CPUH-Research Journal: **2018,** ***3(2),*** 179-186
ISSN (Online): 2455-6076
http://www.cpuh.in/academics/academic_journals.php

Common Foliose Macrolichens of Sikander Dhar, North-Western Himalaya

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ABSTRACT: Floristic studies have been initiated to explore diversity of macrolichens in and around Sikander Dhar. It is situated in Shivalik hills zone of North Western Himalaya and is located in district Mandi of Himachal Pradesh (India). During the present study, a total of seventeen species of foliose macrolichens (*Candelaria concolor* (Dicks.) Arnold, *Canoparmelia pustulescens* (Kurok.) Elix, *Dermatocarpon vellereum* Zschacke, *Heterodermia pseudospeciosa* (Kurok.) W.L. Culb, *Hyperphyscia syncolla* (Tuck. ex Nyl.) Kalb, *Parmotrema austrosinense* (Zahlbr.) Hale, *P. ravum* (Krog & Swinscow) Sérus, *Parmotrema tinctorum* (Despr. ex Nyl.) Hale, *Phaeophyscia ciliata* (Hoffm.) Moberg, *P. hispidula* (Ach.) Essl, *Physcia crispa* Nyl, *P. integrata* Nyl, *Punctelia neutralis* (Hale) Krog, *P. subrudecta* (Nyl.) Krog, *Pyxine asiatica* Vain, *P. isidiophora* (Müll. Arg.) Imshaug and *P. subcinerea* Stirt) have been recorded for the first time from the study area (Sikander Dhar).

Keywords: Floristics; foliose; macrolichens; sikander dhar

INTRODUCTION

The word lichen has a Greek origin which was referred to the superficial growth of fungus like organism. Lichen is not a single organism; it is a stable symbiotic association between fungus (mycobiont) and an alga (photobiont as it contains photosynthetic pigment) or cyanobacteria (blue green alga). The word lichen has a Greek origin which was referred to the superficial growth of fungus like (mycobiont) and an alga (photobiont as it contains photosynthetic pigment) or cyanobacteria (blue green alga) may be present in lichen thallus. Lichens contribute about 8% of life forms on the earth's surface.[1] The diversity of lichens on earth accounts for 20,000 species.[2] It is estimated that Indian lichen flora comprises of 2532 species under 324 genera and 78 families including 541 endemic (21.3 %) species.[3] Whereas, a lot of researchers have explored lichen diversity of Himachal Pradesh, however, Sikander range of Mandi district still remained.[4-20] Owing to the ecological and economic importance and in contrast to the insufficient data available on the geographical distribution, floristic and diversity of lichens in Sikander dhar of Mandi district (Himachal Pradesh), the floristic investigations were initiated to describe and preserve lichen diversity of this area.

MATERIAL NAD METHODS

Study area: During the present study, lichen specimens were collected from in and around shikander dhar. Sikander Dhar is situated in Shivalik hills zone of North Western Himalaya and is located in district Mandi of Himachal Pradesh (India). This area is characterized by temperature ranging between -10^{0}C to 25^{0}C. Precipitation occurs in the form of snow and rainfall. The altitude of this range is 7000 feet. The vegetation of this area chiefly comprises of Deodar, silver fir, chir pinel and oak. Greater part of it consists of rich grass slopes**.**

Collection: The specimens were collected from various habitats and substrates. The field data such as texture, size, colour, macroscopic features and form have been noted in the field book during the excursions.[21] A hand lens (20 X), knife, hammer, chisel and a saw were the tools used while collecting the specimens. The collected specimen were placed in polythene bags (in case of saxicolous lichens) and/or in paper packets of suitable size. A paper slip containing the field data (*viz.* collection number, details of locality, host/substrate, approximate altitude in meters and the date of collection) was placed in each paper packet or polythene bag. The fragile specimens were wrapped in cotton and/or placed in card boxes of suitable size. The fresh specimens were observed and sun dried at the camping site, placed in the paper/or polythene bags along with slip containing field data and naphthalene balls to avoid the insects and were brought to the Laboratory, Department of Bio-Sciences, Career Point University Hamirpur for further taxonomic studies and preservation/deposition in CPUH (The herbarium, Department of Bio-Sciences, Career Point University Hamirpur) after treating them taxonomically.

Identification: The collected lichen specimens were initially segregated according to their growth forms. Within the growth forms the specimens were further grouped according to the type of fruiting bodies (apothecia, perithecia, sterile). The lichens were identified by studying their morphology, anatomy and chemistry. Authenticated taxonomic keys were referred for identification of lichen specimens.[22,23,24] The chemicals

used for the chemical spot tests of the lichens were prepared using standard method after White & James, 1985. These included: 10% Potassium hydroxide (K), 10% aq. Calcium hypochlorite (C) and Stainer's stable solution of p-phenylenediamine (P) composing of p-phenylenediamine (1 g), Sodium sulphite (10 g) and Liquid detergent neutral solution in 100 ml of distilled water (0.5 ml).[25] The specimens were paced in Ultraviolet (UV) chamber at 350 nm to observe their fluorescence.

Sample synthesis and geometric characterization: The synthesis of ZnO nanoparticles was carried out by simple solution route. The starting materials, $Zn(CH_3COO)_2.2H_2O$ and $Co(NO_3)_2.6H_2O$ solution were prepared as follows: Solution-A: 1M $Zn(CH_3COO).2H_2O$ was dissolved in the solution containing 80 ml distilled water and 20 ml ethanol and Solution-B: Different concentrations of Co $(NO_3)_2.6H_2O$ was mixed with 80 ml of deionized water and 20ml of ethanol. Mixing these solutions has resulted into solution C. The experiment was performed at room temperature. Then ammonia solution was added into the solution drop by drop. The initial solution contains milky colored precipitates of Zinc acetate at low concentration of ammonia. Separately, a buffer solution was prepared by dissolving appropriate amounts of sodium hydroxide. The buffer solution was then added drop wise to the vigorously stirred solution C until the precipitation occur. Then put the solution at constant temperature for 1 hour. The precipitate was filtered and washed with distilled water. The precipitate was dried at 500°C for 1 hour in muffle furnace. Then grind the dry particles. The cobalt nitrate/ basic zinc acetate dehydrate precipitate was decomposed in cobalt doped zinc oxide.

Preparation of Co doped ZnO thin films using Spin Coater: The deposition of doped zinc oxide by spin coating technique has seen increased research activity over the past several years as the need for high quality zinc oxide thin films has increased. Spin coating is used for the application of thin films and for this were used as substrates. A typical process involves depositing a small puddle of a Fluid resin onto the center of a substrate and then spinning the substrate at high speed (typically around 3000 rpm). After preparing ZnO colloidal solution, thin films were deposited. We used well cleaned glass slides 75 x 25mm square inch slides of thickness 1.35mm as the substrate. Prior to processing, each glass slide was washed sequentially in acetone and distilled water. The glass slides were then dried. This ensures that there is no contamination on the glass surface that could potentially interfere with deposition of ZnO thin films. The substrate is secure properly on to the spin coater, and with the aid of syringe, small amount of colloidal solution carefully dispersed on to the substrate. The spin coater is immediately spun at the rate of 3000rpm for 30 secs.

The crystal structure and the particle size of the thin films were identified using an X-ray diffractometer (XRD Model: D8 Focus). A UV-2501 UV–vis spectrophotometer (SHIMADZU, Japan) with an integrating sphere was used to directly record diffuse reflectance spectra of the pure and Cobalt doped ZnO.

RESULTS AND DISCUSSION

During the present study, a total of seventeen species of foliose macrolichens have been enumerated for the first time from the study area (Table 1).

Macroscopic and Microscopic characters:

***Candelaria concolor* (Dicks.) Arnold**
Flora, Regensburg 62: 364 (1879)

Thallus corticolous, foliose, in rosettes, upto 15 mm across, minutely lobate; lobes to 2mm long, 0.5 mm wide with granular soredia at lobe ends. Cortex and apothecia K-, C-, KC-,P-, Calycin and pulvinic acid present.

Collection Examined: CPUH 3088, on bark, Murari Devi Temple, 1753m, Sikander Dhar (H.P.), February 25, 2018.

***Canoparmelia pustulescens* (Kurok.) Elix**
Mycotaxon 47: 127 (1993)

Thallus saxicolous, rarely corticolous, upto 5cm across, closely adnate; lobes sublinear, upto 1.2 mm wide, black rimmed near tips; upper side rugulose, isidiate; isidia, irregularly inflated bursting open apically to produce coarse soredia; lower side black sparsely rhizinate; medulla white. Medulla K-, C-, KC-, P-. Sekikaic, homosekikaic and fatty acids present.
Collection Examined: CPUH 3008, on rock, Gehayin ka galu, 1590m, Sikander Dhar (H.P.), February 25, 2018. CPUH 3101, on rock, Gehayin ka galu, 1595m, Sikander Dhar (H.P.), February 25, 2018.

***Dermatocarpon vellereum* Zschacke**
Rabenh. Krypt.-Fl., Edn 2 (Leipzig) 9.1(1): 638 (1934)

Thallus saxicolous, usually monophyllous, upto 12 cm across, umbilicate, thick, leathery; upper side light grey, white to dark pruinose; lower side black, with dense, thick, stumpy, coralloid rhizinomorphs. Thallus 200-450 µm thick in marginal area, 600-1000 µm thick in central part; upper cortex 18-35µm thick; lower cortex 35-100 µm thick. Perithecia pale red; ascospores ellipsoid.
Collection Examined: CPUH 3117, on rock, Ghaadi, 1667m, Sikander Dhar (H.P.), February 25, 2018.

Heterodermia pseudospeciosa (Kurok.) W.L. Culb.
Bryologist 69: 484 (1967)

Thallus terricolous or saxicolous, rosettiform, upto 5cm across, branched; lobes short, flexuose, upto 1.5 mm wide, corticated on both sides; upper side greyish white, sorediate on apices of lobules; lower side white to dark, with sparse rhizines. Medulla K+ yellow turning red, C-, P+ yellow. Zeorin, norstictic and salazinic acids present.
Collection examined: CPUH 3042, on bark, near Murari Devi Temple, 2133m, Sikander Dhar (H.P.), February 25, 2018.

***Hyperphyscia syncolla* (Tuck. ex Nyl.) Kalb**
Lichenes Neotropici, Fascicle VI (nos 201-250) (Neumarkt): no. 230 (1983)

wide: upper side greyish brown to dark brown, pruinose, centrally verrucose, lacking isidia and soredia; medulla white; lower side brown to black centrally, pale to orange marginally, medulla K+ purple (skyrin). Apothecia upto 2 mm in diam.; ascospores Pachysoporaria – type, 15-21 X 7-11µm.
Collection examined: CPUH 3090, on bark, Chowk, 1133m, Sikander Dhar (H.P.), February 25, 2018. CPUH 3106, on bark, Chowk, 1140m, Sikander Dhar (H.P.), February 25, 2018.

***Parmotrema austrosinens* (Zahlbr.) Halee**
Phytologia 28: 335 (1974)

Thallus corticolous, rarely saxicolous, upto 10 cm across; lobes rotund, to 15 (-20) mm wide, eciliate; upper side glaucous to pale grey, faintly white – maculate, soralia marginal, linear; soredia farinose to

granular; lower side centrally black, wide marginal zone ivory, yellow- brown mottled, nude; medulla white. Medulla K-,C+ red, KC+ red, P-. Lecanoric acid present.
Collection examined: CPUH 3091, on twig, Chowk, 1133m, Sikander Dhar (H.P.), February 25, 2018.

***Parmotrema ravum* (Krog & Swinscow) Sérus**
Vězda, Lichenes Selecti Exsiccati, Fascicle 75 (Průhonice): 3 (1983)

Thallus corticolous, adnate, upto 10cm across; lobes 5-12 mm wide, eciliate; upper side pale yellow grey, faintly white maculate or emaculate, soralia marginal, linear to subcapitate on peripheral lobes; soredia granular; lower side centrally black in marginal zone tan, nude; medulla white. Cortex K+ yellow; medulla K-, C-, KC-, P+ orange- red. Atranorin and usnic acid in cortex; protocetraric acid in medulla.
Collection examined: CPUH 3096, on bark, Sikandra, 1540m, Sikander Dhar (H.P.), February 25, 2018.

***Parmotrema tinctorum* (Despr. ex Nyl.) Hale**
Phytologia 28: 339 (1974)

Thallus corticolous or saxicolous, usually 8-20 cm across; lobes 10-20 (-30) mm wide, eciliate; upper side grey to darker, emaculate; isidia granular to filiform becoming coralloid or rarely flattened; lower side centrally black, wide marginal zone tan to brown, nude; medulla white. Medulla K-,C+ red, P-. Lecanoric acid and traces of orsellinic acid present.
Collection examined: CPUH 3087, on bark, near Murari Devi Temple, 2133m, Sikander Dhar (H.P.), February 25, 2018.

***Phaeophyscia ciliata* (Hoffm.) Moberg**
Symb. bot. up sal. 22(no. 1): 30 (1977)

Thallus usually corticolous, rarely terricolous or saxicolous, upto 5 cm across; lobes upto 1.5 mm wide; upper side grey-brown to brown-black, lacking isidia and soredia; lower side black, rhizinate; photobiont layer irregularly thick; medulla white, thin.
Collection examined: CPUH 3048, CPUH 3062, on bark, near Murari Devi Temple, 2133m, Sikander Dhar (H.P.), February 25, 2018.

***Phaeophyscia hispidula* (Ach.) Essl.**
Mycotaxon 7(2): 305 (1978)

Thallus corticolous, terricolous or saxicolous, upto 8 cm across; lobes 2-3 (-5) mm wide, with rounded apices; upper side grey-brown; soralia laminal, capitate, often extending up to margin; soredia rarely becoming granular; lower side black, rhizines long, black, projecting beyond the lobes; medulla white.
Collection examined: CPUH 3050, CPUH 3068, CPUH 3069, CPUH 3070, CPUH 3071, CPUH 3075, CPUH 3103, CPUH 3105, CPUH 3106, on bark, Pandit ka naun, 1745m, Sikander Dhar (H.P.), February 25, 2018.

Physcia crispa Nyl
Syn. meth. lich. (Parisiis) 1(2): 423 (1860)

Thallus corticolous, upto 3 cm across; lobes 1 mm wide, crenulated, with small protrusions becoming isidia-like and breaking into soredia; upper side grey to bluish grey; lower side whitish; rhizines pale; lower cortex paraplectenchymatous. Medulla K-.
Collection examined: CPUH 3001, CPUH 3003, CPUH 3085, on bark, Gehayin ka galu, 1590 m, Sikander Dhar (H.P.), February 25, 2018.

Physcia integrata Nyl
Nylander, Syn. Lich. 1:424 (1860)

Thallus corticolous, rarely saxicolous, to 5 cm across; lobes 1-2 mm wide, rarely minutely lobulate in central part; upper side greyish, lacking isidia and soredia; lower side black; lower cortex paraplectenchymatous. Apothecia upto 2 mm in diam.; ascospores Pachysporaria – type, 18-28 X 8-12 µm. Medulla K+ yellow. Leucotylin and zeorin present.
Collection examined: CPUH 3024, CPUH 3056, on bark, near forest rest house, Murari Devi, 2061m, Sikander Dhar (H.P.), February 25,2018.

***Punctelia neutralis* (Hale) Krog**
Nordic Jl Bot. 2(3): 291 (1982)

pseudocyphellae laminal, becoming sorediate; medulla white; lower side pale brown; lacking apothecia and pycnidia. Medulla K-, C-, P-. Caperatic acid presents.
Collection examined: CPUH 3072, CPUH 3077, CPUH 3080, on bark, Shikandra, 1540m, Sikander Dhar (H.P.), February 25,2018.

***Punctelia subrudecta* (Nyl.) Krog**
Nordic Jl Bot. 2(3): 291 (1982)

Thallus corticolous or saxicolous, 4-6 cm across; lobes 1-3 mm wide; upper side grey to bluish grey, pseudocyphellae punctiform, becoming sorediate; laminal and marginal soralia also present; lower side pale brown. Medulla K-, C+ red, KC+ red, P-. lecanoric acid present.
Collection examined: CPUH 3089, on bark, Shikandra, 1540m, Sikander Dhar (H.P.), February 25, 2018.

***Pyxine asiatica* Vain.**
Hedwigia 46: 171 (1907)

Thallus corticolous, upto 3 cm across; lobes 0.8-1.5 mm wide at periphery; upper side grey to greenish grey, white- maculate, maculae later fissured into pseudocyphellae; soralia laminal, orbicular; soredia farinose; medulla white. Medulla K+ yellowish, C-, P+ yellow to orange. Triterpenes and P+ unknown substances present.

***Pyxine isidiophora* (Müll. Arg.) Imshaug**

Imshaug, Trans. Amer. Microsc. Soc. 76(3): 257.1957

Thallus corticolous; lobes convex; upper side whitish grey, isidiate; isidia globose to cylindrical, simple to branched; medulla white. Apothecia to 2.4 mm in diam.; margins pseudothalline; ascospores 13-17 (-19) X 5-8 µm.

Collection examined: CPUH 3067, on bark, Shikandra, 1540m, Sikander Dhar (H.P.), February 25, 2018.

***Pyxine subcinerea* Stirt**.

Trans. Proc. N.Z. Inst. 30: 397 (1898) [1897]

Thallus corticolous, upto 7 cm across; lobes 1-2 mm wide; upper side greyish margins intermittently pseudocyphellate; pseudocyphellate developing into soralia and spreading on to lamina; soredia white to stramineous; medulla yellow. Upper cortex UV+ yellow; medulla K-, C-,P-. Lichexanthone in cortex and triterpenes in medulla.

Collection examined: CPUH 3073, CPUH 3074, CPUH 3079, on bark, Shikandra, 1540m, Sikander Dhar (H.P.), February 25, 2018.

Table 1: Most Common Foliose Macrolichens of Sikander Dhar

Sr. No.	Species	Family	Substrate
1	*Pyxine asiatica* Vain	Caliciaceae	Saxicolous
2	*Pyxine isidiophora* (Müll. Arg.) Imshaug	Caliciaceae	Corticolous
3	*Pyxine subcinerea* Stirt	Caliciaceae	Corticolous
4	*Candelaria concolor* (Dicks.) Arnold	Candelariaceae	Corticolous
5	*Canoparmelia pustulescens* (Kurok.) Elix	Parmeliaceae	Saxicolous
6	*Parmotrema austrosinense* (Zahlbr.) Hale	Parmeliaceae	Corticolous
7	*Parmotrema ravum* (Krog & Swinscow) Sérus	Parmeliaceae	Corticolous
8	*Parmotrema tinctorum* (Despr. ex Nyl.) Hale	Parmeliaceae	Corticolous

9	*Punctelia neutralis* (Hale) Krog	Parmeliaceae	Corticolous
10	*Punctelia subrudecta* (Nyl.) Krog	Parmeliaceae	Corticolous
11	*Heterodermia pseudospeciosa* (Kurok.) W.L. Culb	Physciaceae	Corticolous
12	*Hyperphyscia syncolla* (Tuck. ex Nyl.) Kalb	Physciaceae	Corticolous
13	*Phaeophyscia ciliata* (Hoffm.) Moberg	Physciaceae	Corticolous
14	*Phaeophyscia hispidula* (Ach.) Essl	Physciaceae	Corticolous
15	*Physcia crispa* Nyl	Physciaceae	Corticolous
16	*Physcia integrata* Nyl	Physciaceae	Corticolous
17	*Dermatocarpon vellereum* Zschacke	Verrucariaceae	Saxicolous

CONCLUSIONS

During the present study about hundred specimens were collected from various localities and substrates of the study area. The taxonomic investigations of these specimens have resulted into identification of seventeen species of foliose macrolichens (*Candelaria concolor* (Dicks.) Arnold, *Canoparmelia pustulescens* (Kurok.) Elix, *Dermatocarpon vellereum* Zschacke, *Heterodermia pseudospeciosa* (Kurok.) W.L. Culb, *Hyperphyscia syncolla* (Tuck. ex Nyl.) Kalb, *Parmotrema austrosinense* (Zahlbr.) Hale, *P. ravum* (Krog & Swinscow) Sérus, *Parmotrema tinctorum* (Despr. ex Nyl.) Hale, *Phaeophyscia ciliata* (Hoffm.) Moberg, *P. hispidula* (Ach.) Essl, *Physcia crispa* Nyl, *P. integrata* Nyl, *Punctelia neutralis* (Hale) Krog, *P. subrudecta* (Nyl.) Krog, *Pyxine asiatica* Vain, *P. isidiophora* (Müll. Arg.) Imshaug and *P. subcinerea* Stirt). All the taxa have been reported for the first time from this area. Most of the recorded macrolichens are corticolous and represented by families Parmeliaceae and Physciaceae.

ACKNOWLEDGEMENTS

Authors are thankful to Chancellor, Career Point University Hamirpur for providing the necessary laboratory facilities

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