

Psoroma nigropunctatum* sp. nov., an alpine lichen in south-eastern Australia related to *P. buchananii

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Abstract

Psoroma nigropunctatum is described as new to science, based on collections from alpine and subalpine areas of the Australian Capital Territory, Victoria and New South Wales. It grows on soil or mosses on rock outcrops and in tussock grasslands. It had previously been misidentified as *Psoroma hypnorum*, but it is more closely related to *P. buchananii*. The two species have large pycnidia and non-verrucose perispores with large, pulvinate apical extensions, but they differ in habit, and the spores of *P. nigropunctatum* are longer and have a perispore that lacks latitudinal gibbæ.

Introduction

Psoroma hypnorum (Vahl.) S.F.Gray is a widespread species originally described and illustrated in *Flora Danica* by Vahl (1787) as *Lichen hypnorum* Vahl. Jørgensen (2001) designated the illustration as a lectotype. A collection by M. Vahl lodged at C, ‘frequentipes totam Norvegiam’, previously designated as neotype by Jørgensen (1978), was subsequently designated as an epitype (Jørgensen 2001). Although rather fragmented, this collection shows a species with squamulose apothecial margins, distinctly white-tomentose lower parts of thalline excipuli and ascospores shaped like ‘hand grenades’, i.e. from weakly citriform to ovoid and ellipsoid, with a perispore covered by distinct and large verrucae, which apically form larger nodulose extensions. A GBIF map of its distribution includes all continents of the world, including Australia. It has been included as an alpine species in the lichen floras of both Australia and New Zealand (Jørgensen & Galloway 1990; Galloway 2007).

Some Australian collections in CANB differ significantly from *Psoroma hypnorum sens. str.* as recognized in the Northern Hemisphere, Antarctica and subantarctic areas of South America. The present study aims to document this material, some specimens being referred to *Psoroma buchananii* (C.Knight) Nyl., and the others to *P. nigropunctatum* Elvebakk & Elix, sp. nov. *Psoroma buchananii* and *P. nigropunctatum* appear to be closely related.

Material and methods

This paper is based on material from B, BM, BOL, CANB H, OTA and TROM. Ascospore structure was studied in water mounts and restricted to spores liberated from their asci. Detailed drawings were made of 140 spores in total, from eight samples of *P. buchananii* and four of *P. nigropunctatum*, and copies of the sketches were included with the specimens. Thin-layer chromatography of acetone extracts followed standardized procedures and used solvents A and C (Orange *et al.* 2010). Nomenclature of ascospore structure follows Nordin (1997).

The species

Psoroma buchananii (C.Knight) Nyl., *Flora* **69**, 328 (1886)

Figs 1–3, 6

For a general description, see Galloway (1985). *Ascospores* globose, subglobose or ellipsoid, 10–17 × 8–12 µm. *Perispores* of the same shape, 13–22 × 9–13 µm, with regular, occasionally nodulose apical extensions 3–5 µm wide and 1–2 µm tall. Low lateral gibbæ present on more than 90% of the spores (Fig. 6).

SPECIMENS EXAMINED

Australia. *New South Wales:* ● without locality, *A.V. Duthie s.n.* (BOL 155417); ● Mount Kosciuszko National Park, 29 km NE of Mt Kosciuszko, junction of Gongarlin and Snowy Pass, 36°17'S, 148°31'E, alt. 960 m, on rocks beside a stream, *L. Tibell 12139*, 6.iv.1981 (B 60 01131113). *Australian Capital Territory:* ● Mt Bimberi, Bimberi Range, 49 km SW of Canberra, 35°40'S, 148°48'E, alt. 1900 m, on shaded rocks in open *Eucalyptus pauciflora* woodland with scattered shrubs, *H. Streimann 9725*, 11.xii.1979 (B 60 0113125). *Victoria:* ● Basalt Hill, Bogong High Plains, Alpine National Park, 35 km NW of Omeo, 36°53'S, 147°18'E, alt. 1650 m, on shaded rock in exposed grasslands with southerly aspect with basalt outcrops and rock faces, *H. Streimann 50568*, 28.xii.1992; ● Track to Mt Cope, Alpine National Park, 23 km SSE of Mount Beauty township, 36°56'S, 147°17'E, alt. 1750 m, growing on sheltered granitic rocks in *Eucalyptus pauciflora* woodland with large granitic outcrops, *J.A. Elix 40758 & H. Streimann*, 19.ii.1994 (B 60 0113118; CANB 9807072); ● *loc. id.*, *J.A. Elix 40797 & H. Streimann* (B 60 0113119; CANB 9807074). *Tasmania:* ● Central Plateau, 4.5 km west of Liawenee, 41°54'S, 146°37'E, alt. 1140 m, over mosses on dolerite rocks in alpine heath, *J.A. Elix 40033 & G. Kantvilas*, 7.xii.1993 (CANB 749775); Mt Wellington, 147°15'S, 42°53'E, *P.W. James*, iii.1963 (BM).

Chile. *Región XI de Aisén:* ● 27 km S of Cochrane along the road, c. 2 km E of Laguna Chacabuco, 47°25.34'S, 72°44.38'W, alt. 450 m, on mosses on a W-facing rock slope, *A. Elvebakk 07:209*, 2.xii.2007 (TROM). *XII Región de Magallanes:* ● Provincia Magallanes: Morro Chico, 52°03'S, 71°24'W, alt. 200 m, over mosses and bryophytes in a vertical S-facing cliff wall in the central valley of the outcrop, *A. Elvebakk 99:1236*, 8.xii.1999 (TROM).

New Zealand. *Otago:* ● Central Otago, Cardrona Pass, 44°59.56'S, 168°56.32'E, alt. 1120 m, on *Schistidium* mosses on a rock in a NW-facing slope within a tussock grass community, *A. Elvebakk 02:575*, 8.xii.2002 (TROM). *Southland:* ● Eyre Mtns, Mt Bee, 45°31'20"S, 168°22'26"E, alt. 990 m, on mossy rock, damp bank beside track, *A. Knight s.n.*, 3.iii.2009 (OTA 61734; TROM).

Psoroma nigropunctatum Elvebakk & Elix, sp. nov.
Mycobank No.: **MB 839617**

Figs 4–6

Similar to *Psoroma buchananii*, but forming mats of smaller, paler and thinner squamules, with flat to weakly concave apothecia, thinner thalline excipuli lacking white tomentum on the lower parts, and longer ascospores, 15–24 µm long, lacking lateral gibbæ.

Type: AUSTRALIA, Victoria: Snowfields region, Alpine National Park, Bogong High Plains, Basalt Hill, 20 km SE of Mount Beauty township, 36°53'S, 147°18'E, alt. 1650 m, growing on mossy rock in exposed grasslands with S aspect with basalt outcrops, *J.A. Elix 40385 & H. Streimann*, 17.ii.1994 (CANB 747029.1–holotype).

Thallus squamulose, tripartite, terricolous, often growing over bryophytes and other lichens, forming patches 2–7 cm wide on an indistinct hypothallus. *Chlorobiont squamules* 0.5–1.5 mm wide, shallowly incised, forming lobules 0.1–0.3 mm wide, prostrate to ascending, 0.1–0.15 mm thick; *upper surface* glabrous, matt, pale ochraceous brown in old herbarium specimens, grey-green when fresh and pale grey-brown when dry, pruinose and greyish at margins. *Upper cortex* c. 40 µm thick, sclerenchymatic; upper third dark brown, below pale brown, paraplectenchymatic, lumina mostly elongate and arranged perpendicularly to the upper surface, 5–8 × 4–6 µm, walls 3–3.5 µm thick. *Chlorobiont layer* 50–60 µm thick, of globose to irregularly subglobose *Trebouxia* cells, 8–17 µm diam.; chloroplasts angular. *Medulla* c. 30 µm thick; *lower cortex* absent. *Cyanobiont Nostoc*, in coralloid cephalodia, dark brown, pruinose or frosted at the lobe margins, 0.1–0.3 mm wide, situated on the chlorobiont squamules or directly on the hypothallus between them, very common. *Nostoc* cells bluish green, irregularly subglobose to ellipsoid, often angular, 4–8 × 3–4 µm, organized within

glomeruli and without visible chain structures. *Apothecia* common, substipitate, 1–4 mm wide, discs reddish brown, weakly concave, becoming flat; *thalline excipulum* 0.2–0.3 mm broad, crenulate, mostly with inrolled lobes 0.2–0.3 mm wide, glabrous on the lower side. *Epithecium* brown, c. 10 µm thick; *hymenium* c. 120 µm, IKI+ blue; *hypothecium* brownish, 60–80 µm thick, algal layer continuous below the hypothecium. *Paraphyses* simple, septate, c. 2.5 µm wide, except for the terminal cells, which are swollen, globose and greenish brown, up to 6 µm wide (difficult to observe because they are strongly adglutinated). *Asci* clavate, c. 80 × 15 µm, with 8 spores, with internal, IKI+, tube-like structures. *Ascospores* regularly ellipsoid, 15–24 × 9–13 µm. *Perispores* of the same shape, 21–30 × 19–13 µm, usually laterally smooth (less than in 10% with low, indistinct gibbae) but with distinct, nodulose apical extensions, up to 6 × 4 µm in size. *Pycnidia* very common, black, verruciform, laminal, 0.2–0.4 mm wide; ostiole fissure-like, 0.2 µm long. *Spermatia/conidia* bacilliform, 2–2.5 × 0.5 µm. *Chemistry*: nil by TLC.

Etymology: The species is named after its abundant black pycnidia.

ADDITIONAL SPECIMENS EXAMINED

Australia. *New South Wales*: ● Great Dividing Range, 5 km SE of Captains Flat, 35°39'S, 149°30'E, alt. 1220 m, *Eucalyptus* forest on a ridge dominated by shrubs, *H. Streimann* 31340, 8.viii.1984 (H); ● Sams Creek, 28 km ENE of Adaminaby, 35°46'S, 148°52'E, alt. 1420 m, on semi-shaded boulder in dry sclerophyll forest on moderate slope, *H. Streimann* 49211, 22.i.1992 (B 60 0113126; CANB); ● Murrumbidgee River, Rules Point, 37 km NW of Adaminaby, 35°43'S, 148°31'E, alt. 1380 m, on exposed rock outcrop above river in short grassland, *H. Streimann* 7468, 11.i.1979 (B 60 0113127; CANB). *Australian Capital Territory*: ● Booth Hill, Booth Range, 46 km SSW of Canberra, 35°43'S, 149°43'E, alt. 1550 m, dry sclerophyll forest on moderate slope with granite boulders, on a boulder, *H. Streimann* 35378, 6.x.1985 (B 79200; CANB); ● Naas Creek, 57 km S of Canberra, 35°49'S, 148°56'E, alt. 1677 m, on rocky creek bank, growing on rock in a snowgum woodland, *D. Verdon* 1702, 18.viii.1975 (B 63093; CANB); ● Mt Bimberi, Bimberi Range, 49 km SW of Canberra, 35°40'S, 148°48'E, alt. 1900 m, on shaded rocks in open *Eucalyptus pauciflora* woodland with scattered shrubs, *H. Streimann* 9724, 11.xii.1979 (B 60 0113122). *Victoria*: ● Track to Mt Cope, Alpine National Park, 23 km SSE of Mount Beauty township, 36°56'S, 147°17'E, alt. 1750 m, growing on sheltered granitic rocks in *Eucalyptus pauciflora* woodland with large granitic outcrops, *J.A. Elix* 40767 & *H. Streimann*, 19.ii.1994 (B 60 0113117; CANB 9807073); ● *loc. id.*, *J.A. Elix* 40802 & *H. Streimann* (B60 0113120; CANB 747031.1); ● Mt McKay, Alpine National Park, 16 km SSE of Mount Beauty township, 36°52'S, 147°14'E, alt. 1840 m, growing on soil over granitic rocks in exposed subalpine grasslands with granitic outcrops, *J.A. Elix* 40549 & *H. Streimann*, 18.ii.1994 (B 60 0113116; CANB 747030); ● Snowfields region, Alpine National Park, Bogong High Plains, Basalt Hill, 20 km SE of Mount Beauty township, 36°53'S, 147°18'E, alt. 1650 m, growing on mossy rock in exposed grasslands with S aspect and basalt outcrops, *J.A. Elix* 40377 & *H. Streimann*, 17.ii.1994 (CANB 746944.1).

Discussion and conclusions

Psoroma buchananii is a widespread, pan-Austral species known from southern South America, New Zealand, the Antarctic islands (the reports might need to be confirmed), and a single locality in Australia. It was reported by Elix (2012) based on a specimen collected at Mount Kosciuszko National Park in New South Wales, but incorrectly reported from Queensland by McCarthy (2020). In the present study, it is reported from eight additional Australian localities, so it has probably been widely overlooked.

Psoroma buchananii is normally readily recognized by its habit, being primarily cushion-forming on saxicolous mosses of the family Grimmiaceae, mostly the genera *Grimmia*, *Racomitrium* and *Schistidium*. Because of its substratum, it often appears to be pulvinate (Fig. 3), and it is characterized by dark-pigmented, robust squamules and cupulate apothecia with thick, inrolled margins. The lower sides of the excipuli have, at least in part, a conspicuous whitish tomentum, as illustrated for *P. hypnorum* (Jørgensen 1978; Elvebakk & Tønsberg

2018). Numerous large, black pycnidia are also conspicuous. Detailed studies of the spores of four specimens from Australia, two from southern Chile and two from New Zealand, show a homogeneous pattern. The ascospores are short and often subglobose, and the perispores have irregularly occurring gibbose structures laterally and large apical extensions that are mostly pulvinate, in some cases nodulose.

Psoroma nigropunctatum forms small-squamulose mats with flat, non-tomentose excipuli on the lower parts of the apothecia, in contrast to *P. buchananii*. Herbarium specimens are pale ochraceous brown (Figs 4–5). The spores scarcely overlap with those of *P. buchananii*; they are longer, lack lateral gibbae and usually have longer apical extensions (Fig. 6).

Due to its spore morphology, the new species can be considered to be distantly related to *P. hypnorum*, which has regularly verrucose perispores with apical extensions. Verrucae are absent from *P. nigropunctatum*; instead the spores look almost identical to those of the ancient and evolutionary isolated genus *Xanthopsoroma* (Elvebakk *et al.* 2010; Spribille *et al.* 2020). However, the new species does not have any affinity with *Xanthopsoroma* in spite of the similarity of the spores. Rather, its strongest affinity is with *P. buchananii* and *P. fruticulosum* P.James & Henssen. Previously, Henssen *et al.* (1983) pointed out that the two former species were related. In the phylogenies reported by Elvebakk *et al.* (2010, 2020) and Park *et al.* (2018), three samples of *P. buchananii* and three of *P. fruticulosum* formed a sister group to *P. paleaceum* (Fr.) Timdal & Tønsberg within the broadly defined *Psoroma hypnorum* group.

Psoroma fruticulosum has the same general spore morphology as *P. buchananii* and *P. nigropunctatum*, but its vertically oriented lobes are very characteristic. There is an obvious need for a better understanding of the phylogenetic relationships among this group of species, including a related, unidentified taxon at present known from a single site in New Zealand, and of the remaining *Psoroma* species. The three former species share an abundance of large, black pycnidia.

Psoroma nigropunctatum is probably widespread in subalpine and alpine areas of south-eastern Australia, including New South Wales, Victoria and the Australian Capital Territory. The 11 specimens with habitat information cited here were collected at altitudes between 1220 m and 1900 m, most commonly on soil on granitic outcrops in *Eucalyptus pauciflora* woodland. In those areas, *P. buchananii* and *P. nigropunctatum* co-occur; indeed they were collected as *Streimann* 9724 and 9725 from the same locality. It remains to be seen whether they maintain a different habitat ecology. Our impression is that *P. buchananii* usually grows directly on moss cushions, whereas *P. nigropunctatum* grows on soil deposits over boulders, intermixed with bryophytes and other lichens.

Psoroma hypnorum var. *hypnorum* was reported from three localities in Tasmania and one in New South Wales by Jørgensen & Galloway (1990), but a number of additional collections have accumulated since then, particularly in Australian herbaria. The present study did not include all of them, but those studied represented either *P. buchananii* or *P. nigropunctatum*, and no true *P. hypnorum* has been seen. Therefore, the latter species should for present be excluded from the lichen flora of Australia, except from likely occurrences in its Antarctic territories. *Psoroma hypnorum* var. *paleaceum* (Fr.) Rostr. remains an accepted Australian species, but it should be treated as *P. paleaceum*, which has been shown by the phylogenies referred to above to be a distinct species and not closely related to *P. hypnorum*.

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Fig. 1. *Psoroma buchananii*, New Zealand, Southland, Knight (OTA 61734; TROM). Scale bar = 5 mm.



Fig. 2. *Psoroma buchananii*, associated with *Bibhya bullata* (Meyen & Flot.) Kistenich, Australia, Victoria, Elix 40758 & Streimann (CANB). Scale bar = 5 mm.



Fig. 3. *Psoroma buchananii* photographed wet in the field in Pali-Aike National Park, southern Chile in 2000.



Fig. 5. *Psoroma nigropunctatum*, Australia, Victoria, Elix 40767 & Streimann (CANB). Scale bar = 5 mm.



Fig. 4. *Psoroma nigropunctatum*, holotype. Scale bar = 5 mm.



Fig. 6. Ascospores of *Psoroma buchananii* (upper row) and *P. nigropunctatum* (lower row) Scale bar = 10 μ m.