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Cover: Rose-breasted Grosbeak Pheucticus ludovicianus, pen & ink with colour pencil. © Lucille Betti-Nash.
Diversity of mosses (Bryophyta) in Pangi valley (Himachal Pradesh, India): an unexplored domain of northwestern Himalaya

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Abstract: Diversity of mosses of a unique and unexplored geographical location in Himalaya, the Pangi valley in Himachal Pradesh, India is investigated. A total of 49 moss species belonging to 21 families have been recorded, including Hedwigia emodica, the detail on the type specimen of which is uncertain and Encalypta vulgaris, a rare moss in the Himalaya. In addition, 13 moss species are new records for Himachal Pradesh. The dominant mosses of the surveyed area are Philonotis and Grimmia, where the latter is frequently found on basic, barren boulders in sunny positions. Among the recorded moss species, 35 are terrestrial, six aquatic, and eight epiphytes. The findings will be useful for forest policies and management of bryophytes conservation in areas which have extreme climatic conditions.

Keywords: Bryophytes, ecosystem, growth forms, hotspots, indicator, macroclimate, patch size, population, richness, taxa.
INTRODUCTION

The Himalayan region constitutes one of the biodiversity hotspots of India, which comprises different kinds of forests and ecosystems in the northwestern Himalaya such as tropical, sub-tropical, temperate, sub-alpine, and alpine forests (Hajra & Rao 1990). The environmental factors such as topography, soil, climate, and geographical location influence the diversity of vegetation in forest ecosystem in the Himalaya (Arora 1995). The biodiversity and productivity in a forest are the two most important attributes, which are associated with the proper functioning of a forest ecosystem in the Himalaya (Haq et al. 2021). Any kind of ecological disturbances in the Himalaya can also affect the global climate by bringing changes in the precipitation and temperature (Khan et al. 2012) and hence affect the vegetation. Therefore, the Himalaya are an excellent zone to study about the biogeographical and ecological patterns of vegetation (Körner 2000) and of course to evaluate the diversity and community composition.

The bryophytes constitute a major part of Himalayan flora. The northwestern (NW) Himalaya comprises an enormous bryophyte diversity and composition. Various authors (Chopra & Kumar 1981; Tewari & Pant 1994; Nath et al. 2008; Alam 2013; Sahu & Asthana 2014) have done preliminary studies on the bryoflora of the NW Himalaya. However, there are still many unexplored domains in the Himalayan region which need to be investigated thoroughly so that the bryophyte species diversity and their role can be assessed. The Pangi valley in Chamba district of Himachal Pradesh (India) is one such unexplored part of the NW Himalaya. The area majorly consists of bare granite rocks and experiences harsh winters and cold summers. The objective of the present study was to assess the moss species diversity in Pangi valley. The study will be helpful in modeling the species-habitat relationship, comparing the species diversity in the disturbed and non-disturbed sites to make better planning for conservation strategies.

MATERIALS AND METHODS

The mosses were collected from the Pangi valley, Himachal Pradesh (India), located at an average elevation of 2,287 m (32.883°N, 76.421°E and 32.926°N, 76.4619°E; Image 1), in the month of June 2022. The area is dominated by conifers which remains dry during most of the year due to little precipitation and a higher snowfall period. The samples were placed in separate bags and the GPS data, their substrate, along with growth forms were noted down. The samples were carefully observed under the microscope (Olympus CX21i) and separated from each other to have the pure samples of the species. The mosses were identified based on their growth forms and micromorphological characters along with the help of relevant literatures (Gangulee 1969–1980; Chopra 1975; Anderson 2007). The mosses are classified following Goffinet et al. (2008). Voucher specimens are deposited at the Herbarium DUH, University of Delhi (India).

RESULTS

In the present study, a total of 49 taxa of mosses under 21 families were recorded. Most of the mosses belong to families Pottiaceae, Bartramiaceae, Grimmiaceae, Amblystegiaceae, and Bryaceae. The genera such as Grimmia Hedw. and Philonotis Brid. were found to be the most dominant in the surveyed area with the maximum number of species. Species of Grimmia were found growing on basic and barren substrates in sunny positions in isolated patches. Some populations were encountered on basic sandstone near the river Chenab. The plants survived the winter well under snow and produced high numbers of sporophytes in spring. Encalypta Hedw. and Hedwigia P.Beauv., represented by few populations, are rare in the area. The record of Hedwigia emodica Hampe ex Müll.Hal. is the interesting one. Species of Philonotis were found to occur on soil or rock along the banks of streams, rivers in spring and waterfall areas, often in the open. Here, the authors also recorded extended distribution of 13 taxa for Himachal Pradesh (Table 1).

DISCUSSION

The bryodiversity of Himachal Pradesh has been studied or reviewed by various authors (Lal 2005; Singh & Singh 2008; Singh & Singh 2010; Dandotiya et al. 2011; Alam 2013; Pande et al. 2017; Kumar et al. 2017). These investigations provided several new records and interesting findings. However, in terms of moss richness and diversity, there are still many under-explored regions in Himachal Pradesh which require frequent and comprehensive field visits.

The climatic condition of the valley allows the development of mosses that are adapted to these...
climatic extremities. Several adaptive features such as the presence of long hyaline tip and compact growth in Grimmiaaceae, presence of chlorophyllose cells in between the hyalocyst cells in Leucobryaceae, and the thick-coarsely papillated, small quadrate surface cells in Pottiaceae (Scott 1982) help these mosses to store water and prevent its loss, enabling these mosses to thrive in harsh and extreme climatic conditions (Image 2 & 3). Other features such as the lanceolate leaves to minimize water loss and optimize light absorption in Grimmiaaceae also help in surviving the extreme conditions. In addition, the wax coating on the leaves of Polytrichaceae members prevent them from water loss as well as extreme sunlight and is considered an adaptation. In the family Pottiaceae, several species show leaf curling in response to change in humidity, which is also recognised as an adaptation factor to extreme conditions as well (Geissler 1982). The mat, cushion, turf, weft, and many such forms are also known as adaptation states to the climate. It is interesting to mention that, in Ptychostomum pseudotriquetrum (Hedw.) J.R.Spence & H.P.Ramsay ex Holyoak & N.Pedersen, there is production of UV-B absorbing anthocyanin pigments that check the physiological activities of the moss under extreme cold or desiccation (Dunn & Robinson 2006; Glime 2017).

A total of six species of Encalypta are known to occur in the northwestern Himalayan region of India, with E. vulgaris the only species reported from Spiti valley and Kangra in Himachal Pradesh previously (Chopra 1975). We found only few small patches of E. vulgaris in the studied area and one patch with a length of ca. 15 cm. which showed relatively less abundance as compared to the other reported moss taxa. The genus Encalypta seems to require a specific habitat condition, i.e., restricted to limestones particularly found growing in the microsites such as on exposed dry rock crevices and on ledges wedged among stones. The genus is easily distinguished by its large plate-like red perigonia which was established in the large patches along with the other herbaceous plants. Moreover, it harbours many small aquatic animals.

Only three species of Hedwigia have been reported from the Himalaya, viz., H. ciliata (Hedw.) Boucher, H. stellata Hedenäs, and H. emodica (Dalton et al. 2013). The major distinguishing characters of H. emodica from other species of its relatives are the presence...
Table 1. Table showing the list of reported bryophyte taxa along with new records, growth form, patch size and families (Classification follows Goffinet et al. 2008).

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Substratum</th>
<th>Moss patch size</th>
<th>Growth form</th>
<th>Family</th>
<th>Voucher number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Anacolia menziesii (Turner) Paris</td>
<td>Rock</td>
<td>Small</td>
<td>Open tuft</td>
<td>Bartramiaceae</td>
<td>DUH15324</td>
</tr>
<tr>
<td>2. Anoectangium stracheyanum Mitt.</td>
<td>Rock</td>
<td>Small</td>
<td>Dense tuft</td>
<td>Pottiaceae</td>
<td>DUH15325</td>
</tr>
<tr>
<td>3. Brachythecium kamounense (Harv.) A.Jaeger</td>
<td>Soil, Rock</td>
<td>Small</td>
<td>Mat</td>
<td>Brachytheciaceae</td>
<td>DUH15415</td>
</tr>
<tr>
<td>4. Bryoerythrophyllum recurvirostrum (Hedw.) P.C.Chen</td>
<td>Rock</td>
<td>Medium</td>
<td>Tuft</td>
<td>Pottiaceae</td>
<td>DUH15326</td>
</tr>
<tr>
<td>5. Bryum argenteum Hedw.</td>
<td>Open soil</td>
<td>Small</td>
<td>Mat</td>
<td>Bryaceae</td>
<td>DUH15291</td>
</tr>
<tr>
<td>6. B. kashmirensis Broth.</td>
<td>Rock</td>
<td>Small</td>
<td>Thin mat,</td>
<td>Bryaceae</td>
<td>DUH15327</td>
</tr>
<tr>
<td>8. Cratoneuron filicinum (Hedw.) Spruce</td>
<td>Near waterfall</td>
<td>Small</td>
<td>Tuft</td>
<td>Amblystegiaceae</td>
<td>DUH15239</td>
</tr>
<tr>
<td>9. Didymodon hastatus (Mitt.) R.H.Zander</td>
<td>Calcium rock</td>
<td>Small</td>
<td>Tuft</td>
<td>Pottiaceae</td>
<td>DUH15331</td>
</tr>
<tr>
<td>10. Encalypta vulgaris</td>
<td>Rock</td>
<td>Large</td>
<td>Cushion</td>
<td>Encalyptaceae</td>
<td>DUH15332</td>
</tr>
<tr>
<td>11. Entodon luteonitens Renauld &amp; Cardot</td>
<td>Forest floor</td>
<td>Small</td>
<td>Tuft</td>
<td>Entodontaceae</td>
<td>DUH15333</td>
</tr>
<tr>
<td>12. Fissidens grandifrons Brid.</td>
<td>Waterfall</td>
<td>Small</td>
<td>Mat/Tuft</td>
<td>Fissidentaceae</td>
<td>DUH15335</td>
</tr>
<tr>
<td>13. F. taxifolius Hedw.</td>
<td>Dry Soil</td>
<td>Small</td>
<td>Tuft</td>
<td>Fissidentaceae</td>
<td>DUH15336</td>
</tr>
<tr>
<td>14. Grimmia donniana Sm.</td>
<td>Rock</td>
<td>Small</td>
<td>Cushion</td>
<td>Grimmaceae</td>
<td>DUH15337</td>
</tr>
<tr>
<td>15. G. elongata Kauff.</td>
<td>Rock</td>
<td>Small</td>
<td>Cushion</td>
<td>Grimmaceae</td>
<td>DUH15338</td>
</tr>
<tr>
<td>16. G. funalis (Schwägr.) Bruch &amp; Schimp.</td>
<td>Calcium wet rock</td>
<td>Medium</td>
<td>Cushion</td>
<td>Grimmaceae</td>
<td>DUH15339</td>
</tr>
<tr>
<td>17. G. fuscolutea Hook.</td>
<td>Rock</td>
<td>Medium</td>
<td>Cushion</td>
<td>Grimmaceae</td>
<td>DUH15340</td>
</tr>
<tr>
<td>18. Haplocodium schimperi Thér.</td>
<td>Tree base, Rock</td>
<td>Small</td>
<td>Mat</td>
<td>Leskeaceae</td>
<td>DUH15292</td>
</tr>
<tr>
<td>20. Hygroamblystegium tenuax (Hedw.) Jenn.</td>
<td>Rock and Walls</td>
<td>Small</td>
<td>Tuft</td>
<td>Pottiaceae</td>
<td>DUH15342</td>
</tr>
<tr>
<td>21. Hymentostylium recurvirostrum (Hedw.) Dixon</td>
<td>Rock</td>
<td>Medium</td>
<td>Tuft/ Tuft</td>
<td>Pottiaceae</td>
<td>DUH15343</td>
</tr>
<tr>
<td>22. Hypericum cupressiforme (Hedw.)</td>
<td>Forest floor</td>
<td>Small</td>
<td>Mat</td>
<td>Hypnaceae</td>
<td>DUH15344</td>
</tr>
<tr>
<td>23. Lescuraea incurvata (Hedw.) E.Lawton</td>
<td>Dry Rocks</td>
<td>Small</td>
<td>Mat</td>
<td>Leskeaceae</td>
<td>DUH15345</td>
</tr>
<tr>
<td>24. Leucodon secundus (Harv.) Mitt.</td>
<td>Tree bark</td>
<td>Medium</td>
<td>Tuft</td>
<td>Leucodontaceae</td>
<td>DUH15424</td>
</tr>
<tr>
<td>25. L. sinensis Thér.</td>
<td>Tree bark</td>
<td>Medium</td>
<td>Tuft/ Mat</td>
<td>Leucodontaceae</td>
<td>DUH15345</td>
</tr>
<tr>
<td>26. Lewinskyella speciosa (Nees) F. Lara, Garillett &amp; Goffinet</td>
<td>Tree branches</td>
<td>Small</td>
<td>Tuft</td>
<td>Orthotrichaceae</td>
<td>DUH15346</td>
</tr>
<tr>
<td>27. Orthotrichium erubescens Müll. Hal.</td>
<td>Tree branches</td>
<td>Medium</td>
<td>Cushion</td>
<td>Orthotrichaceae</td>
<td>DUH15347</td>
</tr>
<tr>
<td>28. Oxyrrhynchiun hians (Hedw.) Loeske</td>
<td>Waterfall</td>
<td>Medium</td>
<td>Tuft</td>
<td>Brachytheciaceae</td>
<td>DUH15348</td>
</tr>
<tr>
<td>29. Palustriellia decipiens (De Not.) Ochyra</td>
<td>Waterfall</td>
<td>Small</td>
<td>Tuft</td>
<td>Amblystegiaceae</td>
<td>DUH15349</td>
</tr>
<tr>
<td>30. Philonotis bartramioides (Griff.) D.G.Griffin &amp; W.R.Buck</td>
<td>Calcium wet rock</td>
<td>Large</td>
<td>Tuft/Cushion</td>
<td>Bartramiaceae</td>
<td>DUH15350</td>
</tr>
<tr>
<td>31. P. leptocarpa (Mitt.)</td>
<td>Wet Soil Calcium rich</td>
<td>Medium</td>
<td>Tuft</td>
<td>Bartramiaceae</td>
<td>DUH15352</td>
</tr>
<tr>
<td>32. P. mollis (Dozy &amp; Molk.) Mitt.</td>
<td>Wet Soil Calcium rich</td>
<td>Medium</td>
<td>Tuft</td>
<td>Bartramiaceae</td>
<td>DUH15353</td>
</tr>
<tr>
<td>33. P. roylei (Hook.f.) Mitt.</td>
<td>Calcium wet rock</td>
<td>Medium</td>
<td>Tuft/Cushion</td>
<td>Bartramiaceae</td>
<td>DUH15354</td>
</tr>
<tr>
<td>34. P. turnerianna (Schwägr.) Mitt.</td>
<td>Wet Soil Calcium rich</td>
<td>Medium</td>
<td>Tuft</td>
<td>Bartramiaceae</td>
<td>DUH15355</td>
</tr>
<tr>
<td>35. Plagiothecium cavifolium (Brid.) Z.Iwats.</td>
<td>Tree base</td>
<td>Small</td>
<td>Mat</td>
<td>Plagiotheciaceae</td>
<td>DUH15314</td>
</tr>
<tr>
<td>36. Pseudoleskeopsis zipperli (Dozy &amp; Molk.) Broth.</td>
<td>Rock</td>
<td>Small</td>
<td>Mat</td>
<td>Leskeaceae</td>
<td>DUH15356</td>
</tr>
<tr>
<td>37. Ptychomitrium tortula (Harv.) A.Jaeger</td>
<td>Tree bark</td>
<td>Small</td>
<td>Tuft</td>
<td>Ptychomitriaceae</td>
<td>DUH15316</td>
</tr>
<tr>
<td>Taxon</td>
<td>Substratum</td>
<td>Moss patch size</td>
<td>Growth form</td>
<td>Family</td>
<td>Voucher number</td>
</tr>
<tr>
<td>-------</td>
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<td>-------------</td>
<td>--------</td>
<td>----------------</td>
</tr>
<tr>
<td>39. Ptychostomum pseudotriquetrum (Hedw.) J.R.Spence &amp; H.P.Ramsay ex Holyoak &amp; N.Pedersen</td>
<td>Open Rock</td>
<td>Medium</td>
<td>Tuft</td>
<td>Bryaceae</td>
<td>DUH15357</td>
</tr>
<tr>
<td>40. Reimersia inconspicua (Griff.) P.C.Chen</td>
<td>Rock, Soil</td>
<td>Small</td>
<td>Tuft</td>
<td>Pottiaceae</td>
<td>DUH15358</td>
</tr>
<tr>
<td>41. Rhynchostegium planiusculum (Mitt.) A.Jaeger</td>
<td>Forest floor</td>
<td>Small</td>
<td>Tuft</td>
<td>Brachytheciaceae</td>
<td>DUH15359</td>
</tr>
<tr>
<td>42. R. ripanioides (Hedw.) Cardot</td>
<td>Waterfall</td>
<td>Small</td>
<td>Tuft</td>
<td>Brachytheciaceae</td>
<td>DUH15360</td>
</tr>
<tr>
<td>43. Rosulabryum capillare (Hedw.) J.R.Spence</td>
<td>Open soil</td>
<td>Small</td>
<td>Tuft</td>
<td>Bryaceae</td>
<td>DUH15361</td>
</tr>
<tr>
<td>44. Sarmentypnum exannulatum (Schimp.) Hednäs</td>
<td>Near waterfall</td>
<td>Small</td>
<td>Mat/ Cushion</td>
<td>Calliergonaceae</td>
<td>DUH15362</td>
</tr>
<tr>
<td>45. Syntrichia ruralis (Hedw.) F.Weber &amp; D.Mohr.</td>
<td>Open dry soil</td>
<td>Small</td>
<td>Tuft</td>
<td>Pottiaceae</td>
<td>DUH15365</td>
</tr>
<tr>
<td>46. Symphysodontella tortifolia Dixon†</td>
<td>Rock</td>
<td>Small</td>
<td>Tuft</td>
<td>Pterobryaceae</td>
<td>DUH15363</td>
</tr>
<tr>
<td>47. Syrrhopodon armatus (Schwägr.)</td>
<td>Soil</td>
<td>Medium</td>
<td>Tuft</td>
<td>Calypogoniaceae</td>
<td>DUH15317</td>
</tr>
<tr>
<td>48. Thuidium assimile (Mitt.) A.Jaeger</td>
<td>Forest floor</td>
<td>Medium</td>
<td>Tuft</td>
<td>Thuidiaceae</td>
<td>DUH15364</td>
</tr>
<tr>
<td>49. Tortella tortuosa (Schrad. ex Hedw.) Limpr.</td>
<td>Dry rocks</td>
<td>Small</td>
<td>Tuft</td>
<td>Pottiaceae</td>
<td>DUH15366</td>
</tr>
</tbody>
</table>

†—New records to Himachal Pradesh | Moss Patch Size: Small = 0−3 cm, Medium = 3−8 cm, Large = < 8 cm

of a long, hyaline tip which covers ca. 20–40% of leaf length; abaxial papillae which varies from branched to stellate and leaf margin either recurved on lower half or plane. *H. ciliata* has been previously reported from Himachal Pradesh and Uttarakhand (Asthana & Sahu 2014). *H. stellata* has been reported from Kashmir and the distribution of *H. emodica* was previously found in Jammu & Kashmir (Dalton et al. 2013). The presence of *H. emodica* in Himachal Pradesh, therefore, implies the range extension of this taxon. Present populations were found growing on sand rocks, boulders, and creeks as well as the lower trunks of *Cedrus* trees. It appears that *Hedwigia* prefers to grow on acidic substratum.

Bryophyte distribution is affected by the macroclimatic conditions, including precipitation and temperature. However, moisture is considered as an important growth stimulator more than any other factor for bryophyte productivity (Skre & Oechel 1981; Porley & Hodgetts 2005). The dominance of families such as Pottiacae and Grimmiaeae, generally growing in exposed sites on granite-mica rocks, indicate that the area has harsh and extreme climatic conditions. Wide distribution of members of Bartramieae shows presence of calcareous substrata (Tewari & Pant 1994). The average bryophyte cover was higher in exposed sites and under coniferous forest patch, and thus considered as important ground cover in the area. The area is dominated by the acrocarpous turfs and cushion forming mosses in comparison to the pleurocarpous mosses. A deep bryophyte layer thickness is commonly associated with species groups that often have large cover, which therefore, produce a high biomass (Sun et al. 2013). This area harbours rich plant diversity. Less population, low developmental activities, and remote location of the area gives the opportunity to have the high regeneration rate of the species. Moreover, the harsh
environmental conditions stimulate the adaptations in the species, hence the species occurring in the area remain unique. It is important to understand the plant communities, especially of lower plant groups, of such sites for comparative study and distribution modelling in future. There is an abundance of rocky bulges and depressions, which provide refuge to species with morphological adaptations to stressful climates and to rare communities of plants, including bryophytes.

The existence of 21 distinct families in this region serves as a clear indication of the considerable diversity in terms of bryophyte richness and composition. This underscores the importance of conducting expeditions in the surrounding areas to compile a cumulative checklist. Such an endeavour will contribute to the formulation of effective policy management and conservation approaches. Although the area is remote, but the small hydroelectric units and camps on ground may make the habitat vulnerable. These anthropogenic disturbances may pose a threat to the survival of many different moss taxa. Poor dispersal range of bryophytes not only limits the population recruitment but also leads to conservation implications. The niche specificity and the role of associated species together with genetic diversity need to be studied further.

CONCLUSIONS

Bryophytes constitute an important component of the ecosystem and contribute a significant portion of species richness and biomass as well as ground cover. Although, they play a significant role in ecosystem functioning yet they receive less attention in biodiversity mapping. These interesting groups of plants are very functioning yet they receive less attention in biodiversity mapping. These interesting groups of plants are very

REFERENCES

Diversity of mosses in Pangi valley, India

Dhyani et al.


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