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Species Diversity of Lichens in Balh Valley of Himachal Pradesh, North Western Himalaya

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ABSTRACT: During present investigation a total of sixty specimens of lichens were collected from Balh valley. The lichens were collected during November 2018 to February 2019 from twenty eight localities of Balh Valley in Mandi district of Himachal Pradesh, North Western Himalaya. A total of nineteen species of lichens were identified on the basis of morphological and anatomical characters. Relevant literature was consulted for confirmation of species identification. Out of the identified species, one species *viz. Usnea longissima* is being reported for the first time from Mandi district. *Phaeophyscia hispidula* is most common out of the nineteen species and is found in fifteen localities. The species diversity index (α, β, ɤ) of all the localities was calculated. The highest alpha diversity (four) was found in Bagla and Kasarla. The lowest alpha diversity (one) was found at Bhour, Chakker, Kansa, Nagchala and Pairi. Beta diversity of all localities was 47 and gamma diversity was 19. The identified specimens have been deposited in CPUH (The Herbarium, Department of Biosciences, Career Point University Hamirpur) for preservation and future reference.

Keywords: Balh valley; Lichen; North Western Himalaya and Species diversity.

INTRODUCTION: Lichens are composite organisms, which have dual nature, and these are formed by the association of two or more different types of organism - a fungus (mycobiont) and an alga (phycobiont). Lichen thallus develop through this association is distinctive as it become visible and behaves completely different from its constituent organism. Lichens play important role in ecosystem as well as in human welfare.[1] Major constituents of Lichen thallus is formed of fungus. Thus these are considered as a special group of fungi under lichenized fungi.[2] About 716 species of follicolous lichen have been broadcast in the world till now out of which 116 are found in India.[3] Lichens are very important elector of Indian flora.[4] Epiphytic lichens were said to be useful biomonitors of air pollutants from very long time Lichens absorbs raw material. Directly from air because they have no roots. Lichen do not have protective tissues or cell type which are required to maintain constant internal water content. The lichen can accumulates heavy metals also.[5] Natural dyes have been prepared from lichens, but the dyeing properties of Indian Lichens are not known. Lichen can also form huge amount of metabolites because of their slow growth and critical living conditions.[6] The available detailed list of lichens from the present study will be record for carrying out biodiversity studies in the area in future. In Himalyas, Himachal Pradesh is one of the most lichen rich region.[7] Lichens are primary producers with important linkage to nutrient cycling and forest food webs.[8] Lichens and the natural products produced from them are used for decorations, perfumes, brewing and distilling, food and natural remedies preparation. The biological activities are very less in lichens as compare to other organism lichens are important source of food for different animals and in some countries, human uses lichen as their diet and traditional medicines.[9] Lichens have come to scientific attention due to difficulties in their identification.[10]

Many lichen species are effective in treatment or curing of various diseases like bronchitis, bleeding piles, stomach disorders, scabies and other disorders of heart and blood.[11] Lichen planus pigmentosus is a disease caused by Lichens which was first described by Bhutani *et al.*[12] Lichens are ecologically important in providing shelter and nesting material for variety of wild animals. Lichen species are identified on the basis of their morphological, anatomical and features.

Lichen litter fall studies provides information to understand lichen diversity as well as preferred substrate of each species, their physical and biological factors, growth patterns of lichen.[13] Lichens are one of the most widely distributed group of organism in the world ranging from Arctic to Antarctic and from rocky shores of the sea. Lichens are well organized gathering of chemicals elements which are taken up from substrate solution, water vapors and rain. Lichens are the major components of Antarctic terrestrial flora, growing abundantly on rocks, boulders, decaying cushions of moss bunch in ice–free areas.[14] The lichens are used in bio-monitoring studies because they provide cost effective tools for mapping spatial and temporal patterns of atmospheric contamination.

The term lichen was coined by Theopharastus during 300 B.C. He launched the lichen group of plant in the scientific world. A Swiss botanist named Schwender was the first who demonstrated the dual nature of lichen thallus in 1867.[16] There are 20,000 species of Lichens reported in all over the world. Out of 20,000 species 98.9% of the lichens belongs to a separate group named Ascomycetes group and the remaining species of lichens are placed in Bacidiomycetes and Deuteriomycetes groups represented by 0.1% and 1% respectively. Two thousand forty species of lichens belonging to 305 genera and 74 families are reported in India.[17] In Himachal Pradesh there are 503 species of lichens belonging to 107 genera and 44 species[18] Himachal Pradesh, located in the Himalayan belt of western region, is rich in lichen and also called as hot spot of lichen diversity. Three hundred sixty eight species of lichens are found from Solan district of Himachal Pradesh, but still some places are unexplored.[19] Sirmour district of Himachal Pradesh located in the Southern Hill range of Himalyas. This district of Himachal Pradesh have 112 species of lichens belonging to 26 family and 44 genera in five reserve forests of Sirmour district .[20] One hundred ninety two species of Lichens belonging to 65 genera and 31 families of Lichens are present in Great Himalayan National Park, Kullu district in which Jiwanal, Sainj and Tirthan valleys were explored.[21] Shimla district contributes few appropriate habitats for different variety of lichens to grow. There are total 192 species of lichens found in different locations of Shimla district.[22] Seventy species of Lichens belonging to 36 genera and 23 families of lichens are found in three district of Himachal Pradesh. These are Bilaspur, Hamirpur and Una. Out of 70 species, 59 species of lichens are from Bilaspur district and 29 and 6 species are found in Hamirpur and Una respectively.[23] Forty species of lichens have been recorded in Mandi district.[24] The review of Literature revealed that diversity of lichens in Balh Valley of Mandi district in Himachal Pradesh is least explored.[25] So, main objectives of the study were: to collect specimens of lichens from different localities and substrates, to study morphology and anatomy of each specimen, to identify species and preserve specimens for future reference and to document species diversity and distribution of lichens in the study.

MATERIALS AND METHODS: Present study was carried out in the Balh valley of tehsil and district Mandi, Himachal Pradesh. The area falls in subtemperate sub-humid mid hill agro-climatic region at an elevation of about 1189 m above mean sea level. It is located South-West of Mandi at 30°31'N latitude and 76°54'E longitude on 21 National Highway. The average annual temperature of the area is 18°C. The valley receives an average annual rainfall of about 1400 mm, most of which is received during the monsoon i.e. June to September.

The specimens were collected randomly from various localities and substrates of the study area. The field data such as texture, size, colour, macroscopic features and form have been noted in the field book during excursions.[25] Fresh specimens were observed and sun dried at the camping site. These were brought to laboratory for further taxonomic studies.

The collected lichen specimens were initially segregated according to their growth forms and further grouped according to fructification type (apothecia, perithecia, sterile). The chemicals used for the chemicals spot tests of the lichens were prepared using standard method.[26] Colour spot test is performed for the identification of lichens. It includes K test (on upper surface or on medulla), C test (on medulla) and Pd test (on medulla).[27]

The morphological and anatomical details are compiled in the form of a description which is compared with the published literature, authenticated taxonomic keys and monographs. Identity of specimens are confirmed by comparing their morphology, anatomy and chemistry with authenticated taxonomic keys.[28,29,30]

For preservation, the specimens were dried after collecting them, placed in the collection bags along with slip containing field data. The slip includes name of species, herbarium No., locality, altitude, host, date of collection and name of collector. 1,4-dichlorobenzene crystals will be put into each packet for protection from attack of worms, insects etc. The specimens are deposited in CPUH (The herbarium, Department of

Bio-Sciences, Career Point University Hamirpur) after identification.[31] The diversity of species was calculated as:

α – Alpha diversity is defined as the number of species present in a single locality.[38]

β- Beta diversity is defined as variation in different species among localities.[38]

ɤ- Gamma diversity is defined as the measure of overall diversity within a large region.[38]

RESULTS AND DISCUSSION: During the present study, a total of nineteen species of Lichens have been enumerated from twenty eight localities of Balh Valley for the first time (Table 1 and Table 2).

Table 1: Number of specimens collected and identified from twenty eight localities.

S. No.	Localities	No. of specimens	Identified species
1	Arthi	3	*Lecanora chlarotera* *Parmotrema mesotropum* *Phaeophyscia hispidula*
2	Baggi	2	*Heterodermia speciosa* *Lecanora chlarotera*
3	Bagla	4	*Aspicilia calcarea* *Brianaria bauschiana* *Chrysothrix candelaris* *Lecanora chlarotera*
4	Bhangrotu	2	*Chrysothrix chlorina* *Phaeophyscia hispidula*
5	Bhour	1	*Lecanora chlarotera*
6	Chakker	1	*Dermatocarpon miniatum*
7	Dadour	2	*Physcia dubia* *Physcia jackii*
8	Galma	3	*Dermatocarpon vellereum* *Phaeophyscia hispidula* *Physcia sorediosa*
9	Gehra	2	*Phaeophyscia hispidula* *Physcia dilatata*
10	Kandyah	3	*Brianaria bauschiana* *Lecanora chlarotera* *Phaeophyscia hispidula*
11	Kansa	1	*Physcia dubia*
12	Kasarla	4	*Lecanora chlarotera* *Parmotrema lattissimum* *Phaeophyscia hispidula* *Physcia dubia*
13	Kummi	3	*Aspicilia calcarea* *Phaeophyscia hispidula* *Usnea longissima*
14	Lohara	2	*Chrysothrix candelaris* *Chrysothrix chlorina*
15	Lunapani	2	*Lecanora chlarotera* *Phaeophyscia hispidula*
16	Mandal	2	*Chrysothrix candelaris* *Phaeophyscia hispidula*

17	Mundru	2	*Lecanora chlarotera* *Parmotrema latissimum*
18	Nagchala	1	*Phaeophyscia hispidula*
19	Nerchowk	3	*Phaeophyscia hispidula* *Phaeophyscia hispidula + Physcia dubia*
20	Pairi	1	*Lecanora chlarotera*
21	Ratti	2	*Chrysothrix chlorina* *Lecanora chlarotera*
22	Rakkar	2	*Chrysothrix candelaris* *Parmotrema andinum*
23	Rajgarh	2	*Chrysothrix chlorina* *Lecanora chlarotera*
24	Saini Mohri	3	*Aspicilia calcarea* *Lecanora chlarotera* *Phaeophyscia hispidula*
25	Sayohali	3	*Graphis scripta* *Lecanora chlarotera* *Phaeophyscia hispidula*
26	Sidhyani	2	*Phaeophyscia hispidula* *Phaeophyscia hispidula*
27	Taroh	2	*Parmotrema mesotropum* *Phaeophyscia hispidula*
28	Tawan	2	*Physcia dubia* *Physcia integrata*

Table 2: Lichens of Balh Valley.

S. No.	Family	Genera	Species
1	Chrysotrichaceae	*Chrysothrix*	*Chrysothric candelaris*
			Chrysothric chlorina
2	Graphidaceae	*Graphis*	*Graphis scripta*
3	Lecanoraceae	*Lecanora*	*Lecanora chlarotera*
4	Megasporaceae	*Aspicilia*	*Aspicilia calcarea*
5	Parmeliaceae	*Parmotrema*	*Parmotrema andinum*
			Parmotrema latissimum
			Parmotrema mesotropum
		Usnea	*Usnea longissima*
6	Physciaceae	*Heterodermia*	*Heterodermia speciosa*
		Phaeophyscia	*Phaeophyscia hispidula*
			Physcia dubia
			Physcia dilatata
			Physcia integrata
			Physcia jackii
			Physcia sorediosa
7	Psoraceae	*Brianaria*	*Brianaria bauschiana*
8	Verrucariaceae	*Dermatocarpon*	*Dermatocapon miniatum*
			Dermatocarpon vellereum

Table 3: Thallus differentiation of identified Lichens.

Saxicolous	Corticolous
Aspicilia calcaria	*Chrysothrix candelaris*
Brianaria bauschiana	*Chrysothrix chlorina*
Dermatocarpon miniatum	*Graphis scripta*
Dermatocarpon vellerum	*Heterdermia speciosa*
Physcia dubia	*Lecanora chlarotera*
-	*Parmotrema andinum*
-	*Parmotrema latissimum*
-	*Parmotrema mesotropum*
-	*Phaeophyscia hispidula*
-	*Physcia dilatata*
-	*Physcia integrata*
-	*Physcia jackii*
-	*Physcia sorediosa*
-	*Usnea longissima*

Table 4: Number of common species among various localitie.

S. No	Species	Localities	Total
1	*Aspicilia calcarea*	Kummi, Sainimohri, Bagla	3
2	*Brianaria bauschiana*	Kandyah, Bagla	2
3	*Chrysothrix candelaris*	Rakkar, Mandal, Lohara, Bagla	4
4	*Chrysothrix chlorina*	Pairi, Bhangrotu, Lohara, Ratti, Rajgarh	5
5	*Dermatocarpon miniatum*	Lunapani, Chakker	2
6	*Lecanora chlarotera*	Bhour, Gehra, Gehra, Baggi, Kasarla, Ratti, Kandyah, Arthi, sayohali, Rajgarh, Lunapani, Sainimohri, Bagla, Mundru	13
7	*Parmotrema latissimum*	Mundru, Kasarla	2
8	*Parmotrema mesotropum*	Arthi, Taroh	2
9	*Phaeophyscia hispidula*	Kummi, Bhangrotu, Mandal, Nerchowk, Gehra, Nagchala, kasarla, Kandyah, Arthi, Sayohali, Galma, Sidhyani, Lunapani, Taroh, Sainimohri	15
10	*Physcia dubia*	Kansa, Tawan, Nerchowk, Kasarla, Dadour	5

Table 5: Number of species already documented from Mandi district.[24]

S. No.	Family	Species
1	Chrysotrichaceae	*Chrysothrix candelaris*
2	Chrysotrichaceae	*Chrysothrix chlorina*
3	Graphidaceae	*Graphis scripta*
4	Lecanoraceae	*Lecanora chlarotera*
5	Megasporaceae	*Aspicilia calcarea*
6	Parmeliaceae	*Parmotrema andinum*
7	Parmeliaceae	*Pramotrema latissimum*
8	Parmeliaceae	*Parmotrema mesotropum*
9	Physciaceae	*Heterodermia speciosa*
10	Physciaceae	*Phaeophyscia hispidula*
11	Physciaceae	*Physcia dubia*
12	Physciaceae	*Physcia diltata*
13	Physciaceae	*Physcia integrata*

14	Physciaceae	*Physcia jackii*
15	Physciaceae	*Physcia sorediosa*
16	Psoraceae	*Brianaria bauschiana*
17	Verrucariaceae	*Dermatocarpon miniatum*
18	Verrucariaceae	*Dermatocarpon vellerum*

Table 6: Lichens and their substrate/hosts.

S. No.	Species	Substrate/Host
1	*Aspicilia calcarea*	Rock
2	*Brianaria bauschiana*	Rock
3	*Chrysothrix candelaris*	Rock, Bark (*Salix balylonica, Pyrus communis)*
4	*Chrysothrix chlorina*	Rock, Bark (Populus)
5	*Dermatocarpon miniatum*	Rock
6	*Dermatocarpon vellereum*	Rock
7	*Graphis scripta*	Bark (*Melia azedarach*)
8	*Heterodermia speciosa*	Bark (*Pinus roxburghii*)
9	*Lecanora chlarotera*	Bark (*Enterolobium cyclocarpum, Neolamarckia cadamba, Leucaena leucocephala, Grewia optiva, Pyrus communis, Caratonia siliqua, Phyllanthus emblica, Ficus benghlensis, Syzygium cumini)*
10	*Parmotrema andinum*	Bark (*Salix balylonica*)
11	*Parmotrema latissimum*	Bark (*Pinus roxburghii, Mangifera indica*)
12	*Parmotrema mesotropum*	Bark (*Salix balylonica*)
13	*Phaeophyscia hispidula*	Bark (*Ficus religiosa, Dalbergia fabaceae, Enterolobium cyclocarpum, Euphorbia neriifolia, Toona ciliata, Morus alba, Neolamarckia cadamba, Ficus carica*), Rock
14	*Physcia dilatata*	Bark (*Neolamarckia cadanba*)
15	*Physcia dubia*	Bark *(Salix balylonica, Toona ciliate, Ficua religiosa, Grewia optiva*)
16	*Physcia integrata*	Bark (*Salix balylonica*)
17	*Physcia jackii*	Bark (*Cedrus deodara*)
18	*Physcia sorediosa*	Rock
19	*Usnea longissima*	Bark (*Taxus cuspidata)*

Table 7: Alpha Diversity.

S. No.	Localities	Alpha(α) Diversity
1	Arthi	3
2	Baggi	2
3	Bagla	4
4	Bhangrotu	2
5	Bhour	1
6	Chakker	1
7	Dadour	2
8	Galma	3
9	Gehra	2

10	Kandyah	3
11	Kansa	1
12	Kasarla	4
13	Kummi	3
14	Lohara	2
15	Lunapani	2
16	Mandal	2
17	Mundru	2
18	Nagchala	1
19	Nerchowk	3
20	Pairi	1
21	Ratti	2
22	Rajgarh	2
23	Rakkar	2
24	Saini Mohri	3
25	Sayohali	3
26	Sidhyani	2
27	Taroh	2
28	Tawan	2

***Beta (β) diversity** = 47*
***Gamma (ɣ) diversity** = 19*

Table 8: Economic importance of Lichens.

S. No.	Species	Economic Importance
1	*Aspicilia calcarea*	Caterpillers, mites and snales use *Aspicilia* as their food and it is a source of nutrition for them.
2	*Dermatocarpon vellerum*	It has anti –microbial properties and these can fight against human pathogen or infective agent viz *Pseudo-monas aeruginosa*.
3	*Lecanora chlarotera*	It is found in different parts of the world. Earth bread is prepared from its flour and powder. It also covers the soil.
4	*Parmotrema andinum*	These have anti-microbial properties and these fight against fungal as well as human pathogenic bacteria.
5	*Phaeophyscia hispidula*	It is pollution tolerant and can resist emission from ve-hicle exhaust.
6	*Usnea longissima*	In China Usnea is used for the treatment of ulcers and for the preparation of cough syrups.

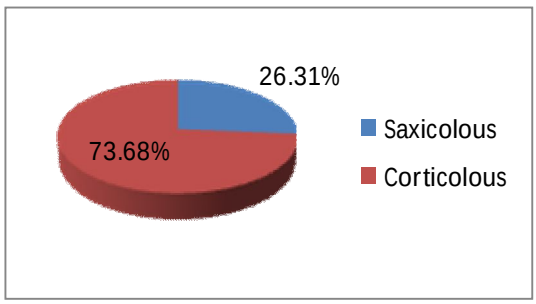

Figure 1: Thallus differentiation of identified li-chens.

CONCLUSION: During present investigation a total of sixty specimens of lichens were collected from Balh valley. The lichens were collected during No-vember 2018 to February 2019 from twenty eight localities (Arthi, Baggi, Bagla, Bhangrotu, Bhour, Chakker, Dadour, Galma, Gehra, Kandyah, Kansa, Kasarla, Kummi, Lohara, Lunapani, Mandal, Mundru, Nagchala, Nerchowk, Pairi, Ratti, Rakker, Rajgarh, Saini Mohri, Sayohali, Sidhyani, Taroh, Tawan) of Balh Valley in Mandi district of Himachal Pradesh. A total of nineteen species of lichens (*Aspicilia calca-rea, Brinaria bauschiana, Chrysothrix candelaris,*

Chrysothrix chlorina, Dermatocarpon miniatum, Dermatocarpon vellerum, Graphis scripta, Heterodermia speciosa, Lecanora chlarotera, Parmotrema andinum, Parmotrema latissimum, Parmotrema mesotropum, Phaeophyscia hispidula, Physcia dilatata, Physcia integrata, Physcia jackii, Physcia sorediosa, Usnea longissima) were identified on the basis of morphological and anatomical characters. Relevant literature was consulted for confirmation of species identification. Out of the identified species, one species *viz. Usnea longissima* is being reported for the first time from Mandi district. *Phaeophyscia hispidula* is most common out of the nineteen species and is found in fifteen localities. The species diversity index (α, β, ɤ) of all the localities was calculated. The highest alpha diversity (four) was found in Bagla and Kasarla. The lowest alpha diversity (one) was found at Bhour, Chakker, Kansa, Nagchala and Pairi. Beta diversity of all localities was 47 and gamma diversity was 19. The identified specimens have been deposited in CPUH (The herbarium, Department of Bio-Sciences, Career Point University Hamirpur) for preservation and future reference.

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