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*Sticta latifrons* is among the largest stalked macrolichens in Australasia. It occurs throughout New Zealand and in eastern Australia. It and the other species of *Sticta* are characterized by a tomentose underside with numerous cyphellae, inspiring the common name of specklebelly lichens. The species was first collected by Banks and Solander during Cook's *Endeavour* voyage from 1768 to 1771. To this day collectors are attracted by its huge leathery lobes and stout holdfast, and it remains the most commonly collected foliose lichen in New Zealand.

0.5 mm 

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## Three new lichen species from Christmas Island, Indian Ocean

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### Abstract

*Anisomeridium calcivorum* sp. nov. (Monoblastiaceae), *Gyalidea incolorata* sp. nov. (Asterothyriaceae) and *Thelidium insulare* sp. nov. (Verrucariaceae) are described from limestone in and adjacent to rainforest in the Australian external territory of Christmas Island, north-eastern Indian Ocean.

### Introduction

A visit by P. McCarthy and H. Lepp to the Australian territory of Christmas Island (north-eastern Indian Ocean) in 2000 led to the discovery of four new species of *Lithothelium* Müll. Arg., *Strigula* Fr. and *Trichothelium* Müll. Arg., and the recognition of almost 100 other lichen taxa (McCarthy 2001a, b, c; McCarthy & Elix 2002; Archer 2003). Recently, a re-examination of the collections yielded undescribed species of *Anisomeridium* (Müll. Arg.) M. Choisy (Monoblastiaceae), *Gyalidea* Lettau ex Vězda (Asterothyriaceae) and *Thelidium* A. Massal. (Verrucariaceae), which are documented here.

### The species

**1. *Anisomeridium calcivorum*** P.M. McCarthy, sp. nov.  
MycoBank No.: **MB 839435**

Fig. 1A–D

Thallus subepilithic to epilithic, pale,  $\pm$  continuous, *c.* 40–80  $\mu$ m thick; photobiont *Trentepohlia* sp.; ascomata perithecioid, prominent, minute, (0.16–)0.21(–0.25) mm diam., with a brown-black ascomatal wall (K<sup>+</sup> greenish black), 25–50  $\mu$ m thick, and a uniformly dark to blackish excipulum; ostiole apical; pseudoparaphyses very thin, anastomosing; asci clavate, narrowly or broadly cylindrical or cylindroclavate, 8-spored and 68–82  $\times$  15–20  $\mu$ m; ascospores 1-septate, anisolocular (with a markedly submedial septum), obliquely or irregularly biseriolate in the ascus, 13–22  $\times$  5.5–9  $\mu$ m; micropycnidia, 50–80(–100)  $\mu$ m, with broad conidia that are 2–3(–3.5)  $\mu$ m in maximum extent.

*Type*: Australia. Christmas Island, The Grotto, 1 km S of North-East Point, 10°25.38'S, 105°42.10'E, alt. *c.* 20 m, on sheltered limestone outcrop in moderately dense primary forest, P.M. McCarthy 1574, 23.vii.2000 (CANB — holotype).

*Thallus* crustose, thinly subepilithic to epilithic, effuse and nondescript to determinate, forming irregular colonies to 10–15 mm wide among other crustose lichens, off-white to very pale greyish green or, less commonly, pale yellowish brown, continuous to very sparingly and faintly rimose, *c.* 40–80  $\mu$ m thick, smooth to minutely and irregularly uneven, ecarticate, heavily impregnated with substratum material. *Photobiont* *Trentepohlia*; cells abundant, in clusters, but not appearing to form filaments, 6–14(–16)  $\mu$ m long; interstitial hyphae 2.5–3.5  $\mu$ m thick, short-celled, rather thick-walled. *Prothallus* not apparent. *Ascomata* rather sparse, perithecioid, semi-immersed to 1/3 immersed in the thallus/substratum, mostly solitary, occasionally paired, jet-black, dull to slightly glossy, smooth, rounded in outline, strongly convex, hemispherical or subglobose and then slightly constricted at the base, (0.16–)0.21(–0.25) mm diam. [*n* = 30]; apex rounded or becoming somewhat flattened or slightly excavate with age. *Ostiole* apical, inconspicuous or in a shallow, concave depression 20–40  $\mu$ m wide, concolorous with the ascomatal wall or slightly paler. *Ascomatal wall* 30–50  $\mu$ m thick near the apex, 25–40  $\mu$ m thick towards the base, brown-black in section, K<sup>+</sup> greenish black, elongate-cellular in medial section, contiguous with the excipulum, extending down to excipulum base

level or slightly incurved beneath the base, not or scarcely overgrown by the thallus. *Excipulum* 15–20 µm thick and dark greenish black to ± black laterally and at the base, of elongate, periclinal hyphae. *Centrum* globose to depressed-ovate, 0.14–0.19 mm wide. *Hymenium* not interspersed with granules or oil globules, KI–. *Subhymenium* hyaline, 20–30 µm thick, KI–, not interspersed with granules and oil globules. *Pseudoparaphyses* 0.5–0.8(–1) µm wide, long-celled, with moderately abundant anastomoses from the ascum base to the ostiole; contents clear. *Asci* clavate, narrowly or broadly cylindrical or cylindroclavate, 8-spored, 68–82 × 15–20 µm [ $n = 10$ ]; apex rounded; ocular chamber of immature asci elongate-tuberculate, at maturity remaining short-tuberculate or almost disappearing; ascoplasm KI+ orange-brown. *Ascospores* hyaline, narrowly ellipsoid to oblong-ellipsoid or shorter and obovate or broadly ellipsoid, 1-septate, usually not constricted at the septum, straight, obliquely or irregularly biseriata in the ascus, (13–)17(–22) × (5.5–)7.5(–9) µm [ $n = 77$ ]; spore wall uniformly thin (< 1 µm), smooth, lacking a perispore; septum markedly submedial, the distal cell longer and usually broader than the proximal; distal apex rounded to subacute; proximal apex more commonly subacute or acute; contents usually clear, occasionally guttulate. *Micropycnidia* very numerous, outwardly black, globose, semi-immersed, 50–80(–100) µm wide, circular to elliptical in outline; pycnidial wall blackish throughout, K+ green-black; conidiophores unbranched, 15–25 × 0.7–1 µm, ± of uniform thickness from base to apex. *Microconidia* colourless, simple, budding from the tips of conidiophores, broadly ellipsoid, subglobose, obovoid or obpyriform, 2–3(–3.5) µm in maximum extent. *Macropycnidia* not seen.

**Etymology:** The epithet *calcivorum* (L, lime-eating) alludes to the substratum preference of the new species.

#### Remarks

The new species is readily distinguished from others in this mainly tropical and subtropical genus by its thin, nondescript thallus, along with minute but prominent ascumata with an apical ostiole, a uniformly very dark excipulum, comparatively broad asci, 1-septate ascospores that are strongly anisolocular (and with a markedly submedial septum), moderately large and biseriata in the asci, as well as broad or rounded microconidia (Harris 1975, 1990, 1995; McCarthy 1993; Aptroot *et al.* 1997; Orange 2013; McCarthy & Kantvilas 2018; Zhang *et al.* 2020). Had it been an exclusively temperate rather than a tropical species, its occurrence on limestone would have further confirmed its novelty, but in the tropics differences in substratum can be less of a barrier to colonization by crustose pyrenolichens. Thus, for example, the eastern Palaeotropical *Willeya pallidopora* (P.M. McCarthy) Gueidan occurs on siliceous and calcareous rocks in eastern Australia and Vietnam (McCarthy 1995; Gueidan *et al.* 2014), although it is exclusively calcicolous in Christmas Island where limestone is the principal saxicolous substratum (McCarthy & Elix 2002). Moreover, several pantropical and Palaeotropical species of *Porina* (Porinaceae), which are commonly corticolous throughout their ranges, are among the dominant crusts on limestone in Christmas Island (McCarthy 2001c), while the otherwise corticolous *A. anisolobum* (Müll. Arg.) Aptroot and *A. polypori* (Ellis & Everh.) M.E. Barr have also been reported from rock in Hong Kong (Aptroot & Seaward 1999). However, with regard to those *Anisomeridium* species, the former has much larger ascumata than *A. calcivorum* and ascospores with an uneven inner wall (Kantvilas & Elix 1992; Aptroot *et al.* 1995, 1997; Harris 1995; McCarthy 2000; McCarthy & Kantvilas 2018), while the anisolocular spores of *A. polypori* are narrower [(3–)4.5–5(–6) µm] and 1–3-septate, and the pycnidia produce bacilliform or ellipsoid microconidia (Orange 2013).

Among other rock-inhabiting species, the Australasian and Pacific *A. laevigatum* (P.M. McCarthy) R.C. Harris is known only from siliceous substrata, and it has a more robust, often areolate thallus, larger ascumata with a thicker involucrellum and ascospores with a medial or submedial septum (McCarthy 1993, 2008; McCarthy & Kantvilas 2018). Another saxicole, *A. carinthiacum* (Steiner) R.C. Harris, is known with certainty from aquatic and semi-aquatic siliceous rocks in North America, Europe, East Asia, Australasia and the Pacific. That species has a comparatively well-developed thallus, anisolocular but smaller ascospores and narrowly elliptical microconidia (Harris 1975; McCarthy 1993, 2000; McCarthy & Johnson 1995;

McCarthy & Kantvilas 2018). Among the limestone-inhabiting or otherwise calcicolous species, *A. finkii* (R.C. Harris) R.C. Harris, from Florida and Puerto Rico, has longer ascospores (20–27 µm long) and elongate microconidia (3–5 × 1–1.5 µm; Harris 1990, 1995), while *A. gregale* R.C. Harris, from Puerto Rico, has clustered ascumata and smaller ascospores (11–13 × 3.5–4.5 µm; Harris 1995). *Anisomeridium calcicola* Upreti & Nayaka (as *calcicolum*), from India, has a green to olivaceous thallus, larger ascumata (0.25–0.5 mm) and minute microconidia 1–1.5 µm diam. (Upreti & Nayaka 2006), and *A. hydei* Aptroot, from concrete in Hong Kong, has larger ascumata (0.2–0.5 mm wide), often simple ascospores 4–6 µm wide (Aptroot & Seaward 1999). Finally, an unnamed calcicolous species reported from Papua New Guinea by Aptroot *et al.* (1997) has uniseriate ascospores of 10–16 × 4–4.5 µm.

Interestingly, the newly described species is not the only calcicolous *Anisomeridium* in Christmas Island, where fragmentary specimens of an unidentified, and possibly unnamed taxon were collected from a similar but more elevated habitat [Christmas Island, near North-South Baseline Road, c. 2 km SSW of airport, disused forest track, 10°28.23'S, 105°40.83'E, alt. 240–250 m, on limestone outcrop in moderately dense primary forest, P.M. McCarthy 1441, 31.vii.2000 (CANB)]. This lichen also has a very thin and rather nondescript thallus with minute (c. 0.2 mm diam.) but prominent, jet-black perithecia, as well as similar micro-pycnidia and conidia. However, the excipulum base ranges from hyaline to dark olive-brown, the asci are narrowly cylindrical and 60–72 × 8–12 µm, with overlapping-uniseriate or irregularly biseriata ascospores and, most strikingly, the ascospores have a medial rather than a markedly submedial septum, and they are considerably smaller than those of *A. calcivorum* [(9.5–)12(–14) × (3.5–)5(–6) µm ( $n = 80$ ); Fig. 1E].

*Anisomeridium calcivorum* grows on limestone at the type locality near the north-eastern coast of Christmas Island. Associated lichens include *Porina bellendenica* Müll. Arg., *P. papuensis* P.M. McCarthy, *P. tetracerae* (Ach.) Müll. Arg., *Thelidium insulare*, *Verrucaria* sp. and *Willeya pallidopora*.

#### ADDITIONAL SPECIMEN EXAMINED

*Christmas Island*. • type locality, P.M. McCarthy 1399 (part), 23.vii.2000 (CANB).

#### 2. *Gyalidea incolorata* P.M. McCarthy, sp. nov.

Figs 2, 3

Mycobank No.: MB 839436

Thallus very pale, rimose, with almost concolorous, adnate to sessile apothecia that are 0.24–0.49 mm wide and uniformly hyaline in section. Proper exciple cupulate, prosoplectenchymatous subtending a non-amyloid hymenium of simple paraphyses and narrowly clavate to elongate-cylindrical asci, each containing eight 3-septate ascospores measuring 9.5–14 × 3–5 µm.

**Type:** Australia. Christmas Island, Settlement, Gaze Road, near Chinese cemetery, 10°25.04'S, 105°40.99'E, c. 40 m alt., on limestone outcrop in moderately dense, primary forest on steep, N-facing hillside, P.M. McCarthy 1513, 30.vii.2000 (CANB — holotype).

**Thallus** crustose, epilithic, forming determinate colonies to 45 mm wide, continuous to sparingly rimose or abundantly and faintly rimose but not areolate, smooth to minutely uneven, dull off-white to very pale greenish, 50–80(–120) µm thick, ecarticate, but with an amorphous, alga-free, necral layer 10–17 µm thick, the thallus non-amyloid in section (I–), not containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub>–). **Algal layer** poorly delimited, c. 40–60 µm thick; cells globose, chlorococcoid, 6–12(–14) µm diam., rather thick-walled; interstitial hyphae obscure, short-celled, 1–2 µm thick. **Medulla** not delimited, much of the lower thallus packed with rock fragments and crystals. **Prothallus** not apparent. **Apothecia** very numerous, usually solitary, adnate to sessile and slightly constricted at the base, mostly rounded, biatorine, (0.24–) 0.37(–0.49) mm diam. [ $n = 70$ ]; disc at first deeply and narrowly urceolate (often appearing plane) and perithecioid, or almost stellate, at maturity broad and slightly concave to plane, smooth, epruinose, pale cream-coloured to pale creamy yellow, when wetted

concolorous but almost waxy-translucent; margin off-white or concolorous with the disc, persistent, smooth and entire or lumpy-coronate, flush with the disc or slightly raised, *c.* 60–80(–100)  $\mu\text{m}$  thick. *Apothecial sections* with the exciple, hymenium, epihymenium and hypothecium uniformly hyaline or with a very pale yellowish tint, K–, N–, I–, KI– (apart from KI+ orange-brown ascoplasm). *Proper exciple* cupulate, laterally 50–70  $\mu\text{m}$  thick (inner hyphae 2.5–4  $\mu\text{m}$  wide, outermost cells slightly larger and more rounded); 20–35  $\mu\text{m}$  thick below the margin (hyphal cells 5–10  $\times$  2–2.5  $\mu\text{m}$ ); 60–100  $\mu\text{m}$  thick at the stipe-like base (vertically orientated hyphae 2.5–3.5  $\mu\text{m}$  wide); anatomically the lateral exciple is a tight, radiating reticulum of prosoplectenchymatous hyphae in a hyaline gelatinous matrix, the upper and outer parts of the exciple (in thin section) concolorous or very pale yellowish. *Hypothecium* hyaline to very pale yellowish, 20–30  $\mu\text{m}$  thick; hyphae tightly packed, short-celled, rather thick-walled, variously orientated, 2–3.5  $\mu\text{m}$  wide. *Hymenium* 55–77  $\mu\text{m}$  thick, not interspersed with oil droplets, granules or crystals, non-amyloid. *Epihymenium* not apparent. *Paraphyses* simple (with no trace at all of branches or anastomoses), 0.5–0.8(–1)  $\mu\text{m}$  thick for most of their lengths, long-celled, not constricted at the septa, appearing stiff, and remaining rigid and unbending when detached or broken; apices not or only moderately swollen (then 1.5–2.5  $\mu\text{m}$  wide), not pigmented, remaining conglutinate in water and KOH, or separating in the latter. *Asci* narrowly clavate or elongate-cylindrical, 8-spored, 48–60  $\times$  6–9  $\mu\text{m}$  [*n* = 20], with a gradually tapering stalk; wall and contents non-amyloid; apex rounded at maturity, with a thin tholus lacking an ocular chamber and apical apparatus. *Ascospores* colourless, 3-septate, narrowly ellipsoid to fusiform-ellipsoid or oblong-fusiform to narrowly fusiform, straight or slightly bent, the septa evenly spaced or oblique and often irregular, uniseriate or overlapping-subbiserial in the ascus, thin-walled, usually lacking a perispore even when immature, (9.5–) 11.5(–14)  $\times$  (3–)4(–5)  $\mu\text{m}$  [*n* = 100]; cell contents clear, neither granulose nor guttulate; spore wall not or only faintly constricted at the septa. *Pycnidia* probably numerous, but very inconspicuous and sectioned only fortuitously, completely immersed in the thallus, 0.1–0.15 (–0.18) mm wide, to 0.12 mm tall, pyriform, the apex and wall hyaline; conidiophores unbranched, 10–13  $\times$  1.5–2  $\mu\text{m}$ . *Conidia* mostly narrowly ellipsoid to bacilliform, 1.5–2(–2.5)  $\times$  0.5–0.8  $\mu\text{m}$ , some more irregular in shape or bent. *Chemistry*: No substances detected by TLC (Elix 2020).

*Etymology*: The specific epithet *incolorata* (colourless) refers to the almost complete absence of pigment in the thallus and apothecia.

#### Remarks

The new species has a rather smooth, whitish thallus that is abundantly but faintly rimose, with almost concolorous, adnate to subsessile apothecia, 0.24–0.49 mm wide and uniformly  $\pm$  hyaline in section. The cupulate, prosoplectenchymatous proper exciple subtends a thin hypothecium and a non-amyloid hymenium of simple paraphyses and narrowly clavate to elongate-cylindrical, 8-spored asci, with  $\pm$  fusiform, 3-septate ascospores of 9.5–14  $\times$  3–5  $\mu\text{m}$ . Inconspicuous, immersed pycnidia also lack pigmentation, producing mostly narrowly ellipsoid to bacilliform conidia 1.5–2.5  $\mu\text{m}$  long.

Thirty-three of the 60 known taxa of *Gyalidea* are obligately saxicolous. Twenty rock-inhabiting species have submuriform or muriform ascospores, while the remaining 13 produce transversely septate ascospores (Vězda 1966; Clauzade & Roux 1985; Vězda *et al.* 1990; Vězda & Poelt, 1990, 1991; Harada & Vězda 1991, 1996, 1999; Galloway 1985, 2007; Gilbert *et al.* 2009; Harada 2016; Harada & Sakata 2016; Kondratyuk *et al.* 2016, 2019; McCarthy 2020). The almost cosmopolitan *G. hyalinescens* (Nyl.) Vězda, which also occurs on acidic rocks in eastern Australia, has pinkish brown apothecia 0.8–1.2 mm wide and larger 3-septate ascospores (15–24  $\times$  5–6.5  $\mu\text{m}$ ; Gilbert *et al.* 2009). While *G. lecanorina*, a New Zealand endemic, is undoubtedly the most similar species to *G. incolorata*, it has a minutely uneven, olivaceous to pale buff or sordid yellowish green thallus, yellow-brown apothecia, often with somewhat blackened margins, a deeper hymenium (*c.* 120  $\mu\text{m}$  thick), and it grows on siliceous rocks (Galloway 1985, 2007). An excellent photograph of the holotype of *G. lecanorina* (WELT) can be viewed at <https://collections.tepapa.govt.nz/object/450618>.

*Gyalidea incolorata* occurs on moderately sheltered limestone outcrops at two localities in and near rainforest in Christmas Island. Associated lichens include *Anisomeridium calcivorum*, *Coenogonium* sp., *Porina bellendenica*, *P. papuensis*, *P. tetracerae*, *Strigula bermudana* (Tuck. ex Nyl.) R.C.Harris, *Verrucaria* sp. and *Willeya pallidopora*.

#### ADDITIONAL SPECIMENS EXAMINED

*Christmas Island*. ● *c.* 700 m ESE of Grants Well, 10°28.89'S, 105°35.42'E, *c.* 250 m alt., on limestone outcrop in scrubby, secondary forest, *P.M. McCarthy 1365 (part), 1366 (part), 1444 (part)*, 31.vii.2000 (CANB).

#### 3. *Thelidium insulare* P.M.McCarthy, sp. nov.

MycoBank No.: **MB 839437**

Figs 4, 5

Thallus epilithic, pale brownish green, medium to dark greenish grey or greyish black, corticate; perithecia semi-immersed to 3/4-immersed, (0.20–)0.35(–0.47) mm diam., each with a thick, well-developed involucrellum that can extend down to or below the pale to blackish or piebald excipulum base. Asci broadly clavate to narrowly obclavate or clavate-cylindrical, 54–65  $\times$  15–21  $\mu\text{m}$ ; ascospores 14–22  $\times$  5.5–9  $\mu\text{m}$  and 1(–3)-septate.

*Type*: Australia. Christmas Island, The Grotto, 1 km S of North-East Point, 10°25.38'S, 105°42.10'E, alt. *c.* 20 m, on sheltered limestone outcrop in moderately dense primary forest, *P.M. McCarthy 1399 (part)*, 23.vii.2000 (CANB — holotype).

*Thallus* crustose, epilithic, pale brownish green or pale to medium greyish green (this colour range usually seen in moderate to deep shade) or medium to dark greenish grey or greyish black (when progressively exposed to bright sunlight; Fig. 4), effuse to determinate and forming colonies to *c.* 20 mm wide, the colour and appearance  $\pm$  unchanging when wetted, continuous or sparingly to richly rimose or patchily areolate, to 100(–150)  $\mu\text{m}$  thick, dull to slightly glossy and resembling oil stains when especially dark,  $\pm$  smooth; areoles somewhat rounded to angular and irregular, 0.2–0.5(–0.6) mm wide, separated by very delicate fissures (to *c.* 20  $\mu\text{m}$  wide) that expose the whitish limestone beneath, the contrast particularly striking when the thallus is darkest. *Cortex* of darker thalli 12–20(–25)  $\mu\text{m}$  thick; cells rounded to broadly ellipsoidal, 4–8  $\mu\text{m}$  in maximum extent, with rather thick, dark olive-brown walls; cortex of the least melanized thalli pale greyish green, to 10(–16)  $\mu\text{m}$  thick; all cortices subtending an uneven and often inconspicuous (on pale thalli), hyaline, amorphous, necral layer 5–8  $\mu\text{m}$  thick. *Photobiont* green, chlorococcoid, forming a well-delimited layer *c.* 20–50  $\mu\text{m}$  thick; cells rounded or broadly and vertically ellipsoid, rather thick-walled, (5–)8–11(–12)  $\mu\text{m}$  wide; interstitial hyphae hyaline, rounded and parenchyma-like, 3–5(–6)  $\mu\text{m}$  wide. *Medulla* nondescript, dominated by substratum material; hyphae short-celled, 2.5–3.5  $\mu\text{m}$  wide. *Prothallus* absent; hypothallus not apparent. *Ascomata* perithecia, moderately numerous, solitary, (0.20–)0.35(–0.47) mm diam. [*n* = 40], dull black, semi-immersed to 3/4-immersed in the thallus, not leaving pits in the substratum; perithecial apex rounded or somewhat flattened, the central ostiole inconspicuous or shallow-concave to deeply excavate, 20–60  $\mu\text{m}$  wide. *Involucrellum* well-developed, 65–90  $\mu\text{m}$  thick below the apex, 40–55  $\mu\text{m}$  thick towards the base, partly overgrown by a thin layer of thallus or not, uniformly greenish black in thin section, usually contiguous with the excipulum and extending almost to excipulum-base level or penetrating more deeply beside a subexcipular layer; that layer 30–80  $\mu\text{m}$  thick, hyaline, parenchymatous, with tightly packed, rounded cells 3–5  $\mu\text{m}$  wide (Fig. 5C); involucrellum occasionally diverging slightly from the excipulum from just below the apex. *Excipulum* 18–27  $\mu\text{m}$  thick at the sides and base, uniformly hyaline to dark greenish brown to green-black or piebald. *Subhymenium* hyaline to pale brown, 30–40  $\mu\text{m}$  thick, K–, KI+ orange-brown; hyphae 2–2.5  $\mu\text{m}$  wide. *Paraphyses* absent. *Periphyses* sparingly branched, *c.* 25–45(–50)  $\times$  1–1.5 (–2)  $\mu\text{m}$ . *Centrum* obpyriform, *c.* 0.14–0.28  $\mu\text{m}$  wide. *Asci* fissitunicate, 8-spored, broadly clavate to narrowly obclavate or clavate-cylindrical, 54–65  $\times$  15–21  $\mu\text{m}$  [*n* = 10]; when immature the tholus is markedly thickened with a narrow ocular chamber; at maturity the

tholus thin and the ocular chamber no longer apparent. *Ascospores* irregularly biseriate in the ascus, or concentrated in the proximal half of obclavate asci, colourless, 1(–3)-septate (no more than 1–5% of spores with 2 or 3 septa), narrowly ellipsoid to oblong-fusiform, straight, occasionally slightly bent, with a medial septum and rounded or subacute ends, rarely slightly constricted at the septum, cells ± equal in size or the distal cell slightly broader, (14–)18.5(–22) × (5.5–)7.5(–9) µm [*n* = 100]; spore wall smooth, to 0.8 µm thick; epispore usually not apparent, occasionally seen in immature and mature spores, 1–1.5 µm thick; spore contents clear. *Pycnidia* absent.

*Etymology*: The epithet *insulare* refers to the island locality of the new species.

#### Remarks

*Thelidium* is diverse and comparatively well documented in northern temperate and boreal latitudes, with approximately 100 accepted taxa (Zschacke 1933; Servit 1954; Kopachevskaya *et al.* 1977; Clauzade & Roux 1985; Orange 1991, 2013; Thüs & Nascimbene 2008; Thüs & Schultz 2009; Harada 2013). By contrast, it appears to be genuinely uncommon, and not just overlooked, in temperate Australia (with six taxa: McCarthy 2001d, 2014; McCarthy & Kantvilas 2016, 2020), and New Zealand (with five: Galloway 2007), and it is even more poorly known in the Subantarctic and southern South America. The genus also seems to be very uncommon in the wet tropics, so its occurrence in Christmas Island is particularly noteworthy.

The new species is characterized by the epilithic, pale brownish green, medium to dark greenish grey or blackish, corticate thallus, moderately large and semi-immersed or more deeply immersed perithecia, with a thick, well-developed involucrellum that can extend down to or below the pale to blackish or piebald excipulum base. The fissitunicate asci are broadly clavate to narrowly obclavate or clavate-cylindrical, and the 1(–3)-septate ascospores are 14–22 × 5.5–9 µm. None of the terrestrial, calcicolous species exclusive to the Northern Hemisphere is likely to be confused with *T. insulare* (Zschacke 1933; Servit 1954; Kopachevskaya *et al.* 1977; Clauzade & Roux 1985; Orange 2013). However, the Australasian flora includes the somewhat similar *T. olivaceum* (Fr.) Körber, which is known from limestone in East Gippsland, Victoria, as well as southern Europe and North America, and that lichen has a dark, rimose to areolate thallus, very small perithecia, 0.18–0.26 mm diam., a hyaline to pale brown excipulum and larger, 1-septate ascospores, 19–25 × 9–12 µm (McCarthy 2001d). Furthermore, *T. calcareum* (C.Knight) Hellb., endemic to New Zealand, has a thin, effuse, blackish thallus, minute, sessile perithecia, to 0.25 mm wide, and smaller 1-septate ascospores, 14–18 × 7–9 µm (Galloway 1985, 2007).

*Thelidium insulare* grows on limestone at three localities near the north-eastern coast of Christmas Island. Associated lichens include *Anisomeridium calcivorum*, *Porina bellendenica*, *P. papuensis*, *P. tetracerae*, *Thelidium insulare*, *Verrucaria* sp. and *Willeya pallidopora*.

#### ADDITIONAL SPECIMENS EXAMINED

*Christmas Island*. ● type locality, *P.M. McCarthy 1568*, 1570, 23.vii.2000 (CANB); ● near Golf Course, 2 km S of North-East Point, 10°25.99'S, 105°42.26'E, alt. c. 25 m, on small limestone boulder on roadside, *P.M. McCarthy 1455*, 25.vii.2000 (CANB); ● near Daniel Roux Cave, 1.5 km S of Smith Point, 10°26.35'S, 105°39.40'E, alt. 70 m, on limestone outcrop in moderately dense primary forest, *P.M. McCarthy 1512*, 29.vii.2000 (CANB).

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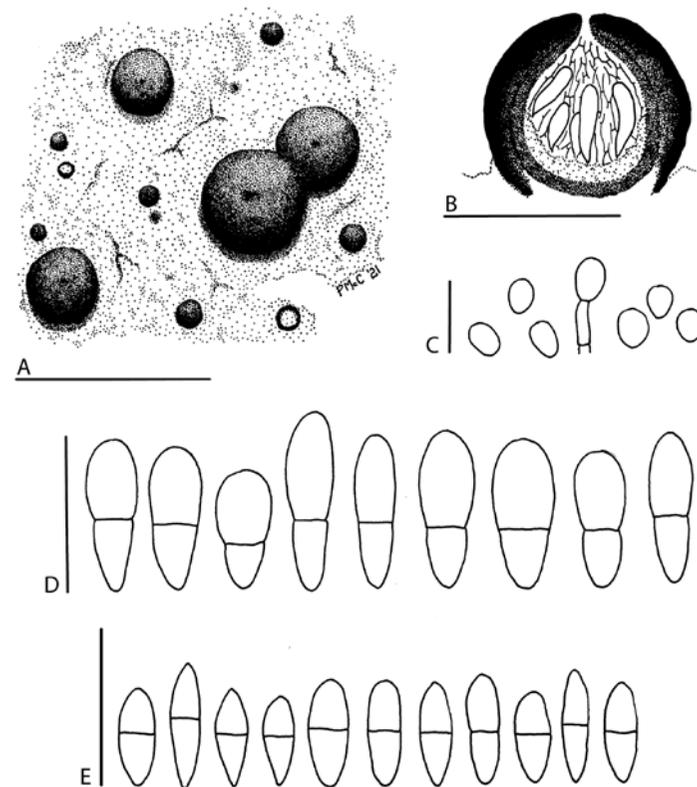


Fig. 1. *Anisomeridium* spp. A–D, *A. calcivorum* (holotype). Habit of thallus, ascomata and microconidia. B, Section of ascoma (semi-schematic). C, Microconidia and part of a conidiophore. D, Ascospores. E, Ascospores of *Anisomeridium* sp. (PMMcC 1441). Scales: A = 0.5 mm; B = 0.2 mm; C = 5  $\mu$ m; D, E = 20  $\mu$ m.



Fig. 2. *Gyalidea incolorata* (holotype). Scales: 1 mm.

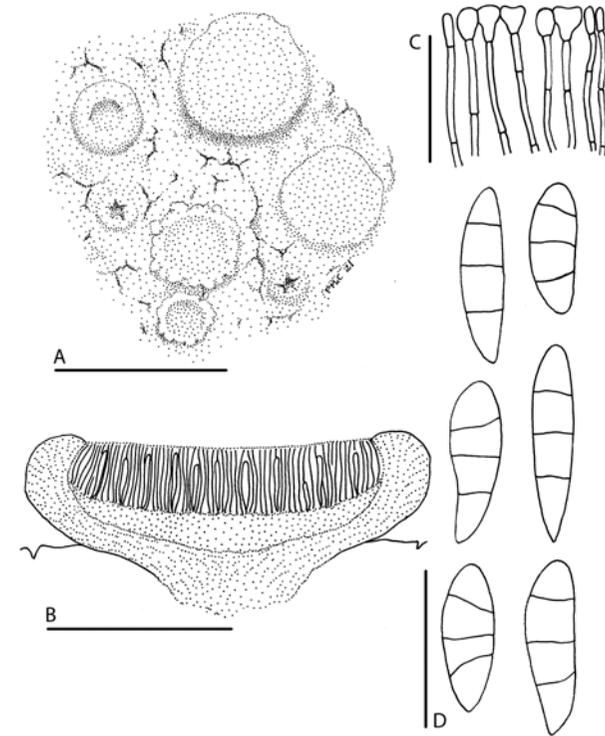


Fig. 3. *Gyalidea incolorata* (holotype). A, Habit of thallus and apothecia. B, Section of apothecium (semi-schematic). C, Apices of paraphyses. D, Ascospores. Scales: A = 0.5 mm; B = 0.2 mm; C, D = 10  $\mu$ m.

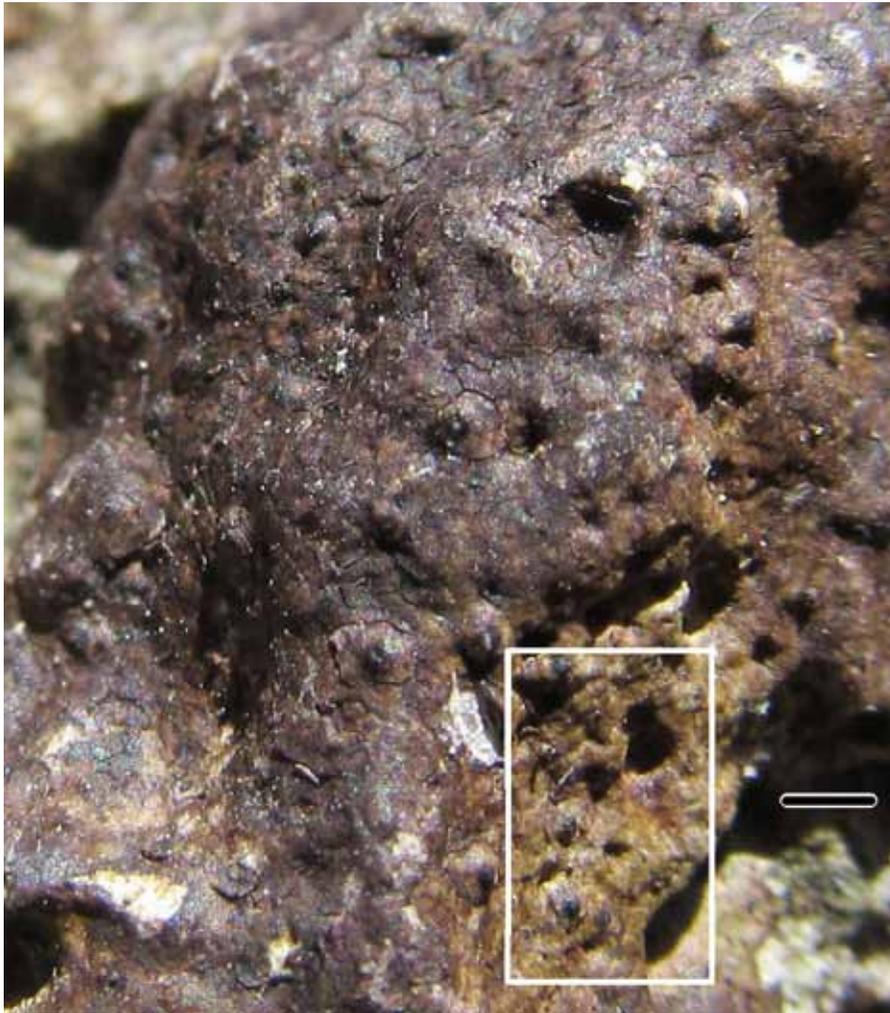


Fig. 4. *Thelidium insulare* (holotype). Note the paler thallus on a more deeply shaded rock surface (box). Scale: 1 mm.

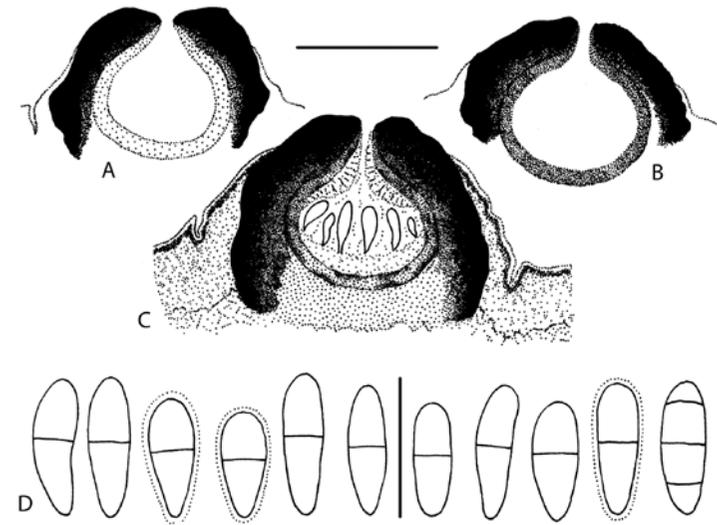


Fig. 5. *Thelidium insulare*. A–C, Sectioned perithecia (semi-schematic). D, Ascospores. Scales: A–C = 0.2 mm; D = 20  $\mu$ m.

**Two new species and four new records of buellioid lichens  
(Caliciaceae, Ascomycota) from Australia**

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**Abstract**

*Amandinea montanensis* Elix & H.Mayrhofer and *Buellia tropica* Elix & H.Mayrhofer are described as new to science. The new combination *Amandinea manamiana* (Diederich) Elix & H.Mayrhofer, is made. It and *Buellia macularis* Zahlbr., *Gassicurtia elizae* (Tuck.) Marbach and *G. rufofuscescens* (Vain.) Marbach are reported for the first time from Australia. *Amandinea montanensis* also occurs in the South Island of New Zealand.

**Introduction**

The present paper continues our investigation of *Buellia*-like lichens in the Southern Hemisphere. For the more recent additions, see Elix (2020), Elix & Kantvilas (2020) and Elix & Mayrhofer (2020) and references cited therein. In this paper, we describe *Amandinea montanensis* from siliceous rocks in alpine and upland areas of southern New South Wales, the Australian Capital Territory, Victoria, Tasmania, and the South Island of New Zealand, as well as *Buellia tropica*, a new saxicolous species of *Buellia* in the broad sense, from north Queensland. The new combination *Amandinea manamiana* (Diederich) Elix & H.Mayrhofer is made. It and *Buellia macularis* Zahlbr., *Gassicurtia elizae* (Tuck.) Marbach and *G. rufofuscescens* (Vain.) Marbach are reported for the first time from Australia. Methods are as described in our previous papers cited above.

**New species**

**1. *Amandinea montanensis*** Elix & H.Mayrhofer, sp. nov.  
Mycobank No.: **MB 839053**

Figs 1, 2

Similar to *Amandinea isabellina* (Hue) Søchting & Øvstedal, but differs in having a thinner thallus and smaller ascospores, 10–17 × 5–10 µm.

*Type:* Australia, New South Wales, Mount Kosciuszko National Park, Perisher Creek between Smiggin Holes and Guthega, 36°22'S, 148°24'E, 1620–1680 m alt., on granite, *H. Mayrhofer 15418*, *H. Hertel & R. Filson*, 3.iii.1985 (holotype – GZU).

*Thallus* crustose, membranaceous to areolate or subsquamulose, to 50 mm wide and 1 mm thick; individual areoles rounded to irregular, 0.1–1.5 mm wide, sometimes becoming aggregated and imbricate to form a secondary warted or subsquamulose crust; upper surface grey-green to grey-brown or olive-brown, matt; prothallus black and marginal, or not apparent; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub><sup>-</sup>), I<sup>-</sup>; photobiont cells 6–19 µm diam. *Apothecia* 0.2–0.5 mm wide, lecideine, broadly adnate to sessile and constricted at the base, isolated or crowded, rounded; disc black, epruinose, plane to weakly convex; *proper excipulum* thin, persistent or excluded in convex apothecia, the outer zone dark brown, 30–50 µm thick, K<sup>-</sup>, N<sup>-</sup>, inner zone pale brown to colourless. *Epithymenium* 8–10 µm thick, dark brown to brown-black, K<sup>-</sup>, N<sup>-</sup>. *Hypothecium* brown to brown-black, 50–80 µm thick, K<sup>-</sup>. *Hymenium* 50–60 µm thick, colourless, not interspersed; subhymenium 20–25 µm thick, colourless to pale brown, not interspersed. *Paraphyses* 1.2–1.5(–2) µm wide, sparsely branched, with apices 3.5–5.5 µm wide and brown caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* *Physconia*-type when

immature, *Buellia*-type when mature, brown, ellipsoid, 10–[13.8]–17 × 5–[7.5]–10 µm, ± curved, rarely constricted at the septum; outer spore-wall weakly ornamented. *Pycnidia* immersed; ostiole black. *Conidia* filiform, curved, 16–32 × 0.7–1 µm.  
*Chemistry:* Thallus K<sup>-</sup>, P<sup>-</sup>, C<sup>-</sup>, UV<sup>-</sup>; no lichen substances detected by TLC.

*Etymology:* The species is named after its distribution mainly in upland and montane regions.

**Remarks**

This species is characterized by the crustose, membranaceous to areolate or subsquamulose, grey-green to grey-brown or olive-brown thallus, the broadly adnate to sessile, lecideine apothecia, the non-amyloid medulla, the 1-septate, *Physconia*- then *Buellia*-type ascospores, 10–17 × 5–10 µm, curved, filiform conidia, 16–32 µm long, and the absence of lichen substances. It had previously been confused with *A. isabellina*, but that species has a thicker, congested verruculose thallus, 1–2.5 mm thick, and larger ascospores, 14–[16.1]–20 × 7–[8.3]–11 µm (Lamb 1968; Elix & Kantvilas 2013).

*Amandinea montanensis* is known from siliceous rocks in upland regions of south-eastern mainland Australia (New South Wales, Australian Capital Territory and Victoria), as well as Tasmania and the South Island of New Zealand. In Australia, associated species include *Acarospora veronensis* A.Massal., *Buellia aethalea* (Ach.) Th.Fr., *B. ocellata* (Flot.) Körb., *Lecanora farinacea* Fée, *Notoparmelia signifera* (Nyl.) A.Crespo, Ferencova & Divakar, *Pertusaria lophocarpa* Körb., *Rhizocarpon geographicum* (L.) DC. and *Xanthoparmelia mougeotina* (Nyl.) D.J.Galloway.

**SPECIMENS EXAMINED**

*New South Wales:* ● Mount Canobolas State Conservation Area, N slopes of Mt Canobolas, 12 km SW of Orange, 33°19'58"S, 148°58'52"E, 1100 m alt., on roadside trachytic rhyolite, *J.A. Elix 46876*, 1.x.2019 (CANB); ● same locality, *P.M. McCarthy 4901*, 1.x.2019 (CANB); ● Kybean, 22.5 km NE of Nimmitabel, *J.S. Williams s.n.*, 13.x.1966 (MEL 1018442); ● Cabonne, roadside between Canowindra and Cargo, c. 400 m alt., on rock, *D., M. & H. Mayrhofer 7988*, 12.viii.1988 (GZU).

*Australian Capital Territory:* ● Brindabella Range, Namadgi National Park, summit of Mt Ginini, 52 km WSW of Canberra, 35°31'47"S, 148°46'22"E, 1762 m alt., on loose stones, *P.M. McCarthy 4720*, 10.i.2018 (CANB).

*Victoria:* ● Grampians National Park, near Silverband Falls, 37°11'S, 142°31'E, on stone, *W.H. Ewers s.n.*, 29.viii.1986 (CANB 777032 *pr. p.*); ● Bogong High Plains, Langford West Aqueduct, Middle Creek, 36°55'S, 147°18'E, c. 1600 m alt., on granite, *H. Mayrhofer 15483*, *H. Hertel & R. Filson*, 26.ii.1985 (GZU); ● Mt Oberon, Wilsons Promontory, 39°02'S, 146°21'E, c. 540 m alt., on granite, *D. & H. Mayrhofer 11509 pr. p.*, 15483 & *E. Hierzer 30.vii.1992* (GZU).

*Tasmania:* ● Lake Kaye, 41°54'S, 146°31'E, 1140 m alt., on basalt boulders in alpine heathland, *G. Kantvilas 94/00 pr. p.*, 8.iii.2000 (HO); ● Daley property, "High Country", c. 2 km W of Long Point, *G. Kantvilas 44/06*, 1.i.2006 (HO).

*New Zealand:* ● South Island, Otago, Taieri Co., summit of Museum Rock, Rock and Pillar Range, 24 km W of Middlemarch, 1280 m alt., on rock tors in alpine zone, *H.A. Imshaug 56089*, 6.xii.1972 (MSC); ● South Island, Otago, Lake Hayes, NE of Queenstown, c. 310 m alt., on boulders along lake shore, *H. Mayrhofer 2243*, 20.ix.1981 (GZU).

**2. *Buellia tropica*** Elix & H.Mayrhofer, sp. nov.  
Mycobank No.: **MB 839055**

Figs 3, 4

Similar to *Buellia herveyensis* Elix, but differs in having somewhat longer ascospores, 17–24 µm long, and a medulla that contains calcium oxalate.

*Type:* Australia, Queensland, Main Range, Millstream Falls National Park, Millstream Falls, 7 km WSW of Ravenshoe, 17°38'S, 148°22'E, 780 m alt., on basalt outcrop at base of falls, *H. Mayrhofer 11793 & E. Hierzer pr. p.*, 10.viii.1993 (CANB – holotype).

*Thallus* crustose, to 12 mm wide and 0.1 mm thick, rimose-areolate, individual areoles irregular, angular, 0.1–0.5 mm wide; upper surface white to whitish grey, matt, densely maculate; prothallus marginal and black, or not apparent; photobiont cells 5–13 µm wide; medulla white, containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub><sup>+</sup>), I–, K+ yellow in part. *Apothecia* 0.05–0.3 mm wide, cryptolecanorine or lecideine, immersed to just adnate; disc black, epruinose, weakly concave at first, then plane. *Excipulum* distinct, persistent, black, in section 30–40 µm thick, outer part brown to dark brown, inner part paler brown, K+ yellow. *Epihymenium* 10–12 µm thick, brown, K+ orange, N–. *Hypothecium* 60–75 µm thick, brown. *Hymenium* 60–75 µm thick, colourless, not interspersed; subhymenium c. 20 µm thick, pale brown, not interspersed. *Paraphyses* 1.5–2 µm wide, simple to weakly branched, capitate, the apices 3.5–5 µm wide, with brown caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* initially of the *Callispora*-type, then *Buellia*-type, 1-septate, olive-brown to brown, ellipsoid, 17–[20.8]–24 × 8–[9.6]–11 µm, constricted at the septum, sometimes slightly curved, often pointed at the apices, with weak subapical wall-thickenings; outer spore-wall rugulate. *Pycnidia* not seen. *Chemistry*: Thallus K+ yellow, P+ pale yellow, C–, UV–; containing atranorin (major).

*Etymology*: The species is named after its tropical distribution in Australia.

### Remarks

The new species is characterized by the crustose, rimose-areolate, white to whitish grey thallus, the *Callispora* then *Buellia*-type ascospores, 17–24 × 8–11 µm, with a rugulate outer wall, and the presence of medullary calcium oxalate and atranorin. *Buellia herveyensis* is quite similar, but differs in having a rimose, chinky, reddish brown to dirty brownish white thallus, straight, *Buellia*-type ascospores and a medulla that lacks calcium oxalate (Elix 2015).

At present, the new species is known only from the type locality. Associated lichens include *Candelaria crawfordii* (Müll.Arg.) P.M.Jørg. & D.J.Galloway, *Heterodermia obscurata* (Nyl.) Trevis., *Lecanora margarodes* (Körb.) Nyl., *L. sulfurescens* Fée, *L. tropica* Zahlbr., *Lepra subventosa* (Malme) I.Schmitt & Lumbsch var. *subventosa* and *Rinodina xanthomelana* Müll.Arg.

### New records

1. *Amandinea manamiana* (Diederich) Elix & H.Mayrhofer, comb. nov. Fig. 5  
Mycobank No.: MB 839051

Basionym: *Buellia manamiana* Diederich, *Biblioth. Lichenol.* **64**, 33 (1997)

*Type*: Papua New Guinea, Madang Province, Manam Island (near Bogia), lava flow of 1957, 2 km S of Waris, on SE shore, 4°07'S, 145°04'E, 10 m alt., on lava rock, *P. Diederich 11413*, 23.vii.1993 (holotype – LG, not seen).

*Thallus* crustose, to 50 mm wide and 50 µm thick, areolate, finely rimose or granular, areoles 0.08–0.2 mm wide; upper surface yellow, flat, dull; prothallus black and marginal, or absent; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub><sup>–</sup>), I–; photobiont cells 5–9 µm wide. *Apothecia* 0.1–0.5 mm wide, lecideine, adnate to sessile and constricted at the base, round; disc black, epruinose, plane to weakly convex. *Excipulum* distinct, persistent, in section 18–35 µm thick, outer zone dark brown, K–, N–, inner zone pale brown. *Epihymenium* 8–10 µm thick, brown, K–, N–. *Hypothecium* 20–50 µm thick, dark brown, K–. *Hymenium* 50–60 µm thick, colourless, not interspersed. *Paraphyses* 1–1.5 µm wide, sparsely branched towards apices, the apices 4–7 µm wide with brown caps. *Asci* *Bacidia*-type, 12–16-spored. *Ascospores* *Buellia*-type, brown, ellipsoid, 8–[9.9]–13 × 3–[4.5]–6 µm, older spores constricted at the septum; outer spore-wall weakly ornamented. *Pycnidia* immersed, black, punctiform. *Conidia* curved, filiform, 19–25 × 0.7–1 µm.

*Chemistry*: Thallus K–, P–, C–, KC+ orange, UV– or UV+ weak orange; containing thuringione (major), arthothelin (minor).

### Remarks

This species was known previously from Papua New Guinea (Aptroot *et al.* 1997). It is characterized by the yellow, areolate, finely rimose or granular crustose thallus, the lecideine apothecia, 12–16-spored asci, *Buellia*-type ascospores, 8–13 × 3–6 µm, curved, filiform conidia, 19–25 µm long, and the presence of thuringione and arthothelin. *Amandinea melaxanthella* (Nyl.) Marbach is very similar, but has smaller apothecia (0.1–0.3 mm wide), 8–16-spored asci and ascospores with a rugulate outer spore-wall. It occurs only on corticolous substrata (Marbach 2000).

### SPECIMEN EXAMINED

*Queensland*: ● Beerwah, Glass House Mountains National Park, above picnic area W of Mt Tibrogargan, N of Beerburum, 37°23'S, 144°19'30"E, 50–80 m alt., on rhyolite outcrops in open sclerophyll forest, *H. Mayrhofer 11499*, *E. Hierzer & N. Stevens*, 20.viii.1993 (GZU).

2. *Buellia macularis* Zahlbr., *Denkschr. Akad. Wiss. Wien math.-naturwiss. Kl.* **104**, 375 (1941) Fig. 6

*Type*: New Zealand: South Island, Central Otago, Hyde, *J.S. Thomson A 41 (T 2328)* (holotype – W, not seen; isotype – CHR).

*Thallus* crustose, to 50 mm wide and 0.1 mm thick, rimose-areolate, areoles 0.2–0.6 mm wide, ± angular, flat or weakly concave; upper surface pale to dark grey or pale grey-brown, dull, often roughened; prothallus usually conspicuous, black, surrounding the thallus, stellate-fimbriate, 0.5–2 mm wide, also growing ± between the areoles and forming mosaics; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub><sup>–</sup>), I–; photobiont cells 8–15 µm wide. *Apothecia* 0.1–1 mm wide, lecideine, immersed, becoming adnate or rarely sessile; disc black, flat, epruinose. *Excipulum* thin, persistent, cupuliform, in section 35–60 µm thick, outer zone greenish black to brown-black, K–, N+ red-violet or red-brown, inner zone pale brown. *Epihymenium* 8–13 µm thick, dark greenish black to olive-brown, K–, N+ red-violet. *Hypothecium* 70–80 µm thick, colourless to pale brown. *Hymenium* 55–80 µm thick, colourless, not interspersed. *Paraphyses* 1.5–2.5 µm wide, simple to moderately branched, with apices 4–5 µm wide and aeruginose-brown caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* *Buellia*-type, 1-septate, olive-brown to brown, broadly ellipsoid, 12–[14.2]–18 × 8–[8.6]–10 µm, becoming constricted at the septum, with obtuse ends, uniformly thin-walled; outer spore-wall microrugulate. *Pycnidia* rare, immersed, urceolate to globose. *Conidia* bacilliform, 5–7 × 1 µm.

*Chemistry*: Thallus K+ yellow then red, P+ yellow-orange, C–, UV–; containing norstictic acid (major) and connorstictic acid (minor).

### Remarks

This species was known previously from New Zealand (Galloway 1985, 2007). It is characterized by the crustose, pale to dark grey or pale grey-brown, rimose-areolate thallus, often with a roughened upper surface, the immersed to adnate, lecideine apothecia, the prominent, fimbriate-stellate, black prothallus, a non-amyloid medulla, the aeruginose, N+ red-violet epihymenium, the *Buellia*-type ascospores, 12–18 × 8–10 µm, bacilliform conidia, 5–7 µm long, and the presence of norstictic acid. *Buellia aethalea* (Ach.) Th.Fr. is somewhat similar, but it lacks the roughened upper surface and has an amyloid medulla in Australia and New Zealand (Elix 2011).

### SPECIMENS EXAMINED

*Australian Capital Territory*: ● Brindabella Range, Namadgi National Park, summit of Mt Ginini, 52 km WSW of Canberra, 35°31'47"S, 148°46'22"E, 1762 m alt., on loose stones in grasses, *J.A. Elix 47103*, 2.iii.2021 (CANB); ● Bruce Ridge, Canberra Nature Park, 35°15'S, 149°05'E, 640 m alt., on quartzite rocks in dry, *Eucalyptus* woodland, *J.A. Elix 23282*, 26.xi.1989 (CANB).

*New Zealand*: ● South Island, Otago, Toko Mouth, 46°13'39"S, 170°01'40"E, 5 m alt., on quartz stones on sandy ground in dune slack, *A. Knight & J.M. Bannister s.n.*, 24.i.2004 (CANB, OTA).

*Lecidea elizae* Tuck., *Amer. J. Sci. Arts*, ser. 2, 25: 428 (1858); *Buellia elizae* (Tuck.) Tuck., *Lichens of California, Oregon and the Rocky Mountains* 25 (1866). *Type*: U.S.A., Virginia, Sussex, *E. Tuckerman ex 3251*, 1854 (holotype – FH, not seen).

*Thallus* crustose, to 50 mm wide and 0.1 mm thick, continuous, granular to coralloid-isidiate, individual granules 50–80 µm wide, isidia 50–100 µm thick; upper surface yellowish grey; prothallus marginal, black; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-; photobiont cells 5–11 µm wide. *Apothecia* 0.2–0.5 mm wide, lecideine, scattered, round, broadly adnate, disc black, orange-pruinose, pruina darkening with age, plane to weakly convex. *Excipulum* persistent, black, in section 30–50 µm thick, the outer part brown-black, K-, paler within. *Epihymenium* 8–12 µm thick, orange to orange-brown, K+ orange solution. *Hypothecium* 100–120 µm thick, olive-black to brown-black, K-. *Hymenium* 60–70 µm thick, colourless, not interspersed but with a few small oil droplets. *Paraphyses* 1.5–1.8 µm wide, simple to sparsely branched, the apices 2–2.5 µm wide with colourless caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* *Buellia*-type, 1-septate, olive-green to brown, broadly ellipsoid, 10–[12.6]–15 × 5–[5.4]–7 µm, rarely constricted at the septum; outer spore-wall moderately ornamented. *Pycnidia* not seen.

*Chemistry*: Thallus K-, C-, KC+ orange, P-, UV-; containing barbatic acid (major), obtusatic acid (minor or trace).

#### Remarks

This species was known previously from North America, Japan and East Africa. (Marbach, 2000). It is characterized by the yellowish grey, crustose thallus, an orange-pigmented epihymenium (K+ orange solution), the orange-pruinose apothecia, *Buellia*-type ascospores, 10–15 × 5–7 µm, and by the presence of barbatic and obtusatic acids.

#### SPECIMENS EXAMINED

*Queensland*: • Atherton Tableland, Koombooloomba Dam, near weir, [17°50'25"S, 145°35'45"E, 700 m alt.], on bark, *W.H. Ewers 7951 pr. p.*, 23.ix.1991 (CANB).

*Japan*: • Prov. Kii, Mt Kōya, on bark, *Y. Asahina s.n.*, 23.viii.1952 (CANB, *Lichenes Japoniae Exsiccati* no. 206, as *Buellia crocata* Zahlbr.).

4. *Gassicurtia rufofuscescens* (Vain.) Marbach, *Biblioth. Lichenol.* 74, 242 (2000) Fig. 8  
*Buellia rufofuscescens* Vain., *Acta Soc. Fauna Fl. Fenn.* 7: 172 (1890). *Type*: Brazil, Minas Gerais, Carassa, *E.A. Vainio, Lichenes Brasiliensis Exsiccati* 473, 1885 (isotype – KIEL not seen).

*Thallus* crustose, to 20 mm wide and 60 µm thick, continuous, smooth to verruculose; upper surface white to grey-white, shiny, esorediate; prothallus marginal, grey to black or absent; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-; photobiont cells 5–10 µm wide. *Apothecia* 0.2–0.4 mm wide, lecideine, scattered, round, sessile, basally constricted, disc black, epruinose or red-brown-pruinose, plane to weakly concave. *Excipulum* persistent, glossy, black, in section 25–35 µm thick, mostly opaque dark brown to brown-black throughout, containing pigment that leaches in K to give a purple solution. *Epihymenium* 7–9 µm thick, red-brown to dark brown, K+ olive, containing granules that are sparingly soluble in K. *Hypothecium* 90–110 µm thick, brown-black, K-. *Hymenium* 55–65 µm thick, colourless, not interspersed but with scattered fine oil droplets, K+ yellow. *Paraphyses* 1.5–2 µm wide, simple to sparsely branched, the apices 3–3.5 µm wide with brown caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* *Physconia*-type then *Buellia*-type, 1-septate, olive-green to brown, ellipsoid, 11–[12.2]–14 × 5–[5.4]–6 µm, rarely slightly constricted at the septum; outer spore-wall moderately ornamented. *Pycnidia* not seen.

*Chemistry*: Thallus K+ yellow, KC-, C+ orange, P-, UV+ orange; containing thiophanic acid (major), 3-*O*-methylthiophanic acid (major) and chiodectonic acid (trace).

#### Remarks

This species was known previously from Central and South America (Marbach, 2000; van den Boom *et al.* 2013). It is characterized by a white to grey-white, smooth to verruculose thallus, a pigmented excipulum (K+ purple solution), *Buellia*-type ascospores, 11–14 × 5–6 µm, and the presence of 3-*O*-methylthiophanic, thiophanic and chiodectonic acids. The specimen cited below was formerly misidentified as *G. pseudosubpulcella* Marbach (Elix & Kantvilas 2015).

#### SPECIMEN EXAMINED

*Queensland*: • Clarke Range, 46 km S of Proserpine, 20°50'S, 148°32'E, 800 m alt., on dead log in *Eucalyptus-Casuarina*-dominated woodland, *J.A. Elix 20941* & *H. Streimann*, 29.vi.1986 (CANB).

#### Acknowledgements

We thank Prof Dr Klaus Kalb (Neumarkt) for assistance with thin-layer chromatography. H.M. acknowledges financial support from the Austrian Science Fund (FWF-project P8500-BIO), and would like to acknowledge his wife Eleonore for her support during field trips in 1992 and 1993, Hannes Hertel and Rex Filson for their support during field trips in 1985, and Nell Stevens for her support during field trips in 1993.

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Figure 1. *Amandinea montanensis* (holotype in GZU). Scale bar = 2 mm.



Figure 3. *Buellia tropica* (holotype in CANB). Scale bar = 1 mm.



Figure 2. Ascospore ontogeny of *Amandinea montanensis*. Scale bar = 10  $\mu$ m.



Figure 4. Ascospore ontogeny of *Buellia tropica*. Scale bar = 10  $\mu$ m.



Figure 5. *Amandinea manamiana* (H. Mayrhofer 11499 et al. in GZU). Scale bar = 2 mm.



Figure 7. *Gassicurtia elizae* (Y. Asahina s.n. in CANB). Scale bar = 1 mm.



Figure 6. *Buellia macularis* (J.A. Elix 23282 in CANB). Scale bar = 2 mm.

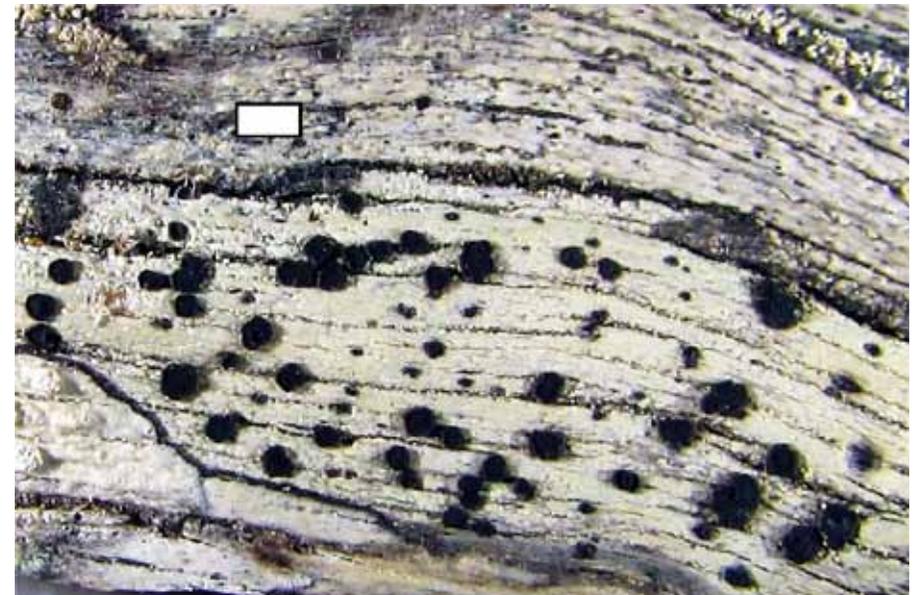


Figure 8. *Gassicurtia rufofuscescens* (J.A. Elix 23282 in CANB). Scale bar = 1 mm.

## *Verrucaria ewersii*, a new calcicolous lichen from South Australia

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### Abstract

*Verrucaria ewersii* P.M. McCarthy (lichenized Ascomycota, Verrucariaceae) is described from mortar in the Adelaide Plains, South Australia. It has a blackish, areolate or subsquamulose thallus with minute, non-involucrellate perithecia, (0.11–)0.17(–0.23) mm wide, a uniformly blackish excipulum and small ascospores (9–15 × 5.5–7 μm).

### Introduction

*Verrucaria sens. lat.*, almost certainly the largest genus of pyrenocarpous lichens, is represented in Australia and its oceanic island territories by 54 known taxa (McCarthy 2012, 2020a), a diversity that is probably less than half of the true number. In this paper, a minute, calcicolous species of *Verrucaria* is described from Dublin, in the Adelaide Plains, South Australia.

*Verrucaria ewersii* P.M. McCarthy, sp. nov.  
MycoBank No.: **MB 839619**

Figs 1 & 2

Characterized by the blackish, corticate, areolate or subsquamulose thallus to 0.1(–0.15) mm thick, minute, non-involucrellate perithecia, 0.11–0.23 mm wide, a uniformly blackish excipulum, 14–40 μm thick, a weakly amyloid hymenial gel, paraphyses 20–30(–35) × 1.5–2 μm, clavate asci 32–42 × 12–17 μm and small ascospores (9–15 × 5.5–7 μm).

*Type:* Australia, South Australia, Lofty North, Dublin, reserve opposite old school and beside oval, 34°27'S, 138°21'E, 700 m alt., on mortar, *W.H. Ewers* 2423, 22.i.1988 (holotype – CANB 774799).

*Thallus* calcicolous, epilithic on mortar but inconspicuous, areolate to subsquamulose (the squamules with slightly raised margins), forming small, scattered or contiguous colonies, primarily greenish black, but with patches of sandy brown to medium greyish green or darker green. *Areoles/squamules* rounded, rounded-irregular or angular, mostly contiguous, occasionally scattered, smooth to minutely uneven, (0.2–)0.3–0.6(–0.8) mm wide, to 0.1(–0.15) mm thick, separated by pale greyish green cracks, corticate. *Cortex* 10–15 μm thick; cells rounded to polygonal, 4–6 μm wide, with rather thick, dark olive-brown walls; cortex subtending an uneven and inconspicuous, hyaline, amorphous, necral layer 5–8 μm thick. *Photobiont cells* dominating the thallus, forming a dense layer to 80(–100) μm deep; cells pale to medium green, unicellular, ± globose, thin- to thick-walled, 6–10(–12) μm diam.; interstitial mycobiont cells parenchymatous, 2–3(–4) μm wide. *Medulla* nondescript, heavily impregnated by substratum material. *Lower cortex* and rhizohyphae absent. *Prothallus* not apparent; hypothallus absent. *Ascomata* perithecia, very numerous (c. 150–250 per square centimetre), usually solitary, occasionally paired or in tight clusters of 3 or 4, mostly 1/3–2/3-immersed in the thallus, (0–)1–4(–7) per areole/squamule, (0.11–)0.17(–0.23) mm wide [*n* = 50], dull black, smooth, sometimes partly overgrown by the thallus, appearing convex, hemispherical, subconical or more irregular in surface view (± round or depressed-ovate when sectioned); perithecial apex rounded or somewhat flattened; ostiole inconspicuous, often in a minute, shallow depression 20–30(–40) μm wide; decayed perithecia leaving shallow depressions in the thallus. *Involucrellum* absent. *Excipulum* (20–)25–35(–40) μm thick near the perithecial apex, dark olive-brown to greenish black, K–, with the cells ellipsoid to globose, thick-walled, 5–8 μm wide; lateral and basal excipular walls greenish black, 14–20(–25) μm thick, the former consisting of periclinal cells 5–9 × 3–5 μm, the base formed of more elongate,

moderately thick-walled, periclinal cells 7–12(–14) × 2–3.5 μm. *Subhymenium* hyaline, 10–20(–25) μm thick. *Paraphyses* absent. *Periphyses* unbranched to sparingly branched, 20–30(–35) × 1.5–2 μm, rather long-celled, with narrow lumina and slightly constricted septa, the end-cells often short and subglobose or narrowly clavate. *Hymenial gel* KI+ deep reddish brown, KI+ medium blue (soon fading to colourless). *Asci* 8-spored, narrowly to broadly clavate, 32–42 × 12–17 μm [*n* = 10], the apex with a thin tholus at maturity, lacking an ocular chamber; ascoplasm I+ orange-brown, KI–. *Ascospores* irregularly biseriolate or massed in the ascus, simple, colourless, narrowly to broadly ellipsoid or oblong-ellipsoid, ± straight, with rounded ends, (9–)13(–15) × (5.5–)6.5(–7) μm [*n* = 30]; wall c. 0.5 μm thick, lacking an epispore; contents clear. *Pycnidia* not seen.

*Etymology:* The species epithet honours Dr William H. (Bill) Ewers (1934–2005), the collector of the type specimen.

### Remarks

The combination of a blackish, areolate or subsquamulose, calcicolous thallus, together with minute, non-involucrellate perithecia with a uniformly blackish excipulum, and small ascospores is diagnostic for *V. ewersii*. *Verrucaria australiensis* P.M. McCarthy, from coastal limestone in south-eastern Australia, has quite similar perithecial morphology and anatomy, but the thallus is endolithic to nondescript and thinly subepilithic, and the perithecia leave pits in the rock following their decay (McCarthy 2012). Another similar species, although one that is known only from consolidated, siliceous soil in south-eastern Australia, viz. *V. kowenensis* P.M. McCarthy, has smaller, simple perithecia, each with a brown-black excipulum apex, but with colourless sides and base, as well as more elongate ascospores, (11–)16(–20) × (5–)6(–7.5) μm (McCarthy 2020b). The almost pantemperate and commonly lichenicolous *V. compacta* (A. Massal.) Jatta has a much thicker thallus, larger perithecia (to 0.3 mm wide) and subglobose or globose ascospores, 8–13 × 8–11 μm (McCarthy 2012). Perhaps the most similar known species is the calcicolous *V. rupicola* (de Lesd.) Breuss, which appears to be endemic to south-western U.S.A. Apart from a very similar thalline and perithecial anatomy, that lichen has a brown thallus and completely immersed perithecia with only the apices visible as black dots (Breuss 2008).

*Verrucaria ewersii* is currently known only from calcareous mortar at the type locality in the Adelaide Plains, South Australia. Associated lichens include *Caloplaca aff. mereschkowskiana* S.Y. Kondr. & Kärnefelt, *Lecania turicensis* (Hepp) Müll. Arg. and *Verrucaria muralis* Ach.

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Fig. 1. *Verrucaria ewersii* (holotype). Scale: 1 mm.

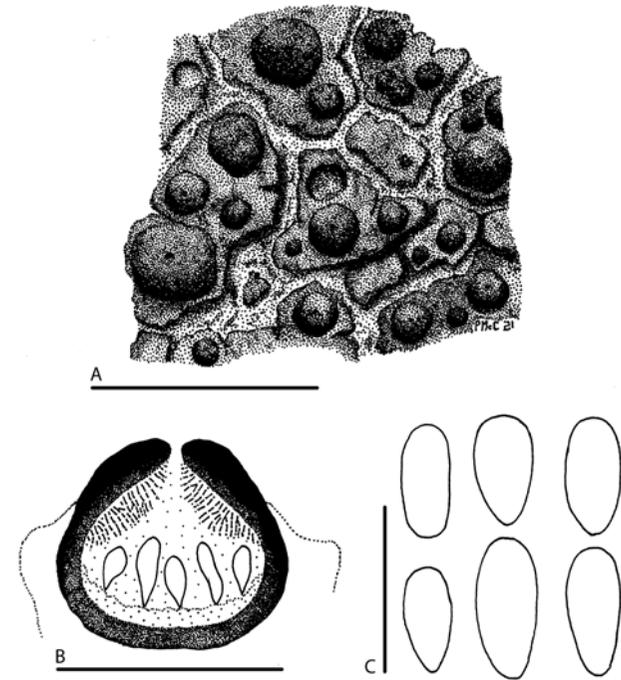


Fig. 2. *Verrucaria ewersii* (holotype). A, Habit of thallus and perithecia; B, Sectioned perithecium (semi-schematic); C, Ascospores. Scales: A = 0.5 mm; B = 0.2 mm; C = 20  $\mu$ m.

## A new species of *Sarcogyne* (Acarosporaceae) on soil in South Australia

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### Abstract

*Sarcogyne humicola* P.M. McCarthy & Elix sp. nov. (Acarosporaceae) is described from siliceous soil in south-eastern South Australia. It has a brown, areolate to subsquamulose thallus with a 3-layered cortex and a thick, continuous algal layer; also dark, adnate, thin-margined apothecia anchored by a thick, colourless stipe growing down from the basal excipulum, and asci containing 50–100(–150) ascospores measuring  $3\text{--}7 \times 2.5\text{--}4 \mu\text{m}$ . An updated key is provided to the 14 species of *Sarcogyne* known from Australia.

### Introduction

This paper is a result of our continuing investigation of the lichen genus *Sarcogyne* Flot. (Acarosporaceae) in Australia (McCarthy & Kantvilas 2013; McCarthy & Elix 2014, 2017a, b, 2020, 2021). The description of *S. humicola* sp. nov. brings to 14 the number of Australian taxa, with six of these occurring on soil. Methods follow those reported in previous contributions.

*Sarcogyne humicola* P.M. McCarthy & Elix, sp. nov.  
Mycobank No.: **MB 840453**

Figs 1, 2

Thallus superficial on siliceous soil, areolate to subsquamulose, 100–200  $\mu\text{m}$  thick, with a 3-layered cortex subtended by a thick, continuous algal layer; attached to the substratum by rhizohyphae. Apothecia very numerous, adnate, 0.34–0.84 mm diam., with a dull dark wine-red disc, a thin, persistent margin that is often paler; the proper excipulum is cupular, predominantly hyaline, its base growing into a thick stipe that anchors the apothecium; epihymenium medium to dark orange-brown; hymenium 80–110  $\mu\text{m}$  thick, not interspersed; paraphyses simple; hypothecium hyaline, 35–60(–75)  $\mu\text{m}$  thick; asci with 50–100(–150) ascospores, these  $3\text{--}7 \times 2.5\text{--}4 \mu\text{m}$ .

*Type:* Australia, South Australia, Mount Lofty Ranges, Guthries Steep Gully, 7 km E of Springton, 34°43'S, 139°09'E, 320 m alt., on consolidated, siliceous soil in pasture with scattered trees and shrubs, *J.A. Elix 26389*, 25.ix.1991 (holotype – CANB).

*Thallus* areolate to subsquamulose, terricolous, superficial, forming continuous colonies to c. 40 mm wide, pale to medium yellowish brown or ochre, to 100–150(–200)  $\mu\text{m}$  thick. *Areoles/squamules* contiguous, concave and with raised margins or plane to slightly convex, 0.3–1 (–1.5) mm wide, mostly angular or irregular, separated by deep, narrow cracks, non-amyloid (I–), not containing calcium oxalate ( $\text{H}_2\text{SO}_4$ –), often almost completely obscured by massed apothecia; surface smooth to minutely and irregular uneven, dull to slightly glossy. *Cortex* clearly delimited in thin section, comprising 3 layers: uppermost *syncortex* hyaline, 12–20 (–25)  $\mu\text{m}$  thick, distally necral and amorphous, grading to paraplectenchymatous below, with the cells thick-walled and lumina rounded to ellipsoid and (1–)2.5–4  $\mu\text{m}$  wide; *eu cortex* with an upper layer 8–15  $\mu\text{m}$  thick, of rounded to vertically elongate, greyish brown to dark brown, moderately thick-walled cells 4–7  $\mu\text{m}$  in maximum extent; this subtended by a layer, 10–15  $\mu\text{m}$  thick, of hyaline, rounded to angular, thin-walled cells 4–6  $\mu\text{m}$  wide; *lateral cortex*, thinner than the upper but similarly tri-layered; lower cortex absent. *Algal layer* occupying most of the thallus, dense, continuous, with an even upper edge, (35–)60–100(–130)  $\mu\text{m}$  thick; cells green,

chlorococcoid, globose, 6–12(–14)  $\mu\text{m}$  wide. *Medulla* usually poorly defined and dominated by soil material, otherwise 20–40  $\mu\text{m}$  thick; hyphae 2–3  $\mu\text{m}$  wide. *Rhizohyphae* long-celled, thin-walled, (2–)3–4(–5)  $\mu\text{m}$  wide, penetrating 0.25 mm or more into the substratum. *Prothallus* and a distinct hypothallus not apparent. *Apothecia* very numerous, lecideine, adnate, solitary or in proliferating clusters, rounded or broadly ellipsoid in outline, (0.34–)0.57(–0.84) mm diam. [ $n = 100$ ], or distorted due to mutual pressure; disc plane to slightly convex at maturity, dull dark wine-red, the colour not changing when wetted, smooth, epruinose; margin c. 50–80  $\mu\text{m}$  thick, entire, slightly to markedly prominent, usually persistent at maturity, concolorous with the disc or somewhat paler and almost similar in colour to the thallus. *Proper excipulum* cupular, 35–50  $\mu\text{m}$  thick laterally, 10–15  $\mu\text{m}$  thick at the base, predominantly hyaline and prosoplectenchymatous except for the outermost zone of the lateral excipulum which is dark brown (K+ intensifying reddish brown, N+ paler brown), 12–15  $\mu\text{m}$  thick, with radiating, thick-walled cells  $5\text{--}8 \times 3\text{--}5 \mu\text{m}$ , these subtended by roundish or moniliform, radiating, hyaline cells  $4\text{--}6 \times 3\text{--}4 \mu\text{m}$ , and in turn by the narrow, periclinal cells of the tightly packed excipulum base,  $6\text{--}10 \times 1\text{--}2 \mu\text{m}$ . *Apothecial stipe* wedge-like, growing down from the centre of the basal excipulum and penetrating almost to the substratum, 120–200  $\mu\text{m}$  wide, hyaline, of thick-walled, long-celled hyphae 2.5–4  $\mu\text{m}$  wide. *Hypothecium* hyaline, 35–60(–75)  $\mu\text{m}$  thick, hyaline to very pale yellowish brown, not interspersed with granules or oil droplets, KI–, K– (but a minutely granular substance becoming visible), N–, of variously orientated and comparatively thick-walled hyphae 1–2  $\mu\text{m}$  wide. *Hymenium* 80–110  $\mu\text{m}$  thick, not interspersed; hymenial gel KI+ pale to deep blue, K–, N–. *Epihymenium* medium to dark orange-brown, 12–20  $\mu\text{m}$  thick, K+ paler orange-brown and diffuse, N–. *Paraphyses* simple, tightly conglutinate in water and K, long-celled, 1–1.5(–2)  $\mu\text{m}$  wide, not constricted at the septa; contents clear to minutely guttulate; apices slightly swollen (c. 2.5  $\mu\text{m}$  wide). *Asci* narrowly to broadly clavate or clavate-cylindrical, containing 50–100(–150) ascospores,  $58\text{--}88(100) \times 12\text{--}18 \mu\text{m}$  [ $n = 12$ ], with a tapering stalk; apex rounded, with a uniformly lightly amyloid tholus to 5  $\mu\text{m}$  thick; ocular chamber low-convex or not apparent. *Ascospores* colourless, simple, narrowly to broadly ellipsoid or subglobose, lacking a perispore,  $(3\text{--})4\text{--}6(7) \times 2.5\text{--}3.5(4) \mu\text{m}$  [ $n = 50$ ]; spore contents usually clear. *Pycnidia* not seen. *Chemistry:* No substances detected by TLC (Elix 2020).

*Etymology:* The epithet *humicola* (L., ground-loving) refers to the occurrence of the new species on soil.

### Remarks

The new species is characterized by the superficial, areolate to subsquamulose thallus on siliceous soil, a distinct, 3-layered cortex that is subtended by a thick, continuous algal layer, very numerous, adnate apothecia with a dull dark wine-red disc, an often paler, thin and persistent margin, the hyaline hypothecium and predominantly hyaline proper excipulum and stipe, along with asci containing 50–100(–150) ascospores that are  $3\text{--}7 \times 2.5\text{--}4 \mu\text{m}$ . This suite of characters sets it apart from the five other terricolous Australian species of *Sarcogyne* (see key below), as well as the five extra-Australian taxa known from soil, as follows.

*Sarcogyne crustacea* K.Knudsen & Kocourk., from soil in south-western U.S.A., has a pale, pseudoareolate thallus that is also truly corticate, sessile apothecia 0.4–1.5 mm wide, with a flexuose margin at maturity, branching paraphyses and ascospores c. 1.5–2  $\mu\text{m}$  wide. (Knudsen & Kocourková 2010).

*Sarcogyne brunnea* K.Knudsen & Flakus, a corticate species from the Andes in Bolivia and Ecuador, has pruinose brownish areoles, an algal layer interrupted by hyphal bundles, immersed apothecia less than 0.6 mm diam. and a hymenium 100–200  $\mu\text{m}$  tall (Knudsen *et al.* 2012).

*Sarcogyne terrena* H.Magn., from Brazil, has apothecia to 0.3 mm wide with a punctiform disc, a hymenium 100–150  $\mu\text{m}$  tall, a very thin hypothecium, branching paraphyses and ascospores c. 1.5  $\mu\text{m}$  wide (Knudsen *et al.* 2012).

*Sarcogyne mitziae* K.Knudsen, Kocourk. & McCune occurs on soil in western North

America. It has a complex corticate thallus as in *S. humicola* (not just an alga-free uppermost layer); however, the apothecia are only 0.2–0.5 mm diam., with discs that turn orange when wetted, and an inspersed hymenium (Knudsen *et al.* 2013).

*Sarcogyne arenosa* (Herre) K. Knudsen & Standley, an occasional colonizer of soil in south-western U.S.A., has a thin, pale areolate thallus ± lacking a cortex, large sessile apothecia and ascospores 1–1.5 µm wide (Knudsen & Standley 2008).

*Sarcogyne humicola* is known only from consolidated, siliceous soil at the type locality in south-eastern South Australia. Associated terricolous species include *Diploschistes hensseniae* Lumbsch & Elix, *Heterodea muelleri* (Hampe) Nyl., *Psora crystallifera* (Taylor) Müll. Arg., *P. decipiens* (Hedw.) Hoffm., *Xanthoparmelia amphixantha* (Müll. Arg.) Hale and *X. pseudoamphixantha* (Elix) Elix & J. Johnst.

#### Key to the Australian species of *Sarcogyne*

- 1 Thallus growing on soil..... 2
- 1: Thallus growing on rock..... 7
- 2 Thallus yellow-green, containing rhizocarpic acid..... *S. tholifera*
- 2: Thallus shades of grey, green or brown, not yellowish, lacking lichen substances..... 3
- 3 Apothecia 0.15–0.45(–0.58) mm diam.; hymenium 150–330 µm thick..... 4
- 3: Apothecia 0.28–0.8(–1.1) mm diam.; hymenium 80–140 µm thick ..... 5
- 4 Thallus off-white to pale greenish grey; apothecia subtended by a continuous algal layer, and with a lightly pruinose disc; proper excipulum colourless at the sides and base; ascospores (3–)5(–7.5) µm long..... *S. porphyricola*
- 4: Thallus pale greyish brown or pale to medium sandy brown; apothecia subtended by a discontinuous algal layer, and with an epruinose disc; proper excipulum mostly medium to dark brown or brown-black at the sides and base; ascospores (2–)3(–4) µm long..... *S. terrulenta*
- 5 Thallus areolate to subsquamulose, with a well-defined, 3-layered cortex; ascospores 50–100(–150) per ascus and 3–7 × 2.5–4 µm..... *S. humicola*
- 5: Thallus crustose and inconspicuous to pseudoareolate, ecorticate or with a thin, poorly defined cortex; ascospores *c.* 150–200 per ascus and 2–5(–6) × 1.5–2.5(–3) µm..... 6
- 6 Epithymenium dark olive-brown to green-black, coarsely uneven in section, 18–50 µm thick; excipulum base brown-black, to 80(–100) µm thick in the centre..... *S. regalis*
- 6: Epithymenium pale brown to medium orange-brown or dark reddish brown, 8–15 µm thick; excipulum base colourless, 10–15(–20) µm thick..... *S. molongloensis*
- 7 Excipulum carbonized ..... 8
- 7: Excipulum not carbonized ..... 9
- 8 Apothecia 0.4–1 mm diam.; margin entire; hypothecium colourless to pale brown..... *S. hypophaea*
- 8: Apothecia 1–3(–6) mm diam.; margin crenulate; hypothecium medium to dark brown..... *S. clavus*
- 9 Thallus on calcareous rocks ..... 10
- 9: Thallus on siliceous rocks..... 12
- 10 Apothecia 0.4–1.2 mm diam.; disc usually white- to blue-grey-pruinose, plane to convex..... *S. regularis*
- 10: Apothecia 0.15–0.5 mm diam.; disc epruinose, deeply concave to plane..... 11

- 11 Apothecia immersed, often leaving pits in the substratum; ascospores 3–6 × 1.5–2.5 µm, *c.* 150–200 per ascus; hypothecium 30–80 µm thick..... *S. meridionalis*
- 11: Apothecia mostly adnate, not leaving pits; ascospores 4–8.5 × 2.5–5 µm, *c.* 80–150 per ascus; hypothecium 10–35 µm thick..... *S. canberrensis*
- 12 Ascospores 6–9.5 µm long, *c.* 40–60(–80) per ascus; thallus containing sekikaic acid; apothecia usually white-pruinose..... *S. sekikaica*
- 12: Ascospores 2.5–5.5(–7) µm long, *c.* (100–)150–180(–250) per ascus; thallus lacking secondary substances; apothecia epruinose..... 13
- 13 Thallus whitish, diffuse, 15–25 µm thick; apothecia usually moderately to markedly convex or subglobose and then strongly constricted at the base..... *S. iridana*
- 13: Thallus pale greenish or pale brown to medium or dark greenish grey, forming substantial colonies that are rimose to areolate and 60–200(–250) µm thick; apothecia innate to adnate, slightly concave to plane or slightly convex, never constricted at the base..... 14
- 14 Apothecia (0.23–)0.4(–0.55) mm diam.; margin 50–70(–80) µm thick, slightly or markedly paler than the disc; proper excipulum annular; hymenium 80–100 µm thick; asci with *c.* 100–150 ascospores, 55–80 µm long..... *S. maritima*
- 14: Apothecia (0.28–)0.65(–1.1) mm diam.; margin *c.* 30–50 µm thick, concolorous with the disc; proper excipulum cupulate; hymenium 100–140 µm thick; asci with *c.* 150–200 ascospores, 65–105 µm long..... *S. molongloensis*

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Fig. 1. *Sarcogyne humicola* (holotype). Scale: 1 mm.

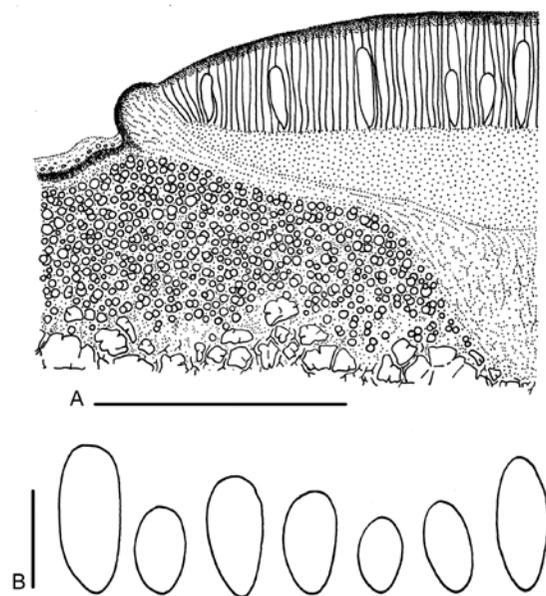


Fig. 2. *Sarcogyne humicola* (holotype). A, Vertical section of part of an apothecium and the adjacent thallus (semi-schematic); B, Ascospores. Scales: A = 0.2 mm; B = 5  $\mu$ m.

**A new species of buellioid lichen (Caliciaceae, Ascomycota) from Otago, South Island, New Zealand**

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**Abstract**

*Buellia springvalensis* Elix & A.Knight is described as new to science. It occurs on quartz pebbles in the saline Springvale Scientific Reserve in Central Otago, South Island, New Zealand, and is characterized by small, *Buellia*-type ascospores, an aeruginose epihymenium and the presence of psoromic acid.

**Introduction**

This paper continues our investigation of *Buellia*-like lichens in New Zealand. For the more recent additions, see Blaha *et al.* (2016), Elix & Mayrhofer (2016, 2017, 2018, 2021), Elix *et al.* (2017), Elix & Knight (2017) and references cited therein. In this paper, we describe a new species of *Buellia* in the broad sense. Methods are as described in the papers cited above.

**The new species**

***Buellia springvalensis*** Elix & A.Knight, sp. nov.  
MycoBank No.: **MB 840261**

Fig. 1

Similar to *Buellia macularis* Zahlbr., but differs in having smaller ascospores, 10–[11.8]–16  $\times$  5–[6.5]–9  $\mu$ m, and in containing psoromic acid rather than norstictic acid.

*Type:* New Zealand, South Island, Otago, Springvale Scientific Reserve, 45°12'18"S, 169°12'08"E, 180 m alt., on quartz pebbles on Miocene mudstone, *A. Knight s.n.*, 9.xii.2020 (holotype – OTA 071080; isotype – CANB).

*Thallus* crustose, to 20 mm wide and 0.2 mm thick, rimose to rimose-areolate; areoles 0.2–0.5 mm wide, rounded, flat or weakly convex, contiguous; upper surface grey-white to pale yellow-grey, dull, often roughened; prothallus usually conspicuous, black, surrounding the thallus, sometimes stellate-fimbriate, to 0.5 mm wide; medulla white, lacking calcium oxalate ( $H_2SO_4^-$ ), I–; photobiont cells 7–14  $\mu$ m wide. *Apothecia* 0.1–0.5 mm wide, lecidine, immersed, then adnate to sessile; disc black, flat to weakly convex, epruinose. *Excipulum* distinct, persistent, cupuliform, in section 25–70  $\mu$ m thick, the outer zone greenish black to brown-black, K–, N+ red-violet or red-brown, the inner zone pale brown. *Epihymenium* 8–12  $\mu$ m thick, dark brown to aeruginose, K–, N+ red-violet. *Hypothecium* 60–80  $\mu$ m thick, pale brown to chestnut-brown. *Hymenium* 50–65  $\mu$ m thick, colourless, not interspersed. *Paraphyses* 1.5–2  $\mu$ m wide, simple to moderately branched, with apices 5–6  $\mu$ m wide and aeruginose-brown caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* *Buellia*-type, 1-septate, olive-brown to brown, broadly ellipsoid, 10–[11.8]–15  $\times$  5–[6.5]–9  $\mu$ m, rarely constricted at the septum, with obtuse ends, uniformly thin-walled; outer spore-wall microrugulate. *Pycnidia* rare, immersed, urceolate to globose. *Conidia* bacilliform, 3–5  $\times$  0.7–1  $\mu$ m.

*Chemistry:* Thallus K+ yellow, P+ yellow, C–, UV–; containing psoromic acid [major].

*Etymology:* The species is named after the type locality.

## Remarks

*Buellia springvalensis* is characterized by the crustose, grey-white to pale yellow-grey, rimose to rimose-areolate thallus, often with a roughened upper surface, by the immersed to sessile, lecideine apothecia, the fimbriate-stellate, black prothallus, a non-amyloid medulla, the aeruginose, N+ red-violet epihymenium, the *Buellia*-type ascospores,  $10\text{--}15 \times 5\text{--}9 \mu\text{m}$ , bacilliform conidia,  $3\text{--}5 \mu\text{m}$  long, and the presence of psoromic acid. It superficially resembles *B. macularis*, but that species differs in having larger ascospores,  $12\text{--}18 \times 8\text{--}10 \mu\text{m}$ , longer conidia,  $5\text{--}7 \mu\text{m}$  long, and in containing norstictic acid. *Buellia springvalensis* also resembles the Australian *B. cravenii* Elix, a species with an aeruginose, N+ red-violet epihymenium and containing psoromic acid. However, *B. cravenii* has longer ascospores,  $12\text{--}[14.3]\text{--}19 \mu\text{m}$  long, and contains atranorin (Elix 2020).

The new species is known only from the type locality, where it is locally common on exposed quartz pebbles. Associated lichens include *Buellia macularis* and *Xanthoparmelia subprolixa* (Nyl. ex Kremp.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch.

## Acknowledgements

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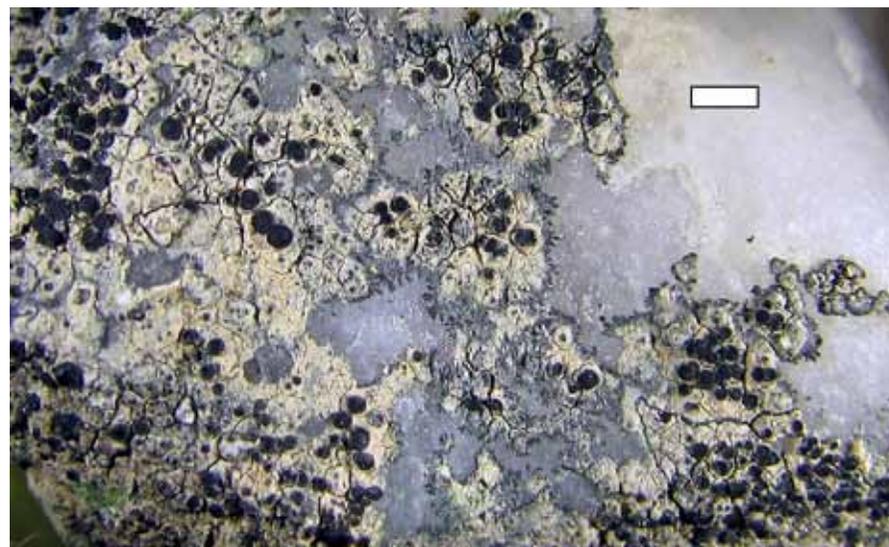


Fig. 1. *Buellia springvalensis* (A. Knight s.n., OTA 071080). Scale = 1 mm.

## Two new records and a revised key to the saxicolous species of *Rinodina* in Australia

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### Abstract

*Rinodina herteliana* Kaschik and *R. teichophiloides* (Stizenb.) Zahlbr. are reported for the first time from Australia, while *R. argopsina* Elix & P.M. McCarthy is shown to be a synonym of *R. thiomela* Müll. Arg. An updated key to the saxicolous Australian species of *Rinodina* is provided.

### Introduction

The saxicolous species of *Rinodina* (Ach.) S.F. Gray in Australia are relatively well known following the initial treatment by Mayrhofer (1984), further additions by Mayrhofer *et al.* (1990), Matzer & Mayrhofer (1994), Matzer *et al.* (1998) and Trinkaus *et al.* (1999), and the more recent revisions by Kaschik (2006) and Elix (2011), as well as the recognition of four additional species (Elix & Giralt 2015; Mayrhofer & Elix 2018; Elix *et al.* 2019; Grube *et al.* 2019). This note documents the recent discovery of *R. herteliana* growing on siliceous rocks in Victoria, a species previously known from the South Island of New Zealand (Kaschik 2006), and *R. teichophiloides* growing on siliceous rocks in south-eastern Australia, previously known from similar substrata in South Africa (Matzer & Mayrhofer 1994, 1996).

### New records

#### 1. *Rinodina herteliana* Kaschik, *Biblioth. Lichenol.* **93**, 57 (2006)

Figs 1, 2

*Type*: New Zealand, South Island, summit of Silver Peak (Pulpit Rock), W of Watati, 45°45'S, 170°26'30"E, 750–760 m alt., on schist, *H. Mayrhofer 13473*, *H. Hertel & G.T. Baylis*, 29.i.1985 (holotype – GZU, not seen).

*Thallus* to 50 mm wide and 0.5 mm thick, crustose, immersed or rimose-areolate or verrucose-areolate; individual areoles 0.1–0.3 mm wide, to 0.15 mm thick; upper surface olive-brown to grey-brown or yellow-brown, ± granular; prothallus not apparent; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-; photobiont cells 7–12 µm in diam. *Apothecia* 0.2–0.8 mm wide, scattered or crowded, pseudolecanorine to lecideine, broadly adnate to sessile; disc black, epruinose, plane to weakly convex; thalline exciple raised above the disc at first, becoming thinner and excluded in older apothecia. *Proper excipulum* dark brown, persistent, in section 20–30 µm thick, outer zone dark brown, K+ red, N+ orange, inner zone paler brown. *Ephymenium* 10–20 µm thick, brown, K-, N-. *Hypothecium* 70–80 µm thick, colourless, interspersed with oil droplets, K-. *Hymenium* 75–100 µm thick, colourless, not interspersed. *Paraphyses* 1.5–2 µm wide, simple to branched, capitate, the apices 3–4 µm wide with brown caps. *Asci* *Lecanora*-type, 8-spored. *Ascospores* *Physcia*-type transitioning into *Mischoblastia*- and *Pachysporaria*-types, 1-septate, brown, broadly ellipsoid, 15–[19.7]–23 × 8–[12.1]–14 µm, torus ± well developed; ontogeny of type-A; outer spore-wall finely ornamented. *Pycnidia* pyriform, immersed, brown to brown-black; conidia bacilliform, 4–5 × 1–1.5 µm. *Chemistry*: Thallus K-, C-, KC-, P-, UV-; proper excipulum K+ red; containing cinnamomeic acid C (major).

### Remarks

This species was known previously from the South Island of New Zealand (Kaschik 2006). It is characterized by the immersed to superficial, olive-brown to grey-brown or yellow-brown crustose thallus, the pseudolecanorine to lecideine apothecia, a dark brown,

K+ red excipulum, *Physcia*-type ascospores transitioning into *Mischoblastia*- and *Pachysporaria*-types, 15–23 × 8–14 µm, and the presence of cinnamomeic acid C.

### SPECIMEN EXAMINED

*Victoria*: ● Trentham Falls, c. 20 km E of Daylesford, NE of Melbourne, 37°23'S, 144°19'30"E, 450 m alt., on rock outcrops in gorge N of falls, *J. Hafellner 15743a* & *R. Filson*, 18.vii.1986 (GZU).

#### 2. *Rinodina teichophiloides* (Stizenb.) Zahlbr., *Cat. Lich. Univ.* **7**, 557 (1931) Figs 3, 4 *Lecanora teichophiloides* Stizenb., *Bericht über die Thätigkeit der St. Gallischen Naturwissenschaftlichen Gesellschaft* **1888/1889**, 212 (1890).

*Type*: South Africa, Western Cape, supra saxa quartzosa ad Muizenberg in Promontorio Bonae Spei, *MacOwan 126* (holotype – ZT, not seen).

*Thallus* to 65 mm wide and 0.5 mm thick, crustose and rimose-areolate or subsquamulose; individual areoles 0.2–1 mm wide, to 0.5 mm thick, contiguous or dispersed; upper surface matt, smooth, esorediate, pale grey to yellow-brown, grey-brown or dark brown; prothallus marginal, brown or not apparent; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-; photobiont cells 10–16 µm in diam. *Apothecia* 0.2–0.8 mm wide, scattered, lecanorine to cryptolecanorine, immersed to broadly adnate; disc brown to black, epruinose, plane to weakly convex; thalline exciple raised above the disc at first, becoming thinner and excluded in older apothecia. *Proper excipulum* greenish black, persistent, in section 25–35 µm thick, outer zone dark brown to aeruginose, N- or N+ purple-brown, inner zone paler brown. *Ephymenium* 10–30 µm thick, dark brown, K-, N-. *Hypothecium* 100–150 µm thick, colourless to pale yellow or yellow-brown, K+ yellow solution or K-. *Hymenium* 90–130 µm thick, colourless, not interspersed. *Paraphyses* 1.5–2 µm wide, simple to branched, capitate, with apices 3–5 µm wide and brown caps, with scattered oil paraphyses 4–6 µm wide. *Asci* *Lecanora*-type, 2–8-spored. *Ascospores* *Teichophila*-type (with internal wall thickenings transitioning from *Pachysporaria*- to *Milvina*- or *Mischoblastia*-types at different stages of development), 1-septate, brown, broadly ellipsoid, (17–)20–[25.1]–32 × 10–[13.9]–18 µm, often dilated at the septum, torus absent; ontogeny of type-A; outer spore-wall finely ornamented. *Pycnidia* pyriform, immersed, brown to brown-black; conidia bacilliform, 4–5 × 1–1.5 µm. *Chemistry*: Thallus K-, C-, KC-, P-, UV-; no lichen substances detected by TLC.

### Remarks

In many respects this species closely resembles *R. reagens* Matzer & H. Mayrhofer. Both have immersed to adnate, lecanorine to cryptolecanorine apothecia, similar-sized ascospores and ascospore ontogeny, and they lack lichen substances. However, *R. reagens* invariably contains a yellow-green hypothecial pigment that yields a K+ yellow to orange solution, and it is restricted to calcareous substrata (Matzer & Mayrhofer 1994, 1996). The differentiation of *R. teichophiloides* from the related Northern Hemisphere *R. teiochophila* (Nyl.) Arnold has been discussed in detail by Matzer & Mayrhofer (1994).

### SPECIMENS EXAMINED

*New South Wales*: ● Tinderry Mountains, 5 km S of Tinderry Peak, 35°44'S, 149°17'E, 1215 m alt., on granite rocks in dry sclerophyll forest, *J.A. Elix 5464*, 12.xi.1978 (CANB).

*Australian Capital Territory*: ● Along the Molonglo River, 0.5 km W of Coppins Crossing, 8.5 km W of Canberra, 35°17'17"S, 149°01'58"E, 530 m alt., on porphyry rock outcrops in pasture, *P.M. McCarthy 4847*, 30.i.2019 (CANB); ● Kowen Road, Kowen Forest, 11.7 km E of Canberra, 35°19'02"S, 149°15'07"E, 700 m alt., on sandstone rocks in open *Eucalyptus* woodland, *P.M. McCarthy 4862*, 31.vii.2019 (CANB).

*Tasmania*: ● N end of Godfreys Beach, Stanley, 40°45'S, 145°18'E, 1 m alt., on seashore basalt rocks, *G. Kantvilas 169/19*, 13.v.2019 (HO).

**A new synonym**

**Rinodina thiomela** (Nyl.) Müll.Arg., *Flora* **64**, 515 (1881)

Synonym: *Rinodina argopsina* Elix & P.M.McCarthy, in Elix *et al.*, *Australas. Lichenol.* **84**, 10 (2019).

**Remarks**

*Rinodina argopsina* Elix & P.M.McCarthy was recently described as being characterized by a crustose, pale whitish green to yellow-green thallus, lecanorine apothecia, 0.2–0.7 mm wide, 1-septate, olive-brown then brown, ellipsoid, *Teichophila*-type ascospores (with internal wall thickenings grading from *Pachysporaria*-type to *Milvina*-, *Physcia*- and *Mischoblastia*-types at different stages of development), 18–30 × 10–17 µm, and the presence of argopsin, zeorin and traces of thiomelin (Elix *et al.* 2019). The reported occurrence of argopsin in this specimen was erroneous, because in fact it came from a co-occurring *Lecidella* species and is absent in uncontaminated *Rinodina* specimens. As a consequence, the morphology, anatomy and chemistry of the type specimen of *R. argopsina* are consistent with those of *R. thiomela*.

**Key to Australian species of *Rinodina* growing on rocks or on saxicolous lichens**

[for illustrations of spore types and ontogeny see Kaschik (2006) and Sheard (2010)]

- 1 Thallus lichenicolous ..... 2
- 1: Thallus autonomous ..... 3
- 2 Ascospores 18–25 × 11–15 µm, *Milvina*-type ..... **R. milvinodes**
- 2: Ascospores 13–21 × 7–12 µm, *Pachysporaria*-type ..... **R. williamsii**
- 3 Thallus yellow or yellow-grey; ascospores *Teichophila*-type ..... 4
- 3: Thallus grey or brown; ascospores various ..... 8
- 4 Hypothecium brown to deep yellow-brown; 6-*O*-methylarthothelin present ..... **R. michaelae**
- 4: Hypothecium colourless to pale yellow-brown; arthothelin and/or thiomelin present... 5
- 5 Thiomelin (major) present; arthothelin absent ..... 6
- 5: Arthothelin (major) present; thiomelin present in minor or trace amounts ..... 7
- 6 Apothecia immersed; ascospores 14–21 × 7–11 µm; subtropical to mainly tropical ..... **R. xanthomelana**
- 6: Apothecia adnate to sessile at maturity; ascospores 20–34 × 11–17 µm; mainly temperate to subtropical ..... **R. thiomela**
- 7 2,5-Dichlorolichexanthone, 4,5-dichlorolichexanthone ± lichexanthone present; ascospores 10–14 µm wide ..... **R. tenniswoodiorum**
- 7: Dichlorolichexanthenes and lichexanthone absent; ascospores 11–20 µm wide ..... **R. arthomelina**
- 8 Thallus on calcareous rocks ..... 9
- 8: Thallus on siliceous rocks ..... 13
- 9 Apothecia immersed; hymenium not inspersioned with oil droplets ..... **R. immersa**
- 9: Apothecia not immersed; hymenium inspersioned with oil droplets or not ..... 10
- 10 Ascospores *Bischoffii*-type; hymenium usually inspersioned with oil droplets ..... **R. bischoffii**
- 10: Ascospores not *Bischoffii*-type; hymenium not inspersioned ..... 11

- 11 Ascospores *Bicincta*-type ..... **R. luridata**
- 11: Ascospores not *Bicincta*-type ..... 12
- 12 Ascospores *Teichophila*-type; spore walls finely scabrid ..... **R. reagens**
- 12: Ascospores *Tunicata*-type; spore walls striate ..... **R. stratunicata**
- 13 Excipulum K+ red or violet; cinnamomeic acid C present ..... **R. herteliana**
- 13: Excipulum K–; cinnamomeic acid C absent ..... 14
- 14 Thallus K+ yellow; atranorin present ..... 15
- 14: Thallus K– or endolithic; atranorin absent ..... 22
- 15 Ascospores *Physcia*- or *Milvina*-type transitioning to *Physcia*-type ..... 16
- 15: Ascospores not *Physcia*-type or *Milvina*-type transitioning to *Physcia*-type ..... 18
- 16 Ascospores 11–16 × 5–9 µm ..... **R. occulta**
- 16: Ascospores 15–27 × 8–13 µm ..... 17
- 17 Ascospores *Physcia*-type, 15–27 × 8–13 µm; pannarin absent ..... **R. confragosa**
- 17: Ascospores *Milvina*-type transitioning to *Physcia*-type, 16–22 × 10–13 µm; pannarin present ..... **R. murrayi**
- 18 Ascospores *Pachysporaria*-type transitioning to *Milvina*-type, 14–20 × 7–12 µm ..... **R. substellulata**
- 18: Ascospores *Mischoblastia*-type transitioning to *Pachysporaria* and *Physcia*-types... 19
- 19 Apothecia lecanorine ..... 20
- 19: Apothecia lecideine to pseudolecanorine (or rarely lecanorine) ..... 21
- 20 Ascospores 15–21 × 9–11 µm; gyrophoric acid present ..... **R. gyrophorica**
- 20: Ascospores 18–27 × 10–15 µm; gyrophoric acid absent... **R. moziana** var. **moziana**
- 21 Excipulum containing an aeruginose, N+ red or purple pigment ..... **R. oxydata**
- 21: Excipulum lacking an aeruginose, N+ red or purple pigment ..... **R. oxydatella**
- 22 Thallus isidiate or blastidiate ..... 23
- 22: Thallus not blastidiate or isidiate ..... 24
- 23 Thallus isidiate ..... **R. austroisidiata**
- 23: Thallus blastidiate ..... **R. blastidiata**
- 24 Ascospores *Dirinaria*-type transitioning to *Physconia*-type, 11–19 × 6–11 µm... **R. oleae**
- 24: Ascospores not *Dirinaria*-type transitioning to *Physconia*-type ..... 25
- 25 Ascospores *Physconia*-type, 12–27 × 8–15 µm; medulla yellow-orange, K+ red in part; skyrin present ..... **R. peloleuca**
- 25: Ascospores not *Physconia*-type; medulla white; skyrin absent ..... 26
- 26 Ascospores *Physcia*- or *Physcia*-type transitioning to *Milvina*-type ..... 27
- 26: Ascospores *Pachysporaria*-, *Teichophila*- or *Tunicata*-type ..... 28
- 27 Ascospores *Physcia*-type, 21–28 × 10–16 µm ..... **R. subcrustacea**
- 27: Ascospores *Physcia*-type transitioning to *Milvina*-type, 15–23 × 7–13 µm ..... **R. cacaotina**

28	Ascospores <i>Tunicata</i> -type (double-walled).....	29
28:	Ascospores <i>Teichophila</i> - or <i>Pachysporaria</i> -type .....	30
29	Internal wall-thickenings <i>Physcia</i> - to <i>Mischoblastia</i> -type; spore-wall striate .....	
	..... <b>R. straitunicata</b>	
29:	Internal wall-thickenings <i>Pachysporaria</i> - to <i>Milvina</i> -type; spore-wall microrugulate .....	
	..... <b>R. confragosula</b>	
30	Ascospores <i>Pachysporaria</i> -type, 17–27 $\mu\text{m}$ long .....	<b>R. ramboldii</b>
30:	Ascospores <i>Pachysporaria</i> - transitioning to <i>Milvina</i> -type, or <i>Mischoblastia</i> - transitioning to <i>Pachysporaria</i> - or <i>Physcia</i> -type .....	31
31	Ascospores <i>Pachysporaria</i> -type transitioning to <i>Milvina</i> -type, 13–21 $\times$ 7–12 $\mu\text{m}$ .....	
	..... <b>R. williamsii</b>	
31:	Ascospores <i>Mischoblastia</i> -type transitioning to <i>Pachysporaria</i> - or <i>Physcia</i> -type.....	32
32	Ascospores 20–32 $\times$ 10–18 $\mu\text{m}$ .....	<b>R. teichophiloides</b>
32:	Ascospores 16–23 $\times$ 9–13 $\mu\text{m}$ .....	<b>R. cana</b>

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Figure 1. *R. herteliana* (Elix 20688 in CANB). Scale bar = 1 mm.

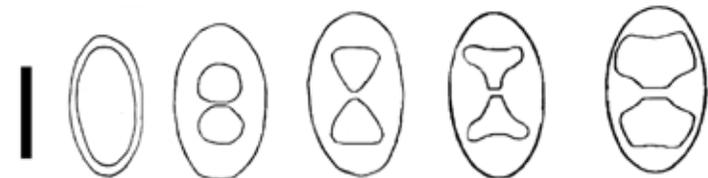


Figure 2. Ascospore ontogeny of *R. herteliana*. Scale bar = 10  $\mu\text{m}$ .

**Two new species of buellioid lichens  
(Caliciaceae, Ascomycota) from South Africa**

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**Abstract**

*Buellia magaliesbergensis* Elix & H.Mayrhofer and *B. subeffigurata* Elix, H.Mayrhofer & Wetschnig, from South Africa, are described as new to science.

**Introduction**

Although the biodiversity of microlichens in southern Africa is not particularly well documented, in recent times the region has proved to be a rich source of crustose Caliciaceae (Bungartz & Wirth 2007; Wirth & Bungartz 2009; Wirth 2010; Fryday *et al* 2020; Elix *et al.* 2021). In this paper, we describe two new saxicolous species of *Buellia* in the broad sense from South Africa.

**Methods**

Observations and measurements of photobiont cells, thallus and apothecium anatomy, asci, ascospores and pycnidia were made on hand-cut sections mounted in water and 10% KOH (K). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K. Medullary sections were treated with 10% sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) and apothecial sections with 50% nitric acid (N). Chemical constituents were identified by thin-layer chromatography (Elix 2020) and comparison with authentic samples.

**New species**

**1. *Buellia magaliesbergensis* Elix & H.Mayrhofer, sp. nov.**  
Mycobank No.: **MB 839188**

Fig. 1

Similar to *Buellia spuria* (Schaer.) Anzi, but differs in having cryptolecanorine then lecideine apothecia with grey-pruinose discs, and by the absence of atranorin.

*Type*: Republic of South Africa, Orange Free State, Magaliesberg Range, W of Pretoria, Breedsnek, slopes c. 50 m W of summit, 1720 m alt., 25°52'S, 27°26'E, on stones on the ground, *D. Triebel & G. Rambold 8689*, 13.iv.1990 (holotype – M).

*Thallus* crustose, to 25 mm wide and 0.5 mm thick, rimose-areolate, chinky; areoles rounded to irregular, 0.2–1 mm wide, crowded and contiguous; upper surface off-white, dull to shiny, smooth, convex, epruinose; prothallus black and between areoles or not apparent; photobiont cells 6–24 µm wide; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub><sup>-</sup>), I+ purple-blue. *Apothecia* 0.2–0.6 mm wide, cryptolecanorine but ultimately lecideine, separate and ± round, immersed to just adnate; disc black, grey-pruinose at first then epruinose, plane to convex with age. *Excipulum* distinct, thin, excluded in older, convex apothecia, in section 25–35 µm thick; outer part aeruginose-dark brown or brown-black, K+ red crystals, N+ purple-brown, brown within. *Hypothecium* 50–70 µm thick, pale red-brown merging with the darker brown, central stipe. *Epithemium* 8–12 µm thick, dark olive-brown to dark brown or aeruginose-black, K+ blue-green, N+ weak purple-brown. *Hymenium* 60–80 µm thick, colourless, not interspersed; subhymenium c. 20 µm thick, pale brown, not interspersed. *Paraphyses* 1–2 µm wide, simple to

sparsely branched, the apices 3.5–4.5 µm wide with brown caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* *Buellia*-type, 1-septate, brown, ellipsoid, 10–[13.4]–16 × 5–[5.9]–7 µm, becoming constricted at the septum, often curved; outer spore-wall finely ornamented (microrugulate). *Pycnidia* common, black, immersed, punctiform. *Conidia* bacilliform to elongate-ellipsoid, 5–7 × 1–1.5 µm.

*Chemistry*: Thallus K+ yellow, P+ yellow-orange, C–, UV–; containing norstictic acid (major), conorstictic acid (minor).

*Etymology*: The species is named after the type locality.

**Remarks**

This species is characterized by the crustose, off-white rimose-areolate thallus with cryptolecanorine then lecideine apothecia with grey-pruinose discs, the amyloid medulla, partially aeruginose, N+ purple-brown excipulum and epithemium, a non-interspersed hymenium, the ellipsoid, 1-septate, *Buellia*-type ascospores, 10–16 × 5–7 µm, and the presence of norstictic acid. *Buellia spuria*, a relatively common South African species, is similar in having *Buellia*-type ascospores of ± the same size and an amyloid medulla, but it differs in having lecideine apothecia with epruinose discs, and it contains additional atranorin (Bungartz *et al.* 2007; Elix 2011).

*Buellia magaliesbergensis* is known only from the type locality, where it co-occurs with a *Caloplaca* and several *Xanthoparmelia* species.

**2. *Buellia subeffigurata* Elix, H.Mayrhofer & Wetschnig, sp. nov.**  
Mycobank No.: **MB 839189**

Figs 2, 3

Similar to *Buellia halonia* (Ach.) Tuck., but differs in having a subsquamulose thallus with placodioid, subeffigurate margins, larger ascospores, 12–21 × 7–13 µm, and in containing thiophanic acid.

*Type*: Republic of South Africa, Northern Cape Province, Namaqualand, Knersvlakte, c. 25 km N of Vanrhynsdorp, in the direction of “Douse the Glim”, [SA-Grid: 3118BC], 31°23'S, 18°42'E, 150 m alt., on quartziferous rock, *W. & U. Wetschnig s.n.*, 2.x.1987 (holotype – GZU).

*Thallus* verrucose-areolate to subsquamulose, to 25 mm wide and 2 mm thick, sometimes forming rosettes to 10 mm wide; areoles rounded, 0.5–3 mm wide, separate to contiguous, irregular, crowded and lumpy within the thallus, but with subeffigurate to placodioid, strongly convex, plicate, marginal lobes 0.4–0.6 mm wide; upper surface off-white to creamy-white, maculate, dull, smooth, convex, epruinose; prothallus not apparent; photobiont cells 6–19 µm wide; medulla white, containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub><sup>+</sup>), I–. *Apothecia* 0.3–2 mm wide, lecideine, separate, broadly adnate, round or distorted; disc black, epruinose, plane to markedly convex with age. *Excipulum* distinct but excluded in older, convex apothecia, in section 30–60 µm thick; outer part aeruginose-dark brown, K+ yellow solution, N+ purple-brown, brown within. *Hypothecium* 150–250 µm thick, dark brown to brown-black, K+ yellow solution, N+ orange-brown. *Epithemium* 10–15 µm thick, dark olive-brown to aeruginose-black, K+ blue-green, N+ purple-brown. *Hymenium* 75–100 µm thick, colourless, not interspersed; subhymenium 30–50 µm thick, pale brown. *Paraphyses* 1–2 µm wide, simple to sparsely branched, the apices 3.5–5 µm wide with aeruginose caps. *Asci* *Bacidia*-type, with 8 or fewer spores. *Ascospores* initially *Physconia*- then *Buellia*-type, 1-septate, brown to dark brown, ellipsoid to broadly fusiform, 12–[16.1]–21 × 7–[8.9]–13 µm, sometimes becoming constricted at the septum, rarely curved; outer spore-wall finely ornamented (microrugulate). *Pycnidia* immersed, punctiform. *Conidia* bacilliform to elongate-ellipsoid, 5–8 × 1–1.5 µm. *Chemistry*: Thallus K+ yellow, P+ yellow-orange, C–, UV–; containing thiophanic acid (major), isoarthothelin (minor) and atranorin (minor).

*Etymology*: The species is named after the subeffigurate marginal lobes.

## Remarks

This species is characterized by the off-white to creamy-white, verrucose-areolate to sub-squamulose thallus with placodioid, subeffigurate margins, the broadly adnate, lecideine apothecia, the non-amyloid medulla containing calcium oxalate, the aeruginose, N+ purple-brown epihymenium, a non-inspersed hymenium, the ellipsoid, 1-septate, *Physconia*- then *Buellia*-type ascospores,  $12\text{--}21 \times 7\text{--}13 \mu\text{m}$ , and the presence of atranorin and thiophanic acid. Ascospore ontogeny is very similar to that of *B. halonia*, but the latter has a thinner thallus, a medulla that lacks calcium oxalate, smaller ascospores,  $11\text{--}19 \times 6\text{--}9 \mu\text{m}$ , and it contains isoarthothelin, roccellic acid and atranorin (Bungartz *et al.* 2007; Elix 2011).

*Buellia subeffigurata* is known from localities in Northern and Western Cape Provinces, South Africa. Associated species include *Buellia halonia* (Ach.) Tuck., *B. namaquaensis* Elix, H. Mayrhofer & Wetschnig and a *Caloplaca* species.

## ADDITIONAL SPECIMENS EXAMINED

Republic of South Africa, *Western Cape Province*: • Sandveld W of Richtersveld, c. 9 km ENE of Beauvallon on the Orange River, SE of Brandkaros,  $28^{\circ}29'S$ ,  $16^{\circ}41'E$ , [SA-Grid: 2816BC], 110 m alt., on greywacke rock, *W. & U. Wetschnig s.n.*, 5.x.1987 (GZU, two collections).

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We thank Dr Dagmar Triebel (Munich) and Prof. Dr Gerhard Rambold (Bayreuth) for generously providing us with the type specimen of *B. magaliesbergensis*, and Dr Klaus Kalb (Neumarkt) for assistance with thin-layer chromatography.

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Figure 1. *Buellia magaliesbergensis* (holotype in M). Scale bar = 2 mm.

*Psoroma inflatum*, a new alpine lichen from New Zealand

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Figure 2. *Buellia subeffigurata* (holotype in GZU). Scale bar = 1 mm.

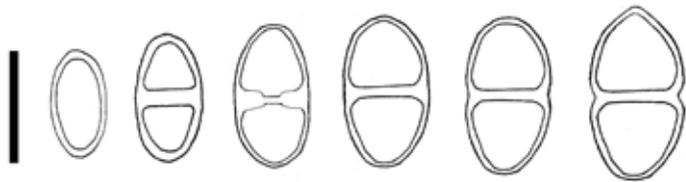


Figure 3. Ascospore ontogeny of *Buellia subeffigurata*. Scale bar = 10 µm.

**Abstract**

*Psoroma inflatum* sp. nov. is described from mountains in Canterbury and Otago in New Zealand's South Island. It is related to *P. hypnorum*, but differs in having a strongly inflated and glossy thallus. The squamules are prostrate, ascending or erect, and form brown, coarsely coraloid patches. They lack a dorsiventral morphology and anatomy, in contrast to other *Psoroma* species, except that the lower sides of ascending lobes are less pigmented and have a white tomentum on the cortex, which is less pigmented, thicker and with elongated lumina. The genus *Psoroma* is currently considered to include 11 species in New Zealand, but it is poorly known and very likely includes even more undescribed taxa.

**Introduction**

Galloway (2007) treated the genus *Psoroma* as comprising 16 species in New Zealand. Since then, two species have been transferred to *Xanthopsoroma* (Elvebakk *et al.* 2010) and one to *Pannaria* (Passo *et al.* 2008), whereas *Psoroma caliginosum* Stirt. and *P. melanizum* Zahlbr. are under study by the author and colleagues as possible members of *Pannaria*. The identity of the true *Psoroma pholidotoides* (Nyl.) Trevis. is still not resolved, and it too might belong in *Pannaria*. However, the name has traditionally been adopted for what is now *Xanthopsoroma contextum* (Stirt.) Elvebakk.

Of the ten species treated by Galloway (2007) and still placed in *Psoroma*, three are corticolous forest species (*P. asperellum* Nyl., *P. coralloideum* Nyl. and *P. geminatum* P.M.Jørg.), four are characteristic alpine species (*P. buchananii* (C. Knight) Nyl., *P. fruticosum* P.James & Henssen, *P. paleaceum* (Fr.) Timdal & Tønsgaard and *P. rubromarginatum* P.James & J.S.Murray), and two are very rare (*P. angustisectum* Zahlbr. and *P. cyanosorediatum* P.M.Jørg.) in addition to *Psoroma hypnorum* (Vahl) S.F.Gray. The latter was described from Norway by Vahl (1787) and is the generic type of *Psoroma*. It is widely distributed, and was considered as "cosmopolitan in cool temperate and arctic-alpine areas" (Smith *et al.* 2009), although "bipolar" as used by Galloway (2007) would describe it more accurately.

In New Zealand *Psoroma hypnorum* has been collected at one montane site in the North Island and ten localities in the South Island, including Old Man Range (Galloway 2007). When I came across a small specimen in the Old Man Range during a visit in 2002, I took it for granted to be *P. hypnorum*. However, later studies, particularly in the three New Zealand herbaria AK, CHR and WELT, have indicated that lichens filed under this name are a very heterogeneous assemblage. So far, I have not seen a single convincing specimen of true *Psoroma hypnorum* in New Zealand. The same is true of Australia, where the species is no longer accepted, and where most of the material represents *P. buchananii* and *P. nigropunctatum* Elvebakk & Elix, a new species (Elvebakk & Elix 2021).

Some specimens deposited in New Zealand herbaria represent a distinct, undescribed species with inflated and strongly glossy squamules. One of the collections is from the Craigieburn Range east of Christchurch, which I visited in 2019 to search for it and two other apparently undescribed Pannariaceae. However, heavy snowfalls restricted the visit to areas just above the tree-line. Still, the species is distinct enough to be described as new based on existing collections, which is the aim of the present contribution.

**Material and methods**

This paper is based on material from the herbaria AK, CHR, TROM, and W; the species has not been found in other herbaria. Ascospore structures were studied in water mounts and restricted to spores liberated from their asci. Detailed drawings of 35 ascospores from three

samples of *P. inflatum* were made, and copies of the sketches were included with the specimens. The sketches were compared with c. 150 unpublished corresponding sketches made earlier of 16 samples of *Psoroma hypnorum* from Europe and South America/Antarctica. Thin-layer chromatography of acetone extracts followed standardized procedures and used solvents A and C (Orange *et al.* 2010). Nomenclature of ascospore structures follows Nordin (1997).

### The species

***Psoroma inflatum*** Elvebakk sp. nov.  
Mycobank No.: **MB 839613**

Figs 1–3

Type: New Zealand. *Canterbury*: Craigieburn Range, slopes between North Canterbury Ski Club Huts and Nervous Knob, 43°07'S, 171°40'E, on soil in crevices amongst rock outcrops through fellfield, 4.xi.1989, *A.E. Wright 9257* (AK 187329 — holotype).

Similar to *Psoroma hypnorum*, but squamules inflated and strongly glossy, ascending, without dorsiventral morphological and anatomical structures, except for white tomentum on the less exposed side, apothecia cupulate with large, swollen inrolled lobes of the thalline excipuli with scattered irregular outgrowths, and ascospores mostly longer and narrower.

*Thallus* squamulose, tripartite, terricolous, often on bryophytes and lichens, forming patches 3–10 cm wide on an indistinct hypothallus. *Chlorobiont squamules* 0.5–3 mm wide, irregularly branched, forming coralloid patches of weakly ascending to erect lobes 0.3–0.6 mm thick, without a dorsiventral morphology and anatomy; *upper surface* glossy, brown, glabrous, except for a distinct white tomentum on the lower, less exposed side. *Cortex* 60–100 µm thick, upper part brown and sclerenchymatic, lower part pale and paraplectenchymatic, lumina mostly elongate, arranged perpendicularly to the upper surface, 4–8 × 2–4 µm, walls 3–4 µm thick, less pigmented and thinner on the less exposed side, where lumina are more elongated, up to 12 µm long and often arranged in a labyrinth-like pattern. *Chlorobiont layer* 80–150 µm thick, below the cortex, of *Trebouxia* cells, globose to irregularly subglobose, 8–20 µm diam.; chloroplasts angular. *Medulla* centrally positioned, 50–150 µm thick, but poorly defined due to transitions towards the surrounding chlorobiont layer. *Cyanobiont Nostoc*, in globose to weakly coralloid, greyish cephalodia, 0.1–0.3 mm wide, situated between chlorobiont squamules, common. *Nostoc* cells greyish green, irregularly subglobose to ellipsoid, often angular, with uneven surfaces, 4–6 × 2–3 µm, organized within small glomeruli and without visible chain structures. *Apothecia* common, substipitate, 3–7 mm wide, discs reddish brown, strongly cupulate; *thalline excipulum* 0.3–1 mm broad, crenate and swollen, of few and large, inrolled lobes 0.3–1 mm wide, occasionally with inflated additional irregular outgrowths, glabrous on the lower side, except for a very thin, partial white tomentum at the bases. *Epithecium* brown, c. 15 µm thick; *hymenium* pale, 100–120 µm, IKI+ blue; *hypothecium* brownish, 60–80 µm, algal layer continuous below the hypothecium. *Paraphyses* simple, septate, c. 2.5 µm wide, and strongly adglutinated in the epithecium. *Asci* clavate, c. 80 × 15 µm, with 8 spores, internally with IKI+ blue structures, seen as tube-like in low IKI concentrations. *Ascospores* regularly ellipsoid to weakly citriform or ovoid, 17–23 × 8–11 µm, perispores 20–30 × 10–13 µm, regularly verrucose, apically mostly with verrucose or nodulose extensions, sometimes triangular and pointed, c. 3 µm long, rarely acuminate and c. 8 µm long. *Pycnidia* not observed.

*Chemistry*: brown melanins, lacking TLC-detectable compounds.

*Etymology*: The species is named for its strongly inflated squamules.

### ADDITIONAL SPECIMENS EXAMINED

New Zealand. *Canterbury*: • Arthur's Pass, basin of Rough Creek, alt. 5500 ft, leg. unknown, '287' (CHR); • spur from Island Saddle Road summit to Crimea Range, 42°10'S, 172°48'E, alt. 1500 m, common on moss in rock crevices on small outcrops in subalpine scrub, *A.E.*

*Wright 12790*, 2.i.2002 (AK 257334A); *Otago*: • North Otago, Kakanui Range, Mt Pisgah, 45.079346°S, 170.391572°E, on tussock bases, summit (1643 m), *J.Scott Thomson*, 1934 (CHR 505269); • *loc. id.*, alt. c. 1150 m, on dead tussocks of *Festuca novaezealandiae*, *J. Scott Thomson ZA 405*, i.1935 (W 1936-1930); • summit of Rock and Pillar Range, alt. 1300 m, on earth, *J. Child*, 13.ii.1941 (CHR 505268); • *loc. id.*, growing amongst low turf on soil at top of road cutting through open tussockland, *A.E. Wright 9207* (AK 187280); • Old Man Ridge, top plateau, Cock Creek Catchment area, 45°21.9'S, 169°12.6'E, alt. 1620 m, on the ground, on plant remains and cryptogams, associated with *Psoroma paleaceum*, *A. Elvebakk 02:620A*, 9.xii.2002 (TROM).

### Remarks

The inflated and glossy thallus of the new species is very characteristic. Figs 1 and 2 show the thick, brown, coarsely coralloid crust, in which the squamules are two to three times thicker than those of *Psoroma hypnorum*. The latter, as well as most other *Psoroma* species, have a distinct dorsiventral lobe pattern, whereas in *P. inflatum* the squamules are weakly ascending to erect. However, the less exposed side also has a cortex, which is covered by a white tomentum, similar to the tomentum on the lower side of the excipuli in *P. hypnorum*. The lower parts of excipuli in *P. inflatum* have a distinctly thinner tomentose layer. The coralloid appearance of the thallus probably explains why Zahlbruckner (1941) determined the specimen *Scott Thomson ZA 405* as *P. coralloideum* Nyl., which in fact is a different species.

Most spores of *P. inflatum* are longer and narrower than those of *P. hypnorum*, and some perispores of *P. inflatum* have pointed extensions. Although the two species look markedly different, they are considered to be related because of their pigmentation and spore characteristics.

The new species is endemic to New Zealand and is so far known from only a handful of localities at altitudes of 1100 to 1600 m in the mountains of Canterbury and Otago. Anthony E. Wright, who collected three of the eight known collections, commented that the species is common in one of the localities in Canterbury. Further searches are expected to show it to be widely distributed in the mountains of the South Island.

At present, my conclusion is that no sample from New Zealand seen to date represents true *P. hypnorum*. That might suggest *P. hypnorum* belongs to an evolutionary lineage that developed in Antarctica and spread along American mountain chains to the Northern Hemisphere, in contrast to a lineage including *P. inflatum* which spread into New Zealand. The *P. buchananii* lineage might have a different evolutionary history. More fresh samples are required for an ongoing phylogenetic study on the evolution of Austral *Psoroma*.

### Acknowledgements

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Fig. 1. *Psoroma inflatum*, holotype. Scale-bar = 5 mm.



Fig. 2. *Psoroma inflatum*, Wright 12790 (AK). Scale-bar = 5 mm.



Fig. 3. Ascospores of *Psoroma inflatum*. Scale-bar = 10 µm.

***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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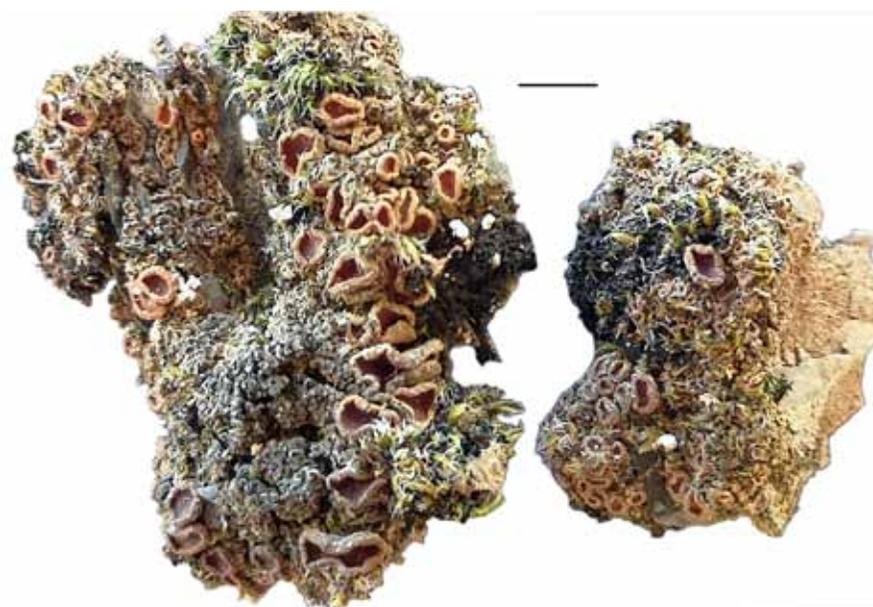


Fig. 1. *Psoroma buchananii*, New Zealand, Southland, Knight (OTA 61734; TROM). Scale bar = 5 mm.



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  $\mu$ m.

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