

Assessment of Lichen Species in a Temperate Region of Garhwal Himalaya, India

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ABSTRACT: An enumeration of 106 lichen species belonging to 47 genera and 28 families from Baniyakund-Chopta areas of Garhwal is provided. The area is dominated by macrolichens (foliose to fruticose form). The area exhibit the luxuriant growth of corticolous lichens represented by the occurrence of 64% of corticolous (bark inhabiting) lichens followed by 30% of saxicolous (rock inhabiting) and 4% of terricolous (soil inhabiting) lichens. A single species growing on leaves (foliicolous) is also recorded from the area. If we compare the lichen diversity of the study area vis-à-vis other regions, it is about 30% of the Garhwal Himalayas, 20% of the Uttarakhand and 10% of the Himalayas and less than 0.5% of Indian lichen diversity. [The Journal of American Science. 2009; 5(4):107-112]. (ISSN 1545-1003).

Key words: Lichen diversity, phorophytes, substratum, growth forms

INTRODUCTION

Lichens comprise a unique group of plant that consists of two unrelated organism, a fungus and an alga, growing together in a close symbiotic association. The study of lichen remains quite neglected throughout the world, through they together with mosses form dominant organisms in ecosystem covering over 10% of the earth terrestrial habitats, particularly at higher elevations (Nash and Egan 1988). Lichens with cyanobacterial blue green symbionts, contribute significantly for forest nitrogen fixation (Slack 1988). Besides many other uses, lichens are also used as pollution monitors. They are the plants that occur in most adverse conditions of climate and substrate. Thus the importance of this group in an ecosystem is very high in its own way. Lichens are just like little sponges that take up everything that comes their way, including air pollution (Fleishner 1994).

Lichens are universally distributed organisms occurring in varied climatic conditions ranging from the poles to the tropics in earth. They may look like crust, spreading rapidly over the surface (crustose lichens) or leafy and loosely attached to the surface (foliose lichens) and branched and shrubby, hanging from tree twigs or branches, with a single attachment (fruticose lichens). The collections were made along the way from Dalkuri to Bhujgali (Chopta) via

Chopta and at different localities of the region. Negi (2000) recorded the occurrence of 85 macrolichens in the area. The micro lichens from the area were not listed so far.

MATERIALS AND METHODS

Site Description

The study site Baniyakund-Chopta is situated between 2500m to 3500m (asl) in the Rudraprayag district of Uttarakhand along with Akashkamini valley at 79⁰-79⁰ 30'E and 30⁰ 30' – 30⁰ 42' N. The local human population settled in the low land fringe areas comprises semi pastoralists with livestock grazing and agriculture as their dominant land use activities. While low elevation woodlands such as *Quercus* forests are open for fodder and fuel wood collection throughout the year, grazing in the higher elevation forests and grasslands starts in early June, reaching a maximum in July, August and stop in early October. The maximum monthly temperature in the area varies from around 19°C to 37°C from the higher altitude grasslands to the lower elevation *Quercus* forests respectively during the snow free months of May to October, while the minimum temperature drops as low as -15°C in the alpine grasslands during the months of December to February.

In general the climate of the Chopta region is less severe summer, more or less higher precipitation and colder or more prolonged winter. The climatic factors i.e. precipitation, temperature, relative humidity and wind, in association with elevation (valley or mountain ranges from foot hills to mountain zones), proximity to Great Himalaya, slope aspect and vegetation type etc, cause variation in climates at local or even micro levels (Gaur 1999). Major output of precipitation is in the form of rainfall besides occasional occurrence of due hailstorms, fog, frost, snow fall etc. The south east monsoon commences towards the end of June and bursts until the mid of September.

Methodology

The lichen specimens were collected with the help of Chisel and Hammer along with their ecological notes. The type of forest vegetation, host tree type, location of the lichens thallus (on trunk, branch, twigs or leaves, soil and rock substratum); together with altitudes and other ecological notes were recorded. The collected specimens were investigated morphologically, anatomically and chemically at Lichenology laboratory of the National Botanical Research Institute, Lucknow. The collected samples were packed on hard card sheets inside a lichen herbarium packet (17cmX10mm) with details of the locality and are preserved at museum Center for Ecological Studies, Appropriate Technology India Ukhimath (Rudraprayag), Uttarakhand and also preserved at Botany Department, Hemwati Nandan Bahuguna Garhwal University Sirinagar (Garhwal) Uttarakhand. A voucher specimen of each species

was also preserved at Herbarium of National Botanical Research Institute, Lucknow (LWG).

Identification of lichen species

The external morphology was studied under dissecting binocular microscope. The anatomy of the thallus and apothecia were studied under compound microscope. The external morphology was examined generally in dry condition but dark brown to bluish specimens of *Leptogium* were studied in wet condition. The anatomical structures were studied after cutting the section of dry material by microtome and with the help of safety razor blade. The thin dry sections of the thallus and ascocarp were immersed in 90% ethyl alcohol to drive off the intercellular or inter-hyphal air bubbles and the sections were mounted in water or in cotton blue in lactophenol. The colour of medulla, epithecium, hypothecium, and ascus were recorded. The shape and size of the asci, ascospores and conidia were measured in the sections mounted in water. The measurements of the thallus, medulla, epithecium, and hymenium were generally taken in the sections mounted in cotton blue. The thallus size was measured in centimeter, lobe size and ascocarps in millimeter and thallus medulla, epithecium, hymenium thickness, asci and ascospores size in milimicron. Chemistry of the specimens was included colour spot tests and Thin Layer Chromatography (TLC).

RESULTS

A total of 106 species of lichen specimens from the study area Chopta forest (a purely *Q. semecarpifolia* forest) between 2500m to 3500m altitudes were recorded (Table 1). The specimens were collected in the month of May to October 2006.

Table 1: List of 28 families with 47 genera and 106 species of lichens recorded on different substrates in the Banyyakund-Chopta.

S. No.	Lichen Taxa	Family	Growth Form	Substratum
1	<i>Acarospora chlorophana</i> (Wahlenb, in Ach.) Massal.	Acarosporaceae	Crustose	On rock
2	<i>Acarospora saxicola</i> Fink ex Hedrick	Acarosporaceae	Crustose	On rock
3	<i>Allocetraria stracheyi</i> (Bab.) Kurok. & Lai	Parmeliaceae	Foliose	On rock
4	<i>Aspicilia dwaliensis</i> Rasanen	Hymeneliaceae	Crustose	On rock
5	<i>Buellia leptocline</i> (Flotow) Massal.	Physciaceae	Crustose	On bark
6	<i>Buellia stigma</i> Tuck.	Physciaceae	Crustose	On rock
7	<i>Bulbothrix bulbochaeta</i> (Hale.) Hale.	Parmeliaceae	Foliose	On bark
8	<i>Bulbothrix meizospora</i> (Nyl.) Hale.	Parmeliaceae	Foliose	On bark
9	<i>Caloplaca pelodella</i> (Nyl.) Hasse	Teloschistaceae	Crustose	On bark
10	<i>Caloplaca</i> sp1	Teloschistaceae	Crustose	On rock
11	<i>Caloplaca</i> sp2	Teloschistaceae	Crustose	On rock
12	<i>Canoparmelia aptata</i> (Krempedh) Elix & Hale	Parmeliaceae	Foliose	On bark
13	<i>Cetrariopsis wallichiana</i> (Taylor) Kurokawa	Parmeliaceae	Foliose	On bark
14	<i>Cetrelia braunsiana</i> (Muell. Arg.) Culb & C. Club	Parmeliaceae	Foliose	On bark
15	<i>Cetrelia cerarioides</i> (Delise ex Duby) Culb & C. Culb	Parmeliaceae	Foliose	On bark
16	<i>Cetrelia pseudolivetorum</i> (Asah) Club & C. Club	Parmeliaceae	Foliose	On bark
17	<i>Cetrelia sanguinea</i> (Schaerer) Club & C. Club	Parmeliaceae	Foliose	On bark
18	<i>Cetrelia sanguinea</i> (Schaerer) Club. & C. Club.	Parmeliaceae	Foliose	On bark
19	<i>Chrysothrix candelaris</i> (L.) Laundon	Chrysothricaceae	Crustose	On bark/rock
20	<i>Chrysothrix chlorina</i> (Ach.) Laundon	Chrysothricaceae	Crustose	On bark
21	<i>Cladonia corymbescens</i> Nyl.	Cladoniaceae	Squamules	On soil
22	<i>Cladonia furcata</i> (Huds) Schrader	Cladoniaceae	Squamules	On bark/rock with moss
23	<i>Cladonia</i> sp.	Cladoniaceae	Squamules	On rock
24	<i>Cladonia squamosa</i> (Scop) Hoffm	Cladoniaceae	Squamules	On bark
25	<i>Dermatocarpon vellereum</i> Zschacke	Dermatocarpaceae	Foliose	On rock
26	<i>Everniastrum cirrhatum</i> (E Fries) Hale ex Sipman	Parmeliaceae	Foliose	On bark
27	<i>Everniastrum nepalense</i> (Taylor) Hale ex Sipman	Parmeliaceae	Foliose	On bark
28	<i>Graphis aicatricosa</i> Nyl.	Graphidiaceae	Crustose	On bark
29	<i>Graphis chlorotica</i>	Graphidiaceae	Crustose	On bark
30	<i>Graphis proserpens</i> Vainio	Graphidiaceae	Crustose	On bark
31	<i>Graphis scripta</i> (L.) Ach.	Graphidiaceae	Crustose	On bark
32	<i>Graphis sikkimensis</i> (Nagarkar & Patw.)	Graphidiaceae	Crustose	On bark
33	<i>Heterodermia diademata</i> (Taylor) D. Awasthi	Phyasciaceae	Foliose	On bark
34	<i>Heterodermia hypocaesia</i> (Yasuda) Awasthi	Phyasciaceae	Foliose	On rock
35	<i>Heterodermia incana</i> (Stirton) D. Awasthi	Phyasciaceae	Foliose	On bark
36	<i>Heterodermia isidiophora</i> (Vainio) Awasthi	Phyasciaceae	Foliose	On bark
37	<i>Heterodermia japonica</i> (Sato.) Swinsc. & Krog.	Phyasciaceae	Foliose	On soil with moss
38	<i>Heterodermia leucomela</i> (L.) Poelt	Phyasciaceae	Foliose	On bark
39	<i>Heterodermia pseudospeciosa</i> (Kurokawa) Culb	Phyasciaceae	Foliose	On bark with moss
40	<i>Heterodermia speciosa</i> (Wulfen) Trevisan	Phyasciaceae	Foliose	On rock
41	<i>Hymenelia</i> sp.	Hymeneliaceae	Foliose	On bark

42	<i>Hypotrachyna awasthi</i> Hale & Patw.	Parmeliaceae	Foliose	On rock with moss
43	<i>Hypotrachyna crenata</i> (Kurok) Hale	Parmeliaceae	Foliose	On rock
44	<i>Hypotrachyna exsecta</i> (Taylor) Hale	Parmeliaceae	Foliose	On bark
45	<i>Hypotrachyna scytophylla</i> (Kurok.) Hale	Parmeliaceae	Foliose	On rock
46	<i>Ioplaca pindarensis</i> (Rasanen) Poelt & Hintergger	Teloschistaceae	Crustose	On rock
47	<i>Lecanora achroa</i> (Nyl.) Crombie	Lecanoraceae	Crustose	On bark
48	<i>Lecanora</i> sp	Lecanoraceae	Crustose	On rock
49	<i>Lecidea</i> sp.	Lecideaceae	Crustose	On bark
50	<i>Lepraria lobificans</i> Nyl.	Lichen imperfecti	Crustose	On bark
51	<i>Lepraria</i> sp1	Lichen imperfecti	Crustose	On bark
52	<i>Lepraria</i> sp2	Lichen imperfecti	Crustose	On bark
53	<i>Leprocaulon pseudoarbuscula</i> (Asah.) Lamb & Ward	Lichen imperfecti	Crustose	On rock
54	<i>Leptogium askotense</i> D. Awasthi	Collemataceae	Foliose	On bark
55	<i>Leptogium papillosum</i> B. de Lesd Dodge	Collemataceae	Foliose	On bark
56	<i>Leptogium pedicelatum</i> M. P. Jorg	Collemataceae	Foliose	On bark
57	<i>Leptogium trichophorum</i> (Muell.) Arg.	Collemataceae	Foliose	On bark
58	<i>Lobaria retigera</i> (Bory) Trevisan	Lobariaceae	Foliose	On bark
59	<i>Lobaria</i> sp	Lobariaceae	Foliose	On bark
60	<i>Myelochora aurulenta</i> (Tuck) Elix & Hale	Parmeliaceae	Foliose	On bark
61	<i>Myelochora irrugans</i> (Nyl.) Exil & Hale	Parmeliaceae	Foliose	On bark
62	<i>Myelochora xantholepsis</i> (Mont & Bosch) Elix & Hale	Parmeliaceae	Foliose	On bark
63	<i>Ochrolechia rosella</i> (Muell. Arg.) Vers.	Pertusariaceae	Crustose	On bark
64	<i>Opegrapha</i> sp.	Opegraphaceae	Crustose	On Leaf
65	<i>Parmelia squarrosa</i> Hale	Parmeliaceae	Foliose	On bark
66	<i>Parmelinella wallichiana</i> (Taylor) Elix & Hale	Parmeliaceae	Foliose	On soil with moss
67	<i>Parmotrema mesotropum</i> (Muell. Arg.) Hale	Parmeliaceae	Foliose	On bark
68	<i>Parmotrema nilgherrense</i> (Nyl.) Hale	Parmeliaceae	Foliose	On bark
69	<i>Parmotrema saccatilobum</i> (Taylor) Hale	Parmeliaceae	Foliose	On bark
70	<i>Peltigera polydactyla</i> (Neck) Hoffm	Peltigeraceae	Foliose	On bark/Soil with moss
71	<i>Peltigera rufescens</i> (Weiss) Humb	Peltigeraceae	Foliose	On soil with moss
72	<i>Pertusaria aquissiae</i> Fe	Pertusariaceae	Crustose	On bark
73	<i>Pertusaria leucosorodes</i> Nyl.	Pertusariaceae	Crustose	On bark
74	<i>Phaeophyscia hispidula</i> (Ach.) Moberg	Phyasciaceae	Foliose	On bark
75	<i>Phyllopsora albicans</i> Muell. Arg.	Lecideaceae	Crustose	On bark
76	<i>Physcia dimidiata</i> (Ach.) Nyl.	Physciaceae	Foliose	On bark
77	<i>Porpidia albocoerulescens</i> (Wulfen) Hertel & Knoph in Hertel	Porpidiaceae	Crustose	On rock
78	<i>Porpidia crustulata</i> (Ach.) Hertel & Knoph in Hertel	Porpidiaceae	Crustose	On rock
79	<i>Porpidia macrocarpa</i> (DC) Hertel & Knoph in Hertel	Porpidiaceae	Crustose	On rock
80	<i>Punctelia borrieri</i> (Sm) Krog.	Parmeliaceae	Foliose	On bark
81	<i>Punctelia neutralis</i> (Hale) Korg.	Parmeliaceae	Foliose	On rock
82	<i>Punctelia subrudecta</i> (Nyl.) Krog.	Parmeliaceae	Foliose	On rock
83	<i>Pyrenula immersa</i> Muell. Arg.	Pyrenulaceae	Crustose	On bark
84	<i>Pyrenula immissa</i> (Stirton) Zahlbr	Pyrenulaceae	Crustose	On bark
85	<i>Pyxine berteriana</i> var <i>himalaica</i> D. Awasthi	Phyasciaceae	Foliose	On bark
86	<i>Pyxine subcinerea</i> Stirton	Physciaceae	Foliose	On bark
87	<i>Ramalina conduplicans</i> Vainio	Ramalinaceae	Fruticose	On bark

88	<i>Ramalina himalensis</i> Rasanen	Ramalinaceae	Fruticose	On rock
89	<i>Ramalina roesleri</i> (Hochst) Hue	Ramalinaceae	Fruticose	On bark
90	<i>Ramalina sinensis</i> Jatta	Ramalinaceae	Fruticose	On bark
91	<i>Rimelia reticulata</i> (Taylor) Hale & Fletcher	Parmeliaceae	Foliose	On rock
92	<i>Stereocaulon foliolosum</i> Nyl.	Stereocaulaceae	Foliose	On rock
93	<i>Stereocaulon pomiferum</i> Duvign.	Stereocaulaceae	Foliose	On rock
94	<i>Sticta nylanderiana</i> Zahlbr.	Stictaceae	Foliose	On bark
95	<i>Sulcaria sulcata</i> (Lev) Bystr. Ex Brodo & D. Hawkow	Alectoriaceae	Foliose	On bark
96	<i>Umbilicaria badia</i> Frey	Umbilicariaceae	Foliose	On rock
97	<i>Umbilicaria indica</i> Frey	Umbilicariaceae	Foliose	On rock
98	<i>Umbilicaria virginis</i> Schaerer	Umbilicariaceae	Foliose	On rock
99	<i>Usnea aciculifera</i> Vainio	Usneaceae	Fruticose	On bark
100	<i>Usnea eumitrioides</i> Mot.	Usneaceae	Fruticose	On bark
101	<i>Usnea indica</i> Mot.	Usneaceae	Fruticose	On rock
102	<i>Usnea longissima</i> Ach.	Usneaceae	Fruticose	On bark
103	<i>Usnea orientalis</i> Mot.	Usneaceae	Fruticose	On bark
104	<i>Usnea pectinata</i> (Taylor)	Usneaceae	Fruticose	On bark
105	<i>Usnea subfloridana</i> (Stirton)	Usneaceae	Fruticose	On bark
106	<i>Verrucaria acrotella</i> Ach.	Verrucariaceae	Crustose	On rock

DISCUSSION

The most common lichen species growing on different phorophytes belongs to the genera *Chrysothrix*, Parmelioid, Usnioid and Graphidiaceous lichens while *Acarospora*, *Aspicilia*, *Umbilicaria*, *Dermatocarpon*, *Porpidia*, *Buellia* and *Caloplaca* mostly prefers to grow on rocks. Species of lichen genera *Peltigera*, *Lobaria* and *Sticta* prefers soil for their growth. The lichen flora in the study area exhibits greatest abundance in variety and luxuriance of growth. The lichens in the study area seem to prefer the bark of trees or rock as their substratum. Lichens also occur on soil, decaying wood, mosses and humus. The corticolous lichens are greatly influenced by the physical characters of the bark. Corticolous lichens may be epiphloedal or endophloedal based on their growth above or within the substratum. In epiphloedal lichens or the lichen tissue (especially the algal layer) develops above the outermost corky layer of bark, although few layers of cork are incorporated into the lower portion of the thallus. In endophloedal lichens the thallus crust lies entirely below the cork of periderm. Section of endophloedal crustose lichens together with their bark substrate generally show that the lichen thallus remains to the corky outer periderm by one or many layers of suberised impermeable cork cells. The nature of bark (smooth or rough) and moisture retaining capacity of bark also plays vital role in determining the type of lichen species. *Quercus*, *Rhododendron*, *Acer* spp. and

many other trees, as well as species of shrub and ringal act as favorable substrate for the luxuriant growth of lichens. Together with trees some shrubs of *Berberis* and *Cotoneaster* also provide a suitable substrate for growth of many lichen taxa.

The growth of lichens on rock is based on the physical and chemical characters of the rocks. The hard, permanent, and moist rock preferred by most of the lichen than the rocks which weather soon and allowing less time to the lichen to produce reproductive organs. Proximity of water to substratum also exerts great influence in determination of the type of lichen growth.

The lichen on the rock depends upon whether the rocks are acidic or basic. The exposure and moisture relationship strongly influence the lichen cover on rocks. The boulders along the stream and in open fields and fell fields are suitable habitats for lichens. In the open boulder fields the foliose lichen *Heterodermia* and *Phaeophyscia* occupies the exposed rocks and boulders while humus and soil containing pebbles at the base of boulders in moist places provide a habitat for lichen species *Cladonia* and *Peltigera*. The exposed dry boulders received sunrays throughout the day remains more or less dry and hot and only few dark black *Buellia* and *Acarospora* species able to grow.

The common epiphytic foliose and fruticose genera are *Everniastrum*, *Parmotermia*, *Heterodermia*, *Bulbothix*, *Hypotrachyna*, *Leptogium*, *Parmelia*, *Parmellinella*, *Lobaria*,

Ramalina, *Rimelia*, and *Usnea*. These genera colonize on trunk, branches, minor branches and twigs.

The moist shady location in the study area provide suitable habitat for growth of terricolous (soil inhabiting) and muscicolous (moss inhabiting) lichen species of *Peltigera* and *Cladonia*. Vertical face of roads covered with moss and small herbaceous plant provide a moist shady habitat for growth of terricolous and muscicolous lichens. Among different lichen forms the foliose forms dominated the area by 57 species followed by crustose 34 and 11 fruticose and 4 squamules species. Among the different lichen families, the Parmeliaceae exhibit its dominance in the area represented by 15 genera (31.9%) out of the 74 genera of lichens known from the area.

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