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Research article

New additions to the lichen flora of Jammu and Kashmir state (India)

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Abstract: Jammu & Kashmir is a Himalayan state of India which exhibits large altitudinal variation and thus houses good lichen diversity in it. Rajouri is one of the border districts of state, situated in the lap of Pir Panjal mountain range and was not well explored in the point of view of lichen diversity. Thus the present study was conducted to explore the lichen diversity from this remote district. The study revealed addition of 12 new records of lichen species for the state of Jammu and Kashmir. The reported species belongs to 11 genera of nine families.
Keywords: Lichen - Rajouri - Western Himalaya - Jammu and Kashmir.

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INTRODUCTION

Jammu and Kashmir is one of the lichen rich regions of Himalaya and often called as Hot Spot of lichen diversity in India (Sheikh *et al*. 2006). The state of Jammu & Kashmir exhibits large altitudinal variation ranging from 300 - 6500 m amsl. The climate of Jammu and Kashmir thus varies from tropical to alpine. The state falls in the lichenogeographic zone consisting of mountainous to semi mountainous plains, Shiwalik ranges, mountains of Kashmir valley, Pir Panjal range, Trans-Himalayan range of Ladakh and Kargil. The literature scanned revealed that Jammu and Kashmir State is represented by the occurrence of only 413 species (Singh & Sinha, 2010, Rai *et al*. 2014, Goni *et al*. 2015, Goni & Sharma 2015).

Rajouri, one of the border districts of Jammu and Kashmir (J&K) state is situated in the lap of Pir Panjal mountain range. It is located between 70–74°4′ East longitude and 32°58′–33°35′ North latitude. The total geographical area of the district is 2630 Km^2. It lies between elevations of 400–6000 m asl. The district experiences hot summers and moderately cold winters. The average temperature varies from 7°C to 37°C. The climate varies from semi-tropical in the southern part to temperate in the mountainous northern part. Its boundaries are connected with district Jammu and Reasi on the eastern side, district Poonch on the west, Pulwama on the north and the famous Red Cliff Line (L.O.C) passes at the south end of district.

The unique topography of the district along with the climatic conditions supports a wide range of vegetation *i.e.* from subtropical to alpine. *Pinus roxburghii* dominates the subtropical part of the region, covering 60% of the total area along with *Phyllanthus emblica, Quercus leucotricophora, Buxus wallichiana, Zanthoxylum armatum, Dalbergia sissoo, Mallotus philippensis, Olea ferruginea, Cassia fistula, Acacia catechu, Syzygium cumini, Ulmus wallichiana, Bauhinia variegate, Albizzia lebbeck, Ziziphus mauritiana, Celtis australis, Populus ciliata, Pyrus pashia and Punica granatum.* The temperate region is rich in *Pinus wallichiana, Rhododendron arboreum, Quercus semicarpifolia, Picea smithiana, Abies pindrow, Salix babylonica and Juniper communis.* Although some studies have been undertaken to document the information on higher plants of the district (Rashid *et al.* 2008, Pant & Verma 2009, Sarver *et al.* 2009, Pant 2011), lower groups have been ignored. As such scanty information is available on lower organisms from this district including lichens. Survey for the exploration of lichens from the area resulted in the addition of 12 species of 11 genera belonging to 09 families to the lichen flora of J&K state.

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MATERIALS AND METHODS

The frequent field visits were carried out from 2013–2015 for the collection of lichens from Rajouri district of Jammu and Kashmir state. The specimens were collected from all the available substrata and the collected specimens were dried and placed in separate herbarium packets along with details of locality, substratum, habit and date. The identification of the specimens was done by using morphological, anatomical and chemical details. Morphological details were studied using a Digi Zoom stereomicroscope and anatomical details under a Nikon compound eclipse 400 microscope. Secondary metabolites were identified with the use of colour spot tests which were performed using 10% KOH solution (K), calcium hypochlorite (C) and para-phenylene diammine (P). Thin layer chromatography was done using solvent system A comprising of Toluene: 1, 4-dioxane:acetic acid; 130:60:20 ml. The silica gel plate spotted with the lichen chemicals extracted in acetone was placed in TLC jar, lined internally by a filter paper and containing solvent. The level of solvent was 1.0 cm below the lichen spots. Solvent gradually rose up in the precoated silica plate and was allowed to rise up to 14 cm mark. Then plate was taken out. 10% aqueous solution of sulphuric acid was sprayed and the plate was placed in hot air oven at 110°C till the different colour spots appeared. The plate was observed under UV light at 350 nm wavelength and finally Rf value was calculated. Identification was made of lichen substances on the basis of position and colour of spots by comparing them with the published charts (Culberson 1972, Walker & James 1980). The recent literature of (Awasthi 1991, 2000, 2007, Divakar & Upreti 2005) was also used for the authentic identification of the specimens. After the complete identification and labelling the specimens were deposited in the herbarium of Centre for Biodiversity Studies of BGSB University and National Botanical Research Institute, Lucknow.

New Additions

A. *Acarospora oxytona* (Ach.) Massal., Ricerch.Auton.Lich.Crost.: 28. 1852. - *Lecanora oxytona* Ach. Lich. Univ.: 436.1810. **(Fig. 1A)**

Thallus saxicolous, marginally lobate, yellow, effigurate, ± areolate, forming continuous often circular patches, circumference distinctly radiate; marginal lobes of thallus rough, subconvex and 1.5–2 mm long. Apothecia plane, solitary to 0.1–1.0 mm in diameter, immersed in areolae; disc plane brown; margin thick, persistent; ascospores simple, hyaline, ellipsoid, 4–5×1.7–2 µm.

Chemistry: Thallus K-, Pd-, C-, KC-. No chemical present.

Specimen examined: Thannamandi, 1500 m, on rock, 25/10/2011, Mamta Bhat Acc. No. 034442 (LWG).

B. *Anema decipiens* (A. Massal.) Forss., Forssell, Nova Acta Reg. Soc. Sci. Upsal., ser. 3, 13: 92, 1885. **(Fig. 1B)**

Thallus saxicolous, minutely lobed, lobes upto 2 mm wide, bluish-grey to black. Apothecia red-brown to black, to 0.5 mm in diameter; ascospores ellipsoidal, 9–15 (–18)×5–9(–12) µm.

Chemistry: Thallus K-, Pd-, C-, KC-. No chemical present.

Specimens examined: Dassal, Rajouri, 1060 m, on rock, 14/08/2013, Mamta Bhat Acc. No. 034483 (LWG).

C. *Bacidia rubella* (Hoffm.) Massal., Ricerch.Auton.Lich.Crost.: 118. 1852. - *Verrucaria rubella* Hoffm. Deutschl. Fl. 2: 174. 1796. **(Fig. 1C)**

Thallus corticolous, crustose, granular – isidiate, grey – green to yellow – green, thin. Apothecia rare (0.4–) 0.7–1(–1.3) mm diameter, distinctly constricted below, flat sometimes convex, pale to dark red-brown, sometimes white pruinose; ascospores acicular, (35–)40–70(–75)×2.5–3(–4) µm.

Chemistry: Thallus K-, Pd-, C-, KC-. No chemical present.

Specimens examined: Koteranka, 1667 m, on bark of *Baxus wallichiana*, 15/10/2012, Mamta Bhat Acc. No. 034543 (LWG).

D. *Bulbothrix setschwanensis* (Zahlbr.) Hale, Phytologia 28: 481. 1974. - *Parmelia setschwanensis* Zahlbr. In Handel Mazzeti, Symbol.Sinic. 3. **(Fig. 1D)**

Thallus saxicolous, foliose, adnate; lobes upto 6 mm wide, bulbate cilia along margins, often only basal bulb distinct; isidia and soredia absent; lower side pale brown, densely rhizinate; medulla white. Apothecia upto 5 mm in diameter; ascospores 12–19(–22)×6–10 µm.

Chemistry: Medulla K+ yellow turning red, Pd+ orange - red, C-, KC-. Salizinic acid present.

Specimens examined: Bakori 1667 m, on bark of *Quercus leucotrichophora*, 09/10/2012, Mamta Bhat Acc. No. 10195 (LWG).

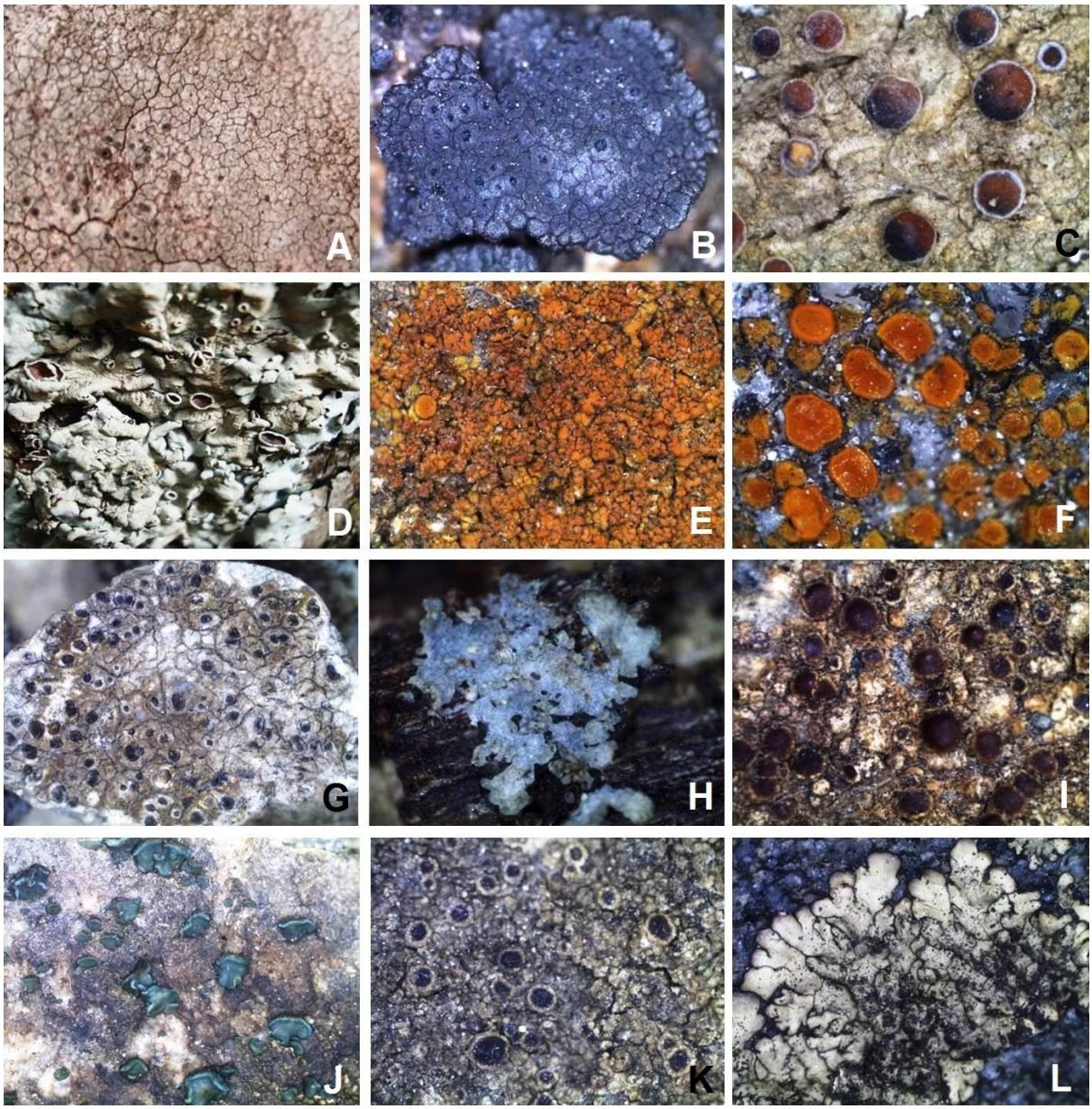

Figure 1. A, *Acarospora oxytona* (Ach.) Massal.; **B,** *Anema decipiens* (A. Massal.) Forss.; **C,** *Bacidia rubella* (Hoffm.) Massal.; **D,** *Bulbothrix setschwanensis* (Zahlbr.) Hale; **E,** *Caloplaca ahmadiana* Poelt & Hinteregger; **F,** *Caloplaca parviloba* Wetmore; **G,** *Diploschistes euganeus* (Massal.) Steiner; **H,** *Hyperphyscia granulata* (Poelt) Moberg; **I,** *Lecanora pseudistera* Nyl.; **J,** *Peltula obscurans* (Nyl.) Gyelink; **K,** *Rinodina sophodes* (Ach.) Massal.; **L,** *Xanthoparmelia congensis* (B. Stein) Hale.

E. *Caloplaca ahmadiana* Poelt & Hinteregger, Bib. Lich. 50: 72–73 (1993). **(Fig. 1E)**

Thallus crustose, saxicolous, thick, 0.5–10.0 mm in diameter, often coalescing with other thalli to cover large areas, orange to brownish-orange, uniformly squamulose, flat to slightly subconvex, margins of squamules lifted from the substrate, primary squamules 0.8–1.5 mm wide, small lobules/squamules budding out from the primary squamules and later on spreading entirely over whole of the surface, secondary squamules (lobules) 0.1–0.2 mm wide. Cortex paraplectenchymatous, 14.0–20.0 µm thick; algal layer continuous.Medulla white, prothallus absent.Apothecia and pycnidia not seen.

Chemistry: Thallus K+ purple, C -, Pd -. Medulla K -, C -, Pd -.Parietin present.

Specimens examined: Dhanore, 1100 m, on rock, 15/10/2012, Mamta Bhat Acc. No. 034553 (LWG).

F. *Caloplaca parviloba* Wetmore, Bryologist 106 (1): 148–149 (2003). **(Fig. 1F)**

Thallus crustose, saxicolous, areolate to sub squamulose, continuous with short narrow elongated lobes, 0.2–0.7 mm, areoles/squamules appressed to the substratum, margins slightly uplifted, flat to somewhat convex, 1.0–1.5 mm wide, margins of areoles with numerous short lobules 0.1 mm wide and 0.2–0.3 mm long, yellow-

orange to orange. Cortex paraplectenchymatous, 15.0–40.0 µm thick. Algal layer continuous to uneven. Medulla white. Prothallus not seen.

Chemistry: Thallus, apothecial disc and epihymenium K+ purple, C -, Pd -; Medulla K -, C -, Pd -. Parietin present.

Specimens examined: Darhal, 1800 m, on rock, 07/09/2012, Mamta Bhat Acc. No. 034572 (LWG).

G. *Diploschistes euganeus* (Massal.) Steiner, Verhandl. Zool. Bot. Ges. Wein 69: 96. 1919. - *Limboria euganea* Massal., Ric. Lich.Grost.: 152. 1852. **(Fig. 1G)**

Thallus saxicolous, crustose, verrucose, areolate, ecorticate or with a corticiform layer, with a green algae, apothecia perithicoid disc pale yellow to brown, disc narrowed and opening by a pore, 0.5–1 µm diameter; paraphysis simple, thallus whitish grey in colour, proper exciple, blackish 30–40 µm thick, hymenium hyaline, 80–100 µm high, spores 8 per ascus, biseriately arranged 24–36×15–18 µm.

Chemistry: No chemicals present.

Specimens examined: Darhal, 1800 m, on rock, 07/09/2012, Mamta Bhat Acc. No. 034458 (LWG).

H. *Hyperphyscia granulata* (Poelt) Moberg, Moberg.Nord. J. Bot. 7: 721. 1987. - *Physciopsis granulate* Poelt, Khumbu Himal 6(2): 91. 1974. **(Fig. 1H)**

Thallus corticolous, to 5 cm across, branched; lobes to 3 mm wide, widest at tips; upper side grey brown to brown, isidiate; isidia granular to globular; medulla orange – red in lower part. India and Nepal specimens sterile.

Chemistry: Skyrin present.

Specimens examined: Shadra Sharief, 1400 m, on bark of *Salix babylonica*, 17/11/2012, Mamta Bhat Acc. No. 034530 (LWG).

I. *Lecanora pseudistera* Nyl., Flora 55: 354. 1872. **(Fig. 1I)**

Thallus crustose, dispersed-verrucose to areolate or subsquamulose, bulbate, whitish to greenish grey, yellowish white to yellowish grey, whitish grey, epruinose; isidia and soredia absent; prothallus absent or invisible. Apothecia numerous, immersed when young, becoming sessile to slightly constricted at the base, 0.3–1.2 mm in diameter; disc reddish orange to dark red brown, epruinose; margin thin, entire, smooth to verruculose, entire to crenulate, concolorous with the thallus, ascus clavate, 38–60×10–15µm; ascospores 8 per ascus, ellipsoidal, 8–15×5–8µm.

Chemistry: Thallus and apothecial margin K+ yellow, C -, PD + yellow. Atranorin and 2' - *O* - methylhyperlatolic acid present.

Specimens examined: Darhal, 1544 m, on rock, 07/09/2012, Mamta Bhat Acc. No. 034470 (LWG).

J. *Peltula obscurans* (Nyl.) Gyelink, Rep. Spec. Nov. Regn. Veg. 38: 308, 1935 - *Endocarpiscum obsurans* Nyl. Bull. Soc. Linn. Normand. 2(6): 309, 1872. **(Fig. 1J)**

Thallus saxicolous, squamulose, squamules greenish grey to olive, 0.75–2.0 mm in diameter, rounded to angular, plain to convex, sometimes deeply lobed, rosette-shaped and attached by umbilicus. Thallus 100–250 µm thick, algal layer 40–100 µm thick, medulla of loose hyphae, 10–30 µm thick, lower cortex 3–5 cell layered, 15–40 µm thick. Apothecia 1–2 (rarely 3) per squamule, disc brown-orange, up to 0.4 mm in diameter, with thalloid rim, hymenium 120–150 µm high, asci clavate, with gelatinous sheath, 72–80×15–20 µm, multispored; spores hyaline, simple, oval, 2–3×1–2 µm.

Chemistry: Thallus K-, I- , (hymenium I+ vinose - red).

Specimens examined: Nadian, Darhal, 1496 m, on rock, 07/09/2012, Mamta Bhat Acc. No. 034518 (LWG).

K. *Rinodina sophodes* (Ach.) Massal., Ricerch.Auton.Lich.Crost.14: 1852. - *Lichen sophodes*Ach., Lich. Suc.Prodrom.67:1798. **(Fig. 1K)**

Thallus corticolous, crustose, grey to dark brown, in small patches, irregularly cracked, flat, determinate, verrucose-areolate; prothallus dark, thin, entire. Apothecia 0.5–1.0 mm diameter ± immersed, sometimes becoming ± sessile, frequent; ascospores 13–16×7–8 µm.

Chemistry: K-, Pd-, C -, KC -. No chemical present.

Specimens examined: Shadra Sharief, 1490 m, on bark of *Pyruspashia*, 17/11/2012. Mamta Bhat Acc. No. 034499 (LWG).

L. *Xanthoparmelia congensis* (B. Stein) Hale, Hale. Phytologia 28: 486. 1974. - *Parmelia congensis* B. Stein, Jahr.Schles.Ges.Vaterl. Cultur 66: 140. 1889. **(Fig. 1L)**

Thallus saxicolous, 2–4 cm across, centrally becoming subcrustose; lobes 0.3–1 mm wide; upper side greenish yellow, isidiate; isidia globose, often bursting open at top, not forming soredia; lower side black, sparsely rhizinate; medulla white. Apothecia not known.

Chemistry: Medulla K+ yellow, C-, KC-, P+ orange. Stictic, constictic, norstictic acids present.

Specimens examined: Darhal, 1544 m, on rock, 07/09/2012, Mamta Bhat Acc. No. 034504 (LWG).

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