Bryophytes of the Southern Islands of Singapore

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ABSTRACT. A checklist of liverworts and mosses is presented based on some 150 specimens collected during the Southern Islands Survey project (2020–2022), as well as additions from a handful of historical collections from the herbarium (SING) of the Singapore Botanic Gardens. Forty-three species across 26 genera and 11 families were recorded from the islands. All species have already been recorded on the main island of Singapore.

Keywords. Conservation, island flora, liverworts, mosses, tropics

Introduction

Bryophytes belong to an ancient group of plants that remain relatively successful today. In terms of extant species numbers, it is the second largest group among land plants, after the angiosperms. Bryophytes are known to occur in all terrestrial habitats, including some in which vascular plants are unable to survive. Bryophytes are known as the amphibians of the plant kingdom; the entire plant body is able to exchange water and gas directly with the environment, thus making them very sensitive to environmental changes.

In Singapore, a total of 286 species of bryophytes have been recorded (Ho et al., 2022; Lindsay et al., 2022). As in many herbaceous and small-sized plants, collection of bryophytes in Singapore has been largely overlooked in local surveys and existing specimens reflect sporadic and scattered collecting efforts whereby some areas have few to no records. Our understanding of the bryophyte flora in Singapore is clearly far behind in comparison to that of the flowering plants.

During the Southern Islands survey (2019–2022) described by Tan et al. (2025), the team aimed to document, as far as possible, the biodiversity of the study area and made some efforts to collect bryophytes during their field work.

Materials and Methods

Specimens collected in the field were sorted under a dissecting microscope. As colonial organisms, more than one species of bryophytes may be found growing together. Mixed collections were segregated as much as possible, especially those consisting of species that had not already been represented by other collections on the same day and locality. Specimens were packed into folded paper envelopes and air dried for a few days. All dried specimens were kept frozen below -20°C for at least 48 hours before processing into actual voucher specimens to be deposited in the Herbarium, Singapore Botanic Gardens (SING). Species identities of records from existing specimens collected from the study area were also confirmed and combined with the results from the field surveys. Species identifications were according to treatments and collaborators for the *Flora of Singapore* project on bryophytes.

Basic topographical data on each island and reef (area, maximum elevation, length of coastline) are given by Tan et al. (2025). Miscellaneous information about past settlements and land use of each island is given by Muzaini et al. (2025).

Results & Discussion

Some 150 specimens of bryophytes collected from the southern islands were identified. Of these, only about 20 collections were made before the Southern Islands survey. A total of 43 species of bryophytes have been determined (Table 1). These include 11 species in 8 genera and 4 families of liverworts, as well as 32 species in 16 genera and 8 families of mosses. No hornwort specimen has been found. A dozen of the records were derived from previous ad-hoc collections by B.C. Ho (May 2005 from Pulau Semakau and Jan. 2014 from the Sisters' Islands and St. John's Island) and a few were from historical collections, including those by J. Sinclair (Dec. 1965 from Pulau Merlimau and Mar. 1953 from the nearby Pulau Damar Laut) and by R.E. Holttum (May 1924 from Pulau Jong). Most notable is a collection of *Taxithelium instratum* (Brid.) Broth. from Pulau Serapu (probably orthographic error for Pulau Seraya, see Chen et al., 2014) by H.N. Ridley made in 1898 (*Ridley 933*), which is also the oldest record of bryophytes from the southern islands of Singapore. This record has been reported by Dixon (1926) as *Taxithelium capillipes* (Sande Lac.) Broth., which is currently considered a synonym of *T. instratum*. Both Pulau Merlimau and Pulau Seraya are today part of the Jurong Island after several phases of land reclamation, joining by a land bridge that connects to an enlarged Pulau Damar Laut and to the southwest of mainland Singapore.

Among the southern islands, Sentosa and St. John's Island have the highest number of recorded bryophytes, each with 16 species (Table 1). Two of the 16 species on Sentosa were not noticed on any of the other islands, compared with five of the 16 species (31%) found on St. John's; incomplete recording might have been partly responsible. Interestingly, St. John's Island is less than 10% of the land area of Sentosa. Both Lazarus Island and Pulau Semakau have 12 recorded species each, while Kusu Island and the Sisters' Islands (combining both smaller islands) have 11 and nine species, respectively. The rest of the surveyed islands each have fewer than five species records, except Pulau Tekukor with six species. Larger islands do not necessarily have higher species richness because some have been developed and left with very little regenerated vegetation.

Among the mosses Calymperaceae, with 12 recorded species, is the largest family overall and the largest family of mosses (Table 1). This is followed by Lejeuneaceae, with seven species, which also represents the largest family for liverworts. Both are important and conspicuous bryophyte families that dominate the bryophyte community in tropical lowland habitats (Gradstein & Pócs, 1989; Gradstein, 1992). Members of both families are largely epiphytes, which is the predominant growth form for bryophytes in tropical forests (Gradstein, 1992). Most of the species found on the southern islands are found on either living tree bark (corticolous) or dead rotten tree trunks and branches (lignicolous). Among terrestrial species, Fissidentaceae, with a single genus *Fissidens*, is the best represented family with six species. *Fissidens* is also the best represented genus. The paucity of ground bryophytes commonly observed in the lowland tropical forests is usually attributed to burial under the persistent leaf litter (Gradstein, 1992). Other genera well represented on the southern islands are *Calymperes* and *Syrrhopodon*, both belonging to the Calymperaceae and with four species each. All liverwort genera, except *Cololejeunea*, are represented by a single species and belong to the leafy form. No thalloid liverwort has been found. The thalloid liverworts have overall lower diversity and are usually found in permanently moist and shady habitats which may not be present on these small islands.

In terms of life-form, the majority of the recorded species are either short tufts (most mosses) or mats (Lejeuneaceae, Pylaisiadelphaceae etc.). Short tufts consist of closely packed erect or vertical shoots with little or no branching, forming a fairly dense carpet. Mats are formed by interwoven prostrate shoots over substrate and often loosely attached by rhizoids (Bates, 1998). Both life-forms are known to be associated with dry habitats, although they may also be attributable to frequent small-scale disturbances (Bates, 1998).

The species richness of bryophytes on the southern islands represents a small fraction (~15%) of the diversity that has already been recorded on the main island of Singapore. This is not surprising because of the harsher environment and lesser diversity of habitat types on these islands. *Cololejeunea wightii* Steph., *Fissidens ceylonensis* Dozy & Molk., *Hyophila involuta* (Hook.) A. Jaeger and *Lejeunea adpressa* Nees have among the highest occurrences with specimens seen across six or seven of the southern islands. These are also some of the commonest species found on the main island. *Cololejeunea wightii* is a tiny leafy liverwort that can be found on the bases of shrubs and dead pieces of wood or branches whenever the humidity is high enough. *Fissidens ceylonensis* is a terrestrial moss frequently found on the soil surface and sometimes on rocks and tree bases. *Hyophila involuta* is among the most abundant of mosses in Singapore, found mostly on calcareous substrates especially any structure or part thereof made of concrete. *Lejeunea adpressa*, better known in the literature as *Lejeunea anisophylla* Mont., is one of most common microepiphytes on tree trunks, tree bases, small shrubs, and even exposed roots of palms.

On the other hand, 30 species or about two thirds of the species found on the southern islands have been collected only once or twice. About half of these are very tiny species that may have been overlooked in some localities. Interestingly, *Syrrhopodon ciliatus* (Hook.) Schwägr. is rarely collected even on the main island of Singapore but was found on discarded coconut husks on Pulau Semakau.

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Table 1. List of bryophytes recorded from the southern islands of Singapore. Liverworts and listed before the mosses and are arranged alphabetically by family and then by species. JRG= Jurong Island, SAL= Pulau Salu, BIO = Pulau Biola, HNT = Pulau Hantu, SMK = Pulau Semakau, JNG = Pulau Jong, SNT = Pulau Belakang Mati (Sentosa Island), KEP = Keppel Island, BRN = Pulau Brani, SIS = Pulau Subar Laut and Pulau Subar Darat (Sisters' Islands), TKR = Pulau Tekukor, SJI = Pulau Sekijang Benderah (St John's Island), LAZ = Pulau Sekijang Pelepah (Lazarus Island), KUS = Pulau Tembakul (Kusu Island).

s/n	Family	Species	Substrate	JRG	SAL	BIO	HNT	SMK	JNG	SNT	KEP	BRN	SIS	TKR	SJI	LAZ	KUS	SUM
	LIVERWORTS																	
1	Lejeuneaceae	*Acrolejeunea fertilis* (Reinw. et al.) Schiffn.	epiphytic					1							1		1	3
2	Lejeuneaceae	*Cheilolejeunea intertexta* (Lindenb.) Steph.	epiphytic			1		1	1									3
3	Lejeuneaceae	*Cololejeunea planissima* (Mitt.) Abeyw.	epiphytic										1					1
4	Lejeuneaceae	*Cololejeunea raduliloba* Steph.	epiphytic							1								1
5	Lejeuneaceae	*Cololejeunea wightii* Steph.	epiphytic					1		1	1			1	1	1	1	7
6	Lejeuneaceae	*Lejeunea adpressa* Nees	epiphytic					1		1			1	1	1		1	6
7	Lejeuneaceae	*Microlejeunea ulicina* (Taylor) Steph.	epiphytic														1	1
8	Lepidoziaceae	*Neolepidozia mamillosa* (Schiffn.) E.D.Cooper	terrestrial												1			1
9	Lepidoziaceae	*Neolepidozia wallichiana* (Gottsche) Fulford & J.Taylor	terrestrial	1														1
10	Lophocoleaceae	*Heteroscyphus zollingeri* (Gottsche) Schiffn.	terrestrial										1					1
11	Solenostomataceae	*Solenostoma truncatum* (Nees) R.M.Schust. ex Váňa & D.G.Long	terrestrial										1					1

Table 1. Continuation.

s/n	Family	Species	Substrate	JRG	SAL	BIO	HNT	SMK	JNG	SNT	KEP	BRN	SIS	TKR	SJI	LAZ	KUS	SUM
	MOSSES																	
12	Bryaceae	*Bryum apiculatum* Schwägr.	terrestrial							1							1	2
13	Bryaceae	*Bryum coronatum* Schwägr.	terrestrial					1						1				2
14	Calymperaceae	*Calymperes crassinerve* (Mitt.) A.Jaeger	epiphytic					1										1
15	Calymperaceae	*Calymperes erosum* Müll. Hal.	epiphytic					1									1	2
16	Calymperaceae	*Calymperes motleyi* Mitt.	epiphytic					1										1
17	Calymperaceae	*Calymperes pallidum* Mitt.	epiphytic											1				1
18	Calymperaceae	*Leucophanes glaucum* (Schwägr.) Mitt.	epiphytic				1	1		1							1	4
19	Calymperaceae	*Mitthyridium fasciculatum* (Hook. & Grev.) H.Rob.	epiphytic	1														1
20	Calymperaceae	*Mitthyridium repens* (Harv.) H.Rob.	epiphytic										1			1		2
21	Calymperaceae	*Octoblepharum albidum* Hedw.	epiphytic												1	1		2
22	Calymperaceae	*Syrrhopodon armatus* Mitt.	epiphytic		1			1	1	1						1		5
23	Calymperaceae	*Syrrhopodon ciliatus* (Hook.) Schwägr.	epiphytic					1										1
24	Calymperaceae	*Syrrhopodon rufescens* Hook. & Grev.	epiphytic													1		1
25	Calymperaceae	*Syrrhopodon spiculosus* Hook. & Grev.	epiphytic			1									1			2
26	Fissidentaceae	*Fissidens ceylonensis* Dozy & Molk.	terrestrial		1					1		1	1		1		1	6

Table 1. Continuation.

s/n	Family	Species	Substrate	JRG	SAL	BIO	HNT	SMK	JNG	SNT	KEP	BRN	SIS	TKR	SJI	LAZ	KUS	SUM
27	Fissidentaceae	*Fissidens crassinervis* Sande Lac.	terrestrial							1						1		2
28	Fissidentaceae	*Fissidens crenulatus* Mitt. var. elmeri (Broth.) Z.Iwats. & Tad.Suzuki	terrestrial		1		1					1				1	1	5
29	Fissidentaceae	*Fissidens guangdongensis* Z.Iwats. & Z.H.Li	terrestrial							1						1		2
30	Fissidentaceae	*Fissidens pellucidus* Hornsch.	terrestrial							1	1		1		1			4
31	Fissidentaceae	Fissidens zollingeri Mont.	terrestrial												1			1
32	Hypnaceae	*Ectropothecium* sp.	terrestrial												1			1
33	Hypnaceae	*Vesicularia* duibyana (Müll.Hal.) Broth.	terrestrial													1		1
34	Hypnaceae	*Vesicularia reticulata* (Dozy & Molk.) Broth.	terrestrial							1								1
35	Leucobryaceae	*Campylopus serratus* Sande Lac.	terrestrial												1			1
36	Leucobryaceae	*Leucobryum aduncum* Dozy & Molk.	terrestrial								1				1			2
37	Pottiaceae	*Hydrogonium consanguineum* (*Thwaites* & Mitt.) Hilp.	terrestrial							1		1					1	3
38	Pottiaceae	*Hyophila involuta* (Hook.) A.Jaeger	terrestrial							1			1	1	1	1	1	6
39	Pylaisiadelphaceae	*Isopterygium albescens* (Hook.) A.Jaeger	epiphytic			1				1				1	1			4
40	Pylaisiadelphaceae	*Isopterygium bancanum* (Sande Lac.) A.Jaeger	epiphytic				1	1										2
41	Pylaisiadelphaceae	*Taxithelium instratum* (Brid.) Broth.	epiphytic	1						1			1		1	1		5

Table 1. Continuation.

s/n	Family	Species	Substrate	JRG	SAL	BIO	HNT	SMK	JNG	SNT	KEP	BRN	SIS	TKR	SJI	LAZ	KUS	SUM
42	Pylaisiadelphaceae	*Taxithelium nepalense* (Schwägr.) Broth.	epiphytic												1			1
43	Sematophyllaceae	*Trichosteleum stigmosum* Mitt.	epiphytic							1	1					1		3
			Total	3	3	3	3	12	2	16	4	3	10	6	16	12	11	