

Assessment of Lichen Diversity in a Part of Madhyamaheshwar Valley of Garhwal Himalaya, Uttarakhand, India

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ABSTRACT

A comprehensive survey was carried out to evaluate the distribution pattern and diversity of lichens in the Madhyamaheshwar valley, Rudraprayag district, Uttarakhand. According to the data gathered, there are 60 species total, divided into 21 families and 33 genera. The extensive diversity of lichen growth types in the region is demonstrated by the presence of 25 species of crustose lichen, followed by 19 foliose and 16 fruticose. The data gathered from the survey indicates that the Parmeliaceae family, with 8 genera and 12 species, is the most prevalent family in the area, followed by the Cladoniaceae family, which has 1

genera and 8 species. The enumeration of lichens from Madhyamaheshwar valley survey reveals that as the altitude increases the number of lichen species also increases. More taxa will undoubtedly be added to the lichen flora of this valley by conducting a thorough study of lichen species in the surrounding areas. Future biomonitoring and bioprospecting studies in the area will be supported by the baseline data provided by the current lichen count.

Keywords Lichen diversity, Madhyamaheshwar valley, Rudraprayag district, Garhwal Himalaya, Uttarakhand.

INTRODUCTION

Lichen is a symbiotic relationship in which fungi and algae are intertwined from a single thallus (Alexopoulos and Mims 1979). Lichens are classified based upon the growth form into three groups: Crustose, Foliose and Fruticose (Nayaka 2014).

A rich diversity of lichens, comprising over 2714 species and accounting for nearly 13.57% of the 20,000 species of lichens currently known worldwide, can be found in India's vast geographical regions and varied climatic conditions (Sinha *et al.* 2018). There are 1200 different species of lichens in the western, central and eastern Himalayas. These lichens are growing because of the favorable climate and the presence of various phorophytes (Shukla *et al.* 2014). The central Himalayan state of Uttarakhand is divided into the Garhwal and Kumaun regions. The region's

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diverse geography and vegetation support over 658 species of lichens (Sinha *et al.* 2018, Singh and Sinha 2010). Karakoti *et al.* (2013) described the lichen flora of Uttarakhand Garhwal Himalayan region, listing 214 species from 80 genera and 34 families. All lichen growth forms were represented by 283 lichen species in the Kumaun Himalayan region, which is a part of Uttarakhand (Joshi *et al.* 2011). Additionally 246 macro-lichen species from 45 genera and 13 families were found in the Kumaun Himalayan region (Mishra and Upreti 2016).

MATERIALS AND METHODS

Survey and collection of lichens : Madhyamaheshwar Valley is located in Rudraprayag District, a part of Garhwal Himalayan region of Uttarakhand. The entire valley expands to about 262 sq km, for the present study we had selected 8 sites named Goundar village, Lower and Upper Bantoli, Khadarakhhal, Nanu-chatti, Maikhamba-chatti, Koon-chatti, Madhyamaheshwar, and Budha Madhyamaheshwar (Plate 1). The lichens were collected from the altitudinal range of 1650 to 3446 m asl and nearly expand about 13.92 sq km and lies between latitudes 30°36'22" N to 30°37'59" N and longitudes 79°11'12" E to 79°12'46" E (Table 1, Fig. 1).

The field survey conducted for collection of lichen flora at different altitudes of the Madhyamaheshwar Valley from the various substratum barks of tree, twigs, mosses, rock, soil and iron fencing (Plate 2). A chisel, twig cutter, and hammer were used to collect most of the crustose and foliose lichens that were tightly attached to the bark, twigs and rock, along with their ecological notes. The macro lichen samples that were hanging on the tree, branches, and trunk were picked by hand. The lichen herbarium packet (17 cm × 13 cm) contained the dried samples, which were packaged on hard card sheets and included information about the substratum, date of collection and location.

Identification

At the National Botanical Research Institute's Lichenology Laboratory in Lucknow, the morphological, anatomical, and chemical characteristics of the

Table 1. Geographical distribution of different sites in Madhyamaheshwar valley.

Sites	Altitude (m)	Latitude	Longitude
Goundar village	1650	30°36'22" N	79°11'22" E
Lower and upper Bantoli	1800	30°36'27" N	79°11'22" E
Khadarakhal	2127	30°36'30" N	79°11'42" E
Nanu-chatti	2257	30°36'41" N	79°12'05" E
Maikhamba-chatti	2668	30°37'14" N	79°12'24" E
Koon-chatti	2943	30°37'42" N	79°12'45" E
Madhyamaheshwar	3299	30°38'06" N	79°13'17" E
Budha Madhyamaheshwar	3446	30°37'59" N	79°12'46" E

collected specimens were investigated. With the help of the current literature, the lichen specimens have been identified and authenticated (Awasthi 1988, 1991, 2000, 2007, Walker and James 1980). The identified lichen specimens have been preserved at the National Botanical Research Institute's (LWG) Herbarium in Lucknow as well as at HNB Garhwal University (A Central University) in Srinagar, Uttarakhand.

RESULTS AND DISCUSSION

The nearly 16-km trek from Goundar village to Budha Madhyamaheshwar reveals an estimated number of 60 species from 33 genera and 21 families (Table-2). The area demonstrates much diversity of all the growth forms of lichen species and is represented by the occurrence of 25 crustose followed by 19 foliose and 16 fruticose (Fig. 2). This information obtained from this survey shows that Parmeliaceae is the most dominant family belonging to 8 genera and 12 species followed by Cladoniaceae family with 1 genera and 8 species. Next to above mentioned families is Graphidaceae occurs with 1 genera and 6 species. Lecanoraceae family with 2 genera and 5 species. Lobariaceae and Pertusariaceae family with 2 genera and 3 species. Ramalinaceae family 1 genera and 3 species. Physciaceae and Teloschistaceae family with 2 genera and 2 species. The following families Collemataceae, Lecideaceae, Megasporaceae and Stereocaulaceae family with 1 genera and 2 species. The remaining families Acarosporaceae, Caliciaceae, Chrysotrichaceae, Ochrolechiaceae, Peltigeraceae, Rhizocarpaceae, Umbilicariaceae, and Verrucariaceae

Table 2. An enumeration of lichens from Madhyamaheshwar valley. Summarization : 1- Goundar village, 2- Lower and Upper bantoli, 3- Khadarakhal, 4- Nanu, 5- Maikhamba, 6-Koonchatti, 7- Madhyamaheshwar, 8- Budha - Madhyamaheshwar. Presence (+), Absence (-).

Sl. No.	Lichen taxa	S1	S2	S3	S4	S5	S6	S7	S8	Substrata
	Acarosporaceae									
1	<i>Pleopsidium flavum</i> (Trevis) Körb.	-	-	-	-	-	-	+	+	Rock
	Caliciaceae									
2	<i>Buellia himalayensis</i> (S.R. Singh and D.D. Awasthi) A. Nordin	-	-	-	-	-	-	+	-	Bark
	Chrysotrichaceae									
3	<i>Chrysothrix candelaris</i> (L.) J.R. Laundon	+	-	-	-	-	-	-	-	Bark
	Cladoniaceae									
4	<i>Cladonia corniculata</i> Ahti and Kashiw	-	-	-	-	-	+	+	+	Deadwood, mosses
5	<i>Cladonia fimbriata</i> (L.) Fr.	-	-	-	-	-	-	-	+	Bark
6	<i>Cladonia fruticulosa</i> Kremp.	-	-	+	+	-	-	-	-	Soil
7	<i>Cladonia laii</i> S. Stenroos	-	-	-	-	-	-	+	+	Mosses
8	<i>Cladonia pocillum</i> (Ach.)	-	-	-	-	-	-	+	+	Rock
9	<i>Cladonia pyxidata</i> (L.) Hoffm	-	-	-	-	-	-	+	+	Mosses
10	<i>Cladonia squamosa</i> Hoffm.	-	-	-	-	-	-	-	+	Rock
11	<i>Cladonia subulata</i> (L.) F.H. Wigg.	-	-	+	+	-	-	-	-	Soil
	Collembataceae									
12	<i>Leptogium askotense</i> D.D. Awasthi	-	-	-	-	-	+	-	+	Bark, mosses
13	<i>Leptogium delavayi</i> Hue	-	-	-	+	-	-	-	-	Mosses
	Graphidaceae									
14	<i>Graphis</i> cfr. <i>duplicata</i> Ach.	-	-	-	-	-	-	+	+	Bark
15	<i>Graphis furcata</i> Fée	-	-	-	-	-	-	-	+	Bark
16	<i>Graphis scripta</i> (L.) Ach.	-	-	-	-	-	-	+	+	Bark
17	<i>Graphis</i> sp1	-	-	-	-	-	-	-	+	Bark
18	<i>Graphis</i> sp2	-	-	-	+	-	-	-	-	Bark, twigs
19	<i>Graphis</i> sp3	-	-	-	-	-	-	-	+	Bark
	Lecanoraceae									
20	<i>Lecanora fimbriatula</i> Stirt.	-	-	-	-	-	+	+	-	Bark
21	<i>Lecanora interjecta</i> Müll. Arg.	-	-	-	-	-	-	-	+	Bark, twigs
22	<i>Lecidella carpathica</i> Körb.	-	-	-	-	-	-	-	+	Rock
23	<i>Lecidella euphorea</i> (Flörke) Kremp.	-	-	-	-	-	-	-	+	Bark
24	<i>Lecidella elaeochroma</i> (Ach.) M. Choisy	-	-	-	-	-	-	+	+	Bark
	Lecideaceae									
25	<i>Porpidia crustulata</i> (Ach.) Hertel and Knoph	-	-	-	-	-	-	-	+	Rock
26	<i>Porpidia macrocarpa</i> (DC.) Hertel and A.J Schwab	-	-	-	-	-	-	-	+	Rock
	Lobariaceae									
27	<i>Lobaria kurokawae</i> Yoshim	-	-	-	-	-	+	-	-	Mosses
28	<i>Lobaria retigera</i> (Bory) Trevis.	-	+	-	-	-	-	-	+	Mosses
29	<i>Sticta henryana</i> Müll. Arg.	-	-	-	-	-	-	-	+	Bark
	Megasporaceae									
30	<i>Aspicilia cinerea</i> (L.) Körb.	-	-	-	-	-	-	+	+	Rock
31	<i>Aspicilia dwaliensis</i> Räsänen	-	-	-	-	-	-	+	+	Rock
	Ochrolechiaceae									
32	<i>Ochrolechia subpallascens</i> Verseghy	-	-	-	-	-	-	+	+	Bark
	Parmeliaceae									
33	<i>Dolichousnea longissima</i> (Ach.) Articus	-	-	-	-	-	+	+	+	Twigs
34	<i>Flavoparmelia caperata</i> (L.) Hale	+	+	+	+	+	+	+	+	Bark, rock
35	<i>Hypotrachyna cirrhata</i> (Fr.) Divakar <i>et al.</i>	-	-	-	-	-	-	+	-	Bark
36	<i>Hypotrachyna nepalensis</i> (Taylor) Divakar <i>et al.</i>	-	-	-	-	-	-	+	+	Bark, twigs
37	<i>Nephromopsis laii</i> (A. Thell and Randlane) Saag and A. Thell	-	-	-	-	-	+	+	+	Bark
38	<i>Parmelinella wallichiana</i> (Taylor) D.D. Awasthi	-	-	-	-	+	+	+	+	Bark, rock
39	<i>Parmotrema nilgherrensis</i> (Nyl.) Hale	-	-	-	-	+	+	+	+	Bark, rock
40	<i>Parmotrema reticulatum</i> (Taylor) M. Choisy	+	+	-	-	+	+	+	+	Bark, mosses, rock
41	<i>Parmotrema thomsonii</i> (Stirt.) A. Crespo, Divakar and Hawksw	-	-	-	-	+	+	+	+	Bark, rock
42	<i>Parmotrema tinctorum</i> (Despr. ex Nyl.) Hale	+	+	+	+	+	+	+	+	Bark, rock
43	<i>Sulcaria sulcata</i> (Lév) Bystrek ex Brodo and D. Hawksw	-	-	-	-	+	+	+	+	Twigs

Table 2. Continued.

Sl. No.	Lichen taxa	S1	S2	S3	S4	S5	S6	S7	S8	Substrata
44	<i>Usnea orientalis</i> Motyka Peltigeraceae	-	-	-	-	-	+	+	+	Twigs
45	<i>Peltigera membranacea</i> (Ach.) Nyl Pertusariaceae	-	-	-	-	-	-	-	+	Mosses
46	<i>Lepra leucosorodes</i> (Nyl.) I. Schmitt, B.G. Hodk and Lumbsch	-	-	-	-	-	-	-	+	Bark
47	<i>Pertusaria composita</i> Zahlbr.	-	-	-	-	-	-	-	+	Twigs
48	<i>Pertusaria velata</i> (Turner) Nyl. Physciaceae	-	-	+	-	+	-	-	-	Bark
49	<i>Heterodermia diademata</i> (Taylor) D.D. Awasthi	+	+	+	+	+	+	+	+	Bark, rock
50	<i>Polyblastidium microphyllum</i> (Kurok) Kalb. Ramalinaceae	-	-	-	-	-	+	+	+	Mosses
51	<i>Ramalina conduplicans</i> Vain	-	-	-	-	-	+	+	+	Bark, twigs
52	<i>Ramalina intermedia</i> (Delise ex Nyl.) Nyl.	-	-	-	-	-	+	+	-	Twigs
53	<i>Ramalina sinensis</i> Jatta Rhizocarpaceae	-	-	-	-	-	+	+	-	Twigs
54	<i>Rhizocarpon geographicum</i> (L.) DC Stereocaulaceae	-	-	-	-	-	-	-	+	Rock
55	<i>Stereocaulon foliolosum</i> var. strictum (C. Bab.) I.M. Lamb	-	-	-	-	-	-	-	+	Rock
56	<i>Stereocaulon myriocarpum</i> Th. Fr. Teloschistaceae	-	-	-	-	-	-	-	+	Rock
57	<i>Caloplaca flavorubescens</i> (Huds.) J.R. Laundon	-	-	-	+	-	-	-	-	Bark
58	<i>Loplaca pindarensis</i> (Räsänen) Poelt and Hinter. Umbilicariaceae	-	-	-	-	-	-	-	+	Rock
59	<i>Umbilicaria indica</i> Frey Verrucariaceae	-	-	-	-	-	-	-	+	Rock
60	<i>Dermatocarpon miniatum</i> (L) W. Mann	+	+	+	+	+	+	+	+	Rock

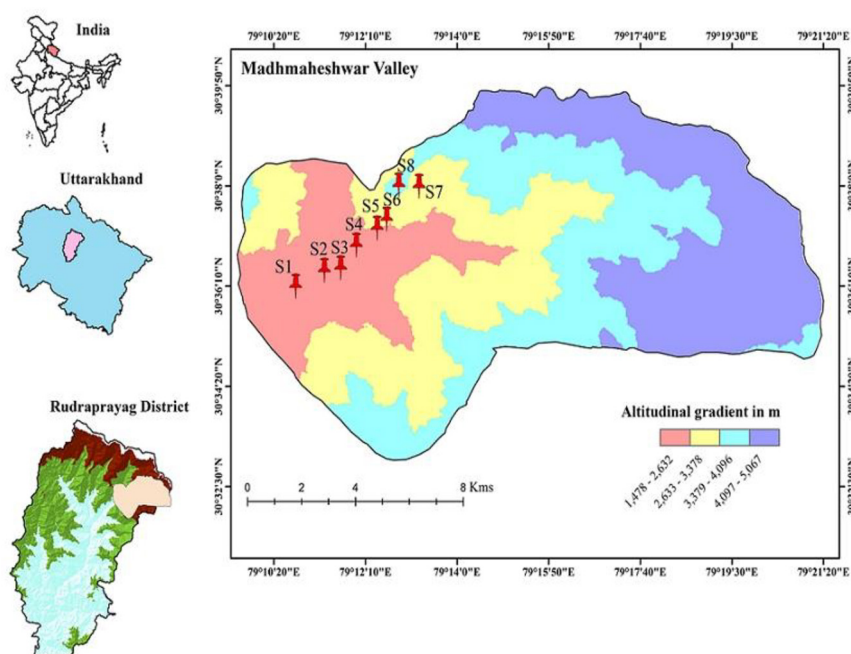


Fig. 1. Map of Madhyamaheshwar valley showing collection sites.



Plate 1. Sites 1 to 8. Localities surveyed for lichen collection enroute to Madhyamaheshwar valley. S1- Goundar village, S2- Lower and Upper bantoli, S3- Khadarakhal, S4- Nanu-chatti, S5- Maikhamba-chatti, S6- Koon-chatti, S7- Madhyamaheshwar, S8- Budha Madhyamaheshwar.

are found with 1 genera and 1 species each (Fig. 3).

30 lichen species in Madhyamaheshwar, 17 lichen

The first time enumeration of lichen species from this valley reveals the largest number of lichens with 47 species were found in Budha Madhyamaheshwar,

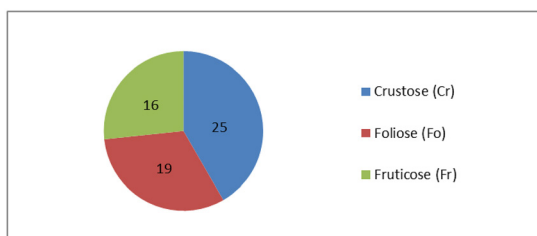


Fig. 2. Diversity of lichens in Madhyamaheshwar valley based on habitat.

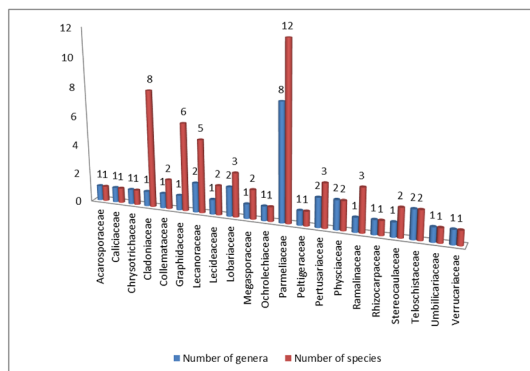


Fig. 3. Dominance of lichen families with respect to abundance of their species in Madhyamaheshwar valley.

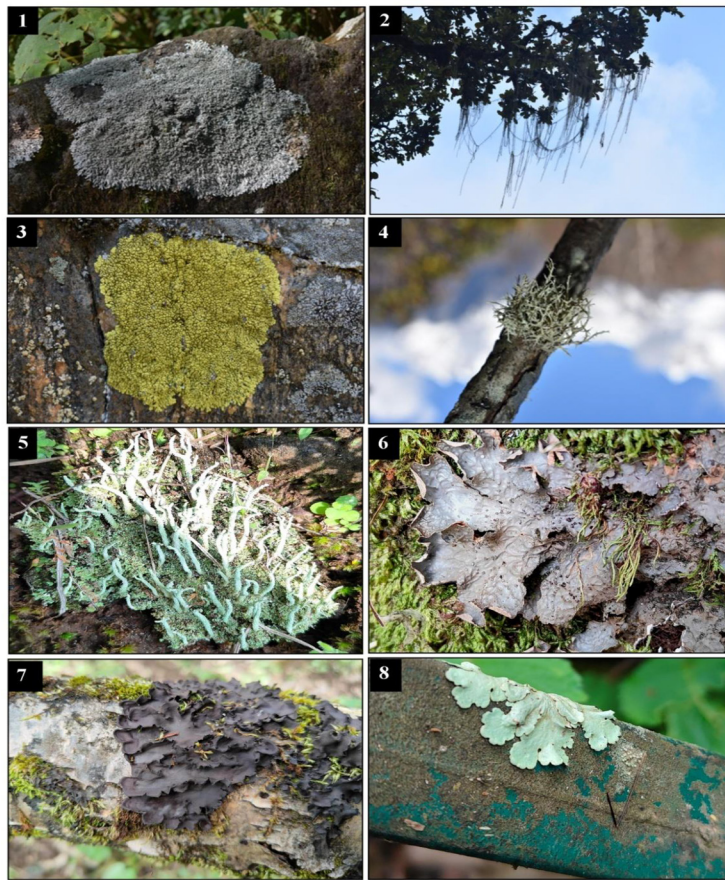


Plate 2. Lichens and their substrates in Madhyamaheshwar valley. 1- *Heterodermia diademata* (Taylor) D.D. Awasthi 2- *Usnea longissima* (Ach.) Articus 3- *Pleopsidium flavum* (Trevis) Korb. 4- *Ramalina conduplicans* Vain. 5- *Cladonia subulata* (L.) F. H. Wigg. 6- *Lobaria retigera* (Bory) Trevis. 7- *Leptogium askotense* D.D. Awasthi 8- *Flavoparmelia caperata* (L.) Hale.

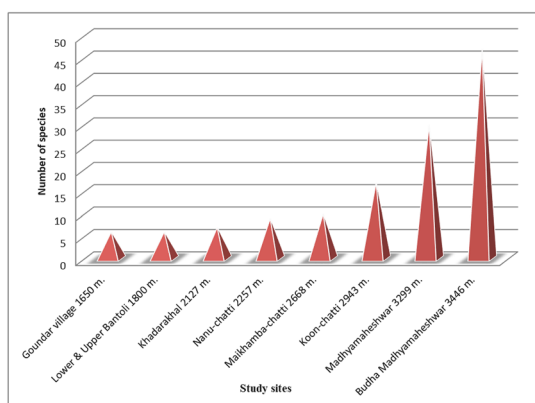


Fig. 4. Diversity of lichen species in Madhyamaheshwar valley based on different altitude.

species in Koon-chatti, 10 lichen species in Maikhamba-chatti, 9 lichen species in Nanu-chatti, 7 species in Khadarakhal and minimum 6 lichen species were found in Goundar village and Lower & Upper Bantoli. The enumeration of lichens from Madhyamaheshwar valley survey reveals that as the altitude increases the number of lichen species also increases (Figure- 4).

CONCLUSION

The lichen flora of Madhyamaheshwar valley, on the way from Goundar village to Budha Madhyamaheshwar over a 16 kilometer track (elevation 1650–3446 m), represent the presence of 60 lichen species, demonstrating the variety and abundance

of lichen species in the area. The species of lichen *Flavoparmelia caperata*, *Parmotrema tinctorum*, *Heterodermia diademata* and *Dermatocarpon miniatum* are commonly distributed in all eight sites. The lichen species *Buellia himalayensis*, *Chrysothrix candelaris*, *Cladonia fimbriatula*, *Cladonia squamosa*, *Leptogium delavayi*, *Graphis* sp2, *Graphis* sp3, *Lecanora interjecta*, *Lecidella carpathica*, *Lecidella euphorea*, *Porpidia crustulata*, *Porpidia macrocarpa*, *Lobaria kurokawae*, *Hypotrachyna cirrhata*, *Peltigera membranacea*, *Lepra leucosorodes*, *Pertusaria composita*, *Rhizocarpon geographicum*, *Stereocaulon foliolosum*, *Stereocaulon myriocarpum*, *Caloplaca flavorubescens*, *Loplaca pindarensis* and *Umbilicaria indica* are adapted for a single locality and restricted to the other sites. By conducting a comprehensive evaluation of lichen species in the surrounding areas, more taxa surely will be added to the lichen flora of this valley. Future biomonitoring and bioprospecting studies in the area will be supported by the baseline data provided by the current lichen count.

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