Lichen genus *Tephromela* in India

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The paper presents a detailed account of three species of *Tephromela* from India. A key for identification of all the species belonging to *Tephromela* so far known from India and Nepal is also provided.

Key-words—*Tephromela*, Lichen, India.

THE lichen genus *Tephromela* was re-established by Hafellner in Kalb (1983) for *Lecanora atra* complex. Circumscription of *Tephromela* was enlarged by Hertel (1984) and Rambold (1989) merged the genus *Heppsora* with its sole species *Heppsora indica*.

Poelt and Grube (1993) reported five species of *Tephromela* from Himalayas. Awasthi (1991) listed three species of this genus from India and Nepal. While revising some tropical species of *Lecanora sensu stricto* with a dark hypothecium, Lumbsch and Guderley (1996) added one more taxon to the list by making new combination *Tephromela khatiensis* (Räsänen) Lumbsch, for two of the Indian *Lecanora* species (*L. khatiensis & L. kumaoensis*) described by Räsänen (1952), which were found to be two different chemotypes of this species.

MATERIAL AND METHOD

During the course of investigation on lichen genus *Lecanora* from India large number of specimens pertaining to *Tephromela* were segregated and the results of the investigation are presented here. The specimens studied belong to Dr. D.D. Awashti's personal lichen collection (AWAS) in Botany Department, Lucknow University Herbarium (LWU); National Botanical Research Institute Herbarium (LWG) and lichen herbarium of National Research Laboratory for Conservation of Cultural Property, Lucknow (NRLC). For anatomical studies a hand microtome (Fuji-Japan) was used to cut section at 12-15 μm thickness and stained with lactophenol cotton blue. Lichen substances were investigated with thin layer chromatography (TLC) in solvent A (180 toluene: 60 dioxane: 8 acetic acid) using the technique given by Culberson (1972) and Walker and James (1980).

Key to *Tephromela* species from India and Nepal

1. Apothecia lecanorine 2
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2. Epihymenium greenish black, thallus verrucose to verruculose-areolate; apothecia 0.5-1.5 mm in diam., hypothecium upper part yellowsh brown, lower part dark red-brown; ascospores 8 – 12 x 5 – 7 μm; atranorin and gangaleoidin as major substances; from Central and Eastern Himalayas; on siliceous rocks.

Tephromela khatiensis (Räsänen) Lumbsch.

2. Epihymenium dark-violet brown, thallus warted areolate to rimose-areolate or plicate-rugose to peltate, apothecia 0.2-3.0 mm in diam.; hypothecium brown to yellow-brown; ascospores 9- 15 x 6 –8 μm; thallus K + yellow, PD + yellow, four chemotypes are observed:

i) containing atranorin, alectoronic acid, a - collatolic acid

ii) additional bourgeanic acid

iii) atranorin, α - collatolic acid

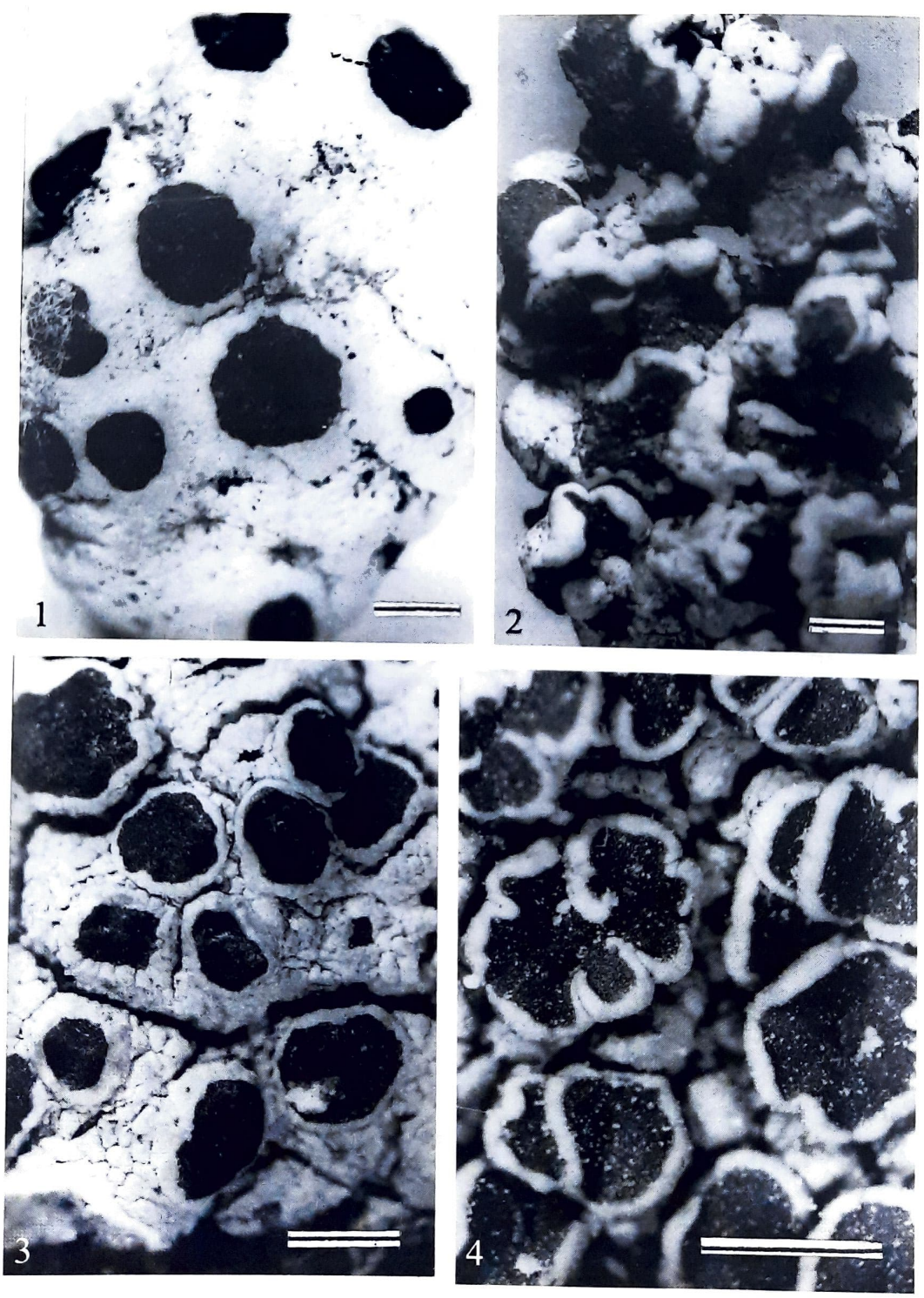
iv) atranorin only

Widely distributed in both hemispheres, from sea level to alpine zone, on exposed siliceous calcareous rocks and on bark *Tephromela atra*(Huds.) Hafellner

3. Thallus warted-areolate, apothecia 3.0 mm diam.; epihymenium blue green to green black; hymenium hyaline, colourless- brownish; atranorin, usnic, stictic and bourgeanic acid present; on siliceous

exposed rocks; from British Isles, European Mountains, Arctic, Northern America, North Asia, Nepal *Tephromela aglaea* (Sommerf.) Hertel & Rambold

3. Thallus bullate-areolate, apothecia 1.7 mm diam., epihymenium bluish green, hymenium green; on exposed siliceous rocks; bipolar in distribution on alpine habitats, continental Australia, north-west Himalayas and Nepal *Tephromela armeniaca* (DC) Hertel & Rambold.



Figs 1-4 Photographs of *Tephromela* species
(sclae bar = 1.0 mm)

Fig. 1 *Tephromela atra* (Huds) Hafellner [Awasthi *et al.* 80-121 (LWU)] – Annotated as *Heppsora indica*] Figs. 2 & 3 *Tephromela atra* (Huds) Hafellner Thallus showing morphological variation Fig. 4. *Tephromela khatiensis* (Räsänen) Lumbsch

1. ***Tephromela armeniaca*** (DC in Lam. & DC) Hertel & Rambold

Bot. Jahrb. Syst. 107: 494. 1985.- *Rhizocarpon armeniacum* DC in Lam. & DC., Fl. France., ed. 3(2): 366-367. 1805

Hue (1892), Babington (1852) and Strachey (1906) reported this taxon under *Lecidea armeniaca* (DC.) Fr., from Himalayas. None of these specimens are available for the present study. According to the description given by Awasthi (1991), the species is characterized by thick bullate-areolate thallus with a well-developed prothallus. Apothecia are immersed, 1.8-2.5 mm in diameter, margin lecideine, epihymenium bluish, green-black; hymenium green, hypothecium colourless to rarely ochraceous, ascospores 7-9.5 x 3.5 – 4.5 μm in size. Thallus cortex K + red, C-, KC-, PD + yellow.

Rambold (1989) mentioned alectorialic, protocetraric and reccellic acids in the Australian specimens.

The taxon is close to *Tephromela aglaea* (Sommerf.) Hertel & Rambold, and *T. testaceoatra* (Vaino) Hertel & Rambold, but *T. aglaea* differs from it in its large (upto 16 x 8.5 μm) ascospores and in presence of atranorin, usnic acid and bourgeanic acids in the thallus, while *T. testaceoatra* differs in having psoromic acid.

According to Rambold (1989) the species is widely distributed in the Northern Hemisphere, occurring in alpine habitats of the holarctic region.

2. ***Tephromela atra*** (Huds.) Hafellner in Kalb

Kalb. Lich. Neotrop. Fasc. VII: 15, 297. 1983

(Figs 1 & 2)

Thallus pale grey to dark grey brown after preservation, smooth, areolate to rimose areolate, 0.2-0.5 mm thick, margin indefinite to definite, prothallus indistinct or whitish grey.

Apothecia rounded, dispersed to crowded sessile, constricted at base, 0.6-2.0 mm in diameter; disc plane to convex, black, nitid, epruinose; margin thalline, white, even or sometimes verrucose, persistent; excipullum 100 μm thick, lateral of hymenium 100-150 μm thick, pale violet-purple; hymenium violet-purple violet, 70-120 μm high, I + blue; epihymenium yellow to yellow brown, 50-70 μm thick; subhymenial layer pale violet-violet, 150-200 μm high; paraphyses brown, branched and anastomosing, asci 8-spored, 40-60 x 10-14 μm; ascospores ellipsoid, 10-14 x 6-8 μm; pycnidia not seen.

Thallus and apothecial margin K+yellow, KC-, C-, PD + yellow, two chemotypes observed in Indian material (a) containing atranorin only (5 specimens) (b) containing atranorin, α-collatolic acid and alectoronic acid (9 specimens).

The taxon is characterized by the presence of violet hymenium, and peculiar chemistry. Rambold (1989) described it as a polymorphic species, varies in the margination, adnation of apothecia and development of thallus (crustose to ± psoroid), while the Indian corticolous specimens exhibit a more or less uniform structure in development of thallus (mostly crustose, continuous smooth to rimose-areolate) sessile apothecia, mostly constricted at base and having persistent, even to slightly verrucose margin. Rambold (l.c.) suggested *Heppsora indica* as the modified growth form of this taxon.

Rambold (l.c.) observed four chemotypes of this taxon in saxicolous Australian specimens, while in Indian material only two chemotypes are present. The only atranorin containing chemotypes exhibit their distribution in central and eastern while the alectoronic and α-collatolic acid containing chemotypes are distributed in central, eastern and southern Indian regions.

This species is widely distributed in both the hemisphere, from sea level to alpine zone, growing on exposed siliceous and calcareous rocks and on bark (Rambold, 1989). Morphologically it is close to *Lecanora fimbriatula* Stirton and *Tephromela khatiensis* (Räsänen) Lumbsch, but both the latter species have different chemistry and anatomy.

Specimens examined-India: Karnataka, Shimoga Distr.: Singh et al 90-170 (NRLC). Madhya Pradesh, Hosangabad Distr.: Upreti & Misra 80-44 (LWU). Shahdol Distr.: Upreti & Misra 80-481, 80-504, 80-524/A (LWU); Awasthi et al. 86-181, 86-217 (LWU). Tamil Nadu, Nilgiri Hills: Awasthi 4541 (AWAS); Awasthi & K. Singh 71-101 (LWU); K.

Singh 71-689 (LWU). Madurai Distr.: Foreau & Awasthi 4198 (AWAS). Palni Hills: Foreau 4122 (AWAS).

3. ***Tephromela khatiensis*** (Räsänen) Lumbsch

Bryologist 99(3): 288. 1996-*Lecanora khatiensis* Räsänen, Arch. Soc. Zool. Bot. Fenn. Vanamo 6(2): 81. 1952. (Fig. 3)

Thallus greenish grey, verrucose to verruculose-areolate, margin definite, sometimes slightly lobate, prothallus whitish grey.

Apothecia sessile, 0.5-1.5 mm in diameter, disc black, plane to convex, shining, epruinose; margin prominent, entire in young apothecia, slightly verrucose-flexuose in mature ones; amphithecium with crystals (more than 10 μm large); epihymenium greenish black, egranular; hymenium hyaline, 90-185 μm high; hypothecium upper part yellowish brown, lower part dark red-brown, 50-100 μm thick; asci clavate, 8-spored, 36-50 x 10-12 μm, ascospores ellipsoid, 8-12 x 5 –7 μm, walls up to 0.5 μm thick; pycnidia immersed in thallus, conidia bacillariformis, 10-18 x 0.5 – 1.0 μm.

Thallus and apothecial margin K + deep yellow, C-, KC-, PD-; two chemotypes observed

(a) containing atranorin and gangaleoidin (9 specimens)

(b) containing atranorin, gangaleoidin and an unknown chemical substance or yellow brown colour at Rf values 36-39 and 55 (15 specimens).

The taxon is distinguished in having black shining apothecial discs, greenish black, granular epihymenium, red-brown hypothecium and a hyaline hymenium.

Lumbsch and Guderley (1996) synonymized *Lecanora khatiensis* Räsänen and *Lecanora kumaoensis* Räsänen under this taxon. The two chemical strains observed in this study distinguish the two basionym epithets described by Räsänen (1952). Chemotype I containing atranorin and gangaleoidin represents *Lecanora kumaoensis* Räsänen, while chemotype II, containing atranorin, gangaleoidin and an unknown chemical substance of yellow brown colour between Rf value 36-39 and 55 represented by *Lecanora khatiensis* Räsänen. Chemotype I shows its restricted distribution in central Himalayas while chemotype II is widely distributed both in central and eastern Himalayas.

In colour of apothecial discs and greenish black epihymenium, the taxon is (O_2) close to *Lecanora fimbriatula* Stirton, but the latter species is corticolous and containing 2-0-methyl-perlatolic acid. In shape, size and colour of apothecial discs, it also resembles *Tephromela atra* but the later differs in having violet hymenium.

Specimens examined Strain I-India. Uttar Pradesh, Almora Distr.: Awasthi 805 (AWAS)- annotated as *Lecanora kumaoensis* Räsänen (isotype). Awasthi 7547 (AWAS); Upreti & Tandon 213420 (LWG). Chamoli Distr.: Dange 76-492 (LWU). Pauri Distr.: Pauri, Singh 68067 (LWG). Tehri Garhwal Distr.: Awasthi 922 (AWAS).

Strain II-India: Meghalaya, Shillong Distr.: Awasthi 6009, 6443 (AWAS), Chatterjee & Singh 91-51, 91-52 (NRLC). Uttar Pradesh, Almora Distr.: Awasthi 3467 (AWAS); Awasthi & Awasthi 605 (AWAS); Upreti & Tandon 213396 (LWG); Upreti & Tandon 213383, 213421, 213463 (LWG); Awasthi & Awasthi 693 (AWAS)-annotated as *Lecanora khatiensis* Räsänen (Isotype). Tehri Garhwal Distr.: Awasthi 861 (AWAS). Pithoragarh Distr.: Upreti & Tandon 104842 (LWG); Upreti 212841 (LWG), West Bengal, Darjeeling Distr.: Awasthi 64-88, 64-124 (AWAS).

NEPAL-E. Nepal: Awasthi 2164 (AWAS).

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