostigmata* Broth. & Paris	8

No.	Name of taxa of mosses	Locality
24	*Arthrocormus schimperi* (Dozy & Molk.) Dozy & Molk.	1, 2, 3, 4, 5, 6, 7, 8
25	*®*Barbella enervis* (Thwaites & Mitt.) M.Fleisch in Broth.	1
26	*Barbula consanguinea* (Thwaites & Mitt.) A.Jaeger	1, 6
27	*Barbula indica* (Hook.) Spreng.	3
28	*Bryum apiculatum* Schwägr.	3, 7
29	*Bryum clavatum* (Schimp.) Müll. Hal.	2, 7
30	*Bryum coronatum* Schwägr.	1, 3, 5, 6
31	*Caduciella mariei* (Besch.) Enroth	3, 8
32	*Callicostella papillata* (Mont.) Mitt. var. *papillata*	2, 8
33	*Callicostella papillata* var. *prabaktiana* (Müll. Hal.) Streimann	1, 2, 4, 7, 8
34	*Calymperes afzelii* Sw.	1, 2, 3, 5, 6, 8
35	*Calymperes boulayi* Besch.	1, 3, 6
36	*Calymperes crassinerve* (Mitt.) A.Jaeger	2, 5, 6
37	*Calymperes erosum* Müll. Hal.	1, 2, 3, 5, 6, 7, 8
38	*Calymperes fasciculatum* Dozy & Molk.	1, 4, 5, 6, 7
39	*Calymperes graeffeanum* Müll. Hal.	6
40	*Calymperes lonchophyllum* Schwägr. subsp. *lonchophyllum*	1, 2, 3, 4, 5, 6, 7, 8
41	*Calymperes lonchophyllum* subsp. *beccarii* (Hampe) M.Menzel	1, 2, 4, 6, 7, 8
42	*Calymperes moluccense* Schwägr.	1, 2, 3, 4, 5, 6, 7, 8
43	*Calymperes motleyi* Mitt. in Dozy & Molk.	3
44	*Calymperes palisotii* Schwägr.	3, 5, 6
45	*Calymperes porrectum* Mitt.	1, 2, 3, 4, 6, 7, 8
46	**Calymperes schmidtii* Broth. in J.Schmidt	1
47	*Calymperes serratum* A.Braun ex Müll. Hal.	2, 5, 6, 8
48	*Calymperes strictifolium* (Mitt.) G.Roth	4, 8
49	*Calymperes taitense* (Sull.) Mitt.	2, 3, 8
50	*Calymperes tenerum* Müll. Hal.	3
51	*Calyptrochaeta remotifolia* (Müll. Hal.) Z.Iwats, B.C.Tan & Touw	2
52	*Campylopus ericoides* (Griff.) A.Jaeger	6
53	*Campylopus exasperatus* (Nees & Blume) Brid.	6
54	*Campylopus macgregorii* Broth. & Geh.	Gunung Padang
55	*Campylopus serratus* Sande Lac.	4, 5, 6
56	*Chaetomitrium borneense* Mitt.	2
57	*Chaetomitrium leptopoma* (Schwägr.) Bosch & Sande Lac.	2, 7
58	*Chaetomitrium orthorrhynchum* (Dozy & Molk.) Bosch & Sande Lac.	2, 4, 7, 8
59	*Chaetomitrium papillifolium* Bosch & Sande Lac.	Kampung Pasir Raja
60	*Chaetomitrium setosum* Broth. ex Dixon	2, 8
61	*Circulifolium exiguum* (Bosch & Sande Lac.) S.Olsson, Enroth & D.Quandt	2, 3, 7, 8
62	*Circulifolium microdendron* (Mont.) S.Olsson, Enroth & D.Quandt	2, 4, 8
63	*Cladopodanthus heterophyllus* (M.Fleisch.) E.B.Bartram	4
64	*Clastobryophilum bogoricum* (Bosch. & Sande Lac.) M.Fleisch.	4, 5, 6
65	*®Clastobryum caudatum* (Sande Lac.) M.Fleisch.	6, 7

No.	Name of taxa of mosses	Locality
66	*Clastobryum cuculligerum* (Sande Lac.) Tixier	1, 2, 6, 7
67	*Clastobryum epiphyllum* (Renauld & Cardot) B.C.Tan & Touw	2, 4, 6
68	*Clastobryum indicum* (Dozy & Molk.) Dozy & Molk.	3, 4
69	**Clastobryum scalare* (Müll. Hal.) Tixier	7
70	*Cryptopapillaria fuscescens* (Hook.) M.Menzel	2
71	*Ctenidiadelphus plumularia* (Müll. Hal.) M.Fleisch.	3
72	*Cyathophorum spinosum* (Müll. Hal.) M.Fleisch.	2
73	**Dendrohypnum subspininervium* subsp. *arborescens* (Mitt.) N.E.Bell, A.E.Newton & D.Quandt	8
74	*Dendrohypnum subspininervium* (Müll. Hal.) N.E.Bell, A.E.Newton & D.Quandt subsp. *subspininervium*	1, 2, 4, 6
75	*Desmotheca apiculata* (Dozy & Molk.) Lindb.	2
76	*Dicranella coarctata* (Müll. Hal.) Bosch & Sande Lac.	6
77	*Dicranoloma blumii* (Nees) Paris	2
78	*Dicranoloma braunii* (Müll. Hal.) Paris	2
79	*Dicranoloma brevisetum* (Dozy & Molk.) Paris	2
80	*Dimorphocladon borneense* Dixon	2, 4, 7, 8
81	*Diphyscium mucronifolium* Mitt.	1, 2, 4, 5, 6, 7, 8
82	®*Distichophyllidium nymanianum* M.Fleisch.	2
83	*Distichophyllum brevicuspis* M.Fleisch.	2
84	*Distichophyllum cuspidatum* (Dozy & Molk.) Dozy & Molk.	2, 4, 6
85	*Distichophyllum mittenii* Bosch & Sande Lac.	2
86	*Distichophyllum nigricaule* var. *cirratum* (Renauld & Cardot) M. Fleisch.	2, 4, 6
87	*Distichophyllum osterwaldii* M.Fleisch.	2, 4
88	*Distichophyllum schmidtii* Broth.	2, 4, 7
89	*Distichophyllum spathulatum* (Dozy & Molk.) Dozy & Molk.	2
90	*Duthiella wallichii* (Mitt.) Müll. Hal.	Terengganu
91	*Ectropotheciella decrescens* (Sande Lac.) M.Fleisch.	Terengganu
92	*Ectropothecium buitenzorgii* (Bél) Mitt.	1, 4, 5, 6, 7
93	*Ectropothecium dealbatum* (Reinw. & Hornsch.) A.Jaeger	1, 4
94	*Ectropothecium eleganti-pinnatum* (Müll. Hal.) A.Jaeger	2, 4, 7
95	*Ectropothecium ichnotocladum* (Müll. Hal.) A.Jaeger	5, 6
96	*Ectropothecium incubans* (Reinw. & Hornsch.) A.Jaeger	Terengganu
97	*Ectropothecium perminutum* Broth. ex E.B.Bartram	5, 6, 7
98	*Ectropothecium singapurense* Dixon	Terengganu
99	®*Ectropothecium striatulum* Dixon ex E.Bartram	1, 4
100	*Ephemeropsis tjibodensis* K.I.Goebel	4, 6
101	*Exostratum blumii* (Nees ex Hampe) L.T.Ellis	1, 2, 3, 4, 6, 7, 8
102	*Fissidens ceylonensis* Dozy & Molk.	1, 6
103	*Fissidens crassinervis* Sande Lac.	1, 2, 3, 4, 5, 6, 7, 8
104	*Fissidens crenulatus* var. *elmeri* (Broth.) Z.Iwats & Tad.Suzuki	3
105	*Fissidens crispulus* Brid. var. *crispulus*	1, 2, 3, 4, 5, 6, 7, 8
106	*Fissidens crispulus* var. *robinsonii* (Broth.) Z.Iwats. & Z.H.Li	4

No.	Name of taxa of mosses	Locality
107	*Fissidens guangdongensis* Z.Iwats. & Z.H.Li	3, 4, 5, 6, 7
108	*Fissidens hollianus* Dozy & Molk.	1, 2, 3, 4, 6, 7, 8
109	*Fissidens javanicus* Dozy & Molk.	1, 2, 3, 4, 6, 7, 8
110	*Fissidens oblongifolius* Hook.*f* & Wilson	6
111	*Fissidens pellucidus* Hornsch.	2, 3, 6, 7, 8
112	*Fissidens serratus* Müll. Hal.	4
113	*Fissidens subangustus* M.Fleisch.	Terengganu
114	*Fissidens zollingeri* Mont.	1, 8
115	*Floribundaria floribunda* (Dozy & Molk.) M.Fleisch.	2, 4
116	®*Gammiella tonkinensis* (Broth. & Paris) B.C.Tan	6
117	*Garovaglia compressa* Mitt.	4, 7
118	*Garovaglia elegans* (Dozy & Molk.) Hampe ex Bosch & Sande Lac.	2
119	*Garovaglia powellii* Mitt.	2
120	*Gymnostomum recurvirostrum* Hedw.	Terengganu
121	*Himantocladium plumula* (Nees) M.Fleisch.	3, 4, 6, 7, 8
122	*Himantocladium cyclophyllum* (Müll. Hal.) M.Fleisch.	5, 6
123	*Homaliodendron flabellatum* (Sm.) M.Fleisch.	2, 4
124	*Hyophila involuta* (Hook.) A.Jaeger	1, 5, 6
125	*Isocladiella surcularis* (Dixon) B.C.Tan & Mohamed	2, 3, 4, 6, 8
126	*Isopterygium albescens* (Hook.) A.Jaeger	1, 2, 3, 5, 6, 7, 8
127	*Leptotrichella miqueliana* (Mont.) Lindb. ex Broth.	2, 3
128	*Leucobryum aduncum* Dozy & Molk. var. *aduncum*	1, 2, 3, 4, 5, 6, 8
129	*Leucobryum aduncum* var. *scalare* Müll. Hal. ex M.Fleisch.	5, 6
130	*Leucobryum bowringii* Mitt.	1, 2, 3, 4, 5, 6, 7
131	*Leucobryum candidum* (Brid. ex P.Beauv.) Wilson	1, 2, 4, 5, 6, 8
132	*Leucobryum chlorophyllosum* Müll. Hal.	2, 3, 4, 5, 6, 7, 8
133	*Leucobryum javense* (Brid.) Mitt.	2, 4, 6
134	*Leucobryum juniperoideum* (Brid.) Müll. Hal.	2
135	*Leucobryum sanctum* (Nees ex Schwägr.) Hampe	1, 2, 3, 4, 5, 6, 7, 8
136	*Leucobryum sumatranum* Broth. ex M.Fleisch.	2, 4
137	*Leucoloma amoene-virens* Mitt.	1, 2, 5, 6, 8
138	*Leucoloma molle* (Müll. Hal.) Mitt.	2, 4, 6
139	*Leucoloma walkeri* Broth.	2
140	**Leucomium strumosum* (Hornsch.) Mitt.	8
141	*Leucophanes angustifolium* Renauld & Cardot	1, 2, 3, 4, 5, 6, 8
142	*Leucophanes candidum* (Schwägr.) Lindb.	4
143	*Leucophanes glaucum* (Schwägr.) Mitt.	3, 4, 5, 6, 7
144	*Leucophanes octoblepharioides* Brid.	1, 2, 3, 4, 5, 6, 7, 8
145	*Lopidium struthiopteris* (Brid.) M.Fleisch.	2
146	*Macromitrium blumei* Nees ex Schwägr.	2, 4
147	*Macromitrium cuspidatum* Hampe	Terengganu
148	*Macromitrium fuscescens* Schwägr.	2, 4
149	*Macromitrium ochraceum* (Dozy & Molk.) Müll. Hal.	4
150	**Macromitrium orthostichum* Nees ex Schwägr.	8

No.	Name of taxa of mosses	Locality
151	*Macromitrium salakanum* Müll. Hal.	2, 8
152	*Mastopoma brauniana* (Bosch & Sande Lac.) H.Akiyama	2
153	****Mastopoma perundulatum*** (Dixon) Horik. & Ando in Kira & Umesao	1
154	*Mastopoma uncinifolium* (Broth.) Broth.	6
155	*Meiothecium microcarpum* (Hook.) Mitt.	5, 6
156	*Meteorium polytrichum* Dozy & Molk.	2
157	*Mitthyridium constrictum* (Sull.) H.Rob.	1, 2, 4, 6, 7, 8
158	*Mitthyridium fasciculatum* subsp. *cardotii* (M.Fleisch.) B.C.Tan & L.T.Ellis	1, 2, 4, 5, 6, 7
159	*Mitthyridium fasciculatum* (Hook. & Grev.) H.Rob. subsp. *fasciculatum*	1, 2, 4, 5, 6, 7
160	*Mitthyridium fasciculatum* subsp. *obtusifolium* (Lindb.) M.Menzel	1, 2
161	*Mitthyridium flavum* (Müll. Hal.) H.Rob.	1, 2, 3, 4, 5, 6, 7, 8
162	*Mitthyridium jungquilianum* (Mitt.) H.Rob.	1, 2, 3, 4, 5, 6, 7, 8
163	*Mitthyridium luteum* (Mitt.) H.Rob.	1, 2, 4
164	*Mitthyridium papuanum* (Broth.) H.Rob.	2, 3, 7, 8
165	*Mitthyridium repens* (Harv.) H.Rob.	2, 3, 4, 5, 6
166	®*Mitthyridium retusum* (Besch.) W.D.Reese	1, 4
167	*Mitthyridium subluteum* (Müll. Hal.) H.K.Nowak	Sekayu Recreational Forest
168	*Mitthyridium undulatum* (Dozy & Molk.) H.Rob.	1, 2, 3, 4, 5, 6, 7, 8
169	*Mitthyridium wallisii* var. *crassum* (Broth.) M.Menzel in M.Menzel & W.Schultze-Motel	1, 2, 4, 5, 6
170	*Mitthyridium wallisii* (Müll. Hal.) H.Rob. var. *wallisii*	1, 2, 4, 5, 6, 7
171	*Mniodendron dendroides* (Brid.) Wijk & Margad.	4, 6
172	*Mniomalia semilimbata* (Mitt.) Müll. Hal.	2, 3, 5, 6
173	*Neckeropsis gracilenta* (Bosch & Sande Lac.) M.Fleisch.	4, 5, 6, 7, 8
174	*Neckeropsis lepineana* (Mont.) M.Fleisch.	Terengganu
175	*Octoblepharum albidum* Hedw.	1, 4, 5, 6
176	*Oedicladium pseudorufescens* (Hampe) B.C.Tan & Mohamed	1, 2, 3, 4, 5, 6, 7
177	*Orthodontium infractum* Dozy & Molk.	6
178	*Papillidiopsis bruchii* (Dozy & Molk.) W.R.Buck & B.C.Tan	4, 6
179	*Papillidiopsis complanata* (Dixon) W.R.Buck & B.C.Tan	1, 2, 4, 5, 6, 7, 8
180	*Papillidiopsis luxurians* (Dozy & Molk.) W.R.Buck & B.C.Tan	5, 6
181	*Papillidiopsis malesiana* W.R.Buck & B.C.Tan	2, 4, 5, 6, 8
182	*Papillidiopsis ramulina* (Thwaites & Mitt.) W.R.Buck & B.C.Tan	2
183	*Pelekium velatum* Mitt.	3, 7, 8
184	*Pinnatella alopecuroides* (Hook.) M.Fleisch.	Terengganu
185	*Pinnatella ambigua* (Bosch & Sande Lac.) M.Fleisch.	Terengganu
186	**Pinnatella kuehliana* (Bosch & Sande Lac.) M. Fleisch.	Batu Biwa Limestone Hill
187	*Pinnatella mucronata* (Bosch & Sande Lac.) M. Fleisch.	2, 3, 5, 6, 7, 8
188	*Pogonatum cirratum* subsp. *fuscatum* (Mitt.) Hyvönen	6

No.	Name of taxa of mosses	Locality
189	**Pogonatum cirratum* subsp. *macrophyllum* (Dozy & Molk.) Hyvönen	6
190	*Pogonatum piliferum* (Dozy & Molk.) Touw	1, 2, 7, 8
191	*Pseudotaxiphyllum pohliaecarpum* (Sull. & Lesq.) Z.Iwats.	6
192	*Pseudotrachypus wallichii* (Brid.) W.R.Buck	4
193	*Pterobryopsis crassicaulis* (Müll. Hal.) M.Fleisch.	2
194	®*Pterobryopsis gedehensis* M.Fleisch.	2, 4
195	*Pyrrhobryum latifolium* (Bosch & Sande Lac.) Mitt.	1, 2, 4, 5, 6, 7, 8
196	*Pyrrhobryum medium* (Besch.) Manuel	4, 6, 7
197	*Pyrrhobryum spiniforme* (Hedw.) Mitt.	2, 4, 5, 6, 8
198	*Radulina borbonica* (Bél.) W.R.Buck	1, 2, 8
199	*Rhaphidostichum bunodicarpum* (C.Müll.) M.Fleisch.	4, 5, 6, 8
200	®*Rhaphidostichum piliferum* (Broth.) Broth.	1, 6
201	*Rhodobryum aubertii* (Schwägr.) Thér.	Terengganu
202	*Rhynchostegiella menadensis* (Sande Lac.) E.B.Bartram	2
203	*Rhynchostegium celebicum* (Sande Lac.) A.Jaeger	Terengganu
204	*Schistomitrium apiculatum* (Dozy & Molk.) Dozy & Molk.	2, 4
205	*Schistomitrium mucronifolium* (Müll. Hal.) M.Fleisch.	Gunung Sembili
206	*Schistomitrium robustum* Dozy & Molk.	4
207	***Sematophyllum subhumile* (Müll. Hal.) M.Fleisch.	5
208	*Sematophyllum subpinnatum* (Brid.) E.Britton	Terengganu
209	*Sphagnum cuspidatum* subsp. *subrecurvum* (Warnst.) A.Eddy var. *subrecurvum*	Terengganu
210	*Sphagnum junghuhnianum* Dozy & Molk.	4
211	*Sphagnum perichaetiale* Hampe	4
212	*Symphysodontella cylindracea* (Mont.) M.Fleisch.	2
213	*Syrrhopodon albo-vaginatus* Schwägr.	1, 2, 3, 4, 5, 6, 7, 8
214	*Syrrhopodon aristifolius* Mitt.	2, 3, 4, 5, 6, 7
215	**Syrrhopodon ciliatus* (Hook.) Schwägr.	1
216	*Syrrhopodon confertus* Sande Lac.	1, 2, 5, 6, 7, 8
217	*Syrrhopodon croceus* Mitt.	1, 2, 3, 4, 5, 6, 7, 8
218	*Syrrhopodon japonicus* (Besch.) Broth.	2
219	*Syrrhopodon loreus* (Sande Lac.) W.D.Reese	1, 2, 4, 5, 6, 7, 8
220	*Syrrhopodon muelleri* (Dozy & Molk.) Sande Lac.	1, 2, 3, 4, 5, 6, 7, 8
221	*Syrrhopodon perarmatus* Broth. in Broth. & Watts	4
222	*Syrrhopodon prolifer* Schwägr. var. *prolifer*	1, 2, 4, 6
223	*Syrrhopodon prolifer* var. *laevis* (Dixon) A.Eddy	4, 7
224	*Syrrhopodon spiculosus* Hook. & Grev. var. *spiculosus*	1, 2, 3, 4, 5, 6, 7
225	®*Syrrhopodon spiculosus* var. *patens* (Dixon) A.Eddy	4
226	®*Syrrhopodon stonae* W.D.Reese	5, 6
227	*Syrrhopodon tjibodensis* M.Fleisch.	2
228	*Syrrhopodon trachyphyllus* Mont.	1, 2, 4, 5, 6, 7, 8
229	*Syrrhopodon tristichus* Nees ex Schwägr.	1, 2, 3, 4, 6, 8
230	**Taxiphyllum taxirameum* (Mitt.) M.Fleisch.	8

No.	Name of taxa of mosses	Locality
231	*Taxithelium instratum* (Brid.) Broth.	2, 3, 5, 6, 7, 8
232	*Taxithelium isocladum* (Bosch & Sande Lac.) Renauld & Cardot	1, 2, 3, 5, 6, 7, 8
233	*Taxithelium kerianum* (Broth.) Broth.	6, 7, 8
234	*Taxithelium lindbergii* (A.Jaeger) Renauld & Cardot	4, 6
235	*Taxithelium nepalense* (Schwägr.) Broth.	1, 2, 3, 6
236	*Taxithelium vernieri* (Duby) Besch.	2
237	*Thuidium cymbifolium* (Dozy & Molk.) Dozy & Molk.	2
238	*Thuidium plumulosum* (Dozy & Molk.) Dozy & Molk.	1, 3, 8
239	*Thuidium pristocalyx* (Müll. Hal.) A.Jaeger	2, 4, 5, 6
240	*Trachyloma indicum* Mitt.	Gunung Padang
241	*Trachypus humilis* Lindb.	2
242	*Trichosteleum boschii* (Dozy & Molk.) A.Jaeger	1, 2, 3, 4, 5, 6, 7, 8
243	*Trichosteleum saproxylophilum* (Müll. Hal.) B.C.Tan, W.B.Schofield & H.P.Ramsay	1, 6
244	*Trichosteleum singapurense* M.Fleisch.	1, 2, 3, 5, 6
245	*Trichosteleum stigmosum* Mitt.	3, 5, 6
246	*Trismegistia calderensis* (Sull.) Broth. var. *calderensis*	2
247	**Trismegistia calderensis* var. *convoluta* (Bosch & Sande Lac.) K.T.Yong, B.C.Tan & B.C.Ho	5
248	**Trismegistia calderensis* var. *subintegrifolia* (Broth.) H.Akiyama	1
249	***Trismegistia complanatula* (Müll. Hal.) Müll. Hal.	5
250	*Trismegistia lancifolia* (Harv. in Hook.) Broth. var. *lancifolia*	1, 2, 4, 5, 6, 7, 8
251	*Trismegistia lancifolia* var. *pseudoplicata* H. Akiyama	6, 7, 8
252	*Vesicularia dubyana* (Müll. Hal.) Broth.	1, 3, 5, 6, 7
253	*Vesicularia miquelii* (Sande Lac.) M.Fleisch.	2, 3, 4, 6, 7, 8
254	*Vesicularia montagnei* (Schimp.) Broth.	3, 5, 6, 7, 8
255	*Vesicularia reticulata* (Dozy & Molk.) Broth.	6, 7, 8
	Name of taxa of liverworts	
256	*Plagiochila arbuscula* (Brid. ex Lehm. & Lindenb.) Lindenb.	Terengganu
257	*Radula retroflexa* Taylor	Kuala Berang

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