

LICHEN DISTRIBUTION IN MILAM GLACIER VALLEY OF PITHORAGARH DISTRICT IN UTTARAKHAND, INDIA

SANTOSH JOSHI AND D.K. UPRETI*

Lichenology Laboratory, National Botanical Research Institute

Rana Pratap Marg, Lucknow (UP) - 226 001, India

**E-mail : upretidk@rediffmail.com*

ABSTRACT

An enumeration of the diversity and distribution of lichens in Milam Glacier valley of Pithoragarh district in Uttarakhand is provided. The area shows an occurrence of 232 species of lichens belonging to 36 families and 73 genera. Parmeliaceae with 18 genera and 49 species and Physciaceae with 7 genera and 26 species dominate the area. Among different growth forms of lichens, foliose comprises the highest number of 104 species, followed by 87 crustose lichens. The valley exhibits maximum number of bark and rock inhabiting lichens represented by 132 and 123 species respectively.

Keywords: Lichens, Diversity, Milam Glacier Valley, Pithoragarh, Uttarakhand.

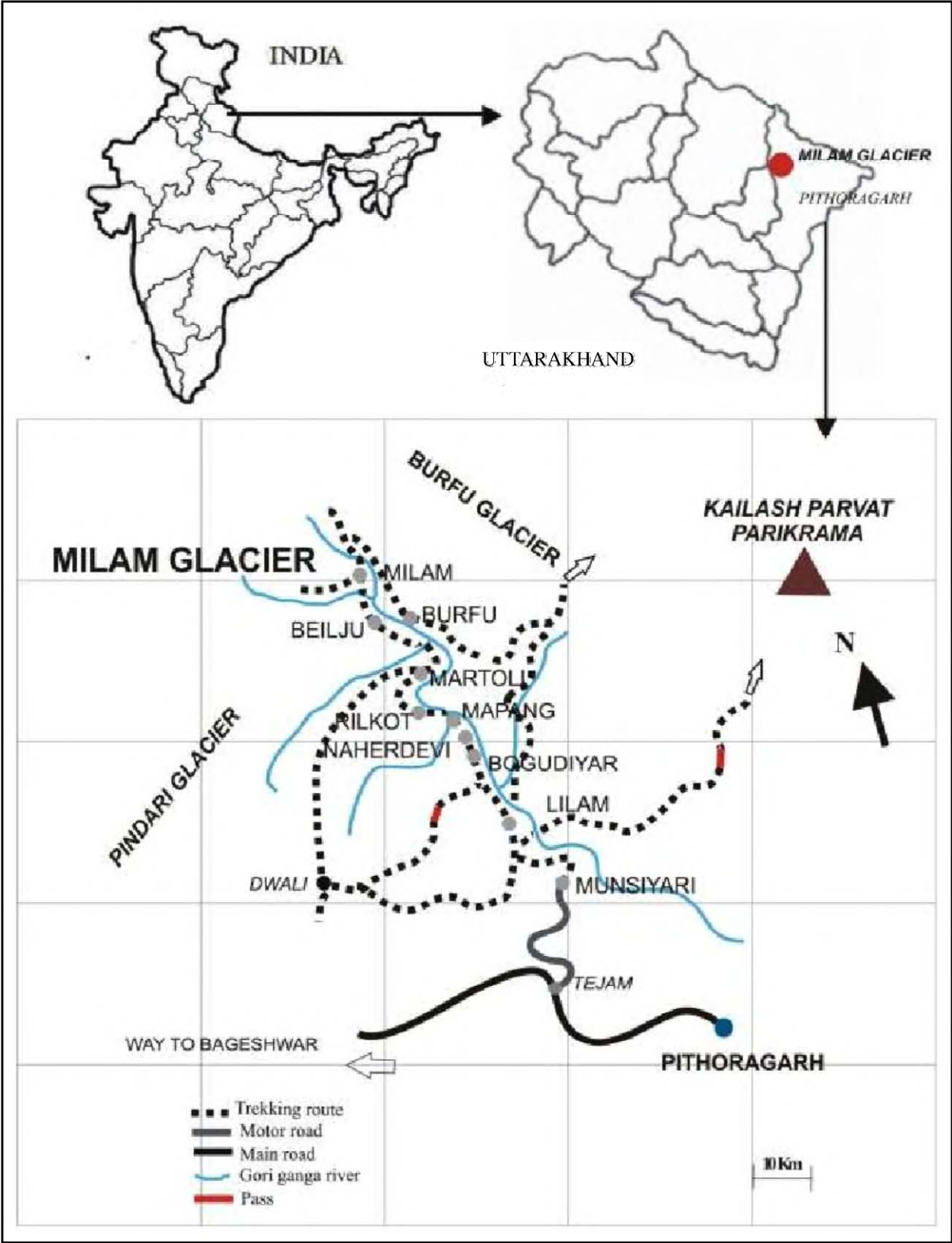
INTRODUCTION

Indian Himalaya has been known for its perennial floristic composition and is considered to be one of the major hot-spots comprising of different plant groups including lichens. These cryptogams play a vital role in maintaining the forest ecosystem and are the critical indicators of healthy environmental conditions. The high altitude region exhibits uniformity in lichen distribution pattern that shows a changing trend with altitudinal gradient. Slope aspects, substratum availability, moisture content, sunlight, UV radiations, temperature and water regimes are among the different micro and macro climatic conditions (factors) that decide the lichen flora of the region.

The Himalayas has been the major part of lichen exploration since eighteenth century. The temperate and easily accessible areas of the Uttarakhand Himalayas (Kumaun and Garhwal Himalayas) have been explored extensively and exhaustively in the past for their lichen wealth. The European botanists collected a large number of lichens from the Central Himalayas, but it was Babington (1852), who mentioned the occurrence of 44 species of which 4 species were new from the lichens collected by Strachey & Winterbottom (in the year 1846 - 49) from Kumaun Himalayas. Stirton (1879) reported 98 lichen taxa based on the collection of G. Watt, A. Watt, King and Thomson from Kumaun Himalayas and some state of east Himalayan region. D. D. Awasthi (1975) provided the floristic account based on the lichens of Pindari Glacier catchment area from Kapkote to Pindari glacier and enumerated 122 species of lichens belonging to 38 genera and 18 families. Upreti & Chatterjee (1999, 2000) ecologically studied the epiphytic lichen flora on *Quercus* and *Pinus* trees in Almora (presently Bageshwar) and Pithoragarh districts of Kumaun Himalayas and reported the occurrence of 64 and 93 lichen taxa respectively. Upreti & al. (2001) published an account of 52 species of lichens from Askote - Sandev Botanical Hot Spot in the Pithoragarh district of Kumaon hills. Pant (2002) enumerated 203 lichen species belonging to 64 genera and 32 families from the Askote - Sandev and Gori - Ganga botanical 'Hot Spot' of Pithoragarh district in Uttarakhand.

Upreti & al. (2010) provided a detailed enumeration of lichens distributed in different districts of Uttarakhand state. Out of 541 species reported by Upreti & al. (2010) 170 species are common to the present enumeration. Few cursory collections of lichens from the Milam Glacier valley were carried out in the past and the specimens were mentioned in some taxonomic (Joshi, 2010) and revisionary studies (Joshi, 2008) of Indian lichens.

Joshi, (2010) exhaustively surveyed the two major glacier valleys (Pindari and Milam) of Uttarakhand and lichen flora of Milam Glacier valley has been documented. The present study provides an account of lichen



Map 1. Localities surveyed for lichen collection in Milam Glacier valley.

species known from subtropical to alpine regions of the valley. The available account of the diversity and distribution of lichens not only enhances our present day knowledge in higher terrain, but also provides a new and detailed information for the preparation of a comprehensive up dated lichen flora of the high altitude glacier valley, which will have diverse significance related with climate change and other biomonitoring studies.

MATERIALS AND METHODS

a) Study area

The south facing Milam Glacier is one of the major glaciers of Asia with elevation ranges from about 5,500m to about 3,870m. The Milam Glacier Valley (popularly known as Johar Valley) is located in the upper catchment of river Gori Ganga (originates from the south of the glacier) in the district of Pithoragarh in Uttarakhand. The valley dimension spanned between 30°05'-30°30' N latitude & 80°05'-80°25' E longitude. The Milam glacier is formed by the snow precipitated from Eastern Trisul peaks (7735m) and surrounding number of rocky peaks and occupies a catchment area of 212sq.km. The total area covered in the present study ranges from 1800-3500m altitudes i.e. from timberline to snow line. The region of Milam glacier extends from Munsyari ranges 2250m., higher up to the glacier at 3500m. altitudes. Lilam, Bogudiyar, Naher Devi, Mapang, Rilkot, Burfu, Beilju, Martoli and Milam are the various inhabited localities on way to Milam glacier (Map 1). The region has a vast diversity of altitude, climate and geology which give rise to characteristic geographic and geomorphic environments from South to North. The valley shows a great deal of variations in floristic composition extending from temperate to alpine type.

Depending upon the altitudes and topography of the region the various localities enroute to the glacier shows diverse macro and microflora. As altitude represents a complex gradient in a mountainous region and along with which the abundance of a particular species and composition of a community changes continuously, the vegetation changes gradually from dense forest of Munsyari to high altitude grasslands (bugyals) of Martoli and Milam villages. The Goriganga valley is rich in alluvial soil and extensively used by the locals for terrace cultivation. A total of sixteen localities in Milam Glacier valley were surveyed for lichen diversity. The localities surveyed for lichen collections are Kalamuni, Khuliya Top, Munsyari (alt. 2200 - 2900m); Munsyari to Lilam (alt. 2250 - 1800m); Nain Singh Top, Lilam to Bogudiar (1800 - 2900m); Bogudiar to Naher Devi (2450 - 2705m); Naher Devi to Mapang (2705 - 3160m); Mapang to Rilkot (3160 - 3200m); Rilkot to Burfu (3200 - 3250m); Burfu, Beilju (3250 - 3420m); Martoli, Martoli to Milam (3390 - 3434m); Milam, Milam to Milam Glacier (3434 - 3500m).

b) Collection and Identification

Lichen collections were made by one of the authors (SJ) in the month of October 2007 and deposited in the lichen herbarium of National Botanical Research Institute (CSIR), Lucknow (LWG). At each locality trees, rocks and the ground were thoroughly searched for extensive collection of lichens.

The samples were collected with annotated data based on their habit, habitat, micro and macro-climatic conditions. The identification of lichens was carried out with the help of literature by Awasthi (1988, 1991, 2000, 2007) and methodology provided by Orange & al. (2001).

RESULTS AND DISCUSSION

The exhaustive field survey of 16 sites (enroute Munsyari to Milam) in 2007 revealed the occurrence of 232 lichen species represented by 36 families and 73 genera (Table 1, Fig. 1). The study area comprised of the temperate and alpine region of Milam Glacier valley in Kumaun Himalayas of Uttarakhand. The area exhibits much diversity of all the growth forms of lichens known to occur in the state. It represents about 43 % of the lichens known from Uttarakhand, 18% from Indian Himalayas and about 8% of the total lichens known from India. The macrolichens (foliose-fruticose form) dominate the area represented by 192 taxa (82.7%) while only 40 microlichens (leprose-crustose-placoid-squamulose form) (17.2%) are known from the valley.

The dominance of foliose lichens followed by crustose species was observed in the valley however, *Lecanora muralis* and *Lobaria retigera* have the wide ecological niche as both the species are found growing in

Table 1: Diversity of lichens in Milam Glacier valley.

S. No.	Taxa	Habit	Habitat	K	Kt	Mu	ML	NST	LB	BN	NM	MR	RB	B	Be	Mar	MarMil	Mil	MG	Specimen examined (Voucher no.) LWG*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
ACAROSPORACEAE																				
1	<i>Acarospora badiofusca</i> (Nyl.) Th. Fr.	cr	s	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	07-010495
2	<i>Acarospora bullata</i> Anzi	cr	s	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	07-010528
3	<i>Acarospora fusca</i> B. de Lesd.	sq	s	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006246
4	<i>Acarospora peltastica</i> Zahlbr.	cr	s	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	07-010354
5	<i>Acarospora saxicola</i> Fink ex Hedrick	sq	s	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	07-010520
6	<i>Acarospora smaragdula</i> (Wahlenb. In Ach.) Massal.	sq	s	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	07-010345
7	<i>Acarospora strigata</i> (Nyl.) Jatta	cr	s	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	07-010519
8	<i>Pleopsidium flavum</i> (Bell) körb.	cr	s	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	07-010346
ALECTORIACEAE																				
9	<i>Sulcaria sulcata</i> (Lév) Bystr. ex Brodo & D. Hawksw.	fr	c	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006935
ARTHONIACEAE																				
10	<i>Arthothelium abnorme</i> var. <i>abnorme</i> (Ach.) Müll. Arg.	cr	c	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007058
ARTHOPYRENIACEAE																				
11	<i>Arthopyrenia alboatra</i> (Kremp.) Müll. Arg.	cr	c	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	L104622
CANDELARIAACEAE																				
12	<i>Candelaria indica</i> (Hue) Vain.	fo	c	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	07-010571
13	<i>Candelariella aurella</i> (Hoffm.) Zahlbr.	cr	s	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	07-010543
14	<i>Candelariella vitellina</i> (Ehrh.) Müll. Arg.	cr	s	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	07-010549
CHRYSOTHRICEAE																				
15	<i>Chrysothrix candelaris</i> (L.) J.R. Laundon	lep	s	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	07-010511
CLADONIACEAE																				
16	<i>Cladonia cartilaginea</i> Müll. Arg.	fr	t	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	07-010350
17	<i>Cladonia chlorophaea</i> (Flörke ex Sommerf.) Spreng.	fr	t, c	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	212948
18	<i>Cladonia coccifera</i> (L.) Willd.	fr	t	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006287
19	<i>Cladonia corniculata</i> Ahti & Kashiw.	fr	t	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	102705
20	<i>Cladonia corymbescens</i> Nyl. ex Leight.	fr	t, c	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	212953
21	<i>Cladonia leuteoalba</i> Wheldon & A. Wilson	fr	t	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	212909
22	<i>Cladonia macilenta</i> Hoffm.	fr	t, l	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	L104613
23	<i>Cladonia pyxidata</i> (L.) Föffm.	fr	t	-	-	-	+	-	-	-	+	-	-	+	-	-	-	-	-	07-010482
24	<i>Cladonia ramulosa</i> (With.) J. R. Laundon	fr	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L104637
25	<i>Cladonia rangiferina</i> (L.) Wigg.	fr	t	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	07-010462
26	<i>Cladonia squamosa</i> Hoffm.	fr	t	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	s.n.

COCCOCARPIACEAE									
27	<i>Coccocarpia erythroxyli</i> (Spreng.) Swinse. & Krog	fo	c, m, t, s	-	-	-	-	+	07-010343
COLLEMATACEAE									
28	<i>Collema crispum</i> (Huds) G. H. Web.	fo	s	-	-	+	-	-	07-010396
29	<i>Collema cristatum</i> (L.) G. H. Web. ex Wigg.	fo	s	-	-	-	-	-	102802
30	<i>Collema fuscovirens</i> (With.) J. R. Laundon	fo	s	-	-	-	+	+	102803
31	<i>Collema leptaleum</i> var. <i>leptaleum</i> Tuck.	fo	c	-	-	-	-	-	102787
32	<i>Collema polycarpon</i> Hoffm.	fo	s	-	-	-	-	-	102813
33	<i>Collema pulcellum</i> Ach. <i>subnigrescens</i> (Müll. Arg.) Degel	fo	c, s	-	-	+	-	-	102788
34	<i>Collema shroumanum</i> var. <i>shroumanum</i> Yasuda	fo	c	-	-	+	-	-	102696
35	<i>Collema tenax</i> var. <i>tenax</i> (Sw.) Ach.	fo	s	-	-	+	-	-	102859
36	<i>Leptogium asiaticum</i> P. M. Jørg.	fo	c, s	-	-	+	-	-	104666/C
37	<i>Leptogium askotense</i> D. D. Awasthi	fo	c, t	+	-	-	-	-	212932
38	<i>Leptogium burnetiae</i> C. W. Dodge	fo	c, t, s	-	+	+	-	-	07-010409
39	<i>Leptogium delavayi</i> Hue	fo	c, m	+	-	+	-	-	07-010404
40	<i>Leptogium denticulatum</i> Nyl.	fo	c	-	+	-	-	-	06-007079
41	<i>Leptogium furfuraceum</i> (Harm.) Sierk	fo	c	-	-	+	-	-	07-010408
42	<i>Leptogium pedicellatum</i> P. M. Jørg.	fo	c, t, s, m	-	-	+	-	-	07-010402
43	<i>Leptogium saturninum</i> (Dicks.) Nyl.	fo	c, s	-	+	-	-	-	212937
44	<i>Leptogium trichophorum</i> Müll. Arg.	fo	c, t, m	+	-	+	-	-	07-010405
FUSCIDEACEAE									
45	<i>Maronea constans</i> (Nyl.) Hepp	cr	c	-	-	-	+	-	L104662
GRAPHIDACEAE									
46	<i>Graphis anfractulosa</i> (Eschw.) Eschw.	cr	c	-	+	-	-	-	L104643
47	<i>Graphis duplicata</i> Ach.	cr	c	-	+	-	-	-	L104624
48	<i>Graphis lineola</i> Ach.	cr	c	-	+	-	-	-	06-007047
49	<i>Graphis proserpens</i> Vain.	cr	c	-	+	-	-	-	06-007033
50	<i>Graphis scripta</i> (L.) Ach.	cr	c	+	-	-	-	-	816
HYMENELIACEAE									
51	<i>Aspicilia almorensis</i> Räsänen.	cr	s	-	+	-	+	-	07-010575
52	<i>Aspicilia caesiocinerea</i> (Nyl. Ex Malbr.) Arnold	cr	s	-	+	-	-	-	07-010525
53	<i>Aspicilia calcarea</i> (L.) Sommerf.	cr	s	+	-	+	+	+	07-010565
54	<i>Aspicilia cinerea</i> (L.) Kürb.	cr	s	-	-	+	-	-	07-010766
55	<i>Aspicilia dwalensis</i> Räsänen.	cr	s	-	-	-	-	-	06-006923
56	<i>Aspicilia maculata</i> (H. Magn.) Oksner	cr	s	-	+	-	-	-	07-010560
57	<i>Lobothallia praepradiosa</i> (Nyl.) Hafellner	p	s	-	-	-	+	+	07-010768
LECANORACEAE									
58	<i>Lecanora achroa</i> Nyl.	cr	c	+	-	-	-	-	06-006266
59	<i>Lecanora alba</i> Lumbsch	cr	c	-	+	-	-	-	06-006282
60	<i>Lecanora campestris</i> (Schaer.) Hue	cr	s	-	-	-	-	-	07-010393
61	<i>Lecanora cinereofusca</i> var. <i>cinereofusca</i> H. Magn.	cr	s, c	-	-	-	-	-	L104630
62	<i>Lecanora concilianda</i> Vain.	cr	c	-	-	-	-	-	L104609
63	<i>Lecanora concilians</i> Nyl.	cr	c	-	+	-	-	-	06-007010
64	<i>Lecanora fimbriatula</i> Stirt.	cr	c	+	+	-	-	-	06-007040

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
65	<i>Lecanora flavidofusca</i> Müll. Arg.	cr	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-010705
66	<i>Lecanora formosula</i> Lumbsch	cr	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006284
67	<i>Lecanora helva</i> Stizenb.	cr	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007031
68	<i>Lecanora indica</i> Zahlbr.	p	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	07-010526
69	<i>Lecanora japonica</i> Müll. Arg.	cr	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06- 007042
70	<i>Lecanora muralis</i> var. <i>dubyi</i> (Müll. Arg.) Poelt	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	102827/B
71	<i>Lecanora muralis</i> (Schreb.) Rabenh. var. <i>muralis</i>	p	-	-	-	-	-	+	+	-	+	+	+	+	+	-	+	-	07-010516
72	<i>Lecanora polytropia</i> (Ehrh.) Rabenh.	cr	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	07-010384
73	<i>Lecanora subimmersa</i> (Fée) Vain.	cr	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	07-008902
74	<i>Lecanora sulphureascens</i> Fée	cr	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006295
75	<i>Lecanora valesiaca</i> (Mü. I. Arg.) Stizenb.	cr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	102837
76	<i>Tephromela khatiensis</i> (Räsänen) Lumbsch	cr	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	07-010421
LECIDEACEAE																			
77	<i>Lecidea paraclitica</i> Nyl.	cr	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	L104691
78	<i>Lecidea turgidula</i> Fr.	cr	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	L104645
LICHEN IMPERFECTI																			
79	<i>Leprocaulon arbuscula</i> (Nyl.) Nyl.	fo	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007043
LOBARIACEAE																			
80	<i>Lobaria kurokawae</i> Yoshim.	cr	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	06-007089
81	<i>Lobaria meridionalis</i> Va.n.	fo	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007088
82	<i>Lobaria pindarenensis</i> Räsänen.	fo	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007087
83	<i>Lobaria retigera</i> (Bory) Trevis.	fo	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	07-010481
84	<i>Sticta limbata</i> (Sm.) Ach.	fo	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-	07-010478
85	<i>Sticta nylanderiana</i> Zahlbr.	fo	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007084
86	<i>Sticta platyphylloides</i> Nyl.	fr	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	s.n.
MONOBLASTACEAE																			
87	<i>Anisomeridium nidulans</i> (Müll. Arg.) R. C. Harris	cr	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007055
NEPHROMATACEAE																			
88	<i>Nephroma helveticum</i> Ach.	fo	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	102779
PANNARIACEAE																			
89	<i>Fuscopannaria saltuensis</i> P. M. Jørg.	sq	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	07-010454
90	<i>Fuscopannaria subgennarascens</i> Upreti & Divakar	sq	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007069
91	<i>Pannaria emodii</i> P. M. Jørg.	sq	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	L104664
PARMELIACEAE																			
92	<i>Bulbothrix meizospora</i> (Nyl.) Hale	fo	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	07-010442
93	<i>Bulbothrix sensibilis</i> (Stein. & Zahlbr.) Hale	fo	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	07-010447
94	<i>Bulbothrix settschwanensis</i> (Zahlbr.) Hale	fo	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	07-010380
95	<i>Canoparmelia texana</i> (Tuck.) Elix & Hale	fo	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	07-010424
96	<i>Cetrelia braunsiana</i> (Müll. Arg.) W.L. Culb. & C. F. Culb.	fo	+	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	07-010431

NELUMBO

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
140	<i>Xanthoparmelia tinctina</i> (Maheu & A. Gillet) Hale	fo	s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	102843
PELTIGERACEAE																				
141	<i>Peltigera canina</i> (L.) Willd.	fo	t, c, s	+	+	-	+	-	+	+	+	-	-	-	-	-	-	-	-	07-010568
142	<i>Peltigera dolichorrhiza</i> (Nyl.) Nyl.	fo	t	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	07-010584
143	<i>Peltigera elisabethae</i> Gyeln.	fo	t	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	07-010340
144	<i>Peltigera membranacea</i> (Ach.) Nyl.	fo	t, s	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	07-010331
145	<i>Peltigera praetextata</i> (Flörke) Zopf.	fo	t, s, c	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	07-010332
146	<i>Peltigera rufescens</i> (Weis.) Humb.	fo	t, s, c	-	-	-	+	-	+	+	+	-	-	-	-	-	-	-	-	07-010473
PELTULACEAE																				
147	<i>Peltula patellata</i> (Bagl.) Swinscow & Krog	sq	s	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	102816
PERTUSARIACEAE																				
148	<i>Ochrolechia rosella</i> (Müll. Arg.) Verseghy.	cr	c	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	06-006265
149	<i>Ochrolechia subpallescens</i> Verseghy.	cr	c	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	06-007017
150	<i>Ochrolechia yasudae</i> var. <i>corallina</i> Poelt	cr	c	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007023
151	<i>Pertusaria albens</i> (Huds.) M. Choisy & Werner	cr	c	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006268
152	<i>Pertusaria amara</i> (Ach.) Nyl.	cr	c	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007037
153	<i>Pertusaria coronata</i> (Ach.) Th. Fr.	cr	c	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007029
154	<i>Pertusaria leucosora</i> Nyl.	cr	s	+	-	-	+	-	+	+	+	-	-	-	-	-	-	-	-	07-010426
155	<i>Pertusaria leucosporodes</i> Nyl.	cr	c	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	06-002026
156	<i>Pertusaria leucostoma</i> (Bernh.) A. Massal.	cr	c	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	L104668/C
157	<i>Pertusaria rigida</i> Müll. Arg.	cr	c	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-002064
158	<i>Pertusaria subochracea</i> Stirt.	cr	c	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-007032
PHYSICIACEAE																				
159	<i>Buellia maculata</i> Bungartz & Nash	cr	s	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	07-010458
160	<i>Dimelaena oreina</i> (Ach.) Norman.	cr	s	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	07-010507
161	<i>Heterodermia albidiflava</i> (Kurok.) D. D. Awasthi	fo	c	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	L104602/A
162	<i>Heterodermia angustiloba</i> (Müll. Arg.) D. D. Awasthi	fo	c, s	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006262
163	<i>Heterodermia boryi</i> (Fée) Kr. P. Singh & S. R. Singh	fo	c, t	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	102699
164	<i>Heterodermia comosa</i> (Eschw.) Follmann & Red.	fo	c	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	07-010776
165	<i>Heterodermia dactyliza</i> (Nyl.) Swinscow & Krog	fo	s, c	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06- 007090
166	<i>Heterodermia diademata</i> (Taylor) D. D. Awasthi.	fo	c, t, s	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	07-010471
167	<i>Heterodermia dissecta</i> var. <i>koyana</i> (Kurok.) J. C. Wei	fo	c, s	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	07-010401
168	<i>Heterodermia firmula</i> (Nyl.) Trevis	fo	s	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	07-010381
169	<i>Heterodermia hypocaesia</i> (Yasuda) D. D. Awasthi	fo	c	-	-	+	-	-	+	+	-	-	-	-	-	-	-	-	-	07-010382
170	<i>Heterodermia incana</i> (Stirt.) D. D. Awasthi	fo	c	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	102738/A
171	<i>Heterodermia japonica</i> (Sato) Swinscow. & Krog	fo	c, s	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	18487
172	<i>Heterodermia leucomelos</i> (L.) Poelt	fo	c, s, t	-	+	-	-	+	+	+	-	-	-	-	-	-	-	-	-	07-010374
173	<i>Heterodermia microphylla</i> (Kurok.) Skorepa	fo	c, t, s	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	07-010370
174	<i>Heterodermia pseudospectiosa</i> (Kurok.) W. L. Culb.	fo	c, t	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	06-006256
175	<i>Heterodermia rubescens</i> (Räsänen.) D. D. Awasthi	fo	c	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	102736
176	<i>Heterodermia spectiosa</i> (Wulf.) Trevis.	fo	c, s	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	06- 006257
177	<i>Phaeophyscia hispidaula</i> (Ach.) Essl.	fo	c, s, t	-	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	07-010467
178	<i>Phaeophyscia pyrrhophora</i> (Poelt)	fo	c	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	102768

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
213 <i>Caloplaca lopera</i> Poelt & Hinter.	cr	s	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006276
214 <i>Caloplaca ochropalca</i> Poelt & Hinter.	cr	s	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006276
215 <i>Caloplaca squamosa</i> (de Lesd.) Zahlbr.	cr	s	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	07-010572
216 <i>Toplaca pindarensis</i> (Räsänen.) Poelt & Hinter.	fo	s	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006228
217 <i>Xanthoria elegans</i> (Link) Th. Fr.	fo	s	-	-	-	-	-	+	-	-	-	+	+	+	+	+	+	-	07-010530
218 <i>Xanthoria parietina</i> (L.) Th. Fr.	fo	s	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	102845
219 <i>Xanthoria sorediata</i> (Vain.) Poelt	fo	s	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	102815
THELOTREMATACEAE																			
220 <i>Diploschistes actinostomus</i> (Pers. ex Ach.) Zahlbr.	cr	s	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	07-010319
221 <i>Diploschistes candidissimus</i> (Krenph.) Zahlbr.	cr	s	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	07-010349
222 <i>Diploschistes scruposus</i> (Schreb.) Norman	cr	s	-	-	-	+	-	-	+	-	-	-	-	-	+	-	-	-	07-010316
TRYPETHELIACEAE																			
223 <i>Lithothelium himalayense</i> Upreti & Aptroot	cr	c	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	212956
UMBILICARIACEAE																			
224 <i>Umbilicaria indica</i> Frey	fo	s	-	+	-	-	+	-	+	-	-	-	-	-	-	-	-	-	07-010575/C
225 <i>Umbilicaria virginis</i> Schaer.	fo	s	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	07-010769
226 <i>Umbilicaria yumana</i> (Nyl.) Hue	fo	c	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	06-006248
VERRUCARIACEAE																			
227 <i>Dermatocarpon minutum</i> (L.) W. Mann.	fo	s	-	+	-	+	-	+	+	+	+	+	-	-	-	-	-	-	07-010325
228 <i>Dermatocarpon vellereum</i> Zschacke	fo	s	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	+	07-010323
229 <i>Endocarpon nanum</i> A. Singh & Upreti	cr	s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	07-010546
230 <i>Endocarpon pusillum</i> Hedwig	cr	s	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	07-010551
231 <i>Staurothele fissia</i> (Taylor) Zwackh	cr	s	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	06-006929
232 <i>Verrucaria acrotella</i> Ach.	cr	s	-	+	-	+	-	+	-	+	-	-	-	-	-	-	-	-	07-010562
Total				41	86	35	47	59	55	28	29	12	6	8	11	14	4	11	8

NELUMBO

Abbreviations:

K=Kalamuni, Kt=Khuliya Top, Mu=Munsiyari, ML=Munsiyari-Lilam, NST=NainSingh Top, LB=Lilam-Bogudiyar, BN=Bogudiyar-NaherDevi, NM=NaherDevi-Mapang, MR=Mapang-Rilkot, RB=Rilkot-Burfu, B=Burfu, Be=Beilju, Mar=Martoli, MarMil=Martoli-Milam, Mil=Milam, MG=Milam Glacier vicinity; lep=leprose, cr=crustose, p= placoid, sq=squamulose, fo=foliose, fr=fruticose; s=saxicolous, c=corticolous, t=terricolous, l=lignicolous, LWG=Herbarium of National Botanical Research Institute (CSIR), Lucknow.

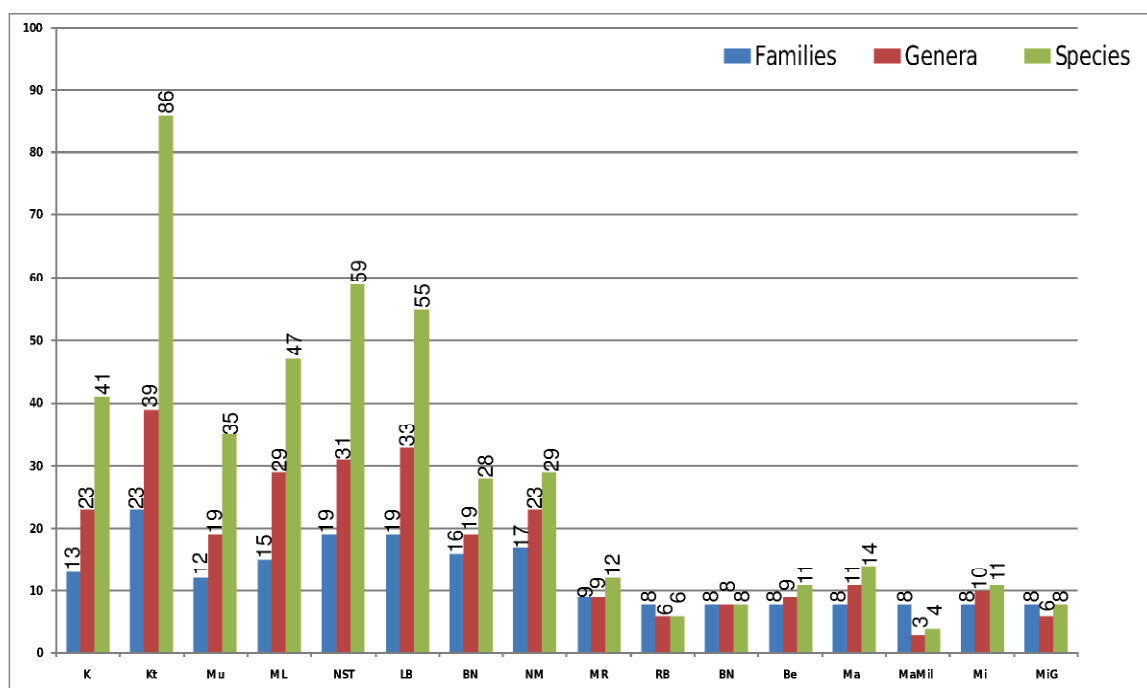


Fig. 1. Diversity of lichens in different localities of Milam Glacier valley.

Table 2. Total number of lichens based on habitat reported from Milam Glacier valley.

Habitat	Total number
Corticolous (C)	88
Saxicolous (S)	83
Terricolous (T)	12
Corti., Saxi. (CS)	22
Corti., Terri. (CT)	6
Saxi., Terri. (ST)	5
Corti., Saxi., Terri. (CST)	11
Corti., Musci. (CM)	1
Corti., Terri., Musci. (CTM)	1
Corti., Saxi., Terri., Musci. (CSTM)	2
Terri., Ligni. (TI.)	1

Table 3. Total number of lichen growth forms reported from Milam Glacier valley.

Growth form	Total number
Leprose (Lep)	1
Crustose (Cr)	85
Placodioid (P)	4
Squamulose (Sq)	8
Foliose (Fo)	104
Fruticose (Fr)	30

Table 4. Total number lichen growth forms reported as per locality from Milam Glacier valley

Localities surveyed	Lep	Cr	P	Sq	Fo	Fr
K	-	14	-	-	21	6
Kt	-	34	-	2	5	15
Mu	-	9	-	-	25	1
ML	-	11	-	1	33	2
NST	-	14	-	-	33	12
LB	-	10	2	1	37	5
BN	1	5	1	2	17	2
NM	-	10	-	1	14	4
MR	-	4	2	1	4	1
RB	-	1	1	1	2	1
B	-	2	1	-	3	2
Be	-	4	2	1	4	-
Mar	-	9	2	-	2	1
MarMil	-	-	-	-	4	-
Mil	-	6	1	-	4	-
MG	-	1	2	-	5	-

Table 5. Total number of lichens based on habitat reported as per locality from Milam Glacier valley.

Localities surveyed	C	S	T	CS	CT	ST	CST	CM	CTM	CSM	CSTM	TL
K	22	3	-	7	2	2	3	1	1	-	-	-
Kt	45	16	3	7	6	1	8	-	-	-	-	-
Mu	14	7	1	7	2	-	3	-	1	-	-	-
ML	12	17	1	7	-	1	8	1	-	-	-	-
NST	33	3	2	10	1	1	5	1	1	-	1	1
LB	10	21	3	7	-	4	6	1	1	-	2	-
BN	3	14	2	1	1	2	5	-	-	-	-	-
NM	-	15	3	2	-	1	6	-	-	-	2	-
MR	-	11	-	-	-	1	-	-	-	-	-	-
RB	-	3	1	-	-	1	-	-	-	-	1	-
B	-	6	1	-	-	1	-	-	-	-	-	-
Be	-	11	-	-	-	-	-	-	-	-	-	-
Mar	-	12	1	-	-	-	1	-	-	-	-	-
MarMil	-	4	-	-	-	-	-	-	-	-	-	-
Mil	-	11	-	-	-	-	-	-	-	-	-	-
MG	1	7	-	-	-	-	-	-	-	-	-	-

eight localities surveyed for lichen collection, followed by *Dermatocarpon vellereum*, *D. miniatum*, *Heterodermia diademata* and *Stereocaulon foliolosum* that show dominance over seven sites. The climatic conditions of the valley are more suitable for the growth of *Lecanora* and *Heterodermia* as both the genera are represented by maximum number of 18 and 16 species respectively. *Acarospora*, *Caloplaca*, *Cladonia*, *Collema* and *Pertusaria* are the other commonly distributed taxa in the valley. The remaining most of the genera have restricted distribution either to temperate or alpine localities. *Anisomeridium*, *Arthopyrenia*, *Arthothelium*,

Buellia, *Byssoloma*, *Canoparmelia*, *Cetrelia*, *Chrysothrix*, *Lecidea*, *Lithothelium*, *Maronea*, *Melanelia*, *Pannaria*, *Peltula*, *Staurothele* and *Sulcaria* collected from a single locality. Among the different families Parmeliaceae dominates the region with 49 species belonging to 18 genera together with Physciaceae and Lecanoraceae having 26 and 19 species belonging to 7 and 2 genera respectively. Alectoriaceae, Arthoniaceae, Arthopyreniaceae, Chrysothricaceae, Coccocarpiaceae, Fuscideaceae, Monoblastaceae, Nephromataceae, Peltulaceae, Pilocarpaceae, Psoraceae and Trypetheliaceae are represented by a single taxon. The valley has a large tract completely devoid of woody (tree) vegetation. The rich diversity of phorophytes in temperate region and rocky upper zone provide excellent opportunities for both bark and rock inhabiting lichens to grow. The valley is represented by 131 corticolous (56.4%) and 123 saxicolous (53%) lichens (Table 2). The region exhibits maximum number of 104 foliose (44.8%) followed by 85 crustose (36.6%) and 30 fruticose lichens (12.9%). Some gatherings of intermediate lichen forms like 8 squamulose (3.4%), 4 placodioid (1.7%) and one leprose (0.4%) were also found (Table 3).

Based on localities Khuliya Top exhibits the maximum diversity of 86 lichen species (37 %) followed by 59 in Nain Singh Top (25.4%), 55 enroute Lilam to Bogudiyar (23.7%) and 47 enroute Munsiyari to Lilam (20.2%) (Figure 1).

The type of phorophytes highly influences the distribution pattern of lichens inhabiting on them. The dense forest conditions with well defined demarcation in plant components in Khuliya and Nain Singh Tops provide different climatic conditions for different lichen taxa to flourish. *Quercus* trees being chief vegetation of Indian Himalayas play a vital role in deciding the lichen richness in forests between Lilam to Bogudiyar and Munsiyari to Lilam. The area on way from Martoli to Milam village constitutes lichen composition a minimum of 4 species (1.7 %) followed by area between Rilkot to Burfu with 6 (2.5%) and 8 (3.4%) species each in Burfu and Milam Glacier vicinity. The way from Martoli to Milam Glacier comprising of barren rocky mountain covered with alpine grasses (unstable substrate for lichen colonization highly influenced by wind and animal trampling). The instability accompanied by same habitat (substrate) conditions lead to decline in species composition.

Inhabited community of Mapang-Rilkot, Beilju, and Milam also bear the same climatic conditions having nominal lichen diversity of 12 (5.1%), 11(4.7%) and 11(4.7%) respectively. Moreover, heavy snowfall in the upper terrain of the valley also hindered the collection in these localities (Tables 4 and 5).

The valley has undulating topography in the lower half where altitude changes abruptly providing wide variation in temperature regime that leads to increase in lichen composition. The maximum number of 185 lichens (79.7%) reported from subtropical to temperate regions between altitudes of 1800-3000 m is recorded. Altitude above 3000m changes gradually up to the glacier and exhibits the occurrence of only 26 species (11.2%).

CONCLUSION

The higher altitude glacier valleys have significance in evaluating the impact of changing macro and microclimatic conditions. Their striated floral composition has limited ecological amplitude that promptly response to a slight change in their immediate environment conditions. Moreover, lichens are well known bioindicators in plant community. The species composition of lichens (based on distribution, growth form, habitat and photobiont) indicates the environmental/forest conditions of the region. Milam Glacier being an easily accessible valley is highly influenced by tourist gathering and other anthropogenic activities. The disturbance is enhanced by tribal communities/villagers having possible interference in forest stability. The extent of disturbance can be evaluated by a constant observation of lichens in the valley. As the study requires long time duration so the initiative work based on the diversity of lichens in the valley provides a base line data for conducting biomonitoring studies in future. Further studies based on the ecological parameters will also clear the picture of lichen distribution pattern in the valley and the localities highly influenced by biotic or abiotic factors.

ACKNOWLEDGEMENTS

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REFERENCES

- AWASTHI, D.D. 1975. Lichen flora of Pindari Glacier valley, India. *Geophytology* 5 (2): 178 - 185.
- AWASTHI, D.D. 1988. A key to macrolichens of India and Nepal. *J. Hattori Bot. Lab.* 65: 207 - 302.
- AWASTHI, D.D. 1991. A key to microlichens of India, Nepal and Sri Lanka. *Biblioth. Lichenol.* 40: 1 - 337.
- AWASTHI, D.D. 2000. *Lichenology in Indian subcontinent: A supplement to "A Handbook of Lichens"*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
- AWASTHI, D.D. 2007. *A Compendium of the Macrolichens from India, Nepal and Sri Lanka*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
- BABINGTON, C. 1852. Lichenes Himalayenses: being an enumeration of the lichens collected in the Himalayan Mountains by Captain R. Strachey of the Bengal Engineers and J.F. Winterbottom, Esqr. F.L.S. during the years 1847 - 48. *Hooker's J. Bot.* 4: 243 - 252.
- JOSHI, S. 2010. *Diversity of lichens in Pindari and Milam regions of Kumaun Himalaya*. Ph.D. Thesis. Kumaun University, Nainital.
- JOSHI, Y. 2008. *Morhotaxonomic studies on lichen family Teloschistaceae from India*. Ph.D. Thesis. Kumaun University, Nainital.
- ORANGE, A., P.W. JAMES, AND F.J. WHITE 2001. Microchemical Methods for the identification of lichens. British Lichen Society.
- PANT, V. 2002. *Biodiversity of lichens in botanical hot spots of Pithoragarh district, Uttaranchal*. Ph.D. Thesis, Kumaun University, Nainital.
- STIRTON, J. 1879. New and rare lichens from India and Himalayas. *Proc. Phil. Soc. Glasgow* 10: 156 - 164.
- UPRETI, D.K. AND S. CHATTERJEE 1999. Epiphytic lichens on *Quercus* and *Pinus* trees in the three forest stands in Pithoragarh district, Kumaun Himalayas, India. *Tropical Ecology* 40(1): 41 - 49.
- UPRETI, D.K. AND S. CHATTERJEE 2000. Distribution of lichens on *Quercus* and *Pinus* trees in Almora district, Kumaon Himalayas. *Geophytology* 28 (1 & 2): 41 - 49.
- UPRETI, D.K., S. NAYAKA AND S. CHATTERJEE 2010. Lichen Diversity of Uttarakhand Himalayas. In: Uniyal, P.L., Chamola, B.P. & Semwal, D.P. (eds), The plant wealth of Uttarakhand. 79 - 195. Jagdamba publishing Co. New Delhi.
- UPRETI, D.K., V. PANT AND P.K. DIVAKAR 2001. Distribution of lichens in Askot- Sandev Botanical Hot Spot of Pithoragarh district, Uttar Pradesh. *Phytotaxonomy* 1: 40 - 45.

Hkkj r d smÜkj k eafi Fkkskx <+ft y sd sfey e fgekuh ?kkVh e a' k kd for j. k

l a k k t k k h , o a M h d s m i g h

l k j k a k

mÜkj k eafi Fkkskx <+ft y sd sfey e fgekuh ?kkVh e a' k kd d h fo fo / r k , o a fo r j . k d k s i m f ' f d ; k x ; k g ; g { k e ' k kd d h d g 232 i z k f r ; k a d k i f r f u f / R o d j r k g S t k s 36 d g k a , o a 73 o a k a l s l a a j l k r h g { k e a ' k kd d g i k j e f y ; b h 18 o a k a , o a 49 i z k f r ; k a r F k f i Q l ; b h d g 7 o a k a , o a 26 i z k f r ; k a d s l k f k v i u h i e g k r k n ' k z h g S ' k kd e a i f . k z 104 i z k f r ; k a d s l k f k l o k z d g S f t l d h r g u k e a i i Z V h e ; ' k kd d o y 87 i z k f r ; k a d s l k f k d e f o f o / r k i m f ' k z d j r s g { k k V h e a o e ' k % o Y d o k h (i M k a d h N k y i j m x u s o k y \$ ' k kd 132 i z k f r ; k j 123 f ' k y k o k h (i R F k j k a i j m x u s o k y \$ i z k f r ; k i v i u h i e g k r k i m f ' k z d j r h g