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Preliminary studies on the moss diversity in Patnitop and its adjoining areas (J&K), North West Himalaya, India

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Present communication deals with the distribution of mosses in Patnitop and other sites in the Udhampur district of Jammu Division, J&K State. It includes 40 species belonging to 25 genera, 16 families and 8 orders.

Key-words — Moss diversity, Patnitop and nearby areas, J&K, India.

INTRODUCTION

The Himalaya's in general are extremely rich in bryophyte diversity with Eastern Himalayas being the richest, followed by the Western and Central Himalayas. During the past few decades, the entire Himalayan ranges have suffered tremendous habitat destruction on account of tourism, urbanization, overexploitation and deforestation due to which large number of these plants have disappeared from their natural homes (Langer & Tanwir, 2004; Pant, 1983; Srivastava, 1998). Many bryologists have raised an alarm from time to time to save these extremely useful plants and emphasized to inventorize and document the bryodiversity of the un/under explored Himalayan regions.

The Jammu and Kashmir State, a part of North-West Himalaya, is rich in bryophyte diversity. The Jammu Division, a conglomerate of hilly areas of districts Rajouri, Poonch, Doda and Udhampur and the plains of Jammu and Kathua has largely remained un/under explored from this angle. Preliminary exploration of a few areas of Jammu region by authors (Langer & Tanwir, 2002; Langer *et al.*, 2003, Tanwir & Langer, 2004; Tanwir, 2005) has revealed the richness of these regions in hepatic diversity.

Bryoexploration of Patnitop and its adjoining areas, largely falling under district Udhampur has lead to the collection of 79 bryophytes including 38 liverworts, 1 hornwort and 40 moss taxa. While information regarding liverworts and hornworts has been provided in this volume (Tanwir *et al.*, 2008), the present paper is restricted to the occurrence and distribution of moss flora of the area mentioned above.

MATERIAL AND METHOD

Diverse habitats in Patnitop and its adjoining areas falling under districts Udhampur and Doda (Sanasar) were explored for their bryodiversity through periodic field trips undertaken during various months of the year (Table 1). Data on various ecological characters (habitat, altitude, soil pH, etc.) were collected in the field itself. Moss taxa collected were identified on basis of morphology and anatomy of various gametophytic and sporophytic characters (Chopra, 1975). Identification was verified by Dr. P. L. Uniyal of University of Delhi, Delhi.

Table 1– Sites of collection along with their altitude

S. No.	Site	Altitude (Metres)
1.	Bahast	1650
2.	Batote	2000
3.	Chilyar	1700
4.	Chokanala	1800
5.	Dhanthal (Udhampur)	550
6.	Kanthgali (Panchari)	1620
7.	Mansar	640
8.	Mantalai	1840
9.	Pangara	1550
10.	Patnitop	2020
11.	Ramnagar	890
12.	Ritti	580
13.	Sanasar	2080
14.	Sudhmahadev	1740

OBSERVATIONS

A total of 40 moss taxa belonging to 25 genera, 8 orders and 16 families have been collected during the present investigation. Observations regarding their habitat and pH are provided in Table 2.

DISCUSSION

Preliminary survey of the area reveals a total of 79 taxa including 38 hepatics, 40 mosses and 1 hornwort belonging to diverse families and orders. This number is likely to increase with further exploration of the area. The mosses collected presently represent 8 orders, 16 families and 25 genera. The largest order with respect to number of families represented in the area of present exploration is Hypnobryales (7) followed by Eubryales (3). Pottiales, Dicranales, Fissidentales,

Table 2 -Showing the Habitat Diversity of Various Moss Taxa Collected from The Study Area

Order/Family	Taxa	Accession no.	Site of collection	Altitude (m)	Habitat	pH
A. HYPNOBRYALES						
a) Thuidiaceae	1. *Anomodon sp.* Hook & Tayl.	GBP-04	Patnitop	2020	Plants inhabit the debris of needle of *Cedrus deodara* exposed to sunlight.	6.5
	2. *A. minor* (Hedw.) Lindb.	GBP-41	Sanasar	2075	Plants pendant, inhabit rock surface near a water stream.	7.2
b) Brachytheciaceae	3. *Brachythecium rutabulum* (Hedw.) B. S. G.	GBP-19	Patnitop	2020	Plants growing singly or in patch of four-five plants on sandy loam soil unexposed to sunlight.	8.1
	4. *Brachythecium sp.*	GBP-14	Patnitop	2020	Plants pendulous on the bark of *Pinus sp.*	7.5
	5. *B. plumulosum* (Hedw.) B. S. G.	GBP-312	Mantalai	1850	Plants inhabit stone wall on sandy soil in moist shady area.	7.1
	6. *Rhynchostegium herbaceum*	GBP-1	Patnitop	2020	Plants inhabit moist sandy clay loam soil among shrubs and gymnospermous tree forest.	6.5
c)Amblystegiaceae	7. *Cratoneuron sp.* (Sull) Spruc	GBP-140	Bahast	1650	Plants inhabit moist sandy loam soil among ferns in exposed condition.	8.2
		GBP-24	Patnitop	2010	Epilithic, growing near water, completely unexposed.	6.5
d)Hypnaceae	8. *Ectropothecium sp.* Mitt.	GBP-13	Patnitop	2020	Plants epiphytic on decayed wood of *Cedrus deodara.*	4.7
		GBP-41	Sanasar	2075	Plants inhabit stone with sandy loam covered moist soil.	7.6
e)Entodontaceae	9. *Isopterygium minutirameum* (C. Muell.) Jaeg.	GBP-117	Ramnagar	1060	Plants inhabit slightly moist soil covered rock in partially exposed condition	8.2
	10. *I. albescens* Hook. Jaeg.	GBP-102	Ritti	580	Plants inhabit moist loamy soil covered rock	8.5
	11. *Entodon myurus* (Hook.) Hampe	GBP-8	Patnitop	2020	Plants pendulous on the bark of *Cedrus deodara.*	4.7
	12. *E.prorepens* (Mitt.) Jaeg.	GBP-9	Patnitop	2020	Plants epiphytic on the bark of *Neolitsea pallens.*	7.6
		GBP-136	Sudhmahadev	1740	Plants pendulous on rock alongside the stream in association with *Fissidens sp.*	7.8
f)Fabroniaceae	13. *Fabronia pusilla* Raddi	GBP-14	Patnitop	2020	Plants epiphytic on the bark of *Pinus sp.*	7.5
	14. *Fabronia sp.* Raddi	GBP-14	Patnitop	2020	Plants inhabit moist soil in shady area.	7.2
g)Plagiotheciaceae	15. *Stereophyllum decorum* (Mitt.) Wijk and Marg.	GBP-133	Sudhmahadev	1650	Plants inhabit moist sandy loam soil near dripping water.	8.5
B. EUBRYALES						
a)Bryaceae	16. *Bryum capillare* Hedw.	GBP-138	Mantalai	1850	Plants inhabit soil among stones in slanting position.	7.7
	17. *Bryum cellulare* Hook.	GBP-62	Patnitop	2000	Plants inhabit soil near water among grasses.	8.4
		GBP-295	Kanthgali	1140	Plants inhabit brick wall of well in extremely moist shady area.	8.2
	18. *Bryum sp.* Hedw.	GBP-12	Patnitop	2020	Plants inhabit moist soil under the shade of hanged soil.	8.5
b)Mniaceae	19. *Plagiomnium undulatum*	GBP-12	Patnitop	2020	Plants inhabit moist soil under the shade of hanged soil.	8.5
	20. *P. cuspidatum*	GBP-1	Patnitop	2020	Plants inhabit moist soil among shrub and gymnosperm tree forest	6.5
		GBP-126	Bahast	1650	Plants inhabit rock, on small quantity of soil in partially exposed conditions.	6.5
c)Rhizogoniaceae	21. *Rhizogonium sp.* Brid.	GBP-14	Patnitop	2020	Plants epiphytic on the bark of *Pinus sp.* in hanging position.	7.5
		GBP-50	Patnitop	2000	Plants inhabit moist soil in partially exposed conditions.	7.8

C. POTTIALES a)Pottiaceae	22. *Barbula constricta* Mitt.	GBP-103	Ramnagar	890	Plants inhabit moist soil covered rock	9.2
	23. *Gymnostomum sp.* (Hedw.)	GBP-115	Ramnagar	1015	Plants inhabit moist soil covered rock	8.5
		GBP-349	Udhampur	510	Plants inhabit stone wall in moist shady area.	8.1
	24. *Hymenostylium recurvirostre* (Hedw.)Dix.	GBP-137	Sudhmahadev	1530	Plants epilithic, growing in small patches in the stream.	7.8
	25. *Hyophila sp.*	GBP-125	Bahast	1430	Plants inhabit soil covered stones.	8.2
	26. *Hyophila involuta* (Hook) A. Jaeger	GBP-345	Mansar	665	Plants growing closely adhered to the brick wall in moist shady area.	7.3
	27. *Timmiella dimmata* (C.Muell)	GBP-301	Chokanala (near Mantalai)	1850	Plants inhabit stone wall in moist shady area.	7.2
D. DICRANALES a)Ditrichaceae	28. *Ceratodon purpureus* (Hedw.) Brid.	GBP-63	Batote	1600	Plants epiphytic on the bark of *Cedrus deodara*.	6.5
	29. *Ceratodon sp.*	GBP-121	Ramnagar	890	Plants inhabit moist loamy soil covered rock.	8.9
	30. *Ditrichum heteromallum* (Hedw.) Britt.	GBP-126	Bahast	1650	Plants inhabit small quantity of sandy loam covered rock in partially exposed conditions.	9.2
	31. *D. heterophyllum*	GBP-27	Patnitop	2020	Plants inhabit moist sandy loam soil among shrubs in deodar forest.	8.5
	32. *D. homomallum* (Hedw.) Hamp.	GBP-121	Ramnagar	890	Plants inhabit moist soil covered rock	8.9
E. FISSIDENTALES a)Fissidentaceae	33. *Fissidens sp.* Mitt	GBP-302	Chokanala (near Mantalai)	1850	Plants inhabit moist soil in shady place	7.8
	34. *F. taxifolius*	GBP-299	Bahast	1650	Plants inhabit moist soil in shady area.	8.2
	35. *F.bryoides*Hedw.	GBP-140	Patnitop	2000	Plants inhabit moist soil among ferns in exposed conditions	8.2
F. ISOBRYALES a)Meteoriaceae	36. *Floribundaria floribunda* (Doz.and Molk) Fleisch	GBP-44	Sanasar	2060	Plants inhabit moist soil near water	9.0
	37. *Leucodon secundus* (Harv.) Mitt.	GBP-107	Ramnagar	1060	Plants inhabit moist shady soil in exposed condition.	8.2
		GBP-102	Ritti	580	Plants inhabit moist soil	8.5
		GBP-125	Bahast	1650	Plants inhabit moist soil covered stone	8.3
G. FUNARIALES a)Funariaceae	38. *Funaria hygrometrica* Hedw.	GBP-50	Patnitop	2000	Plants inhabit moist sandy loam soil in partially exposed condition	7.8
	39. *Physcomitrium repandum*(Griff) Mitt.	GBP-231	Sanasar lake side	2060	Plants inhabit moist soil	9.0
H. GRIMMIALES a)Grimmiaceae	40. *Grimmia elongata* Kauf.	GBP-37	Sanasar	2080	Plants epilithic, growing in moist shady area	6.8

Isobryales, Funariales and Grimmiales are represented by one family each (Table 2).

Mosses are known to grow on a wide range of natural substrata, e.g. soil, rock, bark, rotting wood, dung, animal carcasses, leaf cuticles etc. (Smith, 1982) at different pH and altitudinal ranges. This indicates that either these plants have broad ecological amplitude or precise micro-environmental conditions are repeatedly present in different habitats (Tewari & Pant, 1994).

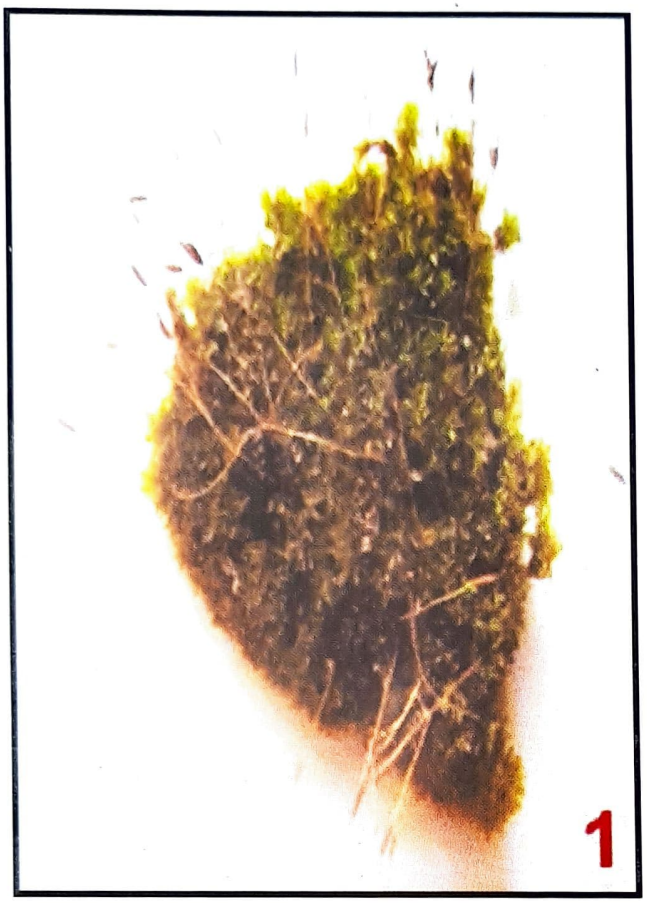

PLATE –1

Photographs showing patches of :
Fig. 1. *Hyophila involuta.* Fig. 2. *Barbula constricta.* Fig. 3. *Entodon myurus.* Fig. 4. *Ectropothecium* sp.

PLATE –2

Photographs showing patches of :
Fig. 1. *Gymnostomum* sp. Fig. 2. *Plagiomnium cuspidatum.* Fig. 3. *Bryum capillare.* Fig. 4. *Floribundaria floribunda.*

PLATE –3

Different habitats of mosses :

Fig. 1. On exposed brick wall. Fig. 2. Under the rock. Fig. 3. On the stone wall. Fig. 4. An epiphytic on the bark of *Pinus* sp.

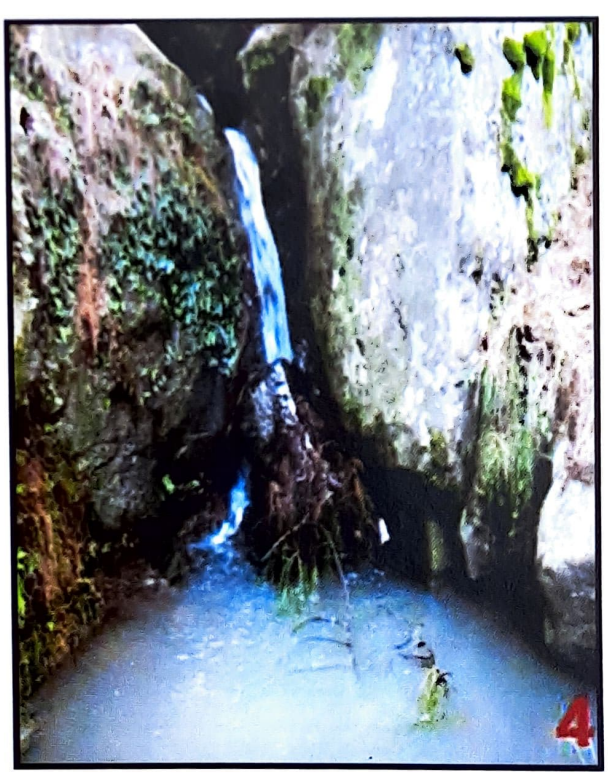

PLATE –4

Habitat diversity :

Fig. 1. Mosses growing near a waterfall. Fig. 2. On the branch of *Quercus leucotrichophora*. Fig. 3. On the stone surface. Fig. 4. On the rock surface near water.

It is evident from Table 2 that the mosses have presently been collected from terrestrial habitat only. Of the various categories , non-epilithic (62.5%) are the most predominant followed by epiphytic (22.5%) and epilithic (15%). Similar trend was observed by the authors while studying the hepatics of the area with 87% non-epilithic, 10% epiphytic and 3% epilithic taxa (Tanwir *et al.*, in this volume). Tewari and Pant (1994) also observed comparable results regarding distribution of liverworts in Nainital. Out of about 90 hepatics, 52 were non-epilithic, 29 epiphytic and 25 epilithic. Moss flora of Nainital, however, portrayed an entirely different distributional pattern as epiphytic taxa (107) outnumbered non- epilithic (99) as well as epilithic (70) forms (Tewari & Pant, 1994). A slightly different trend was observed by Tanwir (2005) for hepatics of district Poonch, as epilithic taxa (40) were nearly double in number than the epiphytic ones (21).

Epiphytic plants are known to exhibit host specificity. Schofield (1985) opined that epiphytic bryophytes tend to be abundant in angiosperm than in gymnosperm forests and secondly, the bryophyte cover on forest floor tends to be greater in gymnosperm than in angiosperm forest. A similar pattern was observed for hepatics of district Poonch. One of the authors collected 21 epiphytic hepatics from this area, growing on tree trunks of as many as 8 phorophytes, including 7 angiosperms and just 1 gymnosperm, *Taxus baccata* (Tanwir, 2005). Epiphytic hepatics of present area, however, reveal a different picture where out of the four , two each have been collected from angiosperm (*Quercus leucotrichophora*) and gymnosperm (*Cedrus deodara, Pinus sp.*) taxa. It becomes evident from Table 3 that taxa collected presently follow a reverse trend, as the epiphytic mosses inhabiting barks of gymnosperm (*Cedrus deodara, Pinus sp.*) host far outnumber those growing on angiosperm (*Neolitsea pallens*) ones.

It is worthwhile to note that in both, Poonch (Tanwir, 2005) and Nainital (Tewari & Pant, 1994), *Quercus leucotrichophora* is reported to support maximum (14 out of 21 and 22, respectively) epiphytic liverworts. These results are in line with those of host specificity of Nainital mosses (Tewari & Pant 1994). Out of the 90 epiphytic mosses, inhabiting 9 different hosts, 70 were found growing on the bark of *Quercus leucotrichophora*. A comparable number of mosses were collected from three other species of *Quercus*, i.e. *Q. floribunda* (68), Q.*semecarpifolia*(53) and *Q. lanuginosa* (37).

Table 4-Altitudinal distribution of various taxa in the area

S. No.	Taxa	Altitude (m)		
		500-1200	1201-1900	Above 1900
1.	*Anomodon sp.*	-	-	+
2.	*A. minor*	-	-	+
3.	*Barbula constricta*	+	-	-
4.	*Brachythecium plumulosum*	-	+	-
5.	*B.rutabulum*	-	-	+
6.	*Brachythecium sp.*	-	-	+
7.	*Bryum capillare*	-	+	-
8.	*B. cellulare*	-	-	+
9.	*Bryum sp.*	-	-	+
10.	*Ceratodon sp.*	+	-	-
11.	*C. purpureus*	-	-	+
12.	*Cratoneuron sp.*	-	+	-
13.	*Ditrichum heteromallum*	-	+	-
14.	*D. heterophyllum*	-	-	+
15.	*D. homomallum*	+	-	-
16.	*Ectropothecium sp.*	-	-	+
17.	*Entodon myurus*	-	-	+
18.	*E. prorepens*	-	+	+
19.	*Fabronia pusilla*	-	-	+
20.	*Fabronia sp.*	-	-	+
21.	*Fissidens bryoides*	-	+	-
22.	*F. taxifolious*	-	+	-
23.	*Fissidens sp.*	-	+	-
24.	*Floribundaria floribunda*	-	-	+
25.	*Funaria hygrometrica*	-	+	-
26.	*Grimmia elongata*	-	-	+
27.	*Gymnostomum sp.*	+	-	-
28.	*Hymenostylium recurvirostre*	-	+	-
29	*Hyophila involuta*	+	-	-
30.	*Hyophila sp.*	-	+	-
31.	*Isopterygium albescens*	+	-	-
32.	*I. minutirameum*	+	-	-
33.	*Leucodon secundus*	+	+	-
34.	*Plagiomnium undulatum*	-	-	+
35.	*P.cuspidatum*	-	+	+
36.	*Physcomitrium repandum*	-	-	+
37.	*Rhizogonium sp.*	-	-	+
38.	*Rhynchostegium herbaceum*	-	-	+
39.	*Sterophyllum decorum*	-	+	-
40.	*Timmiella dimunata*	-	+	-

Table 3-Host specificity of epiphytic taxa

S. No.	Taxa	*Pinus sp.*	*Cedrus deodara*	*Neolitsea pallens*
1.	*Anomodon sp.*	-	+	-
2.	*Brachythecium sp.*	+	-	-
3.	*Ceratodon purpureus*	-	+	-
4.	*Ectropothecium sp.*	-	+	-
5.	*Entodon myurus*	-	+	+
6.	*E. prorepens*	-	-	+
7.	*Fabronia pusilla*	+	-	-
8.	*Rhizogonium sp.*	+	-	-

Altitude is also known to play an important role in hepatic distribution (Kashyap,1921; Srivastava,1998). In Western Himalaya, hepatic diversity is reported to increase upto a height of 2,218m from the plains and decrease thereafter (Kashyap,1921). Similar observations have been made for the hepatics of district Poonch and present study area (Tanwir 2005, Tanwir *et al*., in this volume). The moss species collected now, too reveal correlation with altitude (Table 4). With an increase in altitude, there is concomitant increase in species. Maximum numbers (25) of species have been collected between 1901-2100m and the minimum (9) from the lowest (500-1200m) altitudinal regime. The areas located between 1201-1900m are inhabited by 15 taxa.

A critical survey of Table 4 clearly reveals that:

a) Only one species (*Leucodon secundens*) occurs over a wide range (580-1650m) of altitude,

b) three species of *Ditrichum,* i.e. *D. homomallum*, *D. heteromallum* and *D. heterophyllum* grow at different altitudes (890m, 1650m and 2020m, respectively) and

c) all the epiphytic species (8) occur at high altitude (2020m) only. None of these have been collected from the lowest (500-1200m) or intermediate (1201-1900m) altitudinal ranges.

pH of the substratum is another important factor influencing the bryophyte distribution. Substrata inhabited by moss taxa studied presently range from acidic (4.7) to highly alkaline (9.2). Persual of Table 2 reveals that:

a) Out of 40 taxa, majority of species (29) grow exclusively on alkaline soil (7.5 and above),

b) majority of the taxa occurring on the substratum with acidic pH are epiphytes and

c) just one (2.5%) species (*Fabronia sp.*) inhabits substratum with neutral pH (7.2)

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