



Diversity and Distribution of Bryophytes (Mosses) in East District of Sikkim

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Abstract

Bryophytes form an extreme part of the vegetation and they are important with the prospective of understanding Himalayan ecology. Sikkim, one of the smallest states in India supports a rich growth of bryophytes both in luxuriance and species diversity. In this paper 31 species of mosses are presented that were studied from 22 selected locations of the East district of Sikkim. Details of distribution within the limit of selected study areas, their habitats and associated plants have been discussed based on the field work.

Keywords: Bryophytes, Diversity, Environment, Mosses, Sikkim.

1. INTRODUCTION

Bryophytes represent a group of plants which comprise of several typical features that make them unique among the plant group. Morphologically they are categorized into three groups namely liverworts, hornworts and mosses. They have evolved from the aquatic ancestors of modern green algae and as a pioneer represent terrestrial plant life further contributing the evolution of vascular plants by being a link between the aquatic and the terrestrial plants liverworts and hornworts are considered as lower group among bryophytes whereas mosses are viewed as higher group for having foot, seta, and capsule along with distinct leaves and rhizoids. Diversity and distribution of bryophytes depend on some of the important variables of environment like rainfall pattern, humidity, temperature, elevation gradient and the slope aspects of their habitat. Mosses are critical component of Himalayan forest ecosystem as they perform essential ecological functions and contribute to biomass formation. Wide geographic range distribution of mosses depends on the external environment, their spore dispersal history, habitat availability and associated plants. The size and thickness of moss thallus indicate their response to external indicator of acid rain and air pollution. Mosses are used in landscaping and plant nursery bed management due to their ability to manage water, retaining cold temperature and improvement of air quality.

Sikkim is one of the mountainous states with an area of 7096 sq. km. with an integral part of the Eastern Himalaya which is recognised globally as one of the mega biodiversity hotspot zones. There are four districts in Sikkim and the capital, Gangtok is located in the East district. Within the limit of its boundary, it has altitudinal variation ranges from 350 m to 8598 m which supports large diversity of climate conditions providing different types of micro and macro habitats necessary for colonization of bryophytes. According to floristic data report of the Botanical Survey of India (2019), the total of 2,786 taxa of

bryophytes have been reported from India that comprises 5.57% of total Indian flora. Detailed study of the bryophytes of this region is not yet done except a few assorted publications. Singh *et al.* (2008) reported 342 taxa of liverworts belonging to 88 genera in 44 families from Sikkim. An annotated publication on the bryophytes of this region has been made by Singh *et al.* (2016). However, information on hornworts and mosses of this region are still not much available. Present study highlights the diversity and distribution of mosses and their associated plants in the natural habitat in the East district of Sikkim.

2. METHODOLOGY

2.1 Site Selection

Based on the published literatures and the experience of previous field studies, the following areas were selected for field work applicable to mosses studies in the present work. These areas were visited on foot from Sikkim University for the present work.

Habitats	Locations prioritized with their altitudes
Hill stations with high rainfall (above 4000 mm annual)	Bulbulay (1780m), Ganeshtok (1785m), Fambonglho (1524-2749m), Tinjurey (2130m), Plant Conservatory, Gangtok (2195m)
Edge of waterfalls (species growing on the wet rock near the waterfalls)	Ban Jhakri Falls (1740m), Bakthang waterfalls (1792m)
Roadside (motorable road)	Singtam (430m), Ranipool (910m), Adampool (920m), Samdur (980m), Lumsey (1250m), Tadong (1322m), Syari (1340m), Deorali (1388m), Rumtek (1524m), Barbing (1530m), Ranka (1768m), Chandmari Road (1786m), Tashi view point (1830m), Arithang (2195m)
Riverside (perennial)	Ray Khola (925m)

2.2 Field work

Field studies were conducted during the year 2020-2021 in different localities of the East district of Sikkim within the approximate distance of 25 km from Sikkim University located at 6th Mile, Tadong. Guidelines prescribed for covid19 pandemic by the government (SOP) protocol were strictly followed during the study and precautions were taken maintaining physical distance, wearing face mask, hand gloves and using sanitizer as and when required. Photographs of the studied specimens were taken along with substrates (soil, rock, bricks etc.), host for epiphytic moss. Information on associated plants and the altitudes were also recorded during the field study.

2.3 Identification of specimens

Identification of specimens was done in the laboratory of the Department of Botany, Sikkim University based on the morphological characters. Present identification of the specimens is based on the publications by Robinson (2019), Harold (1968), Barukial (2011) and the Checklist of Botanical Survey of India prepared by Singh *et al.* (2016).

3. Result and Discussion

In the present paper, 31 species of mosses belonging to 18 families and 23 genera have been recorded from 22 selected places of the East District of Sikkim which are enumerated alphabetically irrespective of their taxonomic positions. It is found that most of the mosses are terricolous (grows on soil) followed by rupicolous (grows on rocks, cemented wall etc.) and corticolous (grows on tree trunk/bark). High diversity of mosses was found in Tinjurey area followed by Fambonglho, Bulbulay, Raykhola, Samdur, and Ganesh Tok in that order. High diversity of mosses in these areas may be due to limited accessibility for being far away from human settlement, undisturbed ecological conditions and suitable slope aspects require for the mosses. In contrast, less diversity of mosses was observed in Lumsey, Barbing, Arithang, Syari, Tashi view point and Ranka areas. Less diversity of mosses in these areas may be due to the proximity with human settlements and frequent vehicle movement. Overall, the most abundant mosses found were *Octoblepharum albidum*, *Bryum argenteum*, *Entodon flavescens*, and *Brachythecium rivulare* however, species of *Bryum capillare*, *Orthotrichum diphanum*, and *Physcomitrium eurystomum* were found to be sparsely distributed. Among the 31 species of mosses recorded, 11 genera, namely *Atrichum*, *Bryum*, *Distichium*, *Funaria*, *Leucobryum*, *Mnium*, *Orthotrichum*, *Physcomitrium*, *Pogonatum*, *Polytrichum* and *Trematodon* are acrocarpous and remaining 10 genera namely *Brachythecium*, *Entodon*, *Haplocladium*, *Hedwigia*, *Hylocomium*, *Hypnum*, *Hyophila*, *Leucodon*, *Neckera*, and *Plagiomnium* are pleurocarpous.

For the identification of the collected bryophytes the key characters are:

- 1. Large moss form extensive patches, light to dark green and becomes yellowish when matured. Erect stem, leaves toothed when margin, more crowded above and have a creeping root like structure. Reddish brown seta that holds brown capsule.....*Atrichum undulatum*
- 2. Plant whitish-green to yellowish-green, stem regularly or irregularly branched, sympodial branches common, leaves are ovate, margin serrate or sub-entire. Seta is reddish-brown holding the capsule. Axillary hairs present, branched leaves are ovate-lanceolate to narrow triangular.....*Brachythecium rivulare*
- 3. Plant yellow-green to golden-brown, stem densely foliate and irregularly branched, leaves are ovate-lanceolate, margin weakly serrulate, perichetia and perigonia on the stem. Perichetial leaves are gradually acuminate; seta is reddish-brown holding capsule that becomes orange-brownish after it matures.....*B. plumosum*

4. Plant consists of dense mats of whitish-green leafy stems, branched stems are light green above, reddish in the middle, and brown below; more or less hairless, fibrous rhizoids develop from the stem. Individual leafy stems have a terede thread-like or worm-like appearance. Individual leaves are hairless, ovate and toothless in their margin. Leaf bases clasp to the stem. Capsules are reddish-brown when matured.....*Bryum argenteum*
5. Plants very small, closely tufted, bright dull green to yellowish-green above, dark brown below and in lower part matted with brown radicles. Stem slender, short, erect, green, becoming reddish to brownish in lower portion. Leaves are crowded closer in the upper portion and distant below, ovate to oblong-lanceolate, margin entire. Seta slender, erect, reddish-brown holding dark red capsule when matured and is cup-shaped.....*B. coronatum*
6. Plants soft, densely tuft, yellowish-green above, reddish below, rhizomatous, leaves ovate, spirally twisted when dry, crowded at apex and more distant below, margin smooth. Seta long, reddish-brown, capsule erect and become reddish-brown when matured.....*B. capillare*
7. Plant look dense silky tuft green in colour. Stem slender, long and sometimes branched, leaves are present in two rows and form a white sheathing base. Pericheatial leaves present, which resemble as ordinary leaves. Seta long and become twisted when dry. Capsule erect, brownish-red when matured and rhizoids develop below the stem.....*Distichium capillare*
8. Plants dark green, glossy, branches pinnate, flattened; leaves triangular, ovate-lanceolate, leaves are spreading, margin almost smooth, entire. Seta yellowish-brown, capsule erect to horizontal, when matures green capsule turns to dark red in colour.....*Entodon flavescens*
9. Plant in dense mats, bright green in colour. Leaves are erect to spreading, oblong-lanceolate to oblong-ovate, margin proximally entire, distally serrulate. Pericheatia on stem and branches, inner pericheatial leaves oblong. Seta yellow, capsule long and when it matures it turns to red colour.....*E. macropodus*
10. The stem and branches of this mat forming calcareous loving moss have shiny leaves and appear somewhat worm-like. Leaves are ovate elliptical, stem and branches are flattened covering with leaves. Leaves press closely with stem when dry, perichaetia mostly on stem.....*E. seductrix*
11. Loosely to closely tufted green to yellowish-green plants, simple or branched from base. Upper leaves large, forming a rosette of tip, oblong-obovate to oblong-lanceolate, erect spreading; margin entire at base and serrate at apex. Lower leaves small, seta erect, capsule pendulous, yellow at younger stage and become brown at age with a deep red mouth.....*Funaria hygrometrica*

12. Plant medium-sized, stem leaves erect, distinct, and broadly ovate to triangular, margins plane and serrulate. Branched leaves distant, and ovate. Seta slender, brown, capsule turned brown colour when it matures. Rhizoids loosely attached to the substratum.....***Haplocladium microphyllum***
13. Evergreen moss forms a low cushion of plants. Stems are red to brown, devoid of hair-like rhizoids; they are widely spread or erect. Leaves occur along the stem and moderately densed. Individual leaves are lanceolate-ovate, margins are toothless, they strongly clasp the stem at the base, lower leaf margin are rolled downward, while their middle and upper margins are flat. Leaves are green or yellowish green when wet and greyish when dry. They become attached to the substratum when their stem bases and lower stem develop fibrous rhizoids.....***Hedwigia ciliata***
14. Plant form loose weft of shoots. Shoots are glossy green or brown-green. Branching pattern is complex. It is composed of one or more bipinnate branched “step by step” and each step represents a year growth. Leaves of the main branch are doubling costate. Its appearance is fern-like.....***Hylocomium splendens***
15. Plants look like dark green forming dense tufts. Mostly erect, simple or branched, top leaves are spreading in rosettes, margins rolled in when dry. Leaves oblong, ligulate, sheathing and erect, margin entire below, denticulate at apex. Pericheatleaves not much differentiated; seta apical, capsule cylindrical and becomes brown in colour when matured.....***Hyophila involuta***
16. Plant light or greyish green, branching irregularly pinnate, shoots are green or tinged with a warm, brownish colour in the older part. Leaves closely imbricate, ovate, oblong-lanceolate, margin smooth and denticulate at tip. Top pericheatleaves erect and spreading; seta erect, slender, capsule when matured it turns to red to brown in colour.....***Hypnum cupressiforme***
17. Creeping stems that often form a large mats or cushions vary in colour from almost white when dry to pale green. Leaves are linear-lanceolate and crowded on the stem, veins broad, gradually narrowed from broadly ovate base; rhizoids fibrous.....***Leucobryum javense***
18. Plant whitish-green, silky, branches arise from the main stem and from basal portion; leaf spreading, not much changed when dry, gradually narrowed to tip from a wider base; uniform from base to apex. Seta slender, brown in colour, capsule when matured it turns to brown in colour.....***L. juniperoideum***
19. Plants are large sized, whitish green, in loose tufts. Stems erect, bearing many soft-twisted branches; leaves typically soft-textured, narrowly lanceolate to lanceolate, gradually narrowed to subtubulose apices from broadly elliptic base, acute at apex; rhizoid fibrous.....***L. sanctum***
20. Plants medium-sized, light to dark green, glossy. Stems short or rarely elongate, curved, rarely straight and rigidly spreading, julaceous, fragile branchlets absent

from distal leaf axils. Branch leaves erect-appressed; apex acute to short-acuminate, perichaetia common. Rhizoids fibrous and loosely attached to the substratum.....*Leucodon julaceus*

21. The young plants are bright green, the older are dark-green, simple, and erect, shoots erect from the base. Lower leaves minute, the upper gradually increase in size, the terminal forming a rosette, all oblong-lance shaped, apex more or less acute with a sharp little point; base growing slightly down the stem; margin with a strong red border, spiny toothed from below the middle, the teeth in a double row; veins vanishing below the apex. Dioecious, and male surrounded by rosette leaves.....*Mnium hornum*

22. It forms yellow-green tufts. Primary stem creeping and attached to the substratum, secondary shoots long, hanging with ascending tips, irregularly, pinnately branched. Leaves transversely undulate, ovate-lanceolate, tapering to acute apex, slightly hooked, margin recurved on the one-side, faintly denticulate to the apex. Veins short, double or lacking, rhizoids loosely attached to the substratum.....*Neckera pennata*

23. Plants whitish green forming tuft matson the trunk of rough bark trees, leaves crowded, erect spreading on a very short stem; leaves ligulate, form an oblong or narrowly obovate, it remains same in normal and dry condition, sheathing base broad, apiculate at tip, minutely serrate, usually form a rosette near tip of the plant, rhizoids fibrous.....*Octoblepharum albidum*

24. Plants small, loosely caespitose, green or yellowish green above, yellowish brown to brown below, stem leaves loosely erect when dry, ovate-lanceolate to onlong, margins revolute nearly to base, serrate, apex acute, forked, leaves larger above, erect spreading to reflexed below when wet, ovate-lanceolate, oblong-lanceolate, or lanceolate, ventral surface keeled, margins broadly recurved, entire, crenulate to denticulate at below.....*Orthotrichum diphanum*

25. Plants solitary, yellowish- bright green colour, leaves in wet and dry condition erect, 0.2-0.4 mm, margin entire, and perichaetial leaves not so much differentiated. Seta when young yellowish to green colour and when matured it turns to brown colour, slender; capsule pendulous, green in colour*Physcomitrium eurystomum*

26. This moss is evergreen perennial, short-lived. Sterile shoots produce sprawling unbranched stem, the alternate leaves are arranged horizontally along two sides of such stems, and they tend to be wider in shape than the leaves of fertile shoots. Fertile shoot produce erect unbranched stems. The leaves occur in pseudo whorls along such stem, the leaves of fertile shoots are ascending to spreading. Both the stems and leaves are usually light green when they are moist. On fertile shoots, the leaves are oblong-obovate to oblong-elliptic in shape and on infertile shoots, the leaves are obovate to broadly elliptic in shape. The leaves of both kinds of shoots have tips that are acute and cuspidate and have conspicuous midrib. These leaves have fine sharp teeth along their margins from about the middle of their length to their tips, margin smooth. When they are dry, leaves darken and crinkled; they straighten out and become smooth

again with the return of moisture. Stem and leaves are hairless; seta long, more or less erects, green, yellow, light orange, long, smooth. Capsule light green, yellow, orange, ovoid to cylindrical in shape; fibrous rhizoids.....*Plagiomnium cuspidatum*

27. Plant lax tufts, stem simple, sometimes branched, with pale basal rhizomatous region. Leaves lanceolate, wider sheathing base, apex sharply acute, margin also sharply toothed almost upto the base of the lamina; seta long; capsule erect, reddish brown, ovate, cylindrical, surface rough.....*Pogonatum alloides*
28. It forms loose to dense tufts. The wiry plants are large and olive to dark green, becoming brown to age. Stems are typically unbranched, stiff, and erect. Leaves are spirally arranged to the stem, erect spreading to curved and twisted when dry, spreading with recurved tips when wet, the base clasps the stem with a membranous, shiny sheath, oblong-lanceolate or elliptical, yellowish; margins with unicellular teeth from leaf base to apex, the midrib ends above the apex in a short. Seta long, yellowish-reddish brown; capsule long, brown to dark red brown, inclined, box-like appearance.....*Polytrichum commune*
29. It consists of leafy stems that are more or less erect, although old lower stems are often decumbent on the ground. It forms dense colonies. The stems are light yellowish, brown to dark reddish brown, terete, devoid of hairy-like rhizoids, although some rhizoids are present at the base. Slender leaves are densely distributed along the entire length of the stem. Leaves are widely spreading when moist, while dry leaves are strongly ascending to erect, individual leaves are linear to linear-lanceolate in shape, entire along their margins. Leaves surface are greyish green or dark green, it become brown-red at its tip; midrib extend to entire leaf except at base. Seta long, less erect, red to reddish brown at maturity; capsule immature are erect, while mature are tilted. It attaches to the substratum with the help of fibrous root present at the base of the stem. Lower stem on the ground also can produce rhizoids, from which clonal plants can develop.....*Polytrichum juniperinum*
30. Slender and weak-stemmed moss, moderate-sized, growing in green dense colonies, feather-like, stem leaves triangular, acute to round at apex, branch leaves narrowly ovate-lanceolate, often slightly toothed and inrolled near apex. It generally grows very slowly.....*Sphagnum cuspidatum*
31. Plants minute, yellowish-green, gregarious or scattered, leaves erect spreading, suddenly tapering from the broad, ovate to rectangular sheathing base to a long narrow base, linear subulate acumen, slightly blunt tips; margin slightly toothed at the apex, entire below. Seta long pale yellow, erect, twisted when dry; capsule yellowish-brown, ovate-cylindrical; rhizoids fibrous type.....*Trematodon longicollis*

It was also observed that most of the mosses preferred wet, moist and semi-shaded areas in association with other mosses, liverworts, angiosperms, and pteridophytes. It was also observed that 5 species of mosses namely *Bryum*

argenteum, *Entodon flavescens*, *Hylocomium splendens*, *Hypnum cupressiforme* and *Sphagnum cuspidatum* were not associated with other plants and were growing independently.

Table.1 List of mosses and their habitat, associated plants and local distribution in East district of Sikkim.

Sl. No	Name of the plant	Habitat	Distribution	Associated Plants	References
1	<i>Atrichum undulatum</i> (Hedw.) P.Beauv. F: Polytrichaceae	Soil, road side ditches	Bulbulay, Fambonglho, Ganeshtok, Jawaharlal Nehru Botanical Park, Tinjurey	Liverworts: <i>Marchantia linearis</i> Lehm. & Lindenb. Moss: <i>Bryum capillare</i> Hedw. <i>Leucobryum sanctum</i> Hampe. <i>Polytrichum juniperinum</i> Hedw Angiosperm: <i>Houttuynia cordata</i> Thunb.	Pope (2016)
2	<i>Brachythecium rivulare</i> W.P.Schimper F: Brachytheciaceae	Wet soils, Stream sides Damp rock Decaying woods, edge of the road.	Adamapool, Bakthang falls, Fambonglho, Jawaharlal Nehru Botanical Park, Rumtek, Raykhola, Tinjurey	Moss: <i>Brachythecium plumosum</i> (Hedw.) Schimp. <i>Neckera pennata</i> Hedw. <i>Octoblepharum albidum</i> Hedw. <i>Polytrichum commune</i> Hedw.	Pope (2016)
3	<i>Brachythecium plumosum</i> (Hedw.) Schimp. F: Brachytheciaceae	Wet soils, Stream sides Damp rock Decaying woods, edge of the road.	Bakthang falls, Fambonglho, Jawaharlal Nehru Botanical Park, Samdur, Tinjurey	Moss: <i>Brachythecium rivulare</i> W.P.Schimper Angiosperm: <i>Commelina benghalensis</i> L. <i>Galinsoga parviflora</i> Cav.	Dandotiya <i>et al.</i> (2011)
4	<i>Bryum argenteum</i> Hedw. F: Bryaceae	Poor soil and rocks, cemented walls and rocks.	Banjhakri falls Chandmari, Deorali, Fambonglho, Jawaharlal Nehru Botanical Park, Raykhola Rumtek, Tadong, Tinjurey	It was seen to be grown alone.	Savaroglu <i>et al.</i> (2006); Dandotiya <i>et al.</i> (2011); Pope (2016)

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5	<i>Bryum coronatum</i> Schwagr. F: Bryaceae	Calcareous Soils or wall Rocks.	Bulbulay, Ganeshtok, Samdur	Moss: <i>Hyophila involuta</i> (Hook.) A.Jaeger , <i>Plagiomnium cuspidatum</i> (Hedw.)T.J. Kop	Savaroglu <i>et al.</i> (2006) Barukial (2011); Bansal and Nath (2012); Dandotiya <i>et al.</i> (2011)
6	<i>Bryum capillare</i> Hedw. F: Bryaceae	Woodland, soil bank, tree, log, walls, roofs and rocks.	Samdur	Moss: <i>Entodon macropodus</i> (Hedw.) Mull. Hal., <i>Leucodon julaceus</i> (Hedw.) Sull., <i>Plagiomnium cuspidatum</i> (Hedw.)T.J. Kop	Savaroglu <i>et al.</i> (2006); Barukial (2011); Dandotiya <i>et al.</i> (2011)
7	<i>Distichium capillare</i> (Hedw.) Bruch & Schimp. F: Districhaceae	Moist soil, tree, roadsides, grassland.	Bulbulay, Ganeshtok, Fambonglho, Tinjurey	Moss: <i>Atrichum undulatum</i> (Hedw.) P.Beaurv., <i>Trematodon longicollis</i> Michx., <i>Entodon flavescens</i> (Hook.) A.Jaeger	Savaroglu <i>et al.</i> (2006); Dandotiya <i>et al.</i> (2011)
8	<i>Entodon flavescens</i> (Hook.) A. Jaeger F: Entodontaceae	Rocks, logs	Bakthang falls, Banjhakri falls, Bulbulay, Fambonglho, Ganeshtok, Plant Conservator, Raykhola, Tinjurey	It was growing alone in the area.	Dandotiya <i>et al.</i> (2011); Zhu <i>et al.</i> (2016)
9	<i>Entodon macropodus</i> (Hedw.) Mull. Hal. F: Entodontaceae	Rocks, logs, tree, soil	Samdur	Moss: <i>Bryum capillare</i> Hedw., <i>Octoblepharum albidum</i> Hedw.	Dandotiya <i>et al.</i> (2011); Zhu <i>et al.</i> (2016)
10	<i>Entodon seductrix</i> (Hedw.) Mull. Hal. F: Entodontaceae	Rocks, logs, Tree base, barks	Bulbulay, Fambonglho, Tinjurey	Moss: <i>Octoblepharum albidum</i> Hedw.	Dandotiya <i>et al.</i> (2011); Zhu <i>et al.</i> (2016); Pope (2016)
11	<i>Funaria hygrometrica</i> Hedw. F: Funariaceae	Moist, shady Damp soil, moist wall, rocks.	Adampool Arithang Samdur Singtam	Moss: <i>Bryum capillare</i> Hedw., <i>Leucobryum javense</i> (Brid.) Mitten., <i>Hyophila involuta</i> (Hook.) A.Jaeger	Hoffman (1966); Laha and Lalhriatpui- a (2013)

12	<i>Haplocladium microphyllum</i> (Hedw.) Broth. F: Thuidiaceae	Moist rocks, walls, soil, damp wood.	Raykhola	Moss: <i>Octoblepharum albidum</i> Hedw., <i>Hypnum cupressiforme</i> Hedw.	Engler and Prantl (1907) Mao <i>et al.</i> (2017)
13	<i>Hedwigia ciliata</i> (Hedw.) P.Beauv. F: Hedwigiaceae	Tree trunk, rock.	Bulbulay, Ganeshtok, Raykhola, Samdur	Moss: <i>Octoblepharum Albidum</i> Hedw., <i>Neckera pennata</i> Hedw., <i>Plagiomnium cuspidatum</i> (Hedw.)T.J. Kop	Dandotiya <i>et al.</i> (2011); Efrain (2014)
14	<i>Hylocomium splendens</i> (Hedw.) Schimp. F: Hylocomiaceae	Tree trunk, Logs.	Bulbulay, Fambonglho, Tinjurey	It was grown alone	Pope (2016)
15	<i>Hyophila involuta</i> (Hook.) A.Jaeger F: Pottiaceae	Rocks, soil, logs, walls.	Samdur	Moss: <i>Funaria hygrometrica</i> Hedw., <i>Hedwigia ciliata</i> (Hedw.) P.Beauv.	Barukial (2011); Dandotiya <i>et al.</i> (2011)
16	<i>Hypnum cupressiforme</i> Hedw. F: Hypnaceae	Tree trunk, rocks, logs.	Bulbulay, Fambonglho, Ganeshtok, Raykhola, Tinjurey	It was seen to be grown alone.	Tewari and Pant (2002)Barukial (2011); Pope (2016)
17	<i>Leucobryum javense</i> (Brid.) Mitten. F: Leucobryaceae	Soil, rocks, tree trunks.	Bulbulay, Ganeshtok, Raykhola, Rumtek, Samdur	Moss: <i>Octoblepharum albidum</i> Hedw. Fern: <i>Selaginella kraussiana</i> (Kunze) A. Braun. Angiosperm: <i>Dioscorea bulbifera</i> L.	Dandotiya <i>et al.</i> (2011); Laha and Lalhriatpui a (2013); Tewari and Pant (2002)
18	<i>Leucobryum juniperoideum</i> (Brid.) Mull. Hal. F: Leucobryaceae	Tree, rocks	Fambonglho	Moss: <i>Octoblepharum albidum</i> Hedw.	Dandotiya <i>et al.</i> (2011); Tewari and Pant (2002)
19	<i>Leucobryum sanctum</i> (Nees. ex Schwagr.) Hampe F: Leucobryaceae	Soil, rock, tree.	Bulbulay, Jawaharlal Nehru Botanical Park, Plant conservatory, Raykhola	Moss: <i>Octoblepharum albidum</i> Hedw., <i>Entodon macropodus</i> (Hedw.) Mull. Hal.	Dandotiya <i>et al.</i> (2011); Tewari and Pant (2002)

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20	<i>Leucodon julaceus</i> (Hedw.) Sull. F: Leucodonaceae	Bark, logs, rarely on rocks.	Bulbulay, Fambonglho, Ganeshtok, Raykhola, Tinjurey	Moss: <i>Octoblepharum albidum</i> Hedw.	Dandotiya <i>et al.</i> (2011)*; Stech <i>et al.</i> (2011)
21	<i>Minium homum</i> Hedw. F: Mniaceae	Roots and tree trunks, rocks.	Adampool, Raykhola, Rumtek, Samdur	Moss: <i>Hedwigia ciliata</i> (Hedw.) P.Beauv.	Dandotiya <i>et al.</i> (2011); Pope (2016)
22	<i>Neckera pennata</i> Hedw. F: Neckeraceae	Tree barks.	Bulbulay, Fambonglho, Ganeshtok, Raykhola, Rumtek, Tinjurey	Moss: <i>Hedwigia ciliata</i> (Hedw.) P.Beauv., <i>Brachythecium rivulare</i> W.P.Schimper.	Kuusinen and Penttinen (1999); Dandotiya <i>et al.</i> (2011)
23	<i>Octoblepharum albidum</i> Hedw. F: Octoblepharaceae	Tree	Banjhakri falls, Bakthang falls, Barbing, Bulbulay, Deorali, Fambonglho, Ganeshtok, Raykhola, Rumtek, Samdur, Singtam, Syari, Tadong, Tinjurey	Moss: <i>Brachythecium rivulare</i> W.P.Schimper, <i>Leucodon julaceus</i> (Hedw.) Sull., <i>Leucobryum sanctum</i> (Nees. ex Schwagr.) Hampe., <i>Haplocladium microphyllum</i> (Hedw.) Broth., <i>Hedwigia ciliata</i> (Hedw.) P.Beauv., <i>Entodon macropodus</i> (Hedw.) Mull. Hal.	Barukial (2011); Silva-Micel <i>et al.</i> (2013); Dandotiya <i>et al.</i> (2016)
24	<i>Orthotrichum diphanum</i> Scrad.ex. Brid. F: Orthotrichaceae	Rock, brick walls.	Adampool	Angiosperm: <i>Ageratum conyzoides</i> L.	Dandotiya <i>et al.</i> (2016)
25	<i>Physcomitrium eurystomum</i> Sendtn. F: Funariaceae	Moist walls, rocks.	Adampool	Liverwort: <i>Metzgeria furcata</i> (L.) Corda, Moss: <i>Bryum capillare</i> Hedw.	Dandotiya <i>et al.</i> (2016); Schwarz (2016)
26	<i>Plagiomnium cuspidatum</i> (Hedw.) T.J. Kop F: Mniaceae	Wet and moist soil, tree, and rocks.	Samdur	Moss: <i>Hedwigia ciliata</i> (Hedw.) P.Beauv.	Dandotiya <i>et al.</i> (2016); Pope (2016)
27	<i>Pogonatum alloides</i> (Hedw.) P. Beauv. F: Polytrichaceae	Sandy wet soil, rocks.	Bulbulay, Fambonglho, Ganeshtok, Tinjurey	Angiosperm: <i>Ageratum conyzoides</i> L., <i>Persicaria nepalensis</i> (Meisn.) H.Gross.	Barukial (2011); Pope (2016)

28	<i>Polytrichum commune</i> Hedw. F: Polytrichaceae	Soil over rocks, marshy places.	Adampool, Bulbulay, Fambonglho, Ganeshtok, Raykhola, Rumtek, Samdur	Liverworts: <i>Doumortiera hirsuta</i> (Sw.) Nees., <i>Marchantia polymorpha</i> L. <i>Marchantia linearis</i> Lehm. & Lindenb., <i>Plagiochasma appendiculatum</i> Lehm. & Lindenb., Moss: <i>Brachythecium rivulare</i> W.P.Schimper Angiosperm: <i>Cynodon dactylon</i> (L.) Pers.	Dandotiya <i>et al.</i> (2011); Pope (2016); Popov (2018)
29	<i>Polytrichum juniperinum</i> Hedw. F: Polytrichaceae	Soil, rocks.	Adampool, Bulbulay, Raykhola, Ganeshtok	Angiosperm: <i>Houttuynia cordata</i> Thunb.	Dandotiya <i>et al.</i> (2011); Pope (2016); Popov (2018)
30	<i>Sphagnum cuspidatum</i> Ehrh. ex. Hoffm. F: Sphagnaceae	Wet humus, base of tree near bogs.	Bulbulay, Fambonglho, Ganeshtok, Tinjurey	It was grown alone.	Hanssen <i>et al.</i> (2009); Dandotiya <i>et al.</i> (2011); Pope (2016);
31	<i>Trematodon longicollis</i> Michx. F: Bruchiaceae	Moist soil.	Samdur	Ferns: <i>Nephrolepis cordifolia</i> (L.) K. Presl., <i>Pteridium esculentum</i> (G. Frost.) Cockayne. Angiosperm: <i>Acniella oleracea</i> (L.) R.K. Jansen. <i>Cynodon dactylon</i> (L.) Pers.	Hoffman (2009); Hallingback and Tan (2010); Dandotiya <i>et al.</i> (2011)

Some photo plates of mosses studied in the East district of Sikkim





Distichium capillare (Hedw.) Bruch & Schimp



Entodon macropodus (Hedw.) Mull. Hal.



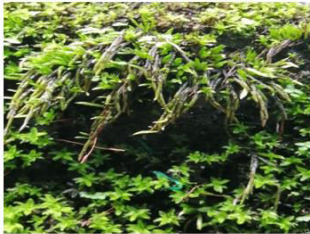
Brachythecium plumosum (Hedw.) Schimp.



Bryum coronatum Schwagr.



Bryum capillare Hedw.



Bryum argenteum Hedw.



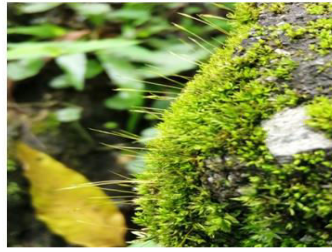
Entodon seductrix (Hedw.) Mull. Hal.



Funaria hygrometrica Hedw.



Hylacomium splendens (Hedw.) Schimp



Hyophila involuta (Hook) A. Jaeger



Haplocladium microphyllum (Hedw.) Broth.



Hedwigia ciliata (Hedw.) P. Beauv.



Hypnum cupressiforme Hedw.



Leucobryum javense (Brid.) Mitten



Leucobryum juniperoides (Brid) Mull. Hal.



Leucobryum sanctum (Nees. ex. Schwagr.) Hampe



Leucodon julaceus (Hedw.) Sull



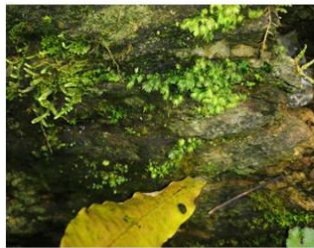
Mnium hornum Hedw.



Neckera pennata Hedw.



Octoblepharum albidum Hedw.



Orthotrichum diphanum Scrad.ex.Brid



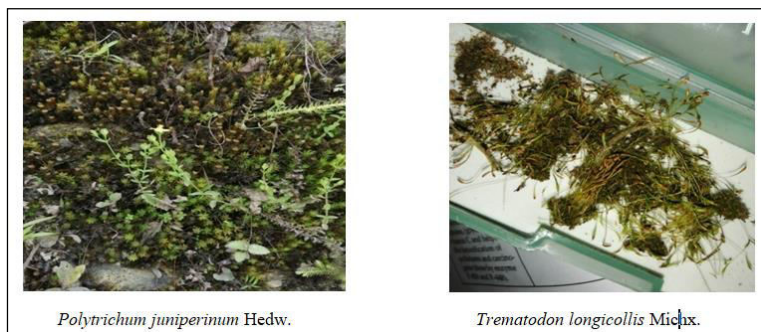
Physcomitrium eurystomum Sendtn.



Plagiommium cuspidatum (hedw.) T.J. Kop



Polytrichum commune Hedw.



CONCLUSION

Sikkim Himalayan region exhibits one of the richest angiosperm diversity in the country and it is equally rich in bryophytes. Among the members in plant kingdom, bryophytes are more sensitive to external environment and they act as an indicator of climate change. However, their occurrence and importance has not been clearly appreciated yet. That may be due to very less studies about them. Basic data on mosses presented in this paper may be regarded as baseline data which should encourage further studies aiming at their bio-monitoring characteristics and phytochemical analysis and conservation.

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