



Assessment of Diversity and Traditional Uses of Bryophytes Along Some Hill Roads in a Biodiversity Hot Spot Region of India-A Case Study of Mizoram

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Abstract: In India, the bryophytes are represented by 2562 taxa (1636 mosses, 887 liverworts and 39 hornworts). They usually inhabit narrow ecological niches with preference for damp and shady conditions. In Himalayas the bryophytes are rich in diversity and well represented due to prevailing of high rainfall and humidity. Eastern Himalayas are richest in bryophyte flora. Bryophytes are of great ecological importance, they are Pioneer of the land plants and the first plants to grow and colonize the barren rocks and lands. In India, the bryophytes are represented by 2562 taxa (1636 mosses, 887 liverworts and 39 hornworts). Along the Mizoram roads 76 species of bryophytes distributed over 29 families have been identified and recorded by the authors. These bryophytes provide vital ecosystem services like soil formation, habitat modification and nutrient cycling and are useful in pollution detection and monitoring. The flavonoids and terpenoids contained in majority of them show various biological activities with considerable potential of chemical and pharmaceutical properties. Road side village people in Mizoram generally use these bryophytes as medicines, vegetable and for prevention of soil erosion. It has been assessed that during road development these flora will be impacted and that will have impact on community settled along the road. Effort has been made in this paper to assess the diversity of bryophytes along the road corridors so that proper planning can be done during road development to save this natural resource.

Keywords: Amphibian, Flavonoids, Terpenoids, Anticancerous, Erosion

1. Introduction

Bryophytes, especially the terrestrial liverworts, are among the pioneers of land vegetation on earth and because of their small size have the ability to colonize nearly all conceivable habitats (micro-environments) in small “pockets” or “niches” which sometimes limit the distribution of certain taxa. They are accepted as the oldest living land plants with the exception of a few aquatic species as fossilized spores of early land plants from the mid-Ordovician (approximately 470 million years ago) have been interpreted as having been produced by early liverworts [1, 2]. Therefore, these plants are considered as an ancient group of plants positioned between Algae and Bryophytes. They normally have a boreal habitat and thrive in humid conditions. As water is

indispensable for the act of fertilization they are also known as Amphibians of the Plant Kingdom. In India, the bryophytes are represented by 2562 taxa (1636 mosses, 887 liverworts and 39 hornworts). They usually inhabit narrow ecological niches with preference for damp and shady conditions. In India, Bryophytes are quite abundant in both Nilgiri hills and Himalayas. Eastern Himalayas are the richest in bryophyte flora. The eastern Himalayas exhibited a more luxurious growth of bryophytes compared to the western Himalayas on account of much rainfall and more humidity in the atmosphere [3].

The bryophytes provide vital ecosystem services like soil formation, habitat modification and nutrient cycling and are useful in pollution detection and monitoring. The flavonoids and terpenoids contained in majority of them show various

biological activities with considerable potential of chemical and pharmaceutical properties [4]. The Bryophytes are not considered to be of much economic value because except a few Bryophytes none of these are of direct use to man. However, they play an important role in the economy of the nature. Bryophytes are also potential sources of new antibiotics and anti-cancerous substances [5]. The recent upsurge of interest in monitoring atmospheric pollution has revealed a new aspect of the relevance of this elegant group of plant kingdom. They have been more rationally used in pollution detection, environmental monitoring and as climatic indicator which can be helpful to management of a particular environment. They act as reservoirs of moisture which provide breeding places for insects, small animals and also excellent propagation beds for plant seeds. They offer microhabitats that are critical to the survival of a tremendous diversity of organisms such as single-celled eukaryotes, protozoa, and numerous groups of invertebrates [6]. These plants are also important as environmental and ecological indicators. In India, initial studies are being conducted to monitor trace element pollution using mosses as biomonitors [7]. Liverworts, in concert with mosses and hornworts, play a significant role in the global carbon budget and CO₂ exchange, plant succession, nutrient cycling, and water retention [8-11]. These groups of land plants also have been used as indicators of past climate change, to validate climate models, and as potential indicators of global warming [12, 13].

Mosses constitute the major component of Indian bryoflora with about 2000 species (including intraspecific categories) belonging to 342 genera and 54 families of these, ca. 1030 occur in Eastern Himalaya. Liverworts are represented by ca. 850 species under 140 genera and 52 families [14, 15]. The majority of them are damp loving, predominantly terrestrial and favour shaded conditions, whereas a number of taxa are epiphytic epiphyllous aquatic and xeromorphic. About 260 taxa or ca. 30% of the total liverwort flora are endemic to different regions of the country with maximum representation in Eastern Himalaya, which account for ca. 60% of the total endemic taxa in the country [16].

Along the Mizoram roads which are part of Eastern Himalaya, 76 species of bryophytes distributed over 29 families have been identified and recorded by the authors. 65 taxa of Bryophytes distributed under 50 genera and 36 families from Mamit district of Mizoram, of these, the mosses are represented by 37 species of 28 genera and 17 families, while Liverworts are represented by 26 species of 20 genera and 18 families. It has also been reported that 41 taxa of Bryophytes distributed under 34 genera and 23 families have been recorded. Of these, the mosses are represented by 23 species of 20 genera and 14 families, while Liverworts are represented by 15 species of 12 genera and 8 families.

Road side village people in Mizoram generally use these bryophytes as medicines, vegetable and for prevention of soil erosion. It has been assessed that during road development these flora will be impacted and that will have impact on community settled along the road. Effort has been made in

this paper to assess the diversity of bryophytes along the road corridors so that proper planning can be done during road development to save this natural resource. 127 species of Mosses under 71 genera belonging to 27 families has been reported from the Assam Valley Wet Evergreen forests, Assam, India [17].

2. Materials and Methods

2.1. Study Area

For listing of the Bryophytes along the roads, three major roads of Mizoram situated in four different locations were selected, namely - Aizawl- Lunglei road, Sheling-Champhai road, Thenzal-Serchip road and Lunglei –Tlabung road (Figure 1). All the roads were surveyed with team of experts for three consecutive years during the months of October to January (2016 to 2018). Data were collected within 200m (considering corridor of impact) of the roads by traversing on foot along all the Bryophyte habitats on both side of the roads (valley side and hill side). Vegetation water channels, ridges and various habitats within the corridor of impact (200m of the road) were also considered for the listing of the Bryophytes.

2.2. Collection of Specimen

The collected fresh materials were examined and fixed in 70 % alcohol as well as mosses were air dried, pressed and stored in suitable well labeled standard sized paper packets as per the internationally accepted herbarium methodology with proper field notes. All the specimens were collected in fertile stage and Mosses were processed through conventional herbarium [18]. They were identified by matching them with herbarium specimens of local universities and research institutions and also by expert team. The identification of taxa has been done in the laboratory by studying the specimens and consulting with various standard literatures.

2.3. Taxonomy

Identification has been done on basis of detailed morpho-taxonomic studies of the material under the Binoculars, Dissceting Microscope, Compound Microscope and Trinocular Microscope. The plants were identified using the different floras [19-22]. Other standard literature were also consulted for identification of the bryophyte flora [23-25]. However, the genera and species taxonomic citation is based on published literature and The Plant List.

Status of the listed Bryophytes in IUCN Red list along the roads under study has been assessed as per of the IUCN Red list 2017 version 3.1. Those not finding place in IUCN red list were assessed as per annual Catalogue of life checklist 2017.

The data on the uses of the Bryophytes were collected through questionnaire, interviews and discussions among local people in presence of the Village Council (VCP), local Vadhya and old men and women of local village community along the roads.

3. Results and Discussion

3.1. Diversity of Bryophytes Along Roads

For listing of the Bryophytes along the roads, four major roads of Mizoram situated in four different locations were selected, namely - Aizawl –Thenzal Lunglei road, Sheling-Champhai road, Thenzal-Serchip road and Lunglei-Tlabung-Kwarpuicchua road were selected for this study (Figure 1).

Total 76 Bryophytes were recorded in four roads distributed over 39 families. Four habitats for Bryophytes were identified along the roads. 72 bryophyte species were recorded from Aizawl –Thenzal Lunglei road, 64 species recorded from Sheling-Champhai road, 67 species were recorded from Thenzal-Serchip and 55 species were recorded from Lunglei-Tlabung-Kwarpuicchua road (Table 1 and Figure 2 & 3).

These habitats are-Terrestrial, growing on moist surface of road side hills (40- 53%), Terrestrial, growing on road side water logged area (submerged), Terrestrial, growing on road side tree bark surface (20-26 %), Terrestrial, growing on road side moist rocky surface (16-21%). Habitat wise distribution of bryophytes indicate that out of 76 species 40 species

(53%) found growing on moist surface of road side hills (40-53%), 20 species (26%) found growing on road side tree bark surface and 16 species (21%) growing on road side moist rocky surface.(Figure 4)

Bryophytes collected and identified along the roads are not listed in IUCN Red list Version 3.1 and Catalogue of life annual checklist 2018.

3.2. Use of Bryophytes by Local People in the Villages Along the Roads

Many tribal communities and rural populations who are living along the road are dependent upon such natural resources like Bryophytes distributed along the roads for treatment of various ailments and diseases and also as food and fodder supplement. Road side village people in Mizoram generally use these Bryophytes as medicines, vegetable and for prevention of soil erosion. During focus group discussions and consultations in villages along the roads under study reveal the fact that villagers could identify and could disclose the information on use of only 10 Bryophyte species which are of traditional use (table 2).

Table 1. Distribution of Bryophytes along the roads with their status in IUCN RED List and Catalogue of Life (COL).

Sl. No	Name of the Bryophyte species	Family	Habitat and Ecology	Status as per IUCN Red list Version 3.1 an Catalogue of life annual checklist 2017	Distribution of Bryophytes along the road	
					Aizawl – Thenzal Lunglei road	Seling-Champhai road
1	<i>Aneura pinguis</i> (L.) Dumort.	Aneuraceae	Terrestrial, growing on moist rocky surface of hills	Not listed	+	+
2	<i>Riccardia chamedryfolia</i> (With.) Grolle.	Aneuraceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
3	<i>Anthoceros formosae</i> Stephani.	Anthocerotaceae	Terrestrial, growing on road side moist surface of hills	Not listed	+	+
4	<i>Anthoceros erectus</i> Kashyap.	Anthocerotaceae	Terrestrial, growing on road side moist surface of hills	Not listed	+	-
5	<i>Phaeoceros laevis</i> (L.) Prosk.	Anthocerotaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
6	<i>Asterella khasiana</i> (Griff.) Grolle.	Aytoniaceae	Terrestrial, growing on road side moist surface of hills	Not listed	-	+
7	<i>Plagiochasma appendiculatum</i> Lehm. & Lindenb.	Aytoniaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	-
8	<i>Bartramia subpellucida</i> Mitt.	Bartramiaceae	Terrestrial, growing on road side moist surface of hills	Not listed	+	-
9	<i>Philonotis Fontana</i> (Hedwig) Bridel.	Bartramiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	-	+
10	<i>Eurhynchium riparioides</i> (Hedw.) P. W. Richards	Brachytheciaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	-
11	<i>Homalothecium sericeum</i> (Hedw.) Schimp.	Brachytheciaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
12	<i>Trematodon longicollis</i> Michx. Hal	Bruchiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
13	<i>Anomobryum filiforme</i> ssp. <i>concinatum</i> (Spruce.) Amann	Bryaceae	Terrestrial, growing on road side moist surface of hills.	Not listed	+	+
14	<i>Brachymerium sikkimense</i> Renaud & Cardot	Bryaceae	Terrestrial, growing on road side moist surface of hills	Not listed	+	+
15	<i>Bryum alpinum</i> Huds. ex. With.	Bryaceae	Terrestrial, growing on moist rocky surface of hills	Not listed	-	+
16	<i>Bryum apiculatum</i> Schwägr.	Bryaceae	Terrestrial, growing on road side moist surface of hills	Not listed	+	+

Sl. No	Name of the Bryophyte species	Family	Habitat and Ecology	Status as per IUCN Red list Version 3.1 an Catalogue of life annual checklist 2017	Distribution of Bryophytes along the road	
					Aizawl – Thenzal Lunglei road	Seling-Champhai road
17	<i>Bryum argenteum</i> Hedw.	Bryaceae	Terrestrial, growing on moist rocky surface of hills	Not listed	+	+
18	<i>Bryum coronatum</i> Schwägr.	Bryaceae	Terrestrial, growing on moist surface of hills	Not listed	+	+
19	<i>Rhodobryum giganteum</i> (Schwägr.) Paris.	Bryaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
20	<i>Calypogeia arguta</i> Nees & Mont. ex Nees	Calypogeiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
21	<i>Cephalozia connivens</i> (Dicks.) Lindb.	Cephaloziaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	–
22	<i>Cyathodium cavernarum</i> Kunze.	Cyathodiaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
23	<i>Cyathophorella tonkinensis</i> (Broth. & Paris) Broth.	Daltoniaceae	Terrestrial, growing on road side tree bark surface	Not listed	–	+
24	<i>Campylopus pilifer</i> Brid.	Dicranaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	–
25	<i>Campylopus introflexus</i> (Hedw.) Brid.	Dicranaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
26	<i>Dicranum flagellare</i> Hedw.	Dicranaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
27	<i>Leucobryum crispum</i> Müll. Hal	Dicranaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
28	<i>Leucobryum candidum</i> (Brid. ex P. Beauv.) Wilson	Dicranaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
29	<i>Dumortiera hirsuta</i> (Sw.) Nees).	Dumortieraceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
30	<i>Erpodium mangiferae</i> C. Muell.	Erpodiaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
31	<i>Fissidens polypodioides</i> Hedw.	Fissidentaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
32	<i>Fissidens nobilis</i> Griff.	Fissidentaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
33	<i>Frullania acutiloba</i> Mitt.	Frullaniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
34	<i>Frullania tamarisci</i> (L.) Dumort.	Frullaniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
35	<i>Frullania ericoides</i> (Nees) Mont.	Frullaniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
36	<i>Frullania neurota</i> Taylor	Frullaniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
37	<i>Frullania retusa</i> Mitt.	Frullaniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
38	<i>Frullania Raddi</i>	Frullaniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
39	<i>Frullania mizoramensis</i> Sushil K. Singh & Barbhuiya, sp. nov	Frullaniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
40	<i>Frullania evelynae</i> S. Hatt. & Thaith. var. <i>devendrae</i> Sushil K. Singh & Barbhuiya var. nov	Frullaniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
41	<i>Funaria hygrometrica</i> Hedw.	Funariaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
42	<i>Physcomitrium sphaericum</i> (C. F. Ludw.) Fűrnr.	Funariaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
43	<i>Physcomitrium pyriforme</i> (Hedwig) Hampe, Linnaea.	Funariaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
44	<i>Jungermania infusca</i> (Mitt.) Stephani	Jungermanniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
45	<i>Taxiphyllum barbieri</i> (Cardot & Copp.) Z. Iwats.	Hypnaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
46	<i>Lejeunea flava</i> (Sw.) Nees Lejeuneaceae	Lejeuneaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+

Sl. No	Name of the Bryophyte species	Family	Habitat and Ecology	Status as per IUCN Red list Version 3.1 an Catalogue of life annual checklist 2017	Distribution of Bryophytes along the road	
					Aizawl – Thenzal Lunglei road	Seling-Champhai road
47	<i>Ptychanthus striatus</i> (Lehm. et Lindenb.) Nee.	Lejeuneaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
48	<i>Marchantia paleacea</i> Bertol.	Marchantiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
49	<i>Marchantia subintegra</i> Mitt.	Marchantiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
50	<i>Marchantia emarginata</i> Reinw., Blume & Nees.	Marchantiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
51	<i>Dumortiera hirsuta</i> (Sw.) Nees	Marchantiaceae	Terrestrial, growing on moist rocky surface of hills	Not listed	+	+
52	<i>Papillaria leuconeura</i> (Müll. Hal.) A. Jaeger	Meteoriaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
53	<i>Meteoriopsis reclinata</i> (Müll. Hal.) M. Fleisch.	Meteorioceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
54	<i>Meteoriopsis squarrosa</i> (Hook. ex Harv.) M. Fleisch.	Meteorioceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
55	<i>Metzgeria conjugata</i> Lindb.	Metzgeriaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
56	<i>Plagiomnium ellipticum</i> (Brid.) T. Kop.	Mniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
57	<i>Neckeropsis undulata</i> (Hedw.) Reichardt	Neckeraceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
58	<i>Octoblepharum albidum</i> Hedw.	Octoblepharaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
59	<i>Pallavicinia lyellii</i> (Hook.) Gray.	Pallaviciniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
60	<i>Pellia epiphylla</i> (L.) Corda	Pelliaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
61	<i>Plagiochila spinulosa</i> (Dicks.) Dumort.	Plagiochilaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
62	<i>Atrichum undulatum</i> (Hedw.) P. Beauv.	Polytrichaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
63	<i>Hyophila involuta</i> (Hook.) A. Jaeger	Pottiaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
64	<i>Pogonatum aloides</i> (Hedw.) P. Beauv.	Polytrichaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
65	<i>Pogonatum contortum</i> (Menzies ex Brid.) Lesq.	Polytrichaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
66	<i>Porella campylophylla</i> (Lehm. & Lindenb.) Trevis.	Porellaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
67	<i>Barbula convoluta</i> Hedw.	Pottiaceae	Terrestrial, growing on moist rocky surface of hills	Not listed	+	+
68	<i>Racopilum cuspidigerum</i> (Schwägr.) Ångström.	Racopilaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
69	<i>Radula complanata</i> (L.) Dumort. Tree bark	Radulaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
70	<i>Riccia discolour</i> Lehm. & Lindenb.	Ricciaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
71	<i>Riccia glauca</i> L. Soil	Ricciaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
72	<i>Riccia fluitans</i> L. Ricciaceae	Ricciaceae	Terrestrial, growing on road side water logged area (submerged)	Not listed	+	+
73	<i>Stereophyllum anceps</i> (Bosch & Sande Lac.) Broth.	Stereophyllaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
74	<i>Targionia hypophylla</i> L.	Targioniaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	-
75	<i>Thuidium cymbifolium</i> (Dozy & Molk.) Dozy & Molk.	Thuidiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
76	<i>Thuidium delicatulum</i> (Hedw.) Schimp.	Thuidiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+

Table 1. Continued.

Sl. No	Name of the Bryophyte species	Family	Habitat and Ecology	Status as per IUCN Red list Version 3.1 an Catalogue of life annual checklist 2017	Distribution of Bryophytes along the road	
					Thenzal-Serchip road	Lunglei-Tlabung-Kwarpuicchua road
1	<i>Aneura pinguis</i> (L.) Dumort.	Aneuraceae	Terrestrial, growing on moist rocky surface of hills	Not listed	-	+
2	<i>Riccardia chamedryfolia</i> (With.) Grolle.	Aneuraceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
3	<i>Anthoceros formosae</i> Stephani.	Anthocerotaceae	Terrestrial, growing on road side moist surface of hills	Not listed	+	+
4	<i>Anthoceros erectus</i> Kashyap.	Anthocerotaceae	Terrestrial, growing on road side moist surface of hills	Not listed	+	+
5	<i>Phaeoceros laevis</i> (L.) Prosk.	Anthocerotaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
6	<i>Asterella khasiana</i> (Griff.) Grolle.	Aytoniaceae	Terrestrial, growing on road side moist surface of hills	Not listed	+	+
7	<i>Plagiochasma appendiculatum</i> Lehm. & Lindenb.	Aytoniaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
8	<i>Bartramia subpellucida</i> Mitt.	Bartramiaceae	Terrestrial, growing on road side moist surface of hills	Not listed	+	+
9	<i>Philonotis Fontana</i> (Hedwig) Bridel.	Bartramiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
10	<i>Eurhynchium riparioides</i> (Hedw.) P. W. Richards	Brachytheciaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
11	<i>Homalothecium sericeum</i> (Hedw.) Schimp.	Brachytheciaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
12	<i>Trematodon longicollis</i> Michx. Hal	Bruchiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
13	<i>Anomobryum filiforme ssp. concinnum</i> (Spruc.) Amann	Bryaceae	Terrestrial, growing on road side moist surface of hills.	Not listed	+	+
14	<i>Brachymerium sikkimense</i> Renaud & Cardot	Bryaceae	Terrestrial, growing on road side moist surface of hills	Not listed	-	+
15	<i>Bryum alpinum</i> Huds. ex. With.	Bryaceae	Terrestrial, growing on moist rocky surface of hills	Not listed	+	+
16	<i>Bryum apiculatum</i> Schwägr.	Bryaceae	Terrestrial, growing on road side moist surface of hills	Not listed	-	+
17	<i>Bryum argenteum</i> Hedw.	Bryaceae	Terrestrial, growing on moist rocky surface of hills	Not listed	+	+
18	<i>Bryum coronatum</i> Schwägr.	Bryaceae	Terrestrial, growing on moist surface of hills	Not listed	+	+
19	<i>Rhodobryum giganteum</i> (Schwägr.) Paris.	Bryaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
20	<i>Calypogeia arguta</i> Nees & Mont. ex Nees	Calypogeiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
21	<i>Cephalozia connivens</i> (Dicks.) Lindb.	Cephaloziaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
22	<i>Cyathodium cavernarum</i> Kunze.	Cyathodiaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
23	<i>Cyathophorella tonkinensis</i> (Broth. & Paris) Broth.	Daltoniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
24	<i>Campylopus pilifer</i> Brid.	Dicranaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
25	<i>Campylopus introflexus</i> (Hedw.) Brid.	Dicranaceae	Terrestrial, growing on moist surface of road side hills	Not listed	-	+
26	<i>Dicranum flagellare</i> Hedw.	Dicranaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
27	<i>Leucobryum crispum</i> Müll. Hal	Dicranaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
28	<i>Leucobryum candidum</i> (Brid. ex P. Beauv.) Wilson	Dicranaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
29	<i>Dumortiera hirsuta</i> (Sw.) Nees).	Dumortieraceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
30	<i>Erpodium mangiferae</i> C. Muell.	Erpodiaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	-
31	<i>Fissidens polyodioides</i>	Fissidentaceae	Terrestrial, growing on moist	Not listed	+	+

Sl. No	Name of the Bryophyte species	Family	Habitat and Ecology	Status as per IUCN Red list Version 3.1 an Catalogue of life annual checklist 2017	Distribution of Bryophytes along the road	
					Thenzal-Serchip road	Lunglei-Tlabung-Kwarpuicchua road
	Hedw.		surface of road side hills			
32	<i>Fissidens nobilis</i> Griff.	Fissidentaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	-
33	<i>Frullania acutiloba</i> Mitt.	Frullaniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
34	<i>Frullania tamarisci</i> (L.) Dumort.	Frullaniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	-
35	<i>Frullania ericoides</i> (Nees) Mont.	Frullaniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	-
36	<i>Frullania neurota</i> Taylor	Frullaniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	-
37	<i>Frullania retusa</i> Mitt.	Frullaniaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
38	<i>Frullania Raddi</i>	Frullaniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
39	<i>Frullania mizoramensis</i> Sushil K. Singh & Barbhuiya, <i>sp. nov</i>	Frullaniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
40	<i>Frullania evelynae</i> S. Hatt. & Thait. var. <i>devendrae</i> Sushil K. Singh & Barbhuiya var. <i>nov</i>	Frullaniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
41	<i>Funaria hygrometrica</i> Hedw.	Funariaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
42	<i>Physcomitrium sphaericum</i> (C. F. Ludw.) Fümrr.	Funariaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
43	<i>Physcomitrium pyriforme</i> (Hedwig) Hampe, Linnaea.	Funariaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
44	<i>Jungermania infusca</i> (Mitt.) Stephani	Jungermanniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
45	<i>Taxiphyllum barbieri</i> (Cardot & Copp.) Z. Iwats.	Hypnaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
46	<i>Lejeunea flava</i> (Sw.) Nees	Lejeuneaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
47	<i>Ptychanthus striatus</i> (Lehm. et Lindenb.) Nee.	Lejeuneaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	-
48	<i>Marchantia paleacea</i> Bertol.	Marchantiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
49	<i>Marchantia subintegra</i> Mitt.	Marchantiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
50	<i>Marchantia emarginata</i> Reinw., Blume & Nees.	Marchantiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
51	<i>Dumortiera hirsuta</i> (Sw.) Nees	Marchantiaceae	Terrestrial, growing on moist rocky surface of hills	Not listed	+	+
52	<i>Papillaria leuconeura</i> (Müll. Hal.) A. Jaeger	Meteoriaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
53	<i>Meteoriopsis reclinata</i> (Müll. Hal.) M. Fleisch.	Meteoriaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	-
54	<i>Meteoriopsis squarrosa</i> (Hook. ex Harv.) M. Fleisch.	Meteoriaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
55	<i>Metzgeria conjugata</i> Lindb.	Metzgeriaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	-
56	<i>Plagiomnium ellipticum</i> (Brid.) T. Kop.	Mniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
57	<i>Neckeropsis undulata</i> (Hedw.) Reichardt	Neckeraceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
58	<i>Octoblepharum albidum</i> Hedw.	Octoblepharaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
59	<i>Pallavicinia lyellii</i> (Hook.) Gray.	Pallaviciniaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
60	<i>Pellia epiphylla</i> (L.) Corda	Pelliaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+

Sl. No	Name of the Bryophyte species	Family	Habitat and Ecology	Status as per IUCN Red list Version 3.1 an Catalogue of life annual checklist 2017	Distribution of Bryophytes along the road	
					Thenzal-Serchip road	Lunglei-Tlabung-Kwarpuicchua road
61	<i>Plagiochila spinulosa</i> (Dicks.) Dumort.	Plagiochilaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	-
62	<i>Atrichum undulatum</i> (Hedw.) P. Beauv.	Polytrichaceae	Terrestrial, growing on moist surface of road side hills	Not listed	-	+
63	<i>Hyophila involuta</i> (Hook.) A. Jaeger	Pottiaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	-
64	<i>Pogonatum aloides</i> (Hedw.) P. Beauv.	Polytrichaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
65	<i>Pogonatum contortum</i> (Menzies ex Brid.) Lesq.	Polytrichaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	-
66	<i>Porella campylophylla</i> (Lehm. & Lindenb.) Trevis.	Porellaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
67	<i>Barbula convoluta</i> Hedw.	Pottiaceae	Terrestrial, growing on moist rocky surface of hills	Not listed	-	+
68	<i>Racopilum cuspidigerum</i> (Schwägr.) Ångström.	Racopilaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	+
69	<i>Radula complanata</i> (L.) Dumort. Tree bark	Radulaceae	Terrestrial, growing on road side tree bark surface	Not listed	+	-
70	<i>Riccia discolour</i> Lehm. & Lindenb.	Ricciaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
71	<i>Riccia glauca</i> L. Soil	Ricciaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+
72	<i>Riccia fluitans</i> L. Ricciaceae	Ricciaceae	Terrestrial, growing on road side water logged area (submerged)	Not listed	+	-
73	<i>Stereophyllum anceps</i> (Bosch & Sande Lac.) Broth.	Stereophyllaceae	Terrestrial, growing on moist surface of road side hills	Not listed	-	+
74	<i>Targionia hypophylla</i> L.	Targioniaceae	Terrestrial, growing on moist rocky surface of road side hills	Not listed	+	+
75	<i>Thuidium cymbifolium</i> (Dozy & Molk.) Dozy & Molk.	Thuidiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	-	+
76	<i>Thuidium delicatulum</i> (Hedw.) Schimp.	Thuidiaceae	Terrestrial, growing on moist surface of road side hills	Not listed	+	+

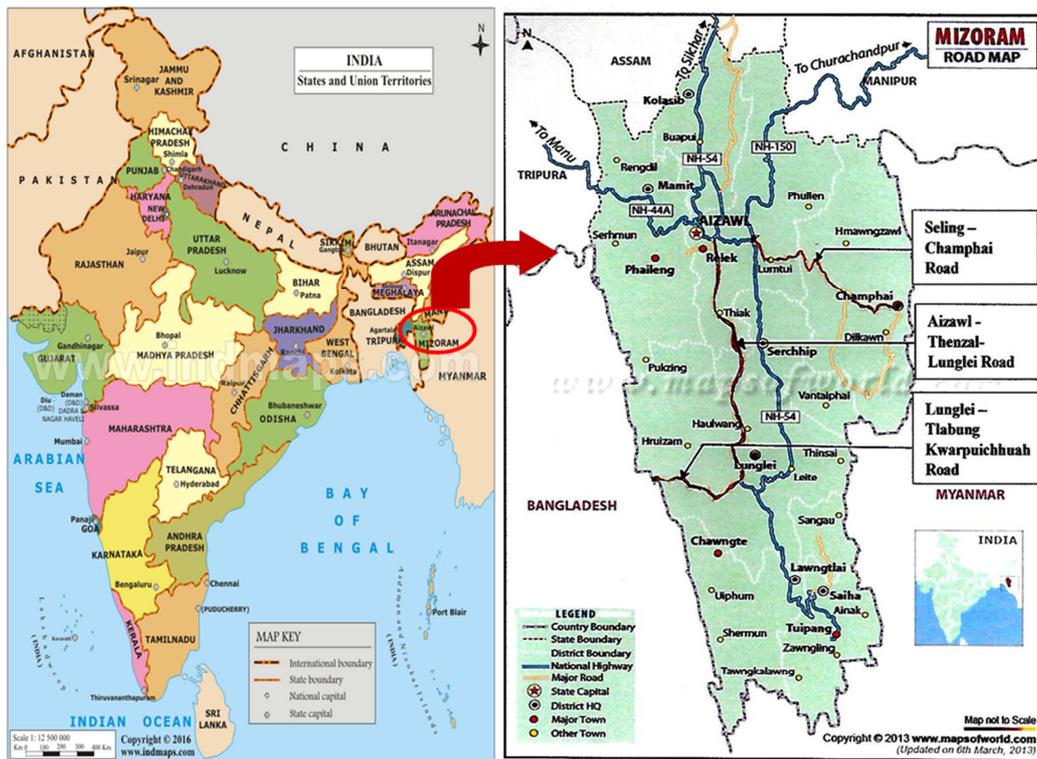


Figure 1. Roads considered for study.

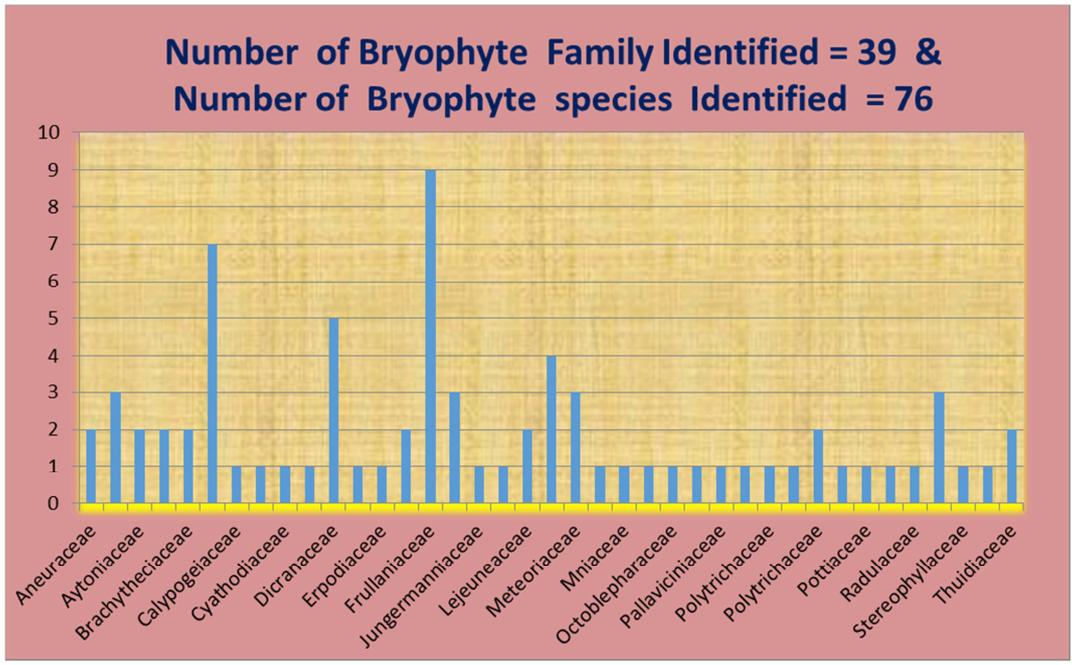


Figure 2. Distribution of Bryophytes along some roads in Mizoram.

Table 2. Traditional use of Bryophytes identified along hill roads.

Name of the Bryophyte species	Use by local people
Marchantia spp	Treatment of Pulmonary tuberculosis and affliction of liver
Sphagnum (Decoction)	Acute hemorrhage and diseases of eye
Polytrichum commune	Stone of kidney and gall bladder
Sphagnum leaves and extracts of Conocephalum conicum, Dumortiera, Sphagnum protoricense, Sphagnum strictum	As Antiseptic for healing of wounds
Sphagnum	Bog succession. Use for protection of banks of lakes or shallow bodies of water into solid soil which supports vegetation
Sphagnum	Sphagnum peat is used as fuel, improvement of the soil texture and in surgical dressings
Mosses	Used as food for chicks & birds
Mosses	For prevention of soil erosion. They usually grow densely and hence act as soil binders.
Mosses	Mosses grow in dense strands forming mat or carpet like structure.
Mosses	Land reclamation., in nurseries beds are covered with thalli of Bryophytes
Dried mosses and other Bryophytes	As packaging material for export of flowers

4. Conclusion

Bryophytes constitute an important element of diverse vegetation complex which play an important role in terrestrial ecosystems such as modification of habitat, nutrient cycling and the maintenance of nutrient status of the soil, primary production etc. Bryophytes are also potential sources of new antibiotics and anti-cancerous substances. The recent upsurge of interest in monitoring atmospheric pollution has revealed a new aspect of the relevance of this elegant group of plant kingdom. They have been more rationally used in pollution detection, environmental monitoring and as climatic indicator which can be helpful to management of a particular environment.

Due to rapid road development and pressures inflicted by growth of human population and their intense activities influencing the biodiversity of the Bryophytes. If their habitat (s) once disturbed they will certainly be dwindled in their both diversity and abundance. The changes in the

microhabitat of bryophytes may seriously affect the species composition very rapidly and thus upset the ecological balance. The conservation of bryophyte is very important in view of their critical role in ecosystem dynamics.

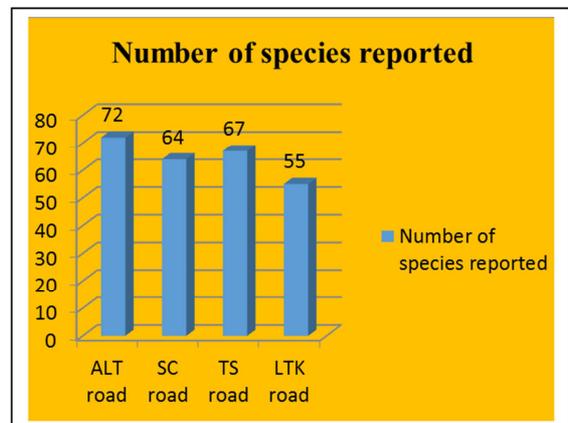


Figure 3. Species wise distribution of Bryophytes along the roads.

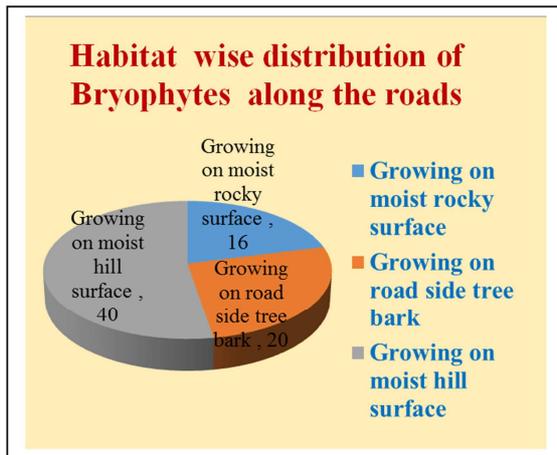


Figure 4. Habitat wise distribution of Bryophytes along the roads.

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References

- [1] Renzaglia, Karen & Schuette, Scott & Duff, Robert & Ligrone, Roberto & Shaw, Arthur & D. Mishler, Brent & Duckett, Jeffrey. (2009). Bryophyte phylogeny: Advancing the molecular and morphological frontiers. *The Bryologist*. 110. 179-213.
- [2] Rubinstein CV, Gerrienne P, Puente G. S. de la, . Astini R. A, Steemans P. (2010). Early Middle Ordovician evidence for land plants in Argentina (eastern Gondwana). *New Phytologist* (2010) 188: 365–369.
- [3] Srivastava, S. C 1998. Distribution of Hepaticae and Anthocerotae in India. In: R. N. Chopra (ed.) *Topics in Bryology*. Allied Publishers Limited, New Delhi.
- [4] Bryophytes in India - list of families and genera of bryophytes in India. ENVIS Centre on Floral Diversity, Botanical Survey of India in 2016.
- [5] Chopra R N and Vashistha B D (1994). Bryophyte Morphogenetic Study, In: *Botany of India (History and Progress)*, I edited by Johri BM (Oxford IBH Publishing Co. Pvt. Ltd., New Delhi) 437-453.
- [6] Gerson U. (1982), Bryophytes and Invertebrates. In: Smith A. J. E. (eds) *Bryophyte Ecology*. Springer, Dordrecht.
- [7] Chakraborty, S. and Paratkar, G. T. (2006). Biomonitoring of Trace Element Air Pollution Using Mosses, *Aerosol and Air Quality Research*, Vol. 6, No. 3, pp. 247-258, 2006.
- [8] H. DeLucia, Evan & Turnbull, Matthew & S. Walcroft, Adrian & Griffin, Kevin & Tissue, David & Glenny, David & M. McSeveny, Tony & Whitehead, David. (2003). The contribution of bryophytes to the carbon exchange for a temperate rainforest, *Global Change Biology* 9 (8): 1158-1170.
- [9] Konrat, Matt & Shaw, Arthur & Renzaglia, Karen. (2014). A special issue of *Phytotaxa* dedicated to Bryophytes: The closest living relatives of early land plants. *Phytotaxa*. 9: 5 - 10.
- [10] H. Brown, Dennis & W. Bates, Jeffrey. (2008). Bryophytes and nutrient cycling. *Botanical Journal of the Linnean society*. 104. 129-147.
- [11] Song L, Zhang YJ, Chen X, Li S, Lu HZ, Wu CS, Tan ZH, Liu WY, Shi XM.(2015) Water relations and gas exchange of fan bryophytes and their adaptations to microhabitats in an Asian subtropical montane cloud forest. *J Plant Res*. 2015 Jul; 128 (4): 573-84.
- [12] Dennis Gignac, L. (2009). Bryophytes as Indicators of Climate Change. *The Bryologist*. 104. 410-420.
- [13] Christopher Ellis (2015), Implication of climate change for UK bryophytes and lichens, *Biodiversity Climate change impacts reports card technical paper*, Royal Botanic Garden Edinburgh.
- [14] Vohra, J. N. And M. N. Aziz. 1997. Mosses. In: Mudgal, V. & R. K. Hajra (Ed.), *Floristic Diversity and Conservation Strategies in India 1*: 301-374. BSI, Kolkata.
- [15] Singh AP., Nath V. Hepaticae of Khasi and Jaintia Hills: Esatern Himalayas. Bishen Singh Mahendra Pal Singh, Dehradun, India, (2007).
- [16] Lalhriatpuia and Ramachandra Laha (2015), Bryophyte Diversity In Mamit District, Mizoram, Northeast India, *Int J Pharm Bio Sci* 2015 Oct; 6 (4): (B) 1204-1209.
- [17] Jayanta Barukial (2011) A study of moss diversity in Assam Valley wet evergreen forests. *Indian Journal of Fundamental and Applied Life Sciences* ISSN: 2231-6345 (Online) Vol. 1 (4): 1-8.
- [18] Sudhanshu Kumar Jain, R. Raghavendra Rao, *A Handbook of Field and Herbarium Methods*, Today & Tomorrow's Printers and Publishers, 1977.
- [19] Gangulee, H. C. 1969-1980. Mosses of Eastern India and adjacent regions. Fasc. 1-8. 1-2142. Calcutta.
- [20] Bir, S. S. & Chopra, R. N. (1972): Thallose Liverworts From Dalhousie, North Western Himalayas. *The Bryologist* 75: 371-372.
- [21] Bansal P and Nath V, *Bryum Bessonii* Ren. & Card. New To Eastern Himalaya In *New National and Regional Bryophyte Records* 32. *J. Bryol.* 34: 231–246 (2012b).
- [22] Bapna, K. R. & Kachroo, P. (2000): *Hepaticology In India II*. Himanshu Publication, Delhi.
- [23] Srivastava, A. & Srivastava, S. C. (2002): Indian Geocalycaceae (Hepaticae) - a taxonomic study. Bishen Singh Mahendra Pal Singh, Dehradun.
- [24] Singh, A. P., Nath, V. and Asthana, A. K. 2002. Studies on *Iieteroscyphus perfoliatus* (Mont.) Schiffii. from Meghalaya (India). *J. Indian Bot. Soc.* 81: 305-307.
- [25] *Plant Discoveries 2016-New Genera, Species and New Records* compiled and edited by Paramjit Singh and S. S. Dash, published by Botanical Survey of India in 2017.