

BRYODIVERSITY OF DISTRICT BUDGAM (JAMMU AND KASHMIR)

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ABSTRACT: Worldwide diversity of bryophytes is 18,500 species in nearly 1,050 genera. It is a matter of great concern that 102 species of bryophyta are listed in the IUCN world red list of 2014. In view of the threatening situation the study of the bryophytic flora of the unexplored area District Budgam (J&K) assumes greater importance. The present survey of the unexplored area till date has revealed the occurrence of 73 bryophyte species in various habitats. These species fall in 32 genera in 10 orders and 18 families. The present study provides a working base to an Ecologist, Cytologist, Chemist, Physiologist and Pharmacist to evaluate potential of these tiny plants in their relevant field of study.

Key Words: Bryophytes, Ethno-medicinal, Budgam, IUCN

INTRODUCTON

Bryophytes are treated as Subkingdom Bryobiotina and divided into three phyla namely, Bryophyta, Marchantiophyta and Anthocerotophyta (Crum, 2001; Shaw and Renzaglia, 2004; and Zander, 2006). The sporophyte is rootless, leafless, permanently attached with gametophyte and dependent on it for nutrition. Gametophyte a dominant generation is attached to surface by thread like structures called rhizoids. They have different habitat preferences e.g. terricolous, saxicolous, corticolous, lignicolous, aquatic, epiphyllous and coprophilous. Their survival in today's flora is due to their unique morphological, physiological and also phytochemical features. Worldwide diversity of bryophytes is 18,500 species in nearly 1,050 genera (Oren *et al.*, 2007). 2489 taxa of bryophytes are recorded from India. Of these 1786 (in 355 genera), 675 (in 121genera) and 25 (in 6 genera) species are of mosses, liverworts and hornworts respectively (Dandotiya *et al.*, 2011). It is a matter of great concern that 102 species of bryophyta are listed in the IUCN world red list of 2014. In view of the threatening situation the study of the bryophytic flora of the unexplored area District Budgam (J&K) assumes greater importance. The present survey of the unexplored area till date has revealed the occurrence of 73 bryophyte species in various habitats. These species fall in 32 genera in 10 orders and 18 families. A perusal of literature reveals that Eastern Himalaya has richer biodiversity than Western Himalaya.

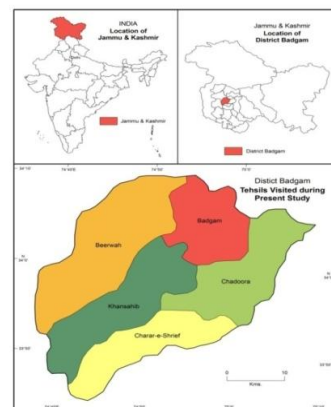
MATERIALS AND METHODS

The materials were collected from different regions of district Budgam (J&K). The field data were

recorded on the spot. The collected mosses in polythene bags were air-dried and then kept in paper bags. Liverworts were fixed in FAA. Detailed morphological and structural organization of the collected taxa was carried out. Dichotomous keys were devised, on the basis of constant characters to enable identification of various taxa. The systematic arrangement of the genera and families of mosses is after Buck and Goffinet (2000) and Goffinet and Buck (2004) and the systematic arrangement of the genera and families of liverworts is after the sequence of Crandall-Stotler *et al.* (2009).

STUDY AREA

In the present study, previously unexplored chosen areas of the district Budgam (Figure 1), in state Jammu and Kashmir were investigated to assess diversity of bryophytes.



Jammu and Kashmir is in the North most of our country, bordered by the international borders of Afghanistan, China and Pakistan. Jammu and Kashmir has three territories, Jammu, Kashmir and Ladakh and Gilgit. The state lies between 32° 44' N latitude and 74°54' E longitude. District

Budgam is situated between 33° 15' and 34° 30' N latitude and 74° and 75° 13'E longitude. It is bounded on South by the Pir Panjal range and on the North by the main or central Himalayan ranges. It has an area of 1291 sq. kms. Baramulla and Srinagar districts are present in North of the district. District Pulwama is present in South and Poonch border occurs in South West. PirPanjal and Karewas as foothills, extending from South-West to North-East separate it from the Chenab

valley and the Jammu region (Najar and Khan, 2011; Lone and Romshoo, 2011). Three types of soil viz., loamy soil, karewa soil and poorly developed mountain soil are present in the district (Raza *et al.*,1978).Climate is of temperate type. There is a heavy snowfall in winters. The average rainfall in the area is 669.1 mm (Rashid *et al.*, 2011). The mean annual temperature is 20.2°C. (Najar and Khan, 2011).

RESULTS AND DISCUSSION

A total number of 73 bryophyte plant species have been recorded from the unexplored study area. These plant species have 32 genera that fall into 10 orders and 18 families (Figure 2).

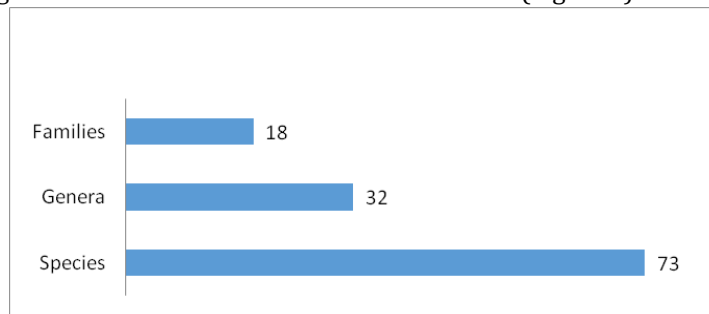


Figure 2: Distribution of bryophytes into families, genera and species.

They were collected from streams, springs, soil, trees, rocks, hills, house walls etc. Most of the plant species were found on the bank of streams, which were mainly growing there to replenish their nutrient requirement that were absorbed by their leaves. A brief information concerning bryophytes collected from the area is summarized in Table 1. A perusal of the table indicates name of the taxon, locality, substratum, herbarium reference number (PAN) and plate number.

A perusal of the bar diagrams, based on the data embodied in the preceding pages of this study, clearly reflects the preponderance of mosses as compared to liverworts in the area of the present study (Figure 3).

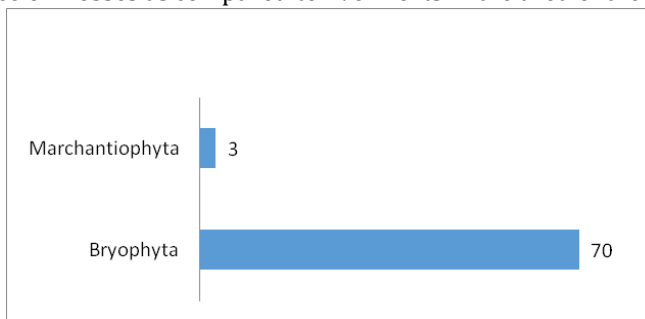


Figure 3: Distribution of mosses and liverworts in study area.

This wide discrepancy in the occurrence/distribution of the two major groups of bryophytes seems to be related to the difference in the inherent potential of tolerance/ adaptation to environmental conditions prevailing in the area. The endohydric and actively ectohydric habit of mosses is another contributory factor for their relatively successful colonization as compared to liverworts which lack endohydric absorption and also have relatively lesser and slower ectohydric property of water absorption. It seems likely that the difference in the ectohydric absorption in the two groups may be due to the difference in the nature of their cell wall materials. The wall materials may be more of hydrophilic colloids in mosses as compared to those of liverworts.

Unfortunately, limited study or lack of it does not permit the writer to draw any final conclusion about this relationship. Nevertheless, it appears desirable to undertake studies on the nature of the wall material in the two groups so as to test the validity/invalidity of the present suggestion.

Presently, this study however, does suggest that the explored area does not provide hospitable conditions for the larger colonization of liverworts.

As evident from the bar diagram (Figure 4), the acrocarpic mosses (44 species) outnumber the pleurocarpic taxa (26 species).

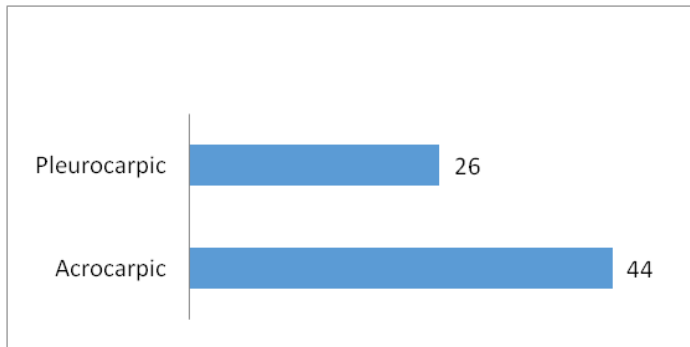


Figure 4: Distribution of acrocarpic and pleurocarpic mosses in study area.

This finding is compatible with the fact that factors governing distribution of mosses, in general, are the same for the large group, yet there is significant variation also within the group. This variation is caused by the largely epiphytic habit of the members of the pleurocarpic group which are exposed to more challenging conditions of water availability and drying action of winds. These factors adversely influence the survival of the pleurocarps which have adversely influence the survival of the pleurocarps in the under study area. It would be of further interest to note that majority of the pleurocarps found in the area are on wet shaped rocks or the base of tree trunks in association with some acrocarpic mosses along with some other ground vegetation.

Among the acrocarpic mosses, the families Bryaceae (represented by 13 species) and Pottiaceae (represented by 19 species) are more commonly distributed in this area (Figure 5, 6).

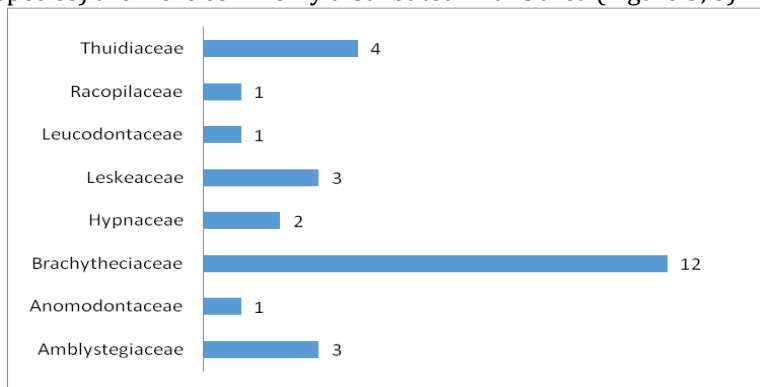


Figure 5: Distribution of families of pleurocarpic mosses in study area.

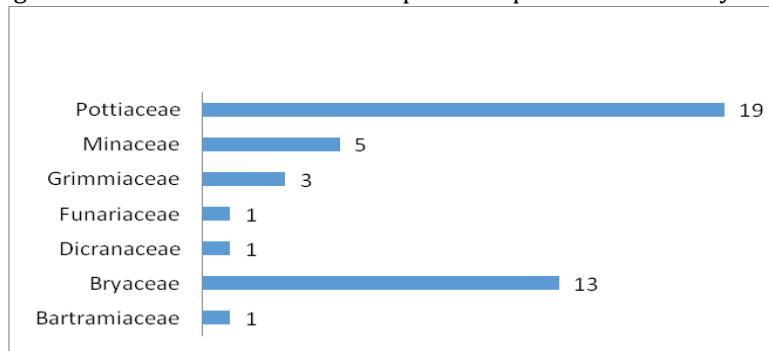


Figure 6: Distribution of families of acrocarpic mosses in study area.

The members of the former family are restricted to moist and shady situations, while the members of the latter family are adapted to exposed situations. This difference in the distribution pattern under contrasting situations seems to be linked with their distinctive morphological and structural organization of stem and

leaves. The short and thickened leaf cells increase the surface area for water absorption and increased photosynthetic activity, the dense papillae in the cells check loss of water and provide protection from high insolation, the densely clothed stems, hair pointed leaves help in water conservation. All these features, singly or in combination found in the Pottiaceae and Grimmaceae, confer adaptive advantage to those families for colonization in exposed habitats. On the other hand, the larger leaves, sparsely clothed stems, the larger leaf cells, smooth areolations, the thin walled epidermis and cortex in the stem, the features that are found in the members of the family Bryaceae, favour/ restrict colonization in shady, moist and damp habitats.

It seems that the families, Pottiaceae and Grimmaceae, both haplolepideous, have evolved ecologically to exploit diverse habitats. The family Bryaceae, a diplolepideous taxon, appears to have lagged behind in evolving different adaptive features that are necessary for colonizing in diverse habitats, and hence are restricted to bryologically hygrophytic and, at best, bryologically mesophytic situations. Interestingly, some species like *Funaria hygrometrica* are acidophilic and *Cratoneuron commutatum* is calcicole, their wide range of distribution shows their broad spectrum of adaptation of these taxa.

TABLE 1

Name of the Taxon	Locality	Substratum	Herbarium reference number (PAN)	Plate No
ORDER: FUNARIALES				
FAMILY: FUNARIACEAE				
<i>Funaria hygrometrica</i> Hedw.	Budgam: Chadoora	Moist and sandy soil; Jun 2012	6121	1
ORDER: GRIMMALES				
FAMILY: GRIMMIACEAE				
<i>Schistidium apocarpum</i> Hedw. B.S.G.	Budgam: Khansahib, Beerwa	Attached to Rock; Feb. 2014	6122	2
<i>Grimma apophysata</i> Hamp. ex Gangulee	Budgam: Charari Sharief	Attached to Rock; growing on tree; Feb. 2014	6124	3
<i>Grimma ovalis</i> (Hedw.) Lindb. tree; Feb. 2014	Budgam: Charari Sharief	Attached to Rock; grown on	6123	4
ORDER: DICRANALES				
FAMILY: DICRANACEAE				
<i>Campylopus fragilis</i> (Brid.) B.S.G.	Budgam: Khansahib	Growing on moist soil; Sep. 2014	6125	5
ORDER: POTTIALES				
FAMILY: POTTIACEAE				
<i>Oxystegus cylindricus</i> (Brid.) Hilp	Budgam: Beerwah	Growing on moist soil and wet wood log Feb 2013	6126	6
<i>Oxystegus khasianus</i> (Mitt.) Gangulee	Budgam: Khansahib	Growing on moist soil; Feb 2013	6127	7
<i>Oxystegus stenophyllus</i> (Mitt.) Gangulee	Budgam: Khansahib	Growing on moist soil; Feb 2013	6128	8
<i>Hyophila involuta</i> (Hook.) Jaeg.	Budgam: Budgam	Growing on moist soil on calcareous wall; Mar 2014	6129	9
<i>Hyophila rosea</i> Williams	Budgam: Budgam	Growing on a moist wall; Mar. 2014	6130	10
<i>Hyophila spathulata</i> (Harv.) Jaeg.	Budgam: Budgam	Growing on a moist wall and Wood log; Feb 2014	6132	11
<i>Hyophila walkeri</i> Broth.	Budgam: Budgam	Growing on a moist wall; Mar 2014	6131	12
<i>Barbula asperifolia</i> Mitt.	Budgam: Budgam, Khansahib	Growing on a moist soil; Feb 2013	6133	13
<i>Barbula constricta</i> Mitt.	Budgam: Budgam, Charari Sharief	Growing on moist soil; Mar 2014	6134	14
<i>Barbula cylindrica</i> (Tayl.) Schimp.	Budgam: Budgam, Charari Sharief, Beerwah	Hanging from trunk of <i>Platanus orientalis</i> trunk; March 2014	6136	15
<i>Barbula nigrescens</i> Mitt.	Budgam: Budgam,	Growing on moist soil; Feb 2013	6137	16
Charari Sharief, Chadoora				
<i>Barbula vinealis</i> Brid.	Budgam: Budgam, Khansahib	Hanging from tree trunk; March 2014	6135	17
<i>Semibarbula orientalis</i> (Weber) Wijk. & Marg.	Budgam: Charari Sharief	Growing on moist soil; Mar 2015	6138	18
<i>Semibarbula ranuii</i> Gangulee	Budgam: Beerwah	Growing on moist soil; Mar 2015	6139	19
<i>Hydrogonium consanguineum</i> (Thw. et Mitt.) Hilp.	Budgam: Beerwah	Growing on sandy soil near stream; Mar 2015	6140	20
<i>Hydrogonium gracilentum</i>	Budgam: Beerwah	Growing on sandy soil near stream;	6141	21

(Mitt) Chen Hedw.	Mar 2015		
<i>Desmatodon gemmascens</i> Chen	Budgam: Budgam	Growing near bank of the stream;	6142 22
	Feb 2013		
<i>Desmatodon latifolius</i> (Hedw.) Brid.	Budgam: Budgam	Growing near bank of the stream;	6143 23
<i>Syntrichia princeps</i> (De Not.) Mitt.	Budgam: Budgam	Attached to the rock ;	6144 24
	Feb 2013		
ORDER BRYALES			
Family Bryaceae			
<i>Pohlia flexuosa</i> Hook.	Budgam: Budgam,	Growing on moist soil, Mar 2015	6145 25
Khansahib, Beerwah			
<i>Pohlia himalayana</i> (Mitt.) Broth.	Budgam: Budgam,	Growing on moist soil, Mar 2015	6146 26
Khansahib, Beerwah			
<i>Pohlia rigescens</i> (Mitt.) Broth	Budgam: Budgam,	Growing on moist soil, Mar. 2015	6147 27
Khansahib, Beerwah			
<i>Brachymenium acuminatum</i> Harv.	Budgam: Budgam,	Growing on moist soil; Oct 2013	6150 28
Khansahib			
<i>Brachymenium bryoides</i> Hook. ex Schwaegr.	Budgam: Charari Sharief,	Growing near the bank of stream; Oct 2013	6149 29
Khansahib			
<i>Brachymenium microstomum</i> Harv.	Budgam: Charari Sharief, Chadoora	Growing near the bank of stream; Oct 2013	6148 30
<i>Bryum alpinum</i> Huds. ex With.	Budgam: Budgam, Khansahib	Growing on moist soil ; Mar 2015	6152 31
<i>Bryum argenteum</i> Hedw.	Budgam: Charari Sharief,	Growing on moist soil; Sep 2013	6116a 32
<i>Bryum capillare</i> Hedw.	Budgam: Budgam, Khansahib	Growing on moist soil, attached to rocks; Sep 2013	6117a 33
<i>Bryum coronatum</i> Schwaegr.	Budgam: Khansahib, Beerwah	Growing on moist soil; Oct 2013	6151 34
<i>Bryum pseudotriquetrum</i> Hedw.	Budgam: Khansahib	Growing on moist sandy Soil; Sep 2013	6118a 35
<i>Bryum recurvulum</i> Mitt.	Budgam: Budgam, Khansahib	Growing on moist soil ; Sep 2013	6119a 36
<i>Bryum uliginosum</i> (Brid.) B.S.G.	Budgam: Khansahib	Growing on wet sand ; Sep 2013	6120a 37
FAMILY: MNIACEAE			
<i>Mnium confertidens</i> (Lindb. Arn.) Kindb.	Budgam: Khansahib, Beerwah	Growing on moist soil and wet logs	6111a 38
Oct 2013			
<i>Mnium cuspidatum</i> Hedw.	Budgam: Budgam, Khansahib	Growing on moist sand ; Oct 2013	6112a 39
<i>Mnium integrum</i> Bosch & Sande Lac.	Budgam: Budgam,	Growing on sandy soil; Oct 2013	6113a 40
Chadoora, Khansahib			
<i>Mnium rostratum</i> schrad.	Budgam: Budgam,	Growing on moist soil; Oct 2013	6114a 41
Charari Sharief,, Khansahib			
<i>Mnium succulentum</i> Mitt.	Budgam: Budgam	Growing on moist soil; Oct 2013	6115a 42
ORDER :BARTRAMIALES			
FAMILY: BARTRAMIACEAE			
<i>Philonotis falcata</i> (Hook.) Mitt.	Budgam: Budgam,	Growing on sandy bank of stream ;	6110a 43
Khansahib, Beerwah	Oct 2012		
SUPERORDER :HYPNANAE			
ORDER :HYPNODENDRALES			
FAMILY RACOPILACEAE			
<i>Racopilum cuspidigerum</i> (Schwaegr.) Åongstr.	Budgam: Charari Sharief,	Attached to rocks; Feb. 2014	6153 44
Khansahib			
ORDER {HYPNALES			
FAMILY: AMBLYSTEGIACEAE			
<i>Drepanocladus aduncus</i> (Hedwig) Warnstorf	Budgam: Khansahib	Growing on sandy bank of stream; Feb 2014	6107a 45

<i>Drepanocladus exannulatus</i> (B. S. G.) Warnst.	Budgam: Khansahib Attached to rocks; Sep 2014	6154 46
<i>Cratoneuron commutatum</i> (Hedw.) Roth.	Budgam: Budgam Attached to rocks; Sep. 2014	6106a 47
FAMILY : LESKEACEAE		
<i>Haplocladium microphyllum</i> (Hedw.) Broth	Budgam: Khansahib Growing on wet wood logs; Oct 2012	6108a 48
<i>Haplocladium schimperi</i> Ther.	Budgam: Khansahib Growing on wet wood logs; Mar 2014	6155 49
<i>Lindbergia duthiei</i> (Broth.) Broth.	Budgam: Charari Sharief Growing on wet sandy soil; Mar 2014	6156 50

FAMILY: THUIDIACEAE

<i>Thuidium glaucinum</i> (Mitt.) Bosch & Sande Lac.	Budgam: Budgam Growing on sandy bank of stream Sep 2014 and wet soil;	6157 51
<i>Thuidium investe</i> (Mitt.) Jaeg. stream and wet soil; Sep 2014	Budgam: Budgam Growing on sandy bank of	6160 52
<i>Thuidium meyenianum</i> (Hamp.) Doz. & Molk.	Budgam: Budgam Growing on sandy bank of stream and wet soil; Sep 2014	6159 53
<i>Thuidium orientale</i> Mitt. ex Dixon wet soil and wood logs; Sep 2014	<i>Budgam: Budgam</i> Growing on sandy bank of stream,	6158 54 .

FAMILY : BRACHYTHECIACEAE

<i>Brachythecium buchananii</i> (Hook.) Jaeg	Budgam: Charari Sharief, Chadoora Growing on wet soil; Sep 2014	6162 55
<i>Brachythecium kamounense</i> (Harv.) Jaeg. Charari Sharief,	Budgam: Budgam, Growing on wet soil; Oct 2012	6103a 56
<i>Brachythecium plumosum</i> (Hedw.) B.S.G. Beerwah	Budgam: Budgam, Growing on wet soil; Oct 2012	6104a 57
<i>Brachythecium rivulare</i> B.S. G.	Budgam: Khansahib, Growing on wet soil; Sep 2014	6161 58
<i>Brachythecium rutabulum</i> (Hedw.) B.S.G.	Budgam: Budgam, Growing on wet soil; Oct 2012	6105a 59
<i>Rhynchostegium celebicum</i> (Lac.) Jaeg.	Budgam: Budgam Growing on wet soil; Mar 2014	6165 60
<i>Rhynchostegium herbaceum</i> . (Mitt.) Jaeg	Budgam: Budgam Growing on wet soil; Mar 2014	6163 61
<i>Rhynchostegium planiusculum</i> (Mitt.) Jaeg.	Budgam: Budgam Growing on wet soil; Mar 2014	6164 62
<i>Rhynchostegiella scabriseta</i> (B.S.G.) Limpr.	Budgam: Budgam Growing on wet soil; Mar 2014	6166 63
<i>Eurhynchium mulleri</i> (Jaeg.) Bartr.	Budgam: Budgam, Growing on sandy bank Khansahib of stream and wet soil; Oct 2013	6168 64
<i>Eurhynchium riparioides</i> (Hedw.) Richs.	Budgam: Budgam, Growing on sandy bank of stream; Oct 2013	6167 65
<i>Eurhynchium swartzii</i> Charari Sharief(Turn.)	Budgam: Budgam, Growing on sandy bank of stream an wet soil; Oct 2013	6169 66

FAMILY :HYPNACEAE

<i>Hypnum aduncoides</i> (Brid.) C. Muell.	Budgam: Budgam Growing on sandy bank of stream and attached to rock; Oct 2012;	6170 67
<i>Hypnum cupressiforme</i> Hedw.	Budgam: Khansahib Growing on sandy bank of stream and attached to rock; Oct 2012	6109a 68

FAMILY: LEUCODONTACEAE

<i>Leucodon sciuroide</i> (Hedw.) Schwaegr Beerwah	Budgam: Khansahib, Growing on tree trunk and hanging from rock; Feb 2014	6171 69
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FAMILY: ANOMODONTACEAE

Herpetineuron tocoae Budgam: Beerwah Growing on wood log and wet soil; Oct 2012 6172 70
(C. Muell.) Card.

PHYLUM: MARCHANTIOPHYTA

ORDER: MARCHANTIALES

FAMILY: MARCHANTIACEAE

Marchantia polymorpha L. Budgam: Budgam, Growing near water spring and soil; Mar 2014 6173 71
Khansahib, Beerwah

FAMILY: DUMORTIERACEAE

Dumortiera hirsuta (Sw.) Budgam: Budgam, Growing near water spring and soil; Mar 2014 6174 72
Nees Reinw. et al. Khansahib

ORDER: PORELLALES

FAMILY: PORELLACEAE

Porella obtusata (Taylor) Budgam: Chadoora, Growing on tree trunk; Mar 2014 6175 73
Trevis var. *macroloba* Khansahib
(Steph.)S. Hatt & Zhang

CONCLUSION

Since no cytological studies of bryophytes of this area have been made so far, it would be premature to speculate the role of polyploidy/ aneuploidy in conferring any advantage or disadvantage in the competitive ability of taxa for initial colonization, successful growth and further spread of the affected species.

The present study, of this unexplored area has resulted in the discovery of several previously unknown taxa. It has laid the base for studying these plants ecologically, cytologically, chemically and pharmaceutically so as to seem potential for academic advancement and human welfare.

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