RESEARCH ARTICLE

A Note on Bryophyte Diversity in Context of Habitat and Anthropogenic Intervention at Ghoom (Darjeeling), Eastern Himalaya, India

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Abstract

An assessment of diversity of bryophytes at Ghoom, Darjeeling Hills has been made. A total of 47 species belonging to 37 genera and 26 families have been identified during the study. Six habitats were selected to compare relative bryophyte distribution. Evaluation of the bryophyte distribution in different habitats has been done with an observation of different growth forms occurring in the area. It has been noticed that bryophyte diversity in terms of number of taxa was quite low here as compared to nearby Jalapahar and Senchal Wildlife Sanctuary of Darjeeling hills surveyed during study, owing to higher level of pollution and habitat loss due to constant anthropogenic movement.

Keywords: Bryophytes, Darjeeling, Diversity, West Bengal.

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Introduction

The Darjeeling hills are a part of the Lesser Himalayas of the East Himalayan region. The topography of the region is marked by steep slopes, loose soil and uneven terrain that give way to steep mountains, rocky patches, ravines, valleys and table top formations in the whole region. Such a varied topography becomes an ideal set up for rich floristic diversity. The humid and moist weather in several months of the year gives an ideal environment to the Bryophyte flora of this region. The present study provides the updated listing of bryophytes of Ghoom region of Darjeeling hills. Ghoom is India's highest railway station and 14th highest Railway station in the world which is covered under the UNESCO World Heritage Site. Some important contributions regarding bryophytes of Darjeeling and East Himalayan region have already been made by Chopra (1975), Gangulee (1969-1980), Srivastava *et al.* (1994), Asthana *et al.* (2005), Lal (2005), Asthana & Sahu (2010), Dandotiya *et al.* (2011), Asthana *et al.* (2012) and M. Dey & Singh (2008). Assessments on chemical aspects of bryophytes of the region were also provided by Chhetri et al. (2009), A. Dey *et al.* (2013) and Mukhiya *et al.* (2014). A detailed assessment of the latest status of bryophyte genera and families has been undertaken considering the void prevailing in the current knowledge of this aspect. This work is a small part of the detailed assessment and provides the current scenario of bryophyte diversity across various habitats at Ghoom area of the Darjeeling hills.

The average elevation of Ghoom is about 2200 m above sea level and it is a place that is frequently visited by tourists and local people. The other nearby areas include Jalapahar, Senchal Wildlife Sanctuary and Tiger Hill. An interesting fact worth mentioning here is that though all the places near Ghoom are accessible to humans, but this place has a large human influx as compared to the other areas. The most probable reason being the Tourist train running from Darjeeling town to Ghoom and densely populated town with continuous civil construction works. The anthropogenic activity here is much high as compared to Jalapahar, Senchal Wildlife Sanctuary (SWLS) and Tiger hill region. The next tourist frequented spot is Tiger Hill but there is least human colonization. What influence anthropogenic movement exerts on relative bryophyte diversity of less and more disturbed sites of bryophyte distribution has been tried to decipher with critical observation. Ghoom in spite of constant human activity offers varied habitats for bryophyte growth.

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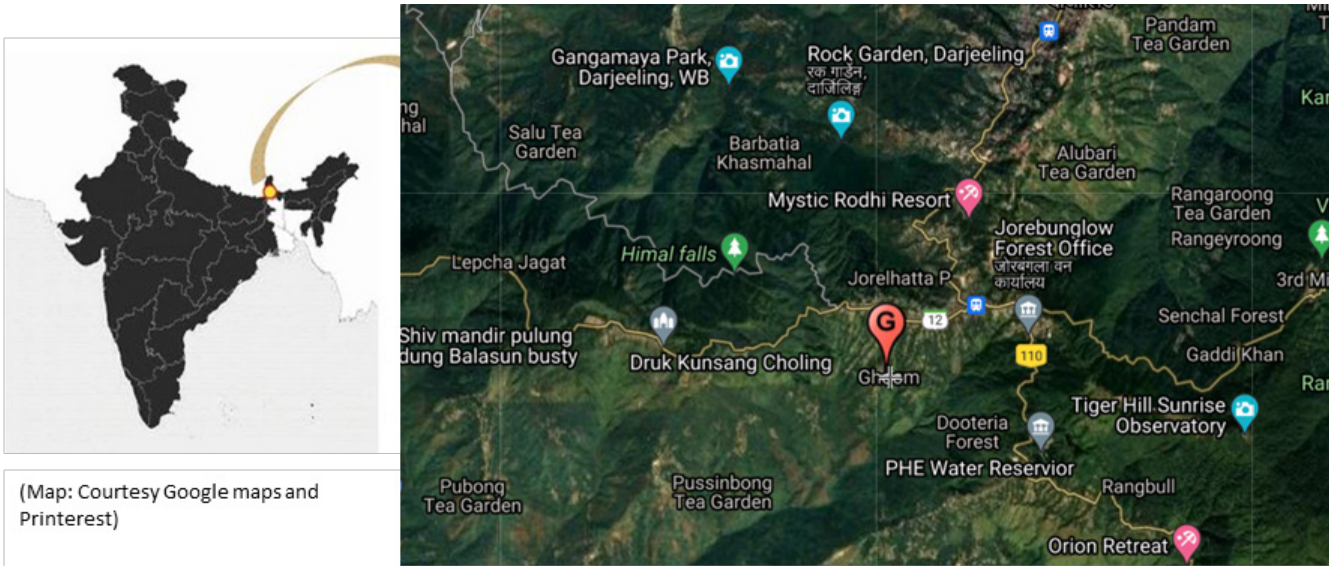
Material and Methods

Ghoom is situated (Fig. 1) at the elevation of about 2,200 m (the collection range of specimens being 2225–2260 m). The temperature ranges from 19°C and 12°C in summer months and 11°C and-1°C in winters. The average relative humidity ranges from 40% (March) to 85% (August). The soil composition here is coarse loamy. The main station area lies about 7 km from the main Dajeeling town and adjacent to Senchal Forest area at one end and Jalapahar area at the other end that is the military cantonment area of the town.

The specimens were collected in the years 2016 and 2018 from six selected habitats at Ghoom (Darjeeling hills), west Bengal. Five samples were collected from each of the habitats viz. soil, soil covered rocks, wet rocks, dry rocks, stony/ brick walls and tree barks. The habitat characteristics were recorded for evaluation of the habitat diversity. The specimens have been



(Map: Courtesy Google maps and Printerest)

Fig. 1: Location of Ghoom at Darjeeling hills

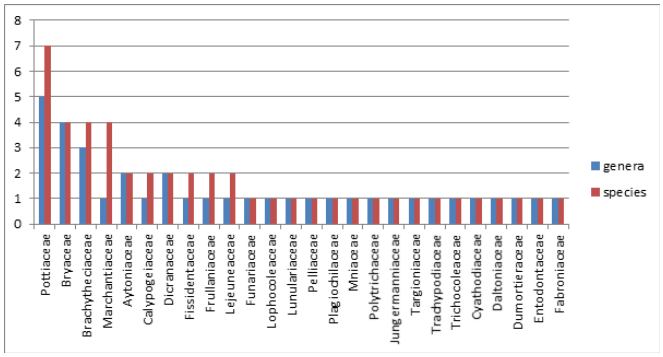


Fig. 2: Diversity of Family, Genera and Species of Bryophytes at Ghoom

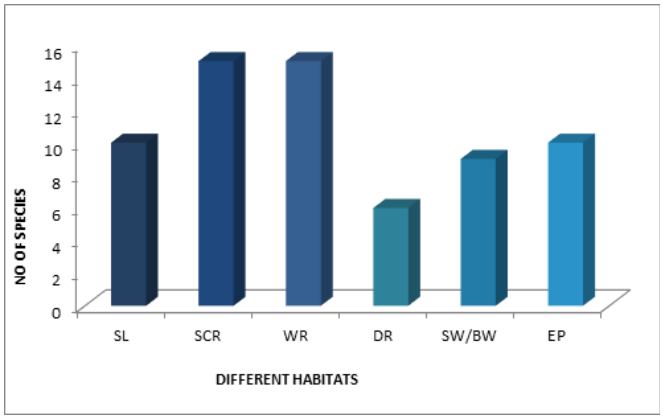


Fig. 3: Habitat distribution of bryophytes at ghoom
(SL = Soil, SCR = Soil Covered Rocks, WR = Wet Rocks, DR = Dry rocks, SW/BW = stony wall/brick wall, EP = epiphytic)

deposited at the bryophyte herbarium at CSIR-NBRI, Lucknow (LWG). Herbarium records of the years 1965, 1981 and 1983 have also been assessed to include the secondary data.

The specimens were collected using the random quadrate method and standard sampling size (10x10cm) was considered for evaluation. Uniform data was collected from different habitats. The preserved specimens were evaluated in the Laboratory and identification was done using binocular and trinocular microscopes. Habitat characteristics (Humidity, temperature, coarse loamy soil composition) were considered to draw inferences in relation to the bryophyte distribution and growth forms exhibited at this region.

Observations

The taxonomic assessment of the bryophytes at Ghoom revealed the occurrence of 47taxa of 37 genera under 26 families (Table-1). Families Pottiaceae, Bryaceae, Fissidentaceae, Aytoniaceae and Marchantiaceae are well represented here. Among Liverworts, family Marchantiaceae is the most well represented whereas among mosses family Pottiaceae is represented by maximum taxa (seven) followed by four taxa each of Bryaceae and Brachytheciaceae (Fig. 2).

Among the various habitats, most appropriate habitats for bryophytes seem to be the wet rocks and soil covered rocks having 16 taxa each as both these substrata have the much needed moisture to help bryophyte growth. Further, soil and tree bark also harboured 11 species. Least number of taxa were encountered on stony/ brick walls (nine) and dry rocks (six) [Fig. 3]. Amongst the growth forms exhibited by the bryophytes, mats were dominant forms followed by short turfs and wefts. Tall turfs and cushions were moderately present whereas pendent and fans were exhibited by only one species each (Table-1). *Fissidens bryoides*, *Lophocolea bidentata* and *Hyophila nymaniana* are the mosses that exhibited growth in two different forms which very well explains that for proper growth the bryophytes tend to favour different growth forms at various microhabitat conditions if the need arises (Table-1).

The bryophytes of Darjeeling hills in general and those present in the East Himalayan region are enormous reservoirs of diversity. Some taxa of bryophytes are distributed in other geographic zones of India as well, whereas some are confined to the Himalayas or eastern Himalayas only when considering distribution in India. Among the liverworts, *Asterella wallichiana*, *Marchantia paleacea*, *M. polymorpha*, *Targionia hypophylla* and among mosses, *Barbula indica*, *Fissidens bryoides*, *F. xiphoides*,

Table 1: Bryophytes at Ghoom (Darjeeling Hills)- Distribution and Growth Forms

S.No.	Name	Family	Habitat	Growth form	Distribution					
					WH	EH	GP	CI	SI	AN
1.	*Acrolejeunea infuscata* (Mitt). J. Wang bis & Gradst.	Lejeuneaceae	Epiphytic	Mats	+	+	−	−	−	+
2.	*Anoectangium aestivum* (Hedw.) Mitt.	Pottiaceae	On stony wall	Short turfs	+	+	−	−	+	−
3.	*Anoectangium stracheyanum* Mitt.	Pottiaceae	On stony wall	Short turfs	+	+	−	−	+	−
4.	*Anomobryum auratum* (Mitt.) A. Jaeger	Bryaceae	On soil	Pendent	+	+	−	−	+	−
5.	*Asterella mussuriensis* (Kashyap) Verd.	Aytoniaceae	Wet rocks	Mats	+	+	−	−	+	−
6.	*A. wallichiana* (Lehm.) Grolle	Aytoniaceae	On stony wall	Mats	+	+	+	+	+	−
7.	*Barbula indica* (Hooker) Spreng.	Pottiaceae	On stony wall	Tall turfs	+	+	+	+	+	−
8.	*Brachymenium bryoides* Hook. ex Schwägr.	Bryaceae	Wet rocks	Short turfs	+	+	−	+	+	−
9.	*Brachymenium capitulatum* (Mitt.) Kindb.	Bryaceae	Epiphytic	Short turfs	−	+	−	−	+	−
10.	*Brachythecium buchananii* (Hook.) A. Jaeger	Brachytheciaceae	Soil, Stony wall, Dry rocks	Wefts	+	+	−	−	+	−
11.	*Brachythecium plumosum* (Hedw.) B.S.G.	Brachytheciaceae	Soil covered rocks	Wefts	+	+	−	−	+	−
12.	*Bryoerythrophyllum yunnanense* (Herzog) P.C. Chen	Pottiaceae	On wet rocks	Tall trufs	+	+	−	−	−	−
13.	*Calypogeia azurea* Stotler & Crotz	Calypogeiaceae	Soil covered rocks, Wet rocks	Mats	+	+	−	+	+	−
14.	*Calypogeia lunata* Mitt.	Calypogeiaceae	On dry rocks	Cushions	+	+	−	+	+	−
15.	*Campylopus subgracilis* Renauld & Cardot ex Gangulee	Dicranaceae	Wet rocks	Short turfs	+	−	−	−	+	−
16.	*Cryptomitrium himalayense* Kashyap	Aytoniaceae	Wet rocks	Mats	+	+	−	−	+	−
17.	*Cyathodium tuberculatum* Udar& D.K. Singh	Cyathodiaceae	On dry rocks	Mats	−	+	−	−	+	−
18.	*Cyathophorella* sp.	Daltoniaceae	Epiphytic	Fans	−	+	−	−	−	−
19.	*Didymodon constrictus* (Mitt.) K. Saito	Pottiaceae	On dry rocks, Wet rocks, On soil covered rocks, Stony wall, soil	Short turfs	+	+	−	−	−	−
20.	*Dumortiera hirsuta* (Sw.) Nees	Dumortieriaceae	Soil covered rocks	Mats	+	+	−	+	+	−
21.	*Entodon concinnus* (De Not.) Paris	Entodontaceae	Soil	Wefts	−	+	−	−	−	−
22.	*Eurhynchium dumosum* (Mitt.) A. Jaeger	Brachytheciaceae	On soil covered rocks	Wefts	−	+	−	−	−	−
23.	*Fabronia secunda* Mont.	Fabroniaceae	Epiphytic	Weft	−	+	−	−	+	−
24.	*F. bryoides* Hedw.	Fissidentaceae	On dry rocks, Stony wall, soil covered rocks, Wet rocks, Soil, Epiphytic	Short turfs, Mats	+	+	+	−	+	−
25.	*F. xiphioides* M. Fleisch.	Fissidentaceae	On soil covered rocks	Short turfs	+	+	+	+	+	+
26.	*Frullania physantha* Mitt.	Frullaniaceae	Epiphytic	Mats	−	+	−	−	−	−
27.	*Frullania* sp.	Frullaniaceae	Epiphytic	Mats	−	+	−	−	−	−
28.	*Funaria hygrometrica* Hedw.	Funariaceae	On soil	Short turfs	+	+	+	+	+	−
29.	*Hyophila involuta* (Hooker) A. Jaeger	Pottiaceae	Wet rocks	Short turfs	+	+	+	+	+	+

S.No.	Name	Family	Habitat	Growth form	Distribution					
					WH	EH	GP	CI	SI	AN
30.	*Hyophila nymaniana* (M. Fleisch.) M. Menzel	Pottiaceae	Stony wall, On dry rocks, Dry rocks, Epiphytic	Tall turfs, Short turfs	+	+	+	+	+	−
31.	*Lophocolea bidentata* (L.) Dumort.	Lophocoleaceae	Wet rocks, soil covered rocks, Soil	Mats, Cushions	+	+	−	−	+	−
32.	*Lunularia cruciata* (L.) Dumort. ex Lindb	Lunulariaceae	On soil covered rocks	Mats	+	+	−	−	+	−
33.	*Marchantia hartlessiana* Stephani	Marchantiaceae	Wet rocks	Mats	−	+	−	−	−	−
34.	*Marchantia paleacea* Bertol.	Marchantiaceae	soil covered rocks	Mats	+	+	+	+	+	−
35.	*Marchantia polymorpha* L.	Marchantiaceae	Soil	Mats	+	+	+	+	+	−
36.	*Marchantia subgeminata* Stephani	Marchantiaceae	Wet rocks	mats	−	+	−	−	−	−
37.	*Microdus brasiliense* (Duby) Thér.	Dicranaceae	soil covered rocks	Short turfs	+	+	−	−	+	−
38.	*Pellia epiphylla* (L.) Corda	Pelliaceae	soil covered rocks, On wet rocks	Mats	+	+	−	−	+	−
39.	*Plagiochila parvifolia* Lindenb.	Plagiochilaceae	Epiphytic	Wefts	+	+	+	−	+	−
40.	*Plagiomnium rhynchophorum* (Harv.) T.J. Kop.	Mniaceae	Soil	Wefts	−	+	−	−	+	−
41.	*Pogonatum aloides* (Hedw.) P. Beauv.	Polytrichaceae	Wet rocks	Tall turfs	+	+	−	−	+	−
42.	*Pohlia minor* Schleich. Ex Schwägr.	Bryaceae	Soil	Short turfs	+	+	−	−	−	−
43.	*Rhynchostegium celebicum* (Sande Lac.) A. Jaeger	Brachytheciaceae	On soil covered rocks	Wefts	+	+	−	−	+	−
44.	*Solenostoma bengalensis* (Amakawa) Váňa & D.G. Long	Jungermanniaceae	Wet rocks	Cushions	−	+	−	−	−	−
45.	*Targionia hypophylla* L.	Targioniaceae	Stony walls	Mats	+	+	+	+	+	−
46.	*Trachypodopsis serrulata* (P. Beauv.) Zanten	Trachypodaceae	Epiphytic, Stony wall	Wefts	+	+	−	−	+	+
47.	*Trichocolea indica* Udar & D. K. Singh	Trichocoleaceae		Mats	−	+	−	−	−	−

(WH: Western Himalaya; EH: Eastern Himalaya; GP: Gangetic plains; CI: Central India; SI: South India; AN: Andaman & Nicobar)
(+ Present; - Absent)

Funaria hygrometrica and *Hyophila involuta* are distributed in all major bryogeographical regions of India. Moreover, some bryophytes restricted to East Himalayan region have also been identified, viz. *Entodon concinnus*, *Eurhynchium dumosum*, *Frullania physantha* and *Marchantia hartlessiana*. *Solenostoma bengalensis* and *Trichocolea indica* encountered here are east Himalayan endemics. The mosses and liverworts at Ghoom showed nearly equal representation with 25 mosses and 22 liverworts being listed herewith. However it is interesting to note that hornworts seemed missing from this site of collection, though they were present at nearby sites such as Senchal Wildlife Sanctuary and Tiger hill. This could possibly be due to habitat disturbances at this site owing to constant human interference.

Discussion

A total of 47 species belonging to 37 genera and 26 families have been recorded from Ghoom. There is ample moisture and elevation at Ghoom that facilitates the bryophyte luxuriance, but in spite of this adequate climate, the bryophyte diversity here is lesser in comparison to the other sites viz. Senchal Wildlife Sanctuary, Jalapahar and Tiger hill which are the other nearby sites of collection. The presence of lesser species at Ghoom can be attributed to higher level of pollution due to several factors like-

- Frequent movement of steam engine train causing flyash deposition over the upper surface of bryophyte mats growing over the nearby rocks and other habitats,
- Habitat loss due to constant Civil construction activity,
- Densely populated human colonization and anthropogenic movement at Ghoom.

Darjeeling hills seem to offer enormous Bryophyte diversity owing to the climatic advantage of the East Himalayan region and graded elevation from lower foothills to the highest peak of Tiger Hill. There are numerous sites of interest from where bryophytes have been collected during the present assessment. These include areas less frequented by humans like Teesta Valley, SWLS, Jalapahar, interiors of Kalimpong. On the other hand, there are sites that witness human activity but in a controlled

manner that helps to check unwanted habitat loss. Such sites include Zoological Garden, Lloyd botanical garden, area near Himalayan Mounteneering Institute (HMI), Lopchu village area and Lebong road. Tiger Hill, SWLS and Jalapahar are the most nearby collection sites to Ghoom with similar elevation, but former three sites were much diverse with more than 60 bryophytes. Also, the species and generic diversity was higher at these places as compared to Ghoom.

Conclusion

Ghoom area of Darjeeling is located at about 2200m altitude provides a favorable climate for the growth of Bryophyte vegetation. During the present study a rich growth of bryophytes has been observed here and 47 taxa have been identified and documented. These plants were found growing mostly on soil covered rocks and wet rocks forming mats. Among mosses, members of family Pottiaceae and among liverworts, members of family Marchantiaceae are well represented in the area. Since Ghoom area is a busy centre of Darjeeling Himalayan Railway with frequent tourist movement and high anthropogenic intervention including dense human colonization and Civil construction activities, it is causing a great habitat loss for plant diversity in general and Bryophytes in particular. During present study it has been found that diversity of bryophytes is comparatively lesser here than nearby SWLS, Jalapahar and Tiger hill localities which are least disturbed sites regarding anthropogenic intervention.

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