New records of squamulose lichens from western Himalaya

D. K. Upreti, Y. Joshi, S. Nayaka and S. Joshi

National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, India
E-mail: upretidk@rediffmail.com; yogesh36953@rediffmail.com;
sanjeeva_n@yahoo.com; sj_lichenology@rediffmail.com

ABSTRACT

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The present paper deals with the description of some squamulose lichens from temperate to alpine regions of western Himalaya. The genera *Miriquidica* and *Lecidoma* (monotypic) are reported for the first time from India, whereas three new records are described for *Toninia*. *Psora decipiens* and *P. himalayana,* poorly known from Indian subcontinent, were also recorded.

Key-words: Lichens, *Lecidoma*, *Miriquidica*, *Psora*, *Toninia*, western Himalaya, India.

INTRODUCTION

The Indian tract of Himalaya exhibits abundant variety and luxuriant growth of temperate-alpine lichens. The corticolous lichens are dominant in the temperate region because of the availability of number of phorophytes. The rocks under moist shady forest and in exposed areas provide diverse habitat for a number of lichen taxa to colonise. The physical and chemical characters, together with the proximity of water to substratum, also exert a great influence in the determination of the type of lichen growth. The soil inhabiting lichens in the area are generally associated with mosses to fulfil their moisture demand. The larger trees are altogether absent in the alpine region, thus majority of lichens grow on rocks or soil generally mixed with mosses.

The temperate-alpine region of Himalaya is most suitable for profuse growth of lichens. Most of the foliose and fruticose lichens recorded from Indian subcontinent have been collected from this region. Lahaul and Spiti district of Himachal Pradesh exhibits the occurrence of more than 80 lichen species belonging to 37 genera and 25 families (Srivastava et al. 2006). The alpine region of Gangotri and Gomukh in Garhwal Himalaya exhibits the occurrence of 149 lichen species belonging to 50 genera and 21 families (Upreti et al. 2004). The lichens in the alpine region form a felt like growth on ground, rocks and boulders in moist, shady and open exposed areas.

During recent field excursions in the temperate-apline region of Himalaya, a large number of lichens were collected. Although most of the foliose and fruticose lichens are well worked out, but the knowledge about squamulose and crustose lichens from this region is scanty. Thus the present enumeration comprises detailed morpho-taxonomic account of seven squamulose lichen taxa from this region. Lichen genus *Toninia,* represented in India by a single species *T. coeruleonigricans* (Leight) Th. Fr., is found growing in north-western Himalaya (Awasthi 1991). Timdal (1991) recorded *T. himalayana* Timdal and *T. cinereovirens* (Schaer.) Massal., from Nepal Himalaya.

From India, the lichen genus *Psora* represented by *P. himalayana* (Bab.) Timdal and *P. decipiens* (Hedwig) Hoffm., were recorded in the fifties of 20th century (Awasthi 2007). Both the taxa were recollected after a long gap and are described here.

Lecidoma demissum (Rusträm) G. Schneider & Hertel, earlier known from Europe and North America, and *Miriquidica mexicana* Rambold, Sipman & Hertel known from North America are new records for India.

MATERIAL AND METHOD

The present study is based on lichen specimens housed at LWG, mostly including recent collections. The morphological characters were examined on dry material under a dissecting microscope (x40). Thallus and ascomata were examined with a compound microscope (x1000, in oil immersion). The sections for anatomical details were mounted in water. All measurements were made in water, but the paraphyses were studied after replacing water with 25% KOH (Wetmore 1994). Chemicals used in identification were 10% KOH (K), calcium hypochlorite (C), para-phenylenediamine (P), concentrated nitric acid (N) and iodine (I). Secondary metabolites were identified by TLC as described by Walker and James (1980). The chromatograms were developed in solvent systems A (toluene: 1, 4-dioxane: acetic acid) and B (hexane: di-ethyl ether: formic acid). Terminology for tissues generally follows that of Nash III and Gries (2002).

TAXONOMIC DESCRIPTION

Lecidoma demissum (Rutström) G. Schneider & Hertel

Plate 1, figure 1

Herzogia 5(3-4): 460. 1981.

Thallus coarsely areolate to subsquamulose, forming small to spreading lumpy mounds, 3 to 7 cm in diam., dark brown, rarely grey to grey brown, ± shiny; areoles 1-2 (-4) mm across, flat to convex, polygonal or somewhat subsquamulose, tightly packed, ± turgid, often contiguous and ± coalescing; lower surface deep brown-black. Apothecia 0.5-1 (-1.5) mm diam., discrete or becoming confluent, ± immersed or adnate, flat or convex; true exciple thin when young, becoming excluded when mature, outer part pale brown, inner part hyaline; disc round, dull brown-black, red-brown when moist; epihymenium 12-18 µm high, red-brown, hymenium 60-70 µm high, hyaline, hypothecium hyaline. Paraphyses straight, thin walled, strongly conglutinated, slightly branched and anastomosed, apical cells swollen with a thin, dark brown cap. Asci *Porpidia*-type, 8-spored, spores hyaline, simple, ellipsoid or ovoid, 12-16 x 5.5-7 µm. Pycnidia not seen.

Chemistry: Thallus K-, C-, KC-, P-. Hymenium I+ blue. Lichen products not detected by TLC.

Distribution: Scotland, N.W. England, N. Wales, Ireland, C. Europe, Fennoscandia, North America (Schneider 1980; Purvis et al. 1992). It is a new record for India.

Remarks: The mature thalli resemble small cow-pats in colour and appearance and is found growing on soil in moist areas of Rohtang Pass, northern Himalayas between altitudes of 3600 and 3750 m.

Specimens examined: Himachal Pradesh, Lahaul & Spiti district, Lahaul valley, Rohtang Pass, alt. 3600 m, 16.09.2001, on soil, D. K. Upreti 01-26571 (LWG); alt. 3750 m, 02.08.2002, D. K. Upreti & P. K. Divakar 02-000018, 02-000019/A (LWG).

Miriquidica mexicana Rambold, Sipman & Hertel

Plate 1, figure 2

Mycotaxon 58: 319-324. 1996.

Thallus crustose, contiguous to dispersed areolate, up to 5 cm or more in diam., up to 0.4 mm thick, pale yellow, brown (when dry), or greenish brown, usually shiny; areoles 0.15-0.9 mm in diam., initially plane, later convex, sometimes undulate or almost semiglobose; prothallus black, conspicuous, composed of dense, dendroid-branched strands, projecting 0.5-1 mm beyond the areoles. Cortex brown pigmented above, epinecral layer 5-15 µm thick, 10-20 µm unpigmented lower cortical layer, medulla white. Apothecia 0.4-0.8 mm in diam., sessile, usually strongly constricted at base, regularly distributed over the thallus, single on the areoles, plane at first, finally convex, disc black when dry, margin black, usually prominent, commonly slightly glossy, sometimes white pruinose, thalline margin absent, exciple dark olive to brown peripherally, hyaline and with inspersed crystals and algal cells internally, epihymenium 10-15 µm high, green to olivaceous, hymenium up to 40 µm high, hyaline below, green or olivaceous above, I- or I+ blue, hypothecium hyaline,

Plate 1

1. *Lecidoma demissum*, Bar = 2 mm. 2. *Miriquidica mexicana*, Bar = 2 mm. 3. *Psora decipiens*, Bar = 4 mm. 4. *Psora himalayana*, Bar = 1 mm. 5. *Toninia cinereovirens*, Bar = 2 mm. 6. *Toninia tristis* ssp. *asiae-centralis*, Bar = 2 mm. 7. *Toninia tristis* ssp. *scholanderi*, Bar = 2 mm.

70-110 µm thick, incrusted with crystals in its lower part. Paraphyses simple, apical region clavate. Asci *Lecanora*-type, 8-spored, spores hyaline, simple, ellipsoid, 8-10 x 3.2-4.5 µm. Pycnidia black, immersed, conidia hyaline, curved to filiform 20-42 x 0.7 µm.

Chemistry: Cortex and medulla K-, C-, KC-, P-. TLC: Lobaric acid.

Distribution: North America and Baja California (Rambold et al. 1996; Nash III et al. 2004). It is a new record for India.

Remarks: It is close to *M. garovaglii* (Schaer.) Hertel & Rambold, which differs in having stictic acid and bigger spores (12-17 x 5-6 µm). It is a new record for Indian lichen flora found growing on exposed siliceous rocks in cold deserts of western Himalayas between elevations of 3800-4700 m.

Specimens examined: Himachal Pradesh, Lahaul & Spiti district, Patsio, alt. 3800 m, on exposed rocks, 04.08.2003, D. K. Upreti & S. Chatterjee 03-001738 (LWG); Kunzum Pass area, alt. 4500 m, on exposed rocks, 03.08.2002, D. K. Upreti & P. K. Divakar 02-000089 (LWG); Baralachala Pass, Top area, alt. 4700 m, on exposed rocks, 04.08.2003, D. K. Upreti & S. Chatterjee 03-001775 (LWG); Jammu & Kashmir, Leh district, Khardungla Pass area, alt. 4700 m, on exposed rocks, 08.08.2003, D. K. Upreti & S. Chatterjee 03-001809/B (LWG).

***Psora decipiens* (Hedwig) Hoffm.**

Plate 1, figure 3

Descript. Adumbr. PI. Lich. 2, 4: 63. 1794.

Thallus squamulose, squamules 3-4 (-6) mm diam., isodiametrical, adnate, scattered to contiguous, concave to convex, usually not regularly depressed at the center. Upper side bright red or sometimes brownish red or partly pale greenish brown, somewhat shiny, epruinose or partly to entirely white pruinose, usually with some fissures; margin white, slightly up-turned, soon becoming crenulate; underside more or less white. Prothallus absent. Upper cortex well developed, 80-120 µm thick, of anticlinally oriented, thick walled hyphae with shortly cylindrical to round lumina, usually containing calcium oxalate, epinecral layer usually present and remnants of dead algae are present throughout the cortex, medulla white, containing calcium oxalate and sometimes lichen substances. Lower cortex poorly developed or absent, attached by a hyphal net. Apothecia up to 2 mm diam., attached marginally to the squamules, sessile, simple, plane to weakly convex when young, soon becoming strongly convex to hemispherical, indistinctly marginate to immarginate, black, more or less shiny, epruinose or ± white-yellow- pruinose; thalline exciple absent, true exciple annular, colourless to pale brown, of radiating hyphae, usually indistinct, become excluded. Epihymenium 12-18 µm high, red-brown or brown, containing anthraquinones (mainly parietin), hymenium 50-75 µm high, hyaline, hypothecium pale brown to hyaline, with calcium oxalate crystals. Paraphyses simple or sparingly branched, strongly conglutinated, apical cell slightly swollen. Asci 8-spored, spores hyaline, simple, ellipsoid, smooth, 11-18 × 6-8 µm. Pycnidia immersed in squamules, ostiole hyaline, conidia elongate-bacilliform, simple, hyaline, 6-7 x 1 µm.

Chemistry: Thallus K-, C-, P-. Epihymenium K+ purple-red, N-, hymenium I-. TLC: Lichen substance absent (strain I); norstictic acid (strain II); or hyposalazinic acid and hypostictic acid (strain III).

Distribution: Cosmopolitan (Follman 1976, Schneider 1980, Timdal 1984, Timdal 1986, Purvis et al. 1992), India and Nepal (Paulson 1925, Smith 1931, Awasthi 2007).

Remarks: *P. decipiens* is closely related to *P. crenata* (Taylor) Reinke, which differs mainly in having broader and thicker squamules with a regular central depression and down-turned, more or less entire margin. However, the squamules of *P. decipiens* usually lack a regular central depression and have up-turned and distinctly crenulate margin. *P. himalayana* (Church. Bab.) Timdal, another related species differs in having laminally attached apothecia and elongated, imbricated squamules. The species have been reported growing in exposed areas over soil and rocks from alpine cold desert regions of northern Himalayas between altitudes of 3900-4700 m in association with cyanolichens, mosses and herbaceous angiospermic plants.

Specimens examined: Himachal Pradesh, Lahaul & Spiti district, Lahaul Valley, 6 km before Chhatru from Koksar side, alt. 3900 m, on soil, 02.08.2002,

D. K. Upreti & P. K. Divakar 02-00161/A (LWG); Baralachala Pass, alt. 4700 m, on soil, 04.08.2003, D. K. Upreti & S. Chatterjee 03-001770 (LWG).

***Psora himalayana* (C. Bab.) Timdal**

Plate 1, figure 4

Bryologist 89: 262-264. 1986.

Thallus squamulose, squamules up to 4 mm diam., usually elongated, adnate when young, later usually ascending and imbricate. Upper side medium brown or reddish brown to dark brown, dull or slightly shiny, epruinose or more rarely faintly white pruinose especially along the margin, usually with some fissures; margin white, more or less straight, soon becoming crenulated or incised; underside pale brown in central part, white near margin. Upper cortex 80- 160 µm thick, composed of usually rather thick-walled hyphae with round or ellipsoid to angular or cylindrical lumina, lacking crystals except for sparse occurrences of calcium oxalate near the margin in pruinose specimens, medulla white, usually containing calcium oxalate in the lower part. Lower cortex not sharply delimited from the medulla, composed of irregularly or mainly anticlinally oriented hyphae with shortly cylindrical lumina, usually containing calcium oxalate. Apothecia up to 2 mm diam., attached laminally to the squamules, simple, strongly convex to hemispherical even when young, dark brown to black, dull or shiny, epruinose or more rarely slightly white (or yellow) pruinose, thalline exciple absent, true exciple annular, colourless to pale brown, of radiating hyphae, usually indistinct, become excluded. Epihymenium 12-18 µm high, red-brown or brown, hymenium 50-75 µm high, hyaline, hypothecium pale brown to hyaline, with calcium oxalate crystals. Paraphyses simple or sparingly branched, strongly conglutinated, apical cell slightly swollen. Asci 8-spored, spores hyaline, simple, ellipsoid, smooth, 11-14 × 7-9 µm. Pycnidia immersed in squamules, ostiole hyaline, conidia elongate-bacilliform, simple, hyaline, 6-7µm.

Chemistry: Thallus K-, C-, P-. TLC: no chemicals detected.

Distribution: Boreal and arctic-alpine areas in northwestern North America, easternmost Europe (Timdal, 1986) and Asia (Timdal 1986, Awasthi 2007).

Remarks: *P. himalayana* differs from *P. globifera* mainly in having smaller, distinctly white-edged, and more regularly imbricate squamules containing calcium oxalate in the medulla and/or the lower cortex. Pruinose specimens of *P. globifera* sometimes resemble *P. himalayana* but may be distinguished morphologically by having the pruina mainly on the upper side near the margin of the squamules, not along the margin. *Psora himalayana* is usually white on the lower side near the margin of the squamules, whereas *P. globifera* is usually pale to medium brown.

Specimens examined: Himachal Pradesh, Kangra district, junction of Pin and Spiti rivers, alt. 3600 m, on rocks, 30.07.1952, O. A. Höeg (LWG-AWAS); Lahaul & Spiti district, Lahaul Valley, 6 km before Chhatru from Koksar side, alt. 3900 m, on soil, 02.08.2002, D. K. Upreti & P. K. Divakar 02-00141 (LWG).

***Toninia cinereovirens* (Schaer.) Massal.**

Plate 1, figure 5

Ric. auton. lich. crost.: 107. 1852.

Thallus squamulose, indeterminate, squamules up to 3 mm in diam., sometimes scattered when young, later contiguous or irregularly imbricate, orbicular to elongated, often deeply lobed, weakly concave to weakly convex. Upper side medium brown to dark brown, often with an olivaceous tinge, epruinose, dull to slightly shiny, sometimes with shallow irregular fissures. Margin usually dark grey but sometimes concolorous with upper side. Underside pale brown to medium brown. Upper cortex 60-100 µm thick, epinecral layer 40 µm thick. Algal layer continuous. Lower cortex poorly developed. Apothecia up to 1 mm in diam., plane to weakly convex, indistinctly marginate, epruinose to faintly pruinose, epihymenium 10-20 µm high, olivaceous brown to bright green, hymenium 60-70 µm high, hyaline, hypothecium pale brown to hyaline, proper exciple dark brown in the rim, pale brown to hyaline in inner part. Paraphyses straight, sparingly branched, thin walled, not or only slightly conglutinated, apical cell distinctly swollen and surrounded by a diffusely delimited gelatinous pigment

cap. Asci 8-spored, spores hyaline, ellipsoid to bacilliform, 1-3 septate, 13-30 x 3-4.5 µm.

Chemistry: Thallus K-, C-, P-. Epihymenium K-, N+ violet, proper exciple K-, N-. TLC: No chemicals (similar to Chemotype 0 of Timdal, 1991).

Distribution: North America (Weber 1963), Central Europe, Kenya, Nepal (Timdal 1991). It is a new record for Indian lichen flora.

Remarks: The species is mainly characterised by having darker, often imbricate squamules with a free or ascending, usually dark grey margin. *T. squalida*, closely related species differs in having pure brown squamules which are never imbricated and the margin of whose is ± appressed to the substrate and concolorous with upper side. Besides that size and septation of the spores also demarcates these two species: *T. cinereovirens* has bacilliform (13.5-30.5 x 3-4.5 µm), 1-3 septate spores, while the spores of *T. squalida* are acicular (23-41.5 x 2.5-4.5 µm) and 3-7 septate. The taxon is found growing in temperate areas of western Himalayas at an altitude of 2700 m on soil over rocks in association with species of *Candelariella.*

Specimen examined: Jammu & Kashmir, Srinagar, Baltal, alt. 2700 m, on soil over rocks, 29.08.1982, A. Singh & D. K. Upreti 13914 (LWG).

Toninia tristis ssp. *asiae-centralis* (Magn.) Timdal

Plate 1, figure 6

Opera Botanica 110: 112. 1991.

Thallus squamulose, indeterminate, squamules up to 2 (-3) mm in diam., scattered to contiguous, usually bullate. Upper side castaneous brown to dark brown, sometimes with a green tinge, dull or shiny, smooth or with shallow fissures in the cortex, with punctiform impressions developing into pores. Margin concolorous with upper side. Underside pale brown to black. Upper cortex 40-160 µm thick, epinecral layer 100 µm thick, algal layer continuous. Lower cortex resembling upper cortex. Apothecium up to 1.5 (-4) mm in diam., plane to weakly convex, marginate to immarginate, epihymenium 10-18 µm high, brown, sometimes with a faintly green tinge, hymenium 60-70 µm high, hyaline, hypothecium pale brown to medium brown in upper part, paler brown lower part, lacking crystals but sometimes containing orange (K+ red) and yellow pigments (K-) in the upper part, proper exciple medium brown to dark brown (sometimes with a green tinge) in the rim, usually paler brown in inner part. Paraphyses straight, sparingly branched, thin walled, not or only slightly conglutinated, apical cell distinctly swollen and surrounded by a diffusely delimited gelatinous pigment cap. Asci 8-spored, spores hyaline, narrowly ellipsoid to fusiform, mainly 1-septate, 12.5-19 x 3.5-5.5 µm. Pycnidia immersed in the squamules, often below pores, conidia filiform.

Chemistry: Thallus K-, C-, P-. Epihymenium K-, N+ violet. Hypothecium K+ red or K-. Proper exciple K-, N- or N+ violet. TLC: Triterpenes at Rf class 5 (similar to Chemotype 4 of Timdal, 1991).

Distribution: Northern Hemisphere, Peru, China, Nepal (Timdal 1991). This subspecies is reported for the first time from India.

Remarks: The species is characterised by 2-3 mm diam., brown, entirely pruinose, punctiform, scattered or contiguous, usually bullate squamules, N+ violet epithecium, hypothecium with orange and yellow pigments, ellipsoid to fusiform, 1-septate spores. *T. tristis* ssp. *arizonica* Timdal, a related species differs in having entirely simple spores and Chemotype 6 (Timdal 1991). It is found growing over soil in temperate to alpine regions between elevations of 3340-3600m.

Specimens examined: Jammu & Kashmir, Leh district, Yeru, alt. 3600 m, on soil among mosses, 06.08.2003, D. K. Upreti & S. Chatterjee 03-001792/ B (LWG); Uttarakhand, Chamoli district, on way to Vasudhara from Mana, alt. 3340 m, on soil, 21.08.2007, D. K. Upreti & S. Nayaka 07-010159 (LWG).

Toninia tristis ssp. *scholanderi* (Lynge) Timdal

Plate 1, figure 7

Opera Botanica 110: 115. 1991.

Thallus squamulose, indeterminate, squamules up to 2 (-3) mm in diam., scattered to contiguous, bullate to horizontally flattened. Upper side castaneous brown to dark brown, sometimes with a green tinge, dull or

shiny, smooth or with shallow fissures in the cortex, with punctiform impressions developing into pores. Margin concolorous with upper side. Underside pale brown to black. Upper cortex 40-160 µm thick, epinecral layer 100 µm thick, algal layer continuous. Lower cortex resembling upper cortex. Apothecium up to 1.5 (-4) mm in diam., plane to weakly convex, distinctly marginate to immarginate, epihymenium brown, sometimes with a faintly green tinge K-, N+ violet (green pigment), hymenium hyaline, 60-70 µm high, hypothecium pale brown to medium brown in upper part, paler brown lower part, lacking crystals and pigments (yellow and orange) in the upper part, proper exciple medium brown to dark brown (sometimes with a green tinge) in the rim, usually paler brown in inner part, K-, N- or N+ violet (green pigment). Paraphyses straight, sparingly branched, thin walled, not or only slightly conglutinated, apical cell distinctly swollen and surrounded by a diffusely delimited gelatinous pigment cap. Asci 8-spored, spores hyaline, simple, narrowly ellipsoid, 9-15.5 x 3.5-5 µm. Pycnidia absent.

Chemistry: Thallus K-, C-, P-. Epihymenium K-, N+ violet. Hypothecium K-. Proper exciple K-, N- or N+ violet. TLC: Triterpenes at Rf class 4 and 4-5 (similar to Chemotype 3 of Timdal 1991).

Distribution: Greenland, the Rocky Mountains, and Nepal (Timdal 1991). It is a new record for Indian lichen flora.

Remarks: The species is characterised by bullate to horizontally flattened, small squamules (2-3 mm) without a central depression and yellow and orange pigments. The species is close to *T. tristis* ssp. *pseudotabacina* Timdal, which differs in having bigger squamules (3-4 mm) with a central depression and Chemotype 2. It is found growing over soil in alpine regions of northern Himalaya between altitudes of 3900-4000 m.

Specimens examined: Uttarakhand, Chamoli district, Badrinath, near Vasudhara Glacier, alt. 3900 m, on soil, 08.09.1991, D. K. Upreti 202365 (LWG); between Vasudhara and Bhagirathi Glacier, alt. 4000 m, on soil, 09.09.1991, D.K. Upreti L13201 (LWG).

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