

Three new species of *Caloplaca* from India

Yogesh JOSHI, Dalip K. UPRETI and Suresh C. SATI

Abstract: Three new species of the lichen genus *Caloplaca* (Teloschistaceae) from India are described. *Caloplaca jatolensis* belongs to the *Triophthalmidium* section, while *C. pseudisteroides* and *C. subleptozona* belong to the *Sideritis* group.

Key words: lichen-forming fungi, plurilocular ascospores, *Sideritis* group, Teloschistaceae, *Triophthalmidium* section, UV+ substances

Introduction

Many fewer species of *Caloplaca* have been reported in India compared to countries in Europe and America or even other countries in Asia. Awasthi (1991) documented 35 species of *Caloplaca* from India whereas Poelt & Hinteregger (1993) reported 111 species of *Caloplaca* from the Himalayas, including parts of China, Nepal, Pakistan and India. Some recent publications (Joshi & Upreti 2006, 2007a, b, 2008) have substantially increased the number of lichenological papers referring to *Caloplaca* in India, so that the number of species has reached *c.* 70, but there are still many as yet undescribed taxa. The present paper describes three species, *C. jatolensis*, *C. pseudisteroides* and *C. subleptozona*, as new to science.

Materials and Methods

The present study is based on collections in LWG (including LWU–AWAS). Morphological and anatomical characters were examined using the methods described by Joshi & Upreti (2006, 2007a, b, 2008). For characters such as size of thallus, lobes, apothecium and thickness of the hymenium, five measurements were recorded for

each specimen; 10 measurements per specimen were recorded for ascospore and conidia dimensions. The dimensions of epihymenium, hymenium and ascospores are generally presented as (minimum value recorded–) lowest specimen arithmetic mean observed–highest specimen arithmetic mean observed (–maximum value recorded). All measurements were made on material mounted in water, but the paraphyses were studied after replacing water with 25% KOH (Wetmore 1994). Calcareous and non-calcareous rocks were determined by application of concentrated HCl. Secondary metabolites were identified by TLC as described by Walker & 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 & Gries (2002).

The Species

Caloplaca jatolensis Y. Joshi & Upreti sp. nov.

Caloplaca homologae similis; thallus corticola, griseus, UV+ flavo-cremeus, discus vinaceus, K–, excipulum lecanorinum, amphithecium et parathecium cum crystallis hyalinis, paraphyses anastomosantes, ascospores 18–20 × 9–11 µm in medio parum constrictae.

Typus: India, Uttarakhand, Almora district, en route to Sunderdhunga, between Jatoli and Dhuniya don, alt. 2700–3300 m, on bark of *Quercus*, 14 September 1995, Upreti & Tandon 213500 (LWG—holotypus; CAL— isotypus).

(Figs 1 & 2)

Thallus crustose, corticolous, (8.5–)10–12(–13) µm thick, smooth, shiny, membranous, continuous to cracked areolate,

Y. Joshi and S. C. Sati: Department of Botany, Kumaun University, D. S. B. Campus, Nainital-263002, India. Email: yogesh36953@rediffmail.com

D. K. Upreti: Lichenology Laboratory, National Botanical Research Institute, Rana Pratap Marg, P. B. No. 436, Lucknow-226001, India.

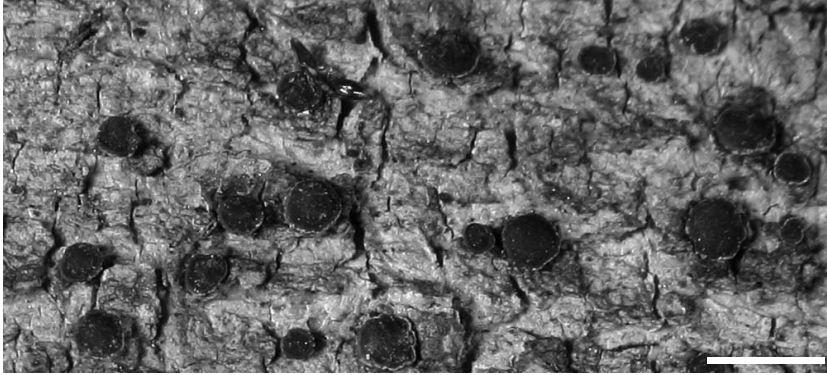


FIG. 1. *Caloplaca jatolensis*, habitus (holotype in LWG). Scale = 3 mm.

indeterminate, effuse, covering a large area, whitish grey to pale grey. Cortex thin, paraplectenchymatous, made up of thin-walled cells, algal layer continuous. *Medulla* loose, prosoplectenchymatous, white. *Prothallus* and *hypothallus* bluish black to black.

Apothecia numerous, scattered to \pm clumped, button-like, sessile to \pm constricted at the base, round, 0.2–1.1 (–1.5) mm diam., disc brownish red (wine-coloured), plane to convex, proper margin thin, 0.2–0.3 mm, flush to slightly raised, concolorous or slightly darker than disc, thalline margin thin, 0.3–0.4 mm, entire, persistent, flat, smooth to crenulate, concolorous with thallus. *Epithemium* golden to golden-brown, (10–)12–15 (–25) μ m high, with dense granular epipsamma; *hymenium* hyaline, (55–)80–100 (–120) μ m high; *hypothecium* hyaline, made up of isodiametric cells, oil droplets present; *parathecium* of elongated cells and with hyaline crystals that do not dissolve in K; *amphithecium* with algal cells, outer surface with anthraquinone crystals. *Paraphyses* thin, anastomosed to \pm branched, end cells clavate and with pale brown epipsamma. *Asci* 8-spored; *ascospores* trilocular [of *C. homologa* type (Hafellner & Poelt 1979)], slightly constricted in the centre, all locules of \pm equal size, (17.2–)18–20 (–21) \times (8.5–)9–11 (–12) μ m.

Pycnidia not seen.

Chemistry. Thallus K+ pale yellow, C–, Pd–, UV+ cream-yellow. Apothecial disc

K–, C–, Pd–. TLC: atranorin, grey spot at Rf 3 and UV+ ice blue spot at Rf 7 after charring in solvents A and B; both in thallus and apothecial disc.

Etymology. The specific epithet is derived from the type locality of the new species.

Ecology and distribution. The species is reported so far only from its type locality growing on the bark of *Quercus* between elevations of 2700–3300 m in the sub-alpine regions of the Himalayas.

Remarks. This species is mainly characterized by a grey, membranous thallus, lecanorine exciple, trilocular ascospores with a constriction in their centre, and an amphithecium with anthraquinone and hyaline crystals in the outer surface (Fig. 2). The new taxon resembles *Caloplaca homologa* (Nyl.) Hellb. in having similar, but smaller, ascospores (*C. homologa* (21)–25 \times (9–)10–12 (–13) μ m). However, lack of anthraquinones and hyaline crystals in the outer surface of the amphithecium of *C. homologa* separates it from the new taxon. *Caloplaca brebissonii* (Fée) R. Sant. ex Hafellner & Poelt, another related species, differs in the absence of hyaline crystals in the parathecium and wider ascospores with an oblong rhomboidal middle locule. In its excipular characters, the new taxon is similar to *C. subdecadens* (Nyl.) Hafellner & Poelt, which differs in having larger ascospores (26–30 \times

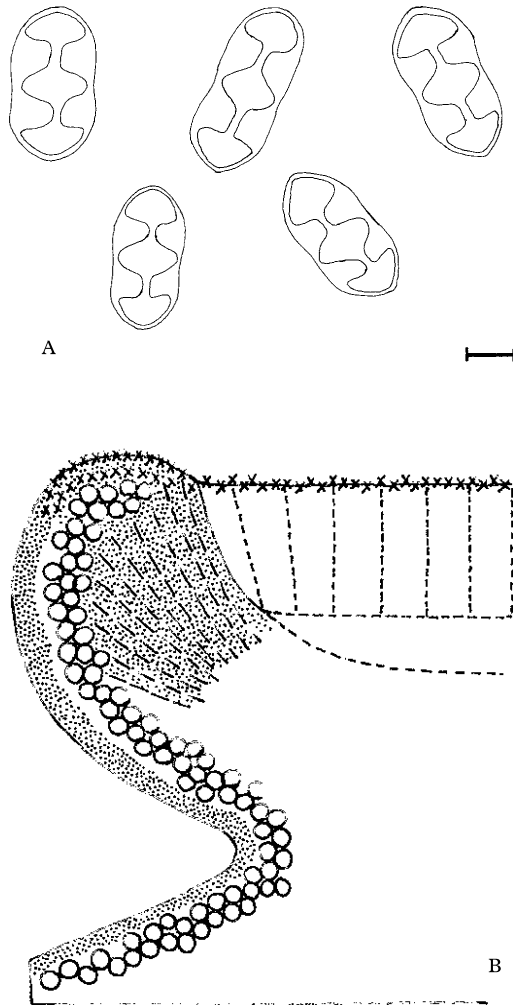


FIG. 2. *Caloplaca jatolensis*. A, ascospores; B, exciple (xxxxx anthraquinone crystals, ∴ hyaline crystals, ○○ algal cells). Scales: A = 5 μ m; B, not to scale.

14–17 μ m) and also in having the middle locule larger than the polar locules.

***Caloplaca pseudisteroides* Y. Joshi & Upreti sp. nov.**

Lecanorae pseudisterae similis sed ascosporis polarilocularibus, (8.5–)10–11(–11.5) \times 5–6 (–6.5) μ m, differt.

Typus: India, Madhya Pradesh, Anuppur district, Amarkantak, 3 km from Jwaleshwar, alt. 603 m, on bauxite rocks, 23 March 2004, Upreti, Nayaka & Satya 04-002851 (LWG—holotypus; CAL—isotypus).

(Fig. 3)

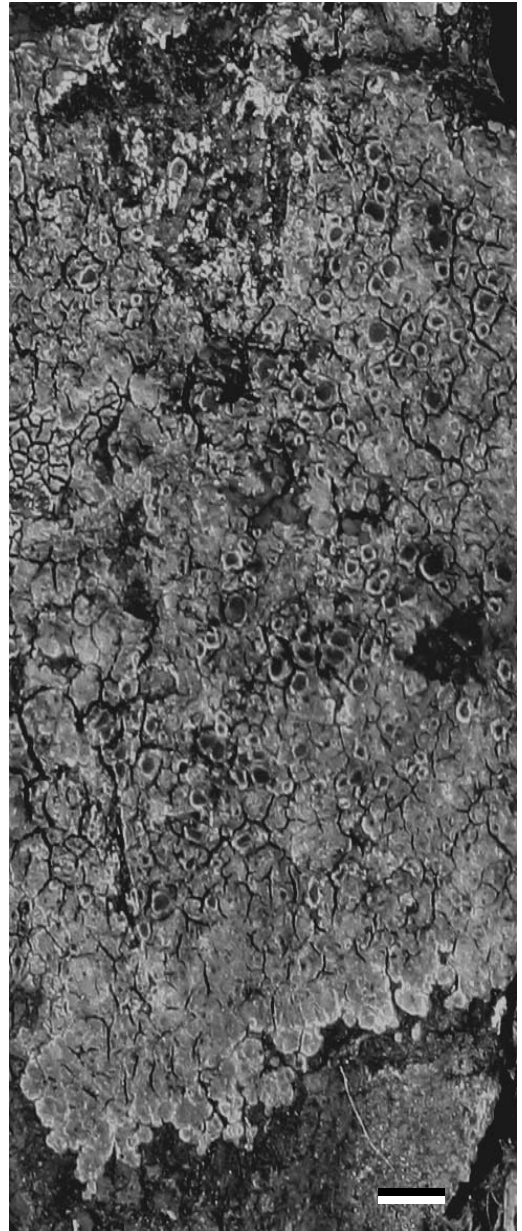


FIG. 3. *Caloplaca pseudisteroides*, habitus (holotype in LWG). Scale = 4 mm.

Thallus crustose, saxicolous, (22–)24–28 (–30) μ m thick, continuous to cracked-areolate to subsquamulose, 0.5–2 cm diam., whitish grey to greyish brown or greyish yellow; thalli often coalescing with each other to

cover large areas. Areoles separated by deep fissures, irregular, flat, \pm imbricate, marginal areoles effuse to subeffigurate, flabellate, young lobules/squamules arising from the older ones, pale yellow. Cortex moderately thick, (13.7–)15–17(–19.5) μm thick, paraplectenchymatous, made up of thin-walled cells, algal layer even and continuous. *Medulla* loose, prosoplectenchymatous, white. *Prothallus* and *hypothallus* black.

Apothecia numerous, scattered, restricted to central parts of the thallus, immersed to sessile, round, 0.2–1 mm diam., disc light brown to brownish black, plane, excipular ring thin and soon evanescent, darker than disc, thalline margin moderately thick, 0.2–0.5 mm, flush, smooth to rarely flexuose, concolorous with the thallus. *Ephymenium* golden-brown to brown, (10–)12–15(–17) μm high; *hymenium* hyaline, (40–)42–60(–70) μm high; *hypothecium* hyaline and with oil droplets; *parathecium* and *hypothecium* made up of isodiametric cells; *amphithecium* with algae. *Paraphyses* thin, \pm furcate at the tips, without swollen tips, firmly conglutinated with each other. *Asci* 8-spored, *ascospores* polaribilocular, broadly ellipsoid, (9.5–)10–11(–11.5) \times 5–6(–6.5) μm , isthmus 5–7 μm .

Pycnidia numerous, 1–4 per areole, ostiole brownish-black, *conidia* bacilliform, 2–3 \times 1 μm .

Chemistry. Thallus K– to K+ faint purple at yellowish regions, C–, Pd–, UV–. Apothecial disc K+ purple, C–, Pd–. TLC: parietin in yellowish regions of thallus and apothecial disc, atranorin in thallus.

Etymology. The specific epithet reflects the similarity of the external morphology of the new species to that of *Lecanora pseudistera* Nyl.

Ecology and distribution. The new taxon is found growing with *C. amarkantakana* Y. Joshi & Upreti, *C. subsoluta* (Nyl.) Zahlbr. and species of the lichen genera *Endocarpon*, *Staurothele* and *Verrucaria* on bauxite rocks in central parts of India at an altitude of c. 600 m.

Remarks. *Caloplaca pseudisteroides* is characterized by a vivid grey to greyish brown to vivid yellow, areolate to subsquamulose thallus, pale brown to brownish-black apothecial disc and firmly conglutinated paraphyses. Superficially, it resembles *Lecanora pseudistera*, but is easily distinguished by its polaribilocular ascospores and K+ purple ephymenium. In this new taxon, the excipular ring, which according to Brodo (1991) is an extension of the proper exciple, approaches some species of the *Caloplaca sideritis* group (Wetmore 1996) such as, *C. sideritis* (Tuck.) Zahlbr. and *C. balansana* (Müll. Arg.) Zahlbr. However, these species differ from *C. pseudisteroides* in having a usually areolate thallus with a distinct, persistent, thick, dark excipular ring between the disc and thalline margin. The colour of apothecial disc resembles that of *C. subsquamulosa* (Müll. Arg.) Zahlbr., which differs in having a smaller, whitish-grey thallus, apothecia (0.2–0.3 mm diam.), larger ascospores (12.5–14 \times 7 μm) and lacks a prothallus, excipular ring and pycnidia. *Caloplaca peliophylla* (Tuck.) Zahlbr., another related species, differs in having a dark grey, stipitate squamulose thallus, a parathecium made up of oval paraplectenchymatous cells, paraphyses with 1–3 slightly enlarged cells and larger ascospores (14–17 \times 7–8.5 μm).

Additional specimens examined. **India:** *Madhya Pradesh:* Anuppur district, Amarkantak, 3 km away from Jwaleshwar, alt. 603 m, on bauxite rock, 2004, Upreti, Nayaka & Satya 04-002863/A, 04-002869/A (LWG); Dudhara, Kapildhara area, south-west of Amarkantak, alt. 606 m, on bauxite rock, 2004, Upreti, Nayaka & Satya 04-002477 (LWG); near Soan muda, Mai ki Bagia, south of Amarkantak, alt. 603 m, on bauxite rock, 2004, Upreti, Nayaka & Satya 04-002428/B (LWG).

***Caloplaca subleptozona* Y. Joshi & Upreti sp. nov.**

C. leptozonae similis; thallus saxicola, cremeus vel pallide griseus, UV+ luteus, discus rubiginosus vel anthracinus, \pm flavopruinosus, margine rubiginosus vel \pm anthracinus, excipulum biatorinum, amphithecium sine algis, paraphyses ad apicem cum 2–5 cellulis tumidis, ascospore 9.0–15.0 \times 5.0–8.0 μm .

Typus: India, Uttarakhand, Nainital district, Jim Corbett Tiger Reserve, near Mohan, on vertical side of rock at road, 18 March 1999, D. K. Upreti L65006 (LWG—holotypus; CAL—isotypus).

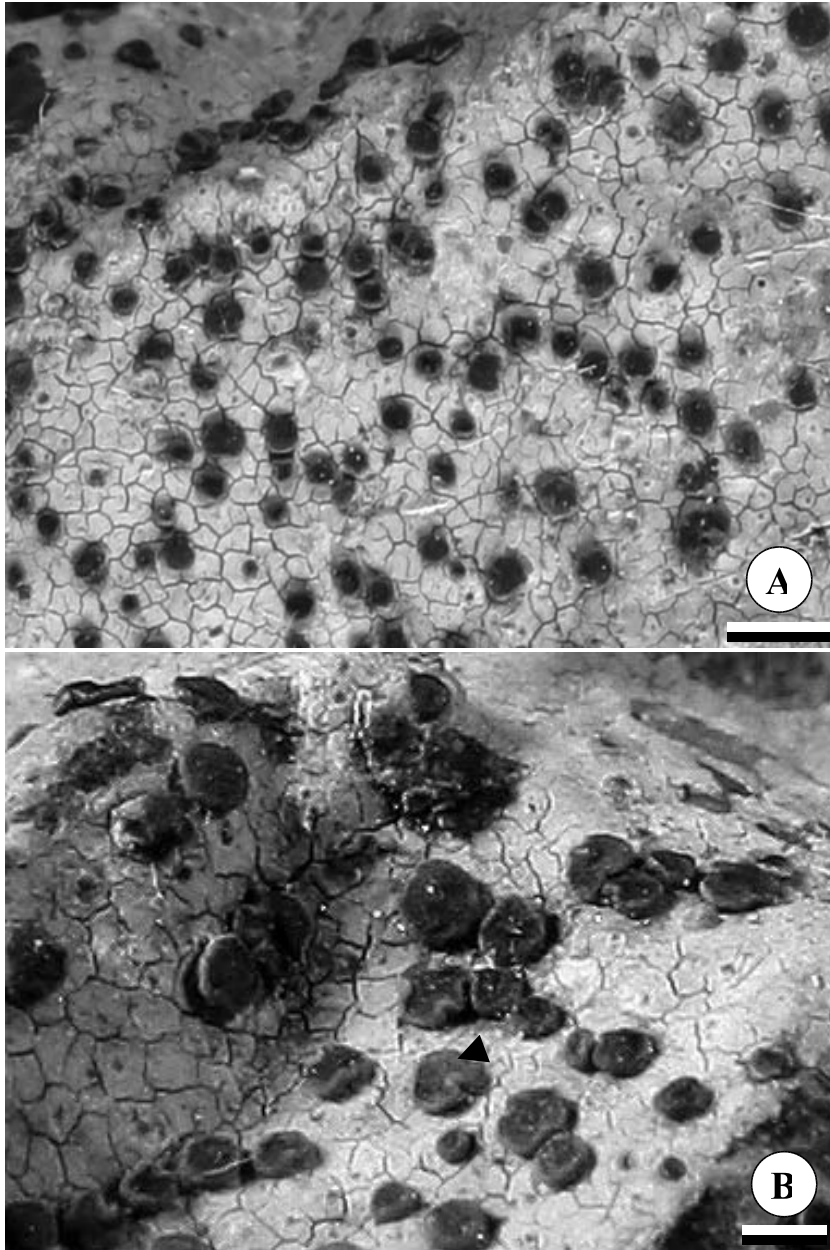


FIG. 4. *Caloplaca subleptozonea*, (holotype in LWG). A, habitus; B, habitus showing apothecia with priuna (arrow). Scales: A = 3 mm; B = 2 mm.

(Fig. 4)

Thallus crustose, saxicolous, 28–35 μm thick, continuous and smooth, cracked

areolate to rimose-areolate, 1–5 cm diam., often coalescing with other thalli to cover large areas, cream to yellowish white to beige greyish. Cortex 7–10(–25) μm thick,

paraplectenchymatous, of thin-walled cells, algal layer continuous. *Medulla* loose, prosolectenchymatous, white. *Prothallus* black.

Apothecia numerous, scattered to clumped, 1–4 per areole when young, solitary at maturity, initially immersed to erumpent, constricted at the base (i.e. button-like), biatorine, round to \pm angular due to pressure, 0.1–0.6 mm diam., disc reddish brown to rusty brown in shady places to brownish black in exposed situations, plane to convex, glossy to matt, \pm pruinose, pruina yellow, proper margin persistent, smooth, entire, flush to slightly raised, thin to thick, \pm covered by yellowish pruina, paler or concolorous to the disc to \pm black, thalline margin absent. *Epithemium* golden to golden-brown, (7–)10–18(–25) μm high, with fine granular epipsamma; *hymenium* hyaline, (40–)60–75(–80) μm high; *hypothecium* hyaline to pale brown, paraplectenchymatous, oil droplets \pm present; *parathecium* paraplectenchymatous in peripheral section, whereas of radiating oval to elongated cells in median section, outer surface aeruginose pigmented; *amphithecium* without algae, but algal cells present at least near the base of the margin. *Paraphyses* simple to slightly septate, thin, furcate to sparingly branched at the tips with upper 2–5 cells swollen, oil paraphyses \pm present. *Asci* 8-spored, *ascospores* polaribilocular, ellipsoid to broadly ellipsoid, becoming citriform in K, (4–)9–15 \times (2.5–)5–8 μm , isthmus 3–4(–5) μm .

Pycnidia immersed, ostiole brownish-black, *conidia* bacilliform, 2–3 \times 0.5–1 μm .

Chemistry. Thallus K+ yellow, C–, Pd–, UV+ yellow. Apothecial disc K+ purple, C–, Pd–. TLC: atranorin and UV+ yellow spots developed after charring between Rf 2–7 in solvent systems A and B.

Etymology. The specific epithet derives from *C. leptozona* (Nyl. in Nyl. & Cromb.) Zahlbr., which the new species very much resembles in its external morphology.

Ecology and distribution. Currently, *C. subleptozona* is known from only four localities in

India, the type locality and one other locality in Uttarakhand, and additional localities in Himachal Pradesh and Rajasthan. The species occurs on rocks in inland areas at elevations from 1000–1800 m in subtropical to temperate regions of India. It grows on both vertical and horizontal faces of calcareous and non-calcareous rocks.

Remarks. The new taxon is affiliated to the *Caloplaca sideritis* group (Wetmore 1996) as anthraquinone pigments are present only in the apothecia and are absent from the thallus. It is generally characterized by UV+, cracked-areolate to rimose-areolate, cream to yellowish white to beige greyish, K+ yellow thallus surrounded by a black prothallus and \pm pruinose constricted apothecia. On vertical rock surfaces, the apothecial discs are reddish brown to rusty brown, without any trace of black, whereas, on strongly exposed horizontal surfaces, the apothecia are completely black. However, transition stages were observed; that is, the exposed parts of the apothecia are black, whereas, the shaded parts are not. The blackening of the apothecial disc and margin, due to exposure, is shared with a number of species [e.g. *C. agrata* (Vain.) Zahlbr., *C. concilians* (Nyl.) H. Olivier, *C. conciliascens* (Nyl.) Zahlbr., *C. exsecuta* (Nyl.) Dalla Torre & Sarnth., *C. leptozona*, *C. litoricola* Brodo, *C. poliotera* (Nyl.) J. Steiner, *C. subpoliotera* Y. Joshi & Upreti and *C. tropica* Y. Joshi & Upreti], but all the species examined have a UV– thallus. The new taxon is similar to *C. leptozona* in having a rimose-areolate, vivid grey thallus and a constricted apothecial disc with a black proper margin. *Caloplaca leptozona* differs, however, in several important features: a UV– thallus, lack of pruina, paraphyses without swollen tips, smaller ascospores (10–11 \times 4–5.5 μm) and larger conidia (3.6 \times 1.2–1.5 μm). *Caloplaca agrata*, another similar species known from Caribbean islands, differs in having a thin, areolate, UV– thallus lacking a prothallus.

Additional specimens examined. **India:** Himachal Pradesh: Kangra district, Macleodganj, alt. 1600–1800 m, on rock, 2001, D. K. Upreti & S. Nayaka 0175249 (LWG). Rajasthan: Mt. Abu, alt. 1200–1350 m, on

rock, 1985, *D. D. Awasthi & G. Awasthi* 85.58 (LWG-LWU). Uttarakhand: Pithoragarh district, Gori-Ganga Catchment, Bangapani, alt. 1000–1300 m, on rock, 2002, *V. Pant* 02-000750 (LWG).

We thank Dr R. K. Tuli, Director, National Botanical Research Institute, Lucknow, for providing laboratory facilities and Dr J. Vondrák for his comments on the paper.

REFERENCES

- Awasthi, D. D. (1991) A key to the microlichens of India, Nepal and Sri Lanka. *Bibliotheca Lichenologica* **40**: 1–337.
- Brodo, I. (1991) Studies in the lichen genus *Ochrolechia*. 2. Corticolous species of North America. *Canadian Journal of Botany* **69**: 733–772.
- Hafellner, J. & Poelt, J. (1979) Die Arten der Gattung *Caloplaca* mit pluriloculären Sporen. *Journal of Hattori Botanical Laboratory* **46**: 1–41.
- Joshi, Y. & Upreti, D. K. (2006) *Caloplaca amarkantakana*, a new species in the *Caloplaca sideritis* group from India. *Lichenologist* **38**: 537–540.
- Joshi, Y. & Upreti, D. K. (2007a) *Caloplaca awasthii*, a new lichen species from India. *Botanical Journal of the Linnean Society* **155**: 149–152.
- Joshi, Y. & Upreti, D. K. (2007b) New species and new records of the lichen genus *Caloplaca* from India. *Lichenologist* **39**: 505–508.
- Joshi, Y. & Upreti, D. K. (2008) Sorediate and isidiate species of the lichen genus *Caloplaca* (Ascomycetes, Teloschistaceae) from India. *Nova Hedwigia* **86**: 259–272.
- Nash, T. H. III & Gries, C. (2002) Introduction. In *Lichen Flora of the Greater Sonoran Desert Region*. Vol. I. (T. H. Nash, III, B. D. Ryan, C. Gries & F. Bungartz, eds): 1–53. Tempe: Lichens Unlimited, Arizona State University.
- Poelt, J. & Hinteregger, E. (1993) Beiträge zur Kenntnis der Flechtenflora des Himalaya. *Bibliotheca Lichenologica* **30**: 1–247.
- Walker, F. J. & James, P. W. (1980) A revised guide to microchemical techniques for the identification of lichen products. *Bulletin of British Lichen Society* **46**: 13–29.
- Wetmore, C. M. (1994) The lichen genus *Caloplaca* in North and Central America with brown or black apothecia. *Mycologia* **86**: 813–838.
- Wetmore, C. M. (1996) The *Caloplaca sideritis* group in North and Central America. *Bryologist* **99**: 292–314.

Accepted for publication 22 July 2008