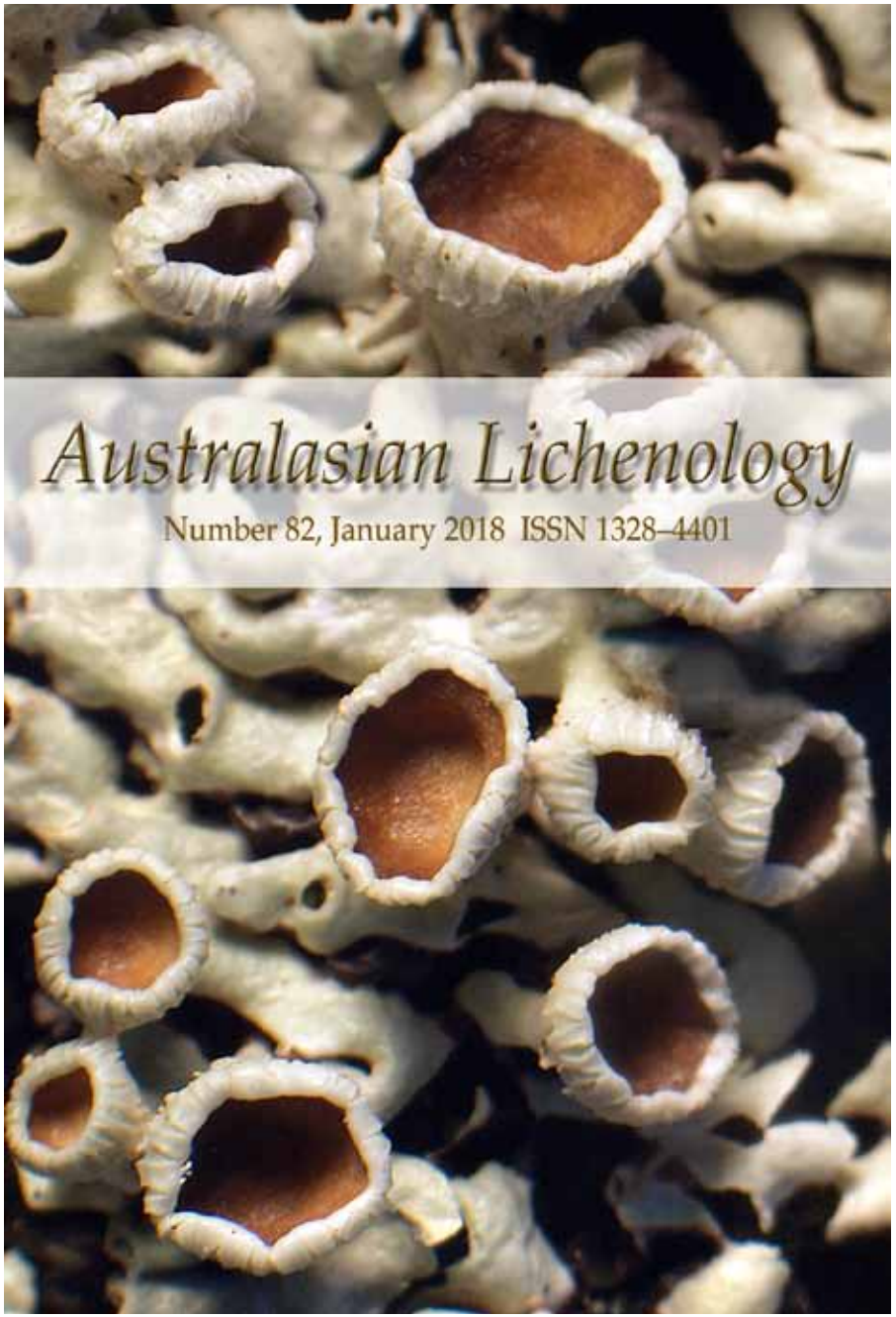

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About a third of New Zealand's 20 species of *Menegazzia* are considered to be endemic, among them *Menegazzia foraminulosa*, which colonizes the bark of lowland to subalpine trees and shrubs on all three main islands of the country. As do many species of the genus, it has a diverse secondary chemistry of depsides (atranorin and chloratranorin), depsidones (stictic, constictic, norstictic and menegazziaic acids), fatty acids and pigments.

5 mm

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New species and records of lichens from the Cook Islands, South Pacific Ocean

Patrick M. McCarthy
64 Broadsmith St, Scullin, A.C.T. 2614, Australia
email: pmcc2614@hotmail.com

John A. Elix
Research School of Chemistry, Building 137
Australian National University, Canberra, A.C.T. 2601, Australia
e-mail: John.Elix@anu.edu.au

Abstract

Lecanographa solicola P.M.McCarthy & Elix (Roccellaceae) and *Pseudocyphellaria louwhoffiae* Elix (Lobariaceae) are described as new from Rarotonga, Cook Islands, South Pacific Ocean. Twenty-eight other taxa are reported for the first time from the Cook Islands. An updated, national lichen checklist is also provided.

The Cook Islands comprises 15 small islands and atolls in 2 million square kilometres of the South Pacific Ocean, flanked by Samoa and Tonga to the west and by French Polynesia to the east. Rarotonga, the largest island, is situated at latitude 21°12–15'S and longitude 159°44–50'W. Fringed by a coral reef, it is 11 km from east to west, 8 km from north to south, and has an area of 67 square kilometres. Volcanic in origin, eruptions, compaction and erosion have formed today's steeply rugged and fertile interior with breccia pinnacles and cliffs, as well as outcrops and boulders of rather porous basalt.

In 1998, the authors, with Dr Simone Louwhoff, visited Rarotonga, primarily to investigate Parmeliaceae and pyrenolichens. Based on specimens collected at that time, 11 new taxa of the genera *Buellia*, *Canoparmelia*, *Pertusaria*, *Porina*, *Pyrenula*, *Strigula* and *Verrucaria* have been described, and numerous other species reported from the Cook Islands for the first time (McCarthy 2000; Louwhoff & Elix 2000; Archer & Elix 2015; Elix 2016). In this contribution, new species of *Lecanographa* Egea & Torrente (Roccellaceae) and *Pseudocyphellaria* Vain. (Lobariaceae) are described from material collected in 1998, and 28 other species are reported for the first time from these islands. The checklist of Cook Islands lichens is brought up-to-date and now includes 113 taxa. However, given the considerable habitat diversity, particularly in Rarotonga, and the sporadic nature of previous lichenological investigations, this figure probably represents no more than 30–40% of the actual lichen diversity.

Methods

Observations and measurements of photobiont cells, thalline and apothecial anatomy, asci, ascospores, pycnidial anatomy and conidia were made on hand-cut sections mounted in water; apothecial were also treated with 10% potassium hydroxide (K) and 50% nitric acid (N). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K and N. Thallus samples were analysed for chemical constituents by thin-layer chromatography (Elix 2014).

New species

Lecanographa solicola P.M.McCarthy & Elix, sp. nov. Figs 1, 2
MycoBank No. **MB 822282**

Characterized by the terricolous, pale brownish grey or pale brown to pale yellow-brown, crustose thallus containing a trentepohlioid photobiont and lacking lichen substances; rather large, brown to black, apothecioid ascomata, (0.48–)0.90(–1.52) mm diam., with a red-brown, basally thick, cupulate proper excipulum; *Grumulosa*-type asci enclosed by sparingly branched and anastomosing paraphysoids with non-swollen and unpigmented apices; fusiform ascospores that are 3(–4)-septate, 16–30 × 5–8 µm, with or without a thin epispore; and usually clustered pycnidia with distinctive, obampulliform conidia with a short to long 'neck', 3–5(–6) × 1–1.5 µm.

Type: Cook Islands: Rarotonga, Raemaru Track, 21°14′S, 159°49″W, alt. *c.* 100 m, on consolidated, siliceous soil on fern-dominated slopes with scattered *Albizzia*, *J.A. Elix 42873*, 8.vi.1998 (holotype – CANB).

Thallus crustose, episubstratic, determinate, continuous, forming colonies to several centimetres wide, pale brownish grey or pale brown to pale yellow-brown, dull, granulose to verruculose, (40–)80–150(–250) µm thick, the surface patchily farinose, ecorticate, or the thallus with an epinecral layer 5–8 µm thick. *Algae* trentepohlioid, occupying a discrete layer up to 50 µm deep, or more diffuse and penetrating 100 µm into the thallus-soil interface; cells broadly ellipsoid to subglobose, 6–10(–13) × 6–8(–10) µm, mostly solitary, or in very short filaments. *Medulla* whitish and discrete or partly or largely obscured by soil particles, *c.* 50–150 µm thick, H_2SO_4–, I–; hyphae 1.5–2.5(–3) µm wide, appearing to penetrate the soil to a depth of 250 µm or more. *Prothallus* not apparent. *Ascomata* numerous, apothecioid, somewhat innate to adnate or subsessile, mostly solitary and rounded in outline, the largest ascomata often with a shallowly or more deeply scalloped edge, (0.48–)0.90(–1.52) mm diam. [*n* = 50]; disc red-brown to dull black, initially plane and then occasionally paler greyish brown, later moderately to strongly convex, smooth, epruinose or lightly grey-pruinose; proper margin initially glossy brown-black to black, to 80 µm thick, not or only moderately prominent and entire to flexuose (i.e. when the disc is plane to low-convex and less than *c.* 0.6 mm wide), epruinose or lightly grey-pruinose, becoming ± excluded, but remaining visible as a dark ring contrasting with the paler disc when the ascoma is wetted. *Thalline margin* lacking. *Proper excipulum* cupulate, deep red-brown, 40– 60(–80) µm thick laterally, 80–150 µm thick at the base, with an external, yellow-brown necral layer 5–8 µm thick; excipulum paraplectenchymatous internally above the ascomatal base, the cells 5–7 µm wide, these becoming elongate and radiating downwards and laterally to the edge of the excipulum, 7–10(–12) × 3–5(–7) µm, K+ yellow-brown laterally and K+ deep orange-red basally, N+ yellow-orange laterally and N+ deep orange-red at the base. *Hypothecium* pale yellow to pale yellowish brown, 50–80 µm thick, with oily inclusions, K+ yellow-orange, N–, merging with the base of the proper excipulum. *Hymenium* 80–100 µm thick, hyaline to very pale yellowish, not inspersed with granules or oil globules, I+ persistently dark blue, K–, N–; hymenial gel KI+ lilac-blue and diffusing into the mounting medium. *Epihymenium* diffuse red-brown, *c.* 20 µm thick, K+ pale orange, the colour rapidly dissipating, N+ pale orange, KI+ lilac blue; K-soluble granules present or absent. *Paraphysoids* tightly conglutinate in water, separating ± instantaneously in K, sparingly branched and anastomosing above, simple or sparingly branched below, long-celled, 1–1.5 µm thick; apices neither swollen nor pigmented. *Asci Grumulosa*-type (*sensu* Egea & Torrente 1994), 8-spored, narrowly clavate or narrowly cylindroclavate, 69–87 × 10–17 µm [*n* = 20]; ascus wall KI–, I+ uniformly pale blue; apex rounded, with a 2–4 µm thick tholus at maturity, without or occasionally with a minute ocular chamber. *Ascospores* colourless, 3(–4)-septate, irregularly biseriate in the ascus, or overlapping-uniseriate below and clustered above, mostly narrowly to broadly fusiform, straight or slightly curved, faintly constricted at the septa or not, (16–)22(–30) × (5–)6.5(–8) µm [*n* = 77]; end cells smaller or all locules of ± equal size throughout spore ontogeny; apices subacute or acute, occasionally the distal end more rounded; endospore thin; spore wall 1–1.5 µm thick; epispore thin or not apparent; contents clear or granular-guttulate. *Pycnidia* moderately numerous, semi-immersed, solitary and 80–120(–150) µm wide or forming irregular, convex clusters of 8–12(– 15), 0.5–0.8 mm in maximum extent, perithecioid, plane to convex and glossy brown-black or, finally, with a gaping, concave to urceolate, epruinose 'disc'; apex 15–20 µm thick; internal wall 8–12 µm thick, medium to dark red-brown (K+ pale yellow-brown to red-brown), with a simple conidiogenous layer; conidiophores 10–15 × 1–1.5 µm. *Conidia* budding off from the apices of conidiophores, simple, straight, obampulliform and with a short to long 'neck', 3–5(–6) × 1–1.5 µm.
Chemistry: No substances detected by TLC.

Etymology: The epithet *solicola* refers to the occurrence of the new species on soil.

Remarks

As outlined in the foregoing diagnosis and elaborated upon in the description, *Lecanographa solicola* exhibits a distinctive suite of thalline, apothecial and pycnidial attributes. Its inclusion in the family Roccellaceae is based on the combination of the trentepohlioid photobiont, sparingly branched and anastomosing paraphysoids and the occurrence of *Grumulosa*-type asci with a KI– and I+ uniformly pale blue tholus.

The placement of the new species in *Lecanographa* Egea & Torrente is more tentative. This genus of 38 species is especially common on bark (less so on rock) in tropical to temperate regions. One terricolous species is known, *viz. L. azurea* Follmann from the Atacama Desert in Chile, which has a complex thallus chemistry, blue-pruinose apothecioid ascomata and long and narrow, 7-septate ascospores (Follmann 2008). The ascomata of *Lecanographa* are lirelliform or apothecioid, with a non-carbonized, dark brown proper excipulum, branched and anastomosing paraphysoids, *Grumulosa*-type asci and mostly fusiform or more elongate, transversely septate ascospores with a comparatively thin endospore (Egea & Torrente 1994; Grube 1998; Egea *et al.* 2004). However, some attributes of *Lecanographa* elsewhere in the world are not replicated in *L. solicola*, e.g. paraphysoids with swollen apices, ascospores being more obviously halonate and turning brown after maturity and, especially, solitary pycnidia with straight or curved, elongate-bacilliform to short-filiform conidia (Egea & Torrente 1994). The pycnidia of *L. solicola* are particularly noteworthy and anomalous, and they often clustered in discrete, convex groups of 8–12(–15), although not compound to the extent of occupying stroma-like structures. The conidia were similarly unexpected, having the shape of inverted flagons with elongate necks (obampulliform; Fig. 2) and closely resembling those seen in many species of *Byssoloma* Trevis. (Pilocarpaceae).

While our principal intention here is to provide a valid name for a highly distinctive species and to assign it to the most appropriate genus, it is hoped that further collections of this and unambiguously congeneric lichens will become available from the Pacific region and beyond. Once that occurs, subsequent chemical and morphological assessments, supplemented by molecular analyses, are likely to necessitate a revised generic placement.

Lecanographa solicola is known only from consolidated, siliceous soil at the type locality in the coastal lowlands of Rarotonga, Cook Islands.

Pseudocyphellaria louwhoffiae Elix, sp. nov. Figs 3, 4
MycoBank No. **MB 823490**

Similar to *Pseudocyphellaria haywardiorum* D.J.Galloway, but differs in forming small rosettes 20–40 mm wide, in having a smooth, white-tomentose upper surface and lobes with pseudoisidiate margins, yellow pseudocyphellae and in containing calycin and pulvinic dilactone.

Type: Cook Islands: Rarotonga, Ara Metua Road, between Avana Drive and Pariki Road, 21°12′S, 159°44′W, alt. *c.* 100 m, on bark in roadside vegetation, *S.H.J.J. Louwhoff 596*, 7.vi.1998 (holotype – CANB).

Thallus foliose, forming small rosettes 20–40 mm wide, loosely attached, the margins often free. *Lobes* sublinear-elongate, 10–15(–20) mm long and 1–2.5 mm wide, ± regularly di- or trichotomously branched, contiguous to weakly imbricate; apices often suberect; lobe margins elevated, thickened above and below, sinuous or ragged, dentate-incised to densely pseudoisidiate, with sparse yellow pseudocyphellae. *Upper surface* pale grey or greyish brown when dry, dark blue-black when wet, smooth, slightly glossy in the thallus centre, white-silky-tomentose, especially towards the margins. *Pseudoisidia* common and conspicuous, mainly marginal, corticate, subglobose or often forming densely coralloid clusters to 0.7 mm high, yellow-green to orange-brown, rarely abraded and appearing granular-sorediate. *Medulla* yellow. *Photobiont Nostoc*. *Lower surface* yellow to yellow-brown; tomentum pale grey to grey-brown or yellow-brown, thick and tangled, most dense towards the margins. *Pseudocyphellae* yellow, sparse, scattered, minute, to 0.1 mm wide; decorticate area plane, immarginate. *Apothecia and pycnidia* not seen.

Chemistry: Thallus and medulla K–, C–, KC–, PD–, UV–; containing 2α,3β-diacetoxystictane (trace), 2α,3β-diacetoxystictane-22-ol (trace), pseudocyphellarin A (minor), pseudocyphellarin B (minor), 2′-*O*-methylpseudocyphellarin A (major), 2′-*O*-methylphenarctin (minor), calycin (minor), pulvinic dilactone (trace).

Etymology: The species is named in honour of our colleague and collector of the type specimen, Dr Simone Louwhoff.

Remarks

The new species is characterized by the thallus forming small rosettes, with a yellow medulla, a cyanobacterial photobiont, relatively narrow, sublinear-elongate lobes with a white-tomentose upper surface and conspicuous, pseudoisidiate margins, yellow pseudocyphellae on the lower surface and in containing the pigments calycin and pulvinic dilactone and depsides of the pseudocyphellarin A chemosyndrome. It is morphologically similar to *P. haywardiorum*, in that the two species have *Nostoc* as photobiont and develop similar pseudoisidia on the lobe margins, but *P. haywardiorum* has a punctate-impressed, non-tomentose upper surface, a white medulla and pseudocyphellae, a bullate lower surface, and it lacks medullary pigments (Galloway 1994). Chemically, *P. louwhoffiae* appears closely related to the Australasian *P. jamesii* D.J.Galloway and *P. nermula* D.J.Galloway, both of which have a yellow medulla and yellow pseudocyphellae on the lower surface. However, *P. jamesii* lacks vegetative propagules, while *P. nermula* has a densely phyllidiate upper surface (Galloway *et al.* 2001). The most similar species is *P. pilosellioides* (Räsänen) A.H.Magn., from southern South America (Galloway 1986). However, the latter has a larger thallus, 50–100 mm wide, with broader lobes, 5–40 mm wide, a reticulately ridged lower surface, a faveolate upper surface near the lobe margins, and it contains additional gyrophoric acid and methyl gyrophorate as well as an alternative suite of triterpenes (Galloway 1992).

Pseudocyphellaria louwhoffiae was found on the bark of trees in open forest at altitudes of 100–360 m. Associated species include *Bulbothrix goebelii* (Zenker) Hale, *B. tabacina* (Mont. & Bosch) Hale, *Coccocarpia palmicola* (Spreng.) Arv. & D.J.Galloway and *Heterodermia propagulifera* (Vain.) Dey.

ADDITIONAL SPECIMENS EXAMINED

Cook Islands: *Rarotonga*. ● Raemaru Track, upper level, 21°14′S, 159°49′W, alt. 200 m, on *Allocasuarina* on fern-dominated slopes with scattered *Albizzia*, *J.A. Elix 42898, 42922*, 8.vi.1998 (CANB).

New records

1. Acarospora *aff.* **veronensis** A.Massal., *Ric. Auton. Lich. Crost.* 29 (1852)

Thallus squamulose, growing on hard, compacted soil and on rock. Squamules solitary and scattered, or in small groups, rounded to shallowly lobate, 0.5–1.5(–1.8) mm wide, 100–250(–300) µm thick, pale brownish grey to medium or dark brown, mostly plane, occasionally slightly convex, smooth, epruinose, K–, C–, KC–; margin initially with a blackish rim up to 50 µm thick, this disappearing at maturity, all squamules with a brown to blackish basal layer 20–40(–80) µm thick. Cortex with an upper, pale brown layer 7–12 µm thick, subtended by a hyaline layer 15–30(–40) µm thick; algal layer with a jagged upper edge, 50–80(–100) µm thick, continuous or not and then broken by columns of thin-walled, vertically oriented hyphae; algal cells 7–15 µm diam. Apothecia 1 or 2 per mature squamule, 0.3–0.5 mm wide, immersed in the thallus; disc concave or plane and flush with the thallus surface, smooth or sulcate, with a low, dark brown rim. Proper excipulum hyaline to pale brown at the sides and base, 25–50 µm thick; epihymenium brown-black, 10–15 µm thick; hymenium 150–230 µm thick; hypothecium pale yellowish brown, 40–50(–70) µm thick. Asci producing at least 200 ascospores; ascospores narrowly ellipsoid to oblong, 2–2.5(–3) × 0.7–1 µm. Pycnidia immersed, to 100 µm wide, with a minute, pale to dark brown apex, hyaline below; conidia bacilliform, 3–5 × 0.5 µm.

The two collections from the Cook Islands are linked to the variable and almost cosmopolitan *A. veronensis* due to their small, scattered, mostly pale brownish grey to brown squamules; these are smooth, epruinose, K–, C– and KC–, and have a dark rim and lower surface. However, the relationship is highly tentative at best because *A. veronensis* has a continuous algal layer with a smooth upper edge, a much shallower hymenium and larger ascospores, (3–)3.8–5 × 1–2.1 µm (see Knudsen 2008; Fletcher *et al.* 2009).

SPECIMENS EXAMINED

Cook Islands: *Rarotonga*. ● Te Kou Track, lower level, 21°13′S, 159°46″W, alt. *c.* 80 m, on basalt in a forest clearing, *P.M. McCarthy 4665*, 7.vi.1998 (CANB); ● Raemaru Track, lower level, 21°14′S, 159°49′W, alt. *c.* 50 m, on hard, very compacted soil beside track, *P.M. McCarthy 4662*, 8.vi.1998 (CANB).

2. Amandinea efflorescens var. **pseudohypopelidna** Marbach, *Biblioth. Lichenol.* **74**, 64 (2000)

Previously known from Australia, New Caledonia and South America (Marbach 2000; Elix 2016, 2018).

SPECIMEN EXAMINED

Cook Islands: *Rarotonga*. ● Muri Lagoon, 21°15′S, 159°44′W, alt. 1 m, on dead coconut palm along foreshore, *J.A. Elix 42729 pr.p.*, 6.vi.1998 (CANB).

3. Calopadia vermiculifera (Vain.) Sérus., *in* Aptroot *et al.*, *Biblioth. Lichenol.* **64**, 42 (1997)

Known from the Philippines, Papua New Guinea and the Seychelles (Santesson 1952; Aptroot *et al.* 1997; Seaward & Aptroot 2009), specimens of this highly distinctive, corticolous species in the Cook Islands have a thin, pale greyish green thallus (no substances detected by TLC) with tangled, superficial cephalodia, orange-brown, lecideine apothecia with paler margins and muriform ascospores that are 74–95 × 21–27 µm and 1 per ascus, along with campylidia that become erect and produce filiform-acicular, 15–21-septate conidia 100–150 × 2–2.5 µm.

SPECIMENS EXAMINED

Cook Islands: *Rarotonga*. ● Papua Falls, Papua Stream, 21°14′S, 159°47′W, alt. 40 m, on *Cecropia peltata*, in open area in moist forest, *J.A. Elix 42932, 42933 p.p.*, 9.vi.1998 (CANB); ● Te Kou Track, lower level, 21°13′S, 159°46′W, alt. 80 m, on *Cecropia* trunk and branches in scattered regrowth forest and taro gardens, *J.A. Elix 42845*, 7.vi.1998 (CANB).

4. Chrysothrix candelaris (L.) J.R.Laundon, *Lichenologist* **13**, 110 (1981)

The known distribution of this almost cosmopolitan lichen includes the Pacific islands of Guadalupe, Maui (Hawaiian Islands), Galapagos Islands and Pitcairn Islands (Elix & McCarthy 2008).

SPECIMEN EXAMINED

Cook Islands: *Rarotonga*. ● *c.* 50 m S of mouth of Avana Stream along Ara Tapu Road, 21°14′S, 159°43′W, alt. 1 m, on bark of *Cocos nucifera* on the seashore, *S.H.J.J. Louwhoff 619 pr.p.*, 9.vi.1998 (CANB).

5. Coenogonium lutescens (Vězda & Malcolm) Malcolm, *Australas. Lichenol.* **54**, 19 (2004)

This lichen was first described from bark in New Zealand (Vězda & Malcolm 1997); it was subsequently reported from Tasmania (Kantvilas & Jarman 2012) and, most recently, from Florida (Seavey *et al.* 2014). The saxicolous thalli of the Cook Islands specimen are very thin and filmy, smooth, slightly glossy and pale green, and the pale yellow, sessile apothecia are 0.2–0.35 mm diam., with a plane to faintly concave disc, and a minutely uneven margin. The hymenium is 50–60 µm thick, and each cylindrical ascus has 8 irregularly biseriate ascospores, 7–9 × 1.5–2.5(–3) µm. Pycnidia were not seen.

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● track from the north to Te Rua Manga (The Needle), 21°13′S, 159°46′W, alt. *c.* 250 m, on shaded basalt, *P.M. McCarthy 4664*, 9.vi.1998 (CANB).

6. Coenogonium queenslandicum (Kalb & Vězda) Lücking, *in* Lücking *et al.*, *Lichenologist* **33**, 201 (2001)
Known from the wet-tropics of Queensland and Thailand (Kalb & Vězda 1994; Rivas Plata *et al.* 2006; Kalb *et al.* 2016), several small thalli were observed on the margin and adjacent underside of an *Inocarpus fagifer* leaf. The thallus is very thin, smooth and dull pale green, and the apothecia are uniformly pale yellow, sessile and 0.3–0.6 mm diam., with a plane to convex disc and a smooth or very faintly denticulate margin. The hymenium is 45–55 µm thick and the cylindrical asci are 35–40 × 4–6 µm, each with 8 irregularly biseriate ascospores, 6–8 × 1.5–1.8 µm. Mature pycnidia were not seen.

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● track from the north to Te Rua Manga (The Needle), 21°13′S, 159°46′W, alt. 200 m, on leaves of *Inocarpus fagifer* in dense rainforest, *P.M. McCarthy 4663*, 9.vi.1998 (CANB).

7. Dirinaria aegialita (Ach.) B.Moore, *Bryologist* **71**, 248 (1968)
The Pacific distribution of this pantropical lichen includes the Bonin Islands, Easter Island, Fiji, Hawaiian Islands, Marquesas Islands, New Caledonia, Norfolk Island, northern Mariana Islands, Pitcairn Islands, Tahiti and Samoa (Elix & McCarthy 2008).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Muri Lagoon, 21°15′S, 159°44′W, alt. 1 m, on dead coconut palm along foreshore, *J.A. Elix 42733*, 6.vi.1998 (CANB); ● Avana Stream, 400 m E of Water Tanks, 21°14′S, 159°45′W, alt. 60 m, on bark of *Hibiscus tiliaceus* in moist lowland forest, *J.A. Elix 42792*, 6.vi.1998 (CANB).

8. Dirinaria applanata (Fée) D.D.Awasthi, *J. Indian Bot. Soc.* **49**, 135 (1970)
The known distribution of this pantropical lichen includes Lord Howe Island, Norfolk Island, New Caledonia, Pitcairn Islands, Tahiti, Tuamotu and Samoa (Elix & McCarthy 2008).

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● Te Kou Track, summit plateau, 21°14′S, 159°46′W, alt. 560–588 m, on tree (*Fitchia* or *Weinmannia*) among ferns, *S.H.J.J. Louwhoff 542*, 7.vi.1998 (CANB).

9. Diorygma pruinosum (Eschw.) Kalb, Staiger & Elix, *Symb. Bot. Upsal.* **34**(1), 166 (2004)
This pantropical species is already known in the South Pacific from New Caledonia and the Solomon Islands (Elix & McCarthy 2008).

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● track from the north to Te Rua Manga (The Needle), near crossing of Avatiu Stream, 21°13′S, 159°46′W, alt. *c.* 150 m, on tree among taro plots, *P.M. McCarthy 1250*, 9.vi.1998 (CANB).

10. Graphis furcata Fée, *Essai Crypt. Écorc.* 40 (1824)
This pantropical, corticolous species occurs in Central and South America, southern Africa, eastern Australia, Lord Howe Island and the Philippines (Archer 2009).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Te Kou Track, summit plateau, 21°14′S, 159°46′W, alt. *c*. 550 m, on tree among ferns, *P.M. McCarthy 1244*, 7.vi.1998 (CANB); ● track from the north to Te Rua Manga (The Needle), 21°13′S, 159°46′W, alt. 200 m, on branch in dense rainforest, P.M. *McCarthy 1259*, 9.vi.1998 (CANB).

11. Heterodermia isidiophorella Elix, *Australas. Lichenol.* **69**, 13 (2011)
Previously known from Australia, the Azores, Malaysia, Thailand and Réunion (Elix 2011b; van den Boom *et al.* 2011; Mongkolsuk *et al.* 2015).

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● Te Kou Track, lower level, 21°13′S, 159°46′W, alt. *c.* 80 m, on basalt in regrowth forest and taro gardens, *J.A. Elix 42821*, 7.vi.1998 (CANB).

12. Heterodermia japonica (Sato) Swinscow & Krog, *Lichenologist* **8**, 122 (1976)
A pantropical to pantemperate species previously known, in the Pacific, from the Northern Mariana Islands (Elix & McCarthy 2008; Elix 2011b).

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● Taputarangi Track, 21°12′S, 159°48′W, alt. 40–100 m, on fallen tree in open forest, *S.H.J.J. Louwhoff 504E*, 6.vi.1998 (CANB).

13. Heterodermia obscurata (Nyl.) Trevis., *Nuovo Giorn. Bot. Ital.* **1**, 114 (1869)
Known from Europe, North, Central and South America, Africa, Asia, Australia and New Zealand, as well as Fiji, the Hawaiian Islands, Islas Juan Fernández and New Caledonia (Elix & McCarthy 2008; Elix 2011b; Mongkolsuk *et al.* 2015).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Avana Stream, 400 m E of Water Tanks, 21°14′S, 159°45′W, alt. 60 m, on bark of *Hibiscus tiliaceus* in moist lowland forest, *J.A. Elix 42793*, 6.vi.1998 (CANB); ● Raemaru Track, 21°14′S, 159°49′W, alt. 100 m, on *Albizzia* on fern-dominated slopes, *J.A. Elix 42883*, 8.vi.1998 (CANB).

14. Heterodermia propagulifera (Vain.) Dey, *in* Parker & Roane, *Dist. Hist. Biota S. Appal.* **4**, 403 (1977)
Heterodermia reagens (Kurok.) Elix, *Australas. Lichenol.* **67**, 6 (2010).
Previously known from Australia, Central and South America, Africa, Asia, and in the Pacific from the Bonin Islands and the Hawaiian Islands (Elix & McCarthy 2008; Elix 2011b; Mongkolsuk *et al.* 2015).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Taputarangi Track, 21°12′S, 159°48′W, alt. 100 m, on fallen tree in open forest, *J.A. Elix 42747*, 6.vi.1998 (CANB); ● Avana Stream, 400 m E of Water Tanks, 21°14′S, 159°45′W, alt. 60 m, on water pipeline in moist lowland forest, *J.A. Elix 42778, 42779*, 6.vi.1998 (CANB); ● Te Kou Track, lower level, 21°13′S, 159°46′W, alt. 80 m, on basalt rocks in scattered regrowth forest and taro gardens, *J.A. Elix 42810, 42814*, 7.vi.1998 (CANB); ● Raemaru Track, upper level, 21°14′S, 159°49′W, alt. 200–280 m, on *Allocasuarina* in *Albizzia-Allocasuarina*-dominated forest, *J.A. Elix 42921*, 8.vi.1998 (CANB); *S.H.J.J. Louwhoff 586B, 586D*, 8.vi.1998 (CANB); ● Papua Falls, Papua Stream, 21°14′S, 159°47′W, alt. 40 m, on *Cecropia peltata* in open area in moist forest, *J.A. Elix 42935*, 9.vi.1998 (CANB); ● mouth of Avana Stream, 21°14′S, 159°43′W, alt. 1 m, on old coconut palm in strand vegetation, *J.A. Elix 42780*, 9.vi.1998 (CANB).

15. Lecanora tropica Zahlbr., *Cat. Lich. Univ.* **5**, 589 (1928)
In the Pacific this pantropical species was previously known from the Galapagos Islands and New Caledonia (Elix & McCarthy 2008).

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● Taputarangi Track, ridge below summit of Tereora Hill, 21°12′S, 159°48′W, alt. *c.* 220 m, on dead branch in open forest, *P.M. McCarthy 1298 pr.p.*, 6.vi.1998 (CANB).

16. Megalospora *aff.* **austropacifica** Lumbsch, Naikatini & Lücking, *in* Lumbsch *et al.*, *Phytotaxa* **18**, 83 (2011)
Recently described from Fiji (Lumbsch *et al.* 2011), *M. austropacifica* provides the closest match for the Cook Islands specimens. Thus, while other members of the *M. sulphurata* group share various diagnostic characters with them (Sipman 1983; Untari 2006), *M. austropacifica* differs only in having somewhat longer, narrower ascospores, i.e. 60–85 × 22–26 µm, with a smooth wall (Lumbsch *et al.* 2011), as opposed to 50–75 × 23–30 µm, with a smooth or warted wall in the Cook Islands material.

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Te Kou Track, summit plateau, 21°14′S, 159°46′W, alt. 560–588 m, on tree (*Fitchia* or *Weinmannia*) among ferns, *S.H.J.J. Louwhoff 557A*, 7.vi.1998 (CANB); ● Raemaru Track, upper level, 21°14′S, 159°49′W, alt. 200 m, on treelet on fern-dominated slopes with scattered *Albizzia*, *J.A. Elix 42911, 42912*, 8.vi.1998 (CANB); ● track from the north to Te Rua Manga (The Needle), 21°13′S, 159°46′W, alt. 200 m, on dead branch in dense rainforest, *J.A. Elix 42951*, 9.vi.1998 (CANB); ● *loc. id.*, *S.H.J.J. Louwhoff 603*, 7.vi.1998 (CANB).

17. Megalospora sulphurata Meyen, *in* Meyen & Flotow, *Nov. Actorum Acad. Caes. Leop. Carol. Nat. Cur.* **19**, Suppl., 228 (1843) var. **sulphurata**
The known distribution of this mainly Palaeotropical and Pacific lichen already includes New Caledonia, the Hawaiian Islands, French Polynesia, Tonga and Samoa (Sipman 1983; Elix & McCarthy 2008).

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● Te Kou Track, summit plateau, 21°14′S, 159°46′W, alt. 560–588 m, on tree (*Fitchia* or *Weinmannia*) among ferns, *S.H.J.J. Louwhoff 557B*, 7.vi.1998 (CANB).

18. Physcia dactylifera Elix, *Australas. Lichenol.* **69**, 25 (2011)
Previously only known from Queensland, Australia (Elix 2011a).

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● Raemaru Track, 21°14′S, 159°49′W, alt. 100 m, on *Albizzia* on fern-dominated slopes, *J.A. Elix 42886*, 8.vi.1998 (CANB).

19. Physcia erumpens Moberg, *Nordic J. Bot.* **6**, 856 (1986)
This species was previously known from Africa, Australia, southern Europe, Macaronesia, North and South America and New Zealand (Moberg 1986; Elix 2011b).

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● Muri Lagoon, 21°15′S, 159°44′W, alt. 1 m, on *Hibiscus tiliaceus* along foreshore, *J.A. Elix 42719*, 6.vi.1998 (CANB).

20. Physcia integrata Nyl., *Syn. Meth. Lich.* **1**(2), 424 (1860)
Known from East Africa, Central and South America, Christmas Island (Indian Ocean) and islands of the Pacific including the Northern Marianas, Henderson Island, Tuamotu and Samoa (Elix & McCarthy 2008; Elix 2011b).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Muri Lagoon, 21°15′S, 159°44′W, alt. 1 m, on *Hibiscus tiliaceus* along foreshore, *J.A. Elix 42716*, 6.vi.1998 (CANB); ● *c.* 50 m S of mouth of Avana Stream along Ara Tapu Road, 21°14′S, 159°43′W, alt. 1 m, on bark of *Hibiscus tiliaceus* on the seashore, *S.H.J.J. Louwhoff 622*, 9.vi.1998 (CANB).

21. Physcia undulata Moberg, *Nordic J. Bot.* **6**, 861 (1986)
This species was previously known from East Africa, Australia, Christmas Island (Indian Ocean), Central and South America and New Zealand (Moberg 1986; Elix 2011b).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Muri Lagoon, 21°15′S, 159°44′W, alt. 1 m, on *Hibiscus tiliaceus* along foreshore, *J.A. Elix 42714*, 6.vi.1998 (CANB); ● Te Kou Track, lower level, 21°13′S, 159°46′W, alt. 80 m, on basalt rocks among scattered regrowth forest and taro gardens, *J.A. Elix 42817, 42826*, 7.vi.1998 (CANB), ● Te Kou Track, lower level, 21°13′S, 159°46′W, alt. 80 m, on *Cecropia* trunk in scattered regrowth forest, *J.A. Elix 42862*, 7.vi.1998 (CANB).

22. Pseudocyphellaria argyracea (Delise) Vain., *Hedwigia* **37**, 35 (1898)
The known distribution of this mainly Palaeotropical and Pacific lichen already includes Fiji, Papua New Guinea, New Caledonia, the Hawaiian Islands, the Galapagos Islands, Tahiti and the Solomon Islands (Galloway 1994).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Taputarangi Track, 21°12′S, 159°48′W, alt. 100 m, on basalt rocks and base of trees in open forest, *J.A. Elix 42752*, *42758*, *42765*, 6.vi.1998 (CANB); ● 400 m E of Water Tanks, 21°14′S, 159°45′W, alt. 60 m, on water pipes and bark of *Hibiscus* in moist lowland tropical forest, *J.A. Elix 42783, 42788*, 6.vi.1998 (CANB); ● Te Kou Track, lower level, 21°13′S, 159°46′W, alt. 80 m, on *Cecropia* trunk and branches in scattered regrowth forest and taro gardens, *J.A. Elix 42842*, 7.vi.1998 (CANB); ● Raemaru Track, upper level, 21°14′S, 159°49′W, alt. 200 m, on dead wood on fern-dominated slopes with scattered *Albizzia*, *J.A. Elix 42899*, 8.vi.1998 (CANB); ● Papua Falls, Papua Stream, 21°14′S, 159°47′W, alt. 40 m, on *Cecropia peltata*, in open area in moist forest, *J.A. Elix 42940, 42944*, 9.vi.1998 (CANB); ● track from the north to Te Rua Manga (The Needle), 21°13′S, 159°46′W, alt. 200 m, on dead branch in dense rainforest, *J.A. Elix 42955*, 9.vi.1998 (CANB).

23. Pyxine cocoes (Sw.) Nyl., *Mem. Soc. Sci. Nat. Cherbourg* **5**, 108 (1858)
This pantropical species is known throughout the South Pacific, including Lord Howe Island, Norfolk Island, New Caledonia, Marquesas Islands, Pitcairn Islands, Tahiti and Tuamotu (Elix & McCarthy 2008).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Papua Falls, Papua Stream, 21°14′S, 159°47′W, alt. 40 m, on *Cecropia peltata*, in open area in moist forest, *J.A. Elix 42933 p.p.*, 9.vi.1998 (CANB); ● mouth of Avana Stream, 21°14′S, 159°43′W, alt. 1 m, on *Hibiscus* trunk in strand vegetation, *J.A. Elix 43006*, 9.vi.1998 (CANB).

24. Pyxine fallax (Zahlbr.) Kalb, *Biblioth. Lichenol.* **88**, 315 (2004)
This paleotropical species is known from South-east Asia, Australia and in the Pacific from the Hawaiian and Bonin Islands (Elix & McCarthy 2008; Elix 2011b).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga.* ● Te Kou Track, lower level, 21°13′S, 159°46′W, alt. *c.* 80 m, on dead log in regrowth forest, *J.A. Elix 42832*, 7.vi.1998 (CANB); ● Raemaru Track, lower level, 21°14′S, 159°49′W, alt. 100 m, on *Albizzia* on fern-dominated slope, *J.A. Elix 42877*,

8.vi.1998 (CANB); ● Papua Falls, Papua Stream, 21°14′S, 159°47′W, alt. 40 m, on *Cecropia peltata* in open area in moist forest, *J.A. Elix 42945*, 9.vi.1998 (CANB).

25. Pyxine farinosa Kashiw., *Bull. Natl. Sci. Mus. Tokyo,* B, **3**, 67 (1977)
This paleotropical species is known from South and East Asia, Australia and in the Pacific from Papua New Guinea and Micronesia (Yap Island) and Tahiti (Elix & McCarthy 2008; Elix 2011b).

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● Raemaru Track, upper level, 21°14′S, 159°49′W, alt. 200 m, on basalt rocks on fern-dominated slope with scattered *Albizzia*, *J.A. Elix 42927*, 8.vi.1998 (CANB).

26. Pyxine retirugella Nyl., *Ann. Sci. Nat., Bot.*, sér. 4, **11**, 240 (1859)
The known distribution of this mainly Palaeotropical and Pacific lichen already includes the Bonin Islands, New Caledonia, the Hawaiian Islands, Kiribati, Marquesas Islands, Pitcairn Islands and Tahiti (Elix & McCarthy 2008; Elix 2011b).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Taputarangi Track, 21°12′S, 159°48′W, alt. 40–100 m, on fallen tree in open forest, *J.A. Elix 42746*, 6.vi.1998 (CANB); ● Avana Stream, 400 m E of Water Tanks, 21°14′S, 159°45′W, alt. 60 m, on bark of *Hibiscus tiliaceus* in moist lowland forest, *J.A. Elix 42789, 42805*, 6.vi.1998 (CANB); ● Te Kou Track, lower level, 21°13′S, 159°46′W, alt. *c.* 80 m, on basalt in a forest clearing, *J.A. Elix 42811*, 7.vi.1998 (CANB); ● Raemaru Track, upper level, 21°14′S, 159°49′W, alt. 270 m, on treelet, slope near summit cliff, *J.A. Elix 42907*, 8.vi.1998 (CANB); ● track to Te Rua Manga (The Needle), 21°13′S, 159°46′W, alt. 200 m, on dead branch in dense rainforest, *J.A. Elix 42956*, 9.vi.1998 (CANB).

27. Sporopodium phyllocharis (Mont.) A.Massal., *Geneac. Lich.* 9 (1855)
This pantropical, foliicolous species is known throughout the Pacific region, its range including New Caledonia, Tonga, Samoa, American Samoa, French Polynesia and the Hawaiian Islands (Elix & McCarthy 2008).

SPECIMEN EXAMINED
Cook Islands: *Rarotonga*. ● track from the north to Te Rua Manga (The Needle), 21°13′S, 159°46′W, alt. 200 m, on leaves of *Inocarpus fagifer* in dense rainforest, *P.M. McCarthy 4656, 4659, 4660, 9.vi.1998* (CANB).

28. Thelotrema diplotrema Nyl., *Ann. Sci. Nat., Bot.*, sér. 4, **11**, 258 (1859)
This pantropical species is already known in the South Pacific from New Caledonia (Mangold *et al.* 2008).

SPECIMENS EXAMINED
Cook Islands: *Rarotonga*. ● Raemaru Track, upper level, 21°14′S, 159°49′W, alt. 200 m, on branch, on fern-dominated slopes with scattered *Albizzia*, *P.M. McCarthy 4661*, 8.vi.1998 (CANB); ● track from the north to Te Rua Manga (The Needle), 21°13′S, 159°46′W, alt. 200 m, on branch in dense rainforest, *P.M. McCarthy 1255*, 9.vi.1998 (CANB).

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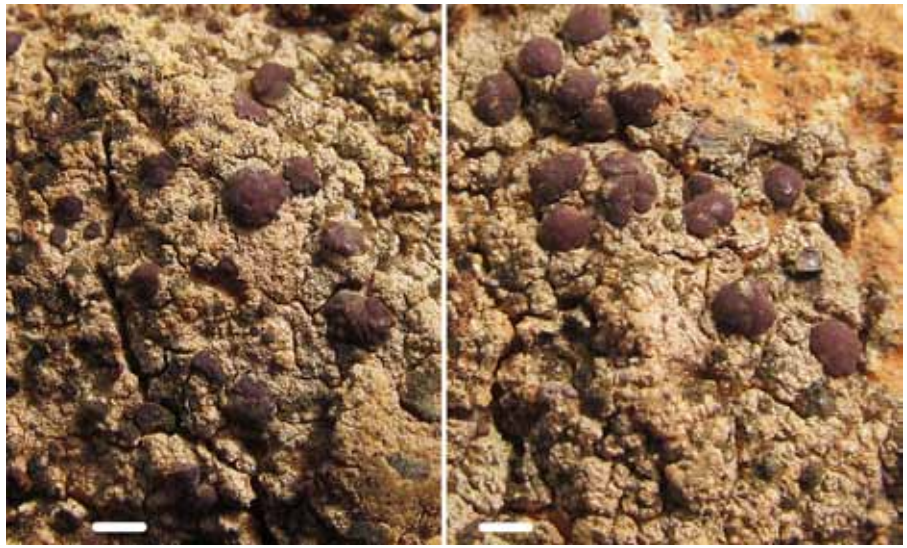

Figure 1. *Lecanographa solicola* (holotype). Scale bars: 1 mm.

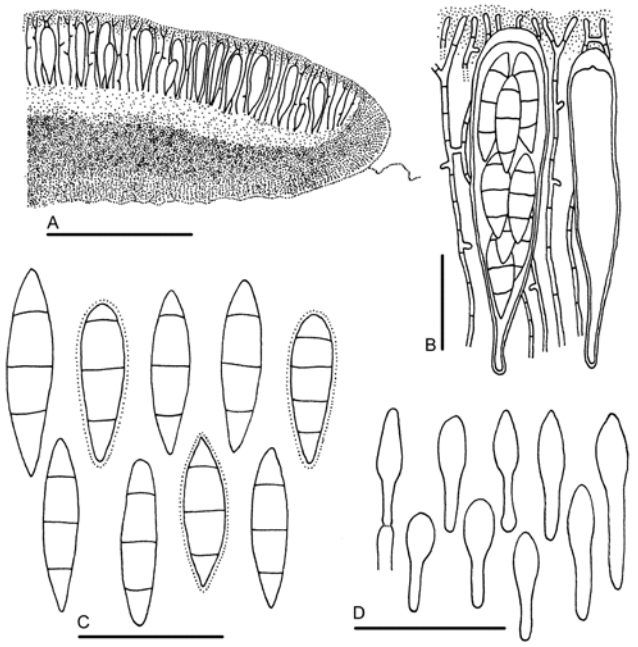

Figure 2. *Lecanographa solicola* (holotype). A, Part of a sectioned apothecium (semi-schematic); B, Immature and mature asci with paraphysoids (in water); C, Ascospores; D, Conidia. Scale bars: A = 0.2 mm; B, C = 20 µm; D = 5 µm.

Figure 3. *Pseudocyphellaria louwhoffiae* (holotype; dry thallus). Scale bar: 5 mm.

Figure 4. *Pseudocyphellaria louwhoffiae* (holotype; wet thallus). Scale bar: 5 mm.

Acarospora *aff.* **veronensis** A.Massal. ..... this paper
Amandinea efflorescens var. **pseudohypopelidna** Marbach ..... this paper
Anisomeridium anisolobum (Müll.Arg.) Aptroot ..... McCarthy (2000)
Anisomeridium carinthiacum (J.Steiner) R.C.Harris ..... McCarthy (2000)
Anisomeridium consobrinum (Nyl.) Aptroot ..... McCarthy (2000)
Buellia bahiana Malme ..... Elix (2016)
Buellia rarotongensis Elix ..... Elix (2016)
Bulbothrix goebelii (Zenker) Hale ..... Louwhoff & Elix (2000)
Bulbothrix isidiza (Nyl.) Hale ..... Louwhoff & Elix (2000)
Bulbothrix tabacina (Mont. & Bosch) Hale ..... Louwhoff & Elix (2000)
Calopadia vermiculifera (Vain.) Sérus. ..... this paper
Canoparmelia rarotongensis Louwhoff & Elix ..... Louwhoff & Elix (2000)
Celothelium cinchonarum (Müll.Arg.) Vain. ..... McCarthy (2000)
Chrysothrix candelaris (L.) J.R.Laundon ..... this paper
Coccocarpia palmicola (Spreng.) Arv. & D.J.Galloway ..... Arvidsson (1982)
Coenogonium lutescens (Vězda & Malcolm) Malcolm ..... this paper
Coenogonium queenslandicum (Kalb & Vězda) Lücking ..... this paper
Collema rugosum Kremp.* ..... Degelius (1974)
Diorygma pruinosum (Eschw.) Kalb, Staiger & Elix ..... this paper
Dirinaria aegialita (Ach.) B.Moore ..... this paper
Dirinaria applanata (Fée) D.D.Awasthi ..... this paper
Dirinaria picta (Sw.) Schaer. ex Clem. ..... Vainio (1924) [?]
Gassicurtia subpulchella (Vain.) Marbach ..... Elix (2016)
Glyphis cicatricosa var. **simplicior** (Vain.) Zahlbr. ..... Sbarbaro (1939)
Glyphis parksiana Räsänen ..... Sbarbaro (1939)
Graphis furcata Fée ..... this paper
Heterodermia isidiophorella Elix ..... this paper
Heterodermia japonica (Sato) Swinscow & Krog ..... this paper
Heterodermia obscurata (Nyl.) Trevis. ..... this paper
Heterodermia propagulifera (Vain.) Dey ..... this paper
Lecanographa solicola P.M.McCarthy & Elix ..... this paper
Lecanora tropica Zahlbr. ..... this paper
Lecanora leprosa Fée ..... Sbarbaro (1939)
Leptogium azureum (Sw. ex Ach.) Mont. ..... Sbarbaro (1939)
Leptogium cyanescens var. **trachynum** Vain. ..... Sbarbaro (1939)
Leptogium diaphanum (Mont.) Nyl. ..... Jatta (1903)
Leptogium fallax Müll.Arg. ..... Jatta (1903)
Leptogium moluccanum var. **hypoleia** Vain. ..... Sbarbaro (1939)
Megalospora *aff.* **austropacifica** Lumbsch, Naikatini & Lücking ..... this paper
Megalospora sulphurata Meyen var. **sulphurata** ..... this paper
Parmotrema cristiferum (Taylor) Hale ..... Louwhoff & Elix (2000)
Parmotrema endosulphureum (Hillm.) Hale ..... Louwhoff & Elix (2000)
Parmotrema reticulatum (Taylor) M.Choisy ..... Louwhoff & Elix (2000)
Parmotrema saccatilobum (Taylor) Hale ..... Louwhoff & Elix (2000)
Parmotrema tinctorum (Despr. ex Nyl.) Hale ..... Louwhoff & Elix (2000)
Pertusaria atroguttata A.W.Archer & Elix ..... Archer & Elix (2015)
Pertusaria commutata Müll.Arg. ..... Archer & Elix (2015)
Pertusaria homilocarpa A.W.Archer & Elix ..... Archer & Elix (2015)
Pertusaria megacarpa A.W.Archer & Elix ..... Archer & Elix (2015)
Pertusaria montpittensis A.W.Archer ..... Archer & Elix (2015)
Pertusaria rarotongensis A.W.Archer & Elix ..... Archer & Elix (2015)
Pertusaria rarotongensis var. **stictica** A.W.Archer & Elix ..... Archer & Elix (2015)
Pertusaria thiospoda C.Knight ..... Archer & Elix (2015)

Physcia dactylifera Elix ..... this paper
Physcia erumpens Moberg ..... this paper
Physcia integrata Nyl. ..... this paper
Physcia undulata Moberg ..... this paper
Physma byrsinum (Ach.) Tuck. ..... Sbarbaro (1939)
Porina *aff.* **cestrensis** (Mich.) Müll.Arg. ..... McCarthy (2000)
Porina deminuta P.M.McCarthy ..... McCarthy (2000)
Porina exocha (Nyl.) P.M.McCarthy ..... McCarthy (2000)
Porina farinosa C.Knight ..... McCarthy (2000)
Porina guentheri (Flot.) Zahlbr. ..... McCarthy (2000)
Porina mastoidea (Ach.) Müll.Arg. ..... McCarthy (2000)
Porina nucula Ach. ..... McCarthy (2000)
Porina perminuta Vain. ..... McCarthy (2000)
Porina subinterstes (Nyl.) Müll.Arg. ..... McCarthy (2000)
Porina tetracerae (Ach.) Müll.Arg. ..... McCarthy (2000)
Pseudocyphellaria argyracea (Delise) Vain. ..... this paper
Pseudocyphellaria desfontainii (Delise) Vain. ..... Sbarbaro (1939)
Pseudocyphellaria homalosticta Vain. ..... Galloway (1994)
Pseudocyphellaria louwhoffiae Elix ..... this paper
Pseudocyphellaria intricata (Delise) Vain. ..... Sbarbaro (1939)
Pseudocyphellaria prolificans (Nyl.) Vain. ..... Galloway (1994)
Pyrenula astroidea (Fée) R.C.Harris ..... McCarthy (2000)
Pyrenula *aff.* **citriformis** R.C.Harris ..... McCarthy (2000)
Pyrenula concatervans (Nyl.) R.C.Harris ..... McCarthy (2000)
Pyrenula confinis (Nyl.) R.C.Harris ..... McCarthy (2000)
Pyrenula leucostoma Ach. ..... McCarthy (2000)
Pyrenula macularis (Zahlbr.) R.C.Harris ..... McCarthy (2000)
Pyrenula nitidula (Bres.) R.C.Harris ..... McCarthy (2000)
Pyrenula ochraceoflava (Nyl.) R.C.Harris var. **ochraceoflava** ..... McCarthy (2000)
Pyrenula ochraceoflava var. **pacifica** P.M.McCarthy ..... McCarthy (2000)
Pyrenula philippina var. **oceanica** Sbarbaro ..... Sbarbaro (1939)
Pyxine cocoes (Sw.) Nyl. ..... this paper
Pyxine fallax (Zahlbr.) Kalb ..... this paper
Pyxine farinosa Kashiw. ..... this paper
Pyxine retirugella Nyl. ..... this paper
Ramalina australiensis Nyl. ..... Blanchon & de Lange (2011)
Ramalina microspora Kremp. ..... Blanchon & de Lange (2011)
Ramalina leiodea (Nyl.) Nyl. ..... Blanchon & de Lange (2011)
Ramalina luciae Molho, Bodo, W.L.Culb. & C.F.Culb.** ..... Blanchon & de Lange (2011)
Ramalina pacifica Asah. var. **pacifica** ..... Stevens (1983)
Ramalina peruviana Ach. ..... Blanchon & de Lange (2011)
Ramalina subcomplanata Nyl. ..... Sbarbaro (1939)
Ramalina subfraxinea Nyl. ..... Sbarbaro (1939)
Sporopodium phyllocharis (Mont.) A.Massal. ..... this paper
Sticta sinuosa Pers. ..... Sbarbaro (1939)
Strigula decipiens (Malme) P.M.McCarthy var. **decipiens** ..... McCarthy (2000)
Strigula decipiens var. **divisa** P.M.McCarthy ..... McCarthy (2000)
Strigula smaragdula Fr.:Fr. ..... McCarthy (2000)
Strigula "sp. A" ..... McCarthy (2000)
Thelotrema diplotrema Nyl. ..... this paper
Thelotrema monosporum Nyl. ..... Sbarbaro (1939)
Trichothelium assurgens (Cooke) Aptroot & Lücking ..... McCarthy (2000)
Usnea fautauenis Vain. ..... Sbarbaro (1939)
Usnea nidifica Taylor ..... Motyka (1936–38) [?]
Varicellaria velata (Turner) Schmitt & Lumbsch ..... Archer & Elix (2015)

Verrucaria fortuita P.M.McCarthy ..... McCarthy (2000)
Verrucaria fuscella (Turner) Winch ..... McCarthy (2000)
Verrucaria howensis P.M.McCarthy ..... McCarthy (2000)
Verrucaria mundula P.M.McCarthy ..... McCarthy (2000)
Xanthoparmelia subramigera (Gyeln.) Hale ..... Louwhoff & Elix (2000)
* Aitutaki
** Rarotonga and Mangaia

Ten new lichen species (Ascomycota) from Australia

John A. Elix
Research School of Chemistry, Building 137
Australian National University, Canberra, A.C.T. 2601, Australia
e-mail: John.Elix@anu.edu.au

Patrick M. McCarthy
64 Broadsmith St, Scullin, A.C.T. 2614, Australia
e-mail: pmcc2614@hotmail.com

Abstract

Ten lichens (Ascomycota) are described as new from Australia: *Byssoloma australiense* P.M.McCarthy & Elix (Pilocarpaceae; Queensland, New South Wales), *Catillaria laevigata* P.M.McCarthy & Elix (Catillariaceae; eastern New South Wales), *Cladia xanthocarpa* Elix & P.M.McCarthy (Cladoniaceae; north-eastern Queensland), *Japewiella variabilis* Elix & P.M.McCarthy (Lecanoraceae; the Australian Capital Territory, New South Wales, Queensland, South Australia, Western Australia), *Lecidella meridionalis* Elix & P.M.McCarthy (Lecanoraceae; Western Australia, South Australia, Victoria, New South Wales), *L. occidentalis* Elix & P.M.McCarthy (Western Australia), *Megalaria insularis* P.M.McCarthy & Elix (Ramalinaceae; Norfolk Island), *Micarea humilis* P.M.McCarthy & Elix (Pilocarpaceae; the Australian Capital Territory, New South Wales), *Porpidia littoralis* (Lecideaceae; southern New South Wales) and *Ramboldia oxalifera* P.M.McCarthy & Elix (Lecanoraceae; northern New South Wales). The new combination *Lecidella leptolomoides* (Müll.Arg.) Elix is made for *Lecidea leptolomoides* Müll.Arg.

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Introduction

New and newly reported Australian lichens (lichenized Ascomycota) have been documented by us in recent papers (McCarthy & Elix 2016, 2017; Elix & McCarthy 2017). In this contribution, we describe ten new species based on our collections and other partially identified material in CANB. Most are known from southern Australia, and they represent the genera *Byssoloma* Trevis. (Pilocarpaceae), *Catillaria* A.Massal. (Catillariaceae)**,** *Cladia* Nyl. (Cladoniaceae)**,** *Japewiella* Printzen (Lecanoraceae), *Lecidella* Körb. (Lecanoraceae), *Megalaria* Hafellner (Ramalinaceae), *Micarea* Fr. (Pilocarpaceae), *Porpidia* Körb. (Lecideaceae) and *Ramboldia* Kantvilas & Elix (Lecanoraceae).

Methods

Observations and measurements of photobiont cells, thalline and apothecial anatomy, asci, ascospores, pycnidial anatomy and conidia were made on hand-cut sections mounted in water and treated with 10% potassium hydroxide (K), 50% nitric acid (N) and 10% hydrochloric acid (H). Calcium oxalate was detected by treatment of thalline and apothecial sections with a 10% aqueous solution of sulfuric acid; it forms colourless, needle-shaped crystals. Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K. Chemical constituents were identified by thin-layer chromatography (Elix 2014) and comparison with authentic samples.

New species

1. Byssoloma australiense P.M.McCarthy & Elix, sp. nov**.** Figs 1, 2
MycoBank No. **MB 822597**

Thallus crustose, epilithic, rimose to areolate, or consisting of thick, dense aggregations of pseudoisidia, ecorticate, containing xanthones. Apothecia black, adnate to subsessile, lecideine to biatorine, 0.23–0.54 mm wide, convex; proper excipulum annular, greenish brown to greenish black, with unbranched, vestigial, byssoid hyphae that become obscured as the apothecial margin becomes excluded; hypothecium dark brown to brown-black, 75–120(–170) µm thick; asci *Byssoloma*-type, 38–60 × 9–14 µm; ascospores narrowly ellipsoid to oblong-ellipsoid, fusiform or oblong, 3-septate, 9–16 × 3.5–5 µm. Pycnidia with obpyriform to obampulliform or biclavate conidia, 3–5(–6.5) × 1–1.5(–2) µm.

Type: Australia, Queensland, E of entrance to Carnarvon National Park, 90 km NNW of Injune, 25°04'S, 148°16'E, 460 m alt., on sandstone of escarpment in *Eucalyptus* woodland, *J.A. Elix 34203*, 21.viii.1993 (holotype – CANB).

Thallus crustose, epilithic, forming discrete colonies to 4 cm wide, off-white or pale grey to pale greyish green, rimose to areolate (areoles to 0.3 mm wide) and up to 0.1(–0.12) mm thick, the surface smooth to irregularly rugose or verrucose, or the thallus 0.3–0.8(–1) mm thick and consisting of aggregations of subglobose or oblong, erect to prostrate, smooth pseudoisidia 50–80(–100) µm in maximum extent, ecorticate, but often with a 2–4 µm thick necral layer, or an outermost layer of periclinal hyphae. *Algal layer* well defined or not, 30–60 µm thick; cells green, globose, chlorococcoid, 6–13(–15) µm diam.; interstitial hyphae 1–2(–2.5) µm wide. *Medulla* poorly delimited, 30–50 µm thick, the hyphae, thin-walled, short- to long-celled, 2–4 µm wide. *Prothallus* usually absent or not apparent, or more distinct and thin, effuse, whitish to silvery grey. *Apothecia* usually moderately numerous to abundant, lecideine or biatorine, adnate to subsessile, not or slightly constricted at the base, rounded in outline and usually solitary, (0.23–)0.40(–0.54) mm diam. [*n* = 120], or more irregular in shape when in pairs or clusters of 3–5 merging or proliferating apothecia, moderately to strongly convex, dull black, smooth; margin concolorous with the disc or slightly paler, soon becoming excluded. *Thalline excipulum* absent. *Proper excipulum* uniformly greenish brown to greenish black, or with a much paler brown outer zone 10–15 µm thick and consisting of tightly contiguous, elongate, thick-walled hyphae, 2–2.5 µm wide, from which the vestigial, byssoid hyphae originate, narrowly annular and with a broad gap in the centre of the apothecial base, 25–40 µm thick laterally (thin section), 30–60 µm thick at the base which can scarcely be distinguished from the adjacent hypothecium, K+ grey-green to purple-brown, N+ pale red-brown to purple-brown; immature apothecia with numerous, unbranched, hyaline hyphae projecting laterally from the proper excipulum (8–15 µm long and 2.5–5 µm wide), longer and more numerous hyphae projecting from the outer base of the excipulum [to 25(–30) µm long]; hyphae becoming less noticeable as the apothecia mature, become more convex and the excipulum is almost excluded. *Hypothecium* dark brown with a reddish tinge to brown-black, 75–120(–170) µm thick, most pronounced in the most convex apothecia, K+ deep purple to purple-black, N+ deep red-brown; hyphae thick-walled, 2–3(–4) µm wide, variously oriented in the centre, more elongate and radiating laterally towards the excipulum and downwards towards the apothecial base. *Hymenium* 50–70 µm thick, inspersed with sparse to numerous granules, dissolving in K, I+ blue; subhymenium indistinct. *Epihymenium* 7–10(–15) µm thick, dark brown to dark olive-brown or bluish grey, with or without crystals, K+ purple-brown or dilute indigo, N+ purple. *Paraphyses* tightly conglutinate in water, loosening a little in K, sparingly to richly branched and anastomosing, long-celled, 0.8–1(–1.5) µm thick; apices not or scarcely swollen (clavate or globose and up to 2 µm wide), not pigmented. *Asci* narrowly to broadly clavate or cylindroclavate, *Byssoloma*-type (Hafellner 1984), 8-spored, 38–60 × 9–14 µm [*n* = 20]. *Ascospores* colourless, 3-septate at maturity, narrowly ellipsoid to oblong-ellipsoid, fusiform or oblong, straight or slightly curved, irregularly biseriate in the ascus, occasionally slightly constricted at the septa, (9–)13(–16) × (3.5–)4.5(–5) µm [*n* = 173], thin-walled, with or without an uneven perispore to 1 µm thick; contents clear. *Pycnidia* absent or moderately numerous to abundant especially near the thallus margin, semi-immersed to almost completely immersed in the thallus, rounded to pyriform, 50–80(–100) µm wide; apex greenish black to black, plane to slightly concave, to 80 µm wide; conidiogenous layer simple, the conidiophores unbranched, 10–15 µm long. *Conidia* obpyriform to obampulliform, occasionally biclavate, 3–5(–6.5) × 1–1.5(–2) µm.

Chemistry: Thallus K–, C–, KC–, PD–, UV+ orange; containing 2,5,7-trichloro-3-*O*-methylnorlichexanthone (major), 5,7-dichloro-3-*O*-methylnorlichexanthone (minor), ±3-*O*-methylasemone (minor) by TLC.

Etymology: The specific epithet refers to discovery of the new species in Australia.

Remarks

Byssoloma australiense is characterized by having a pale, well-developed thallus that is variable in colour and morphology (see below), but, more significantly, by the combination of convex apothecia with a reduced or excluded proper margin at maturity, marginal, byssoid outgrowths that are faint in immature apothecia, eventually seen only in thin section as short, simple hyphae projecting from the lower sides and base of the excipulum, and persistently 3-septate ascospores.

A genus of 46 known taxa, most *Byssoloma* species are obligately foliicolous in tropical, subtropical and warm-temperate regions; a small minority are known to inhabit the bark of forest trees, and even fewer are saxicolous. The almost cosmopolitan *B. subdiscordans* (Nyl.) P.James, which can grow on leaves, bark and rock, has a thin and often effuse thallus 20–30(–50) µm thick, and usually plane to slightly convex apothecial discs each with a well-developed, whitish tomentose-arachnoid margin (Lücking 2008; Giavarini and Sérusiaux 2009). While it is commonly saxicolous in Europe, elsewhere it is usually found on bark and leaves. The saxicolous *B. adspersum* Malcolm & Vězda, from New Zealand and south-eastern Australia, has an uneven, continuous to sparingly rimose thallus, larger apothecia than those of *B. australiense*, 0.5–0.8 mm wide, with a reduced but usually persistent byssoid margin and mostly longer, 3–5-septate ascospores (Malcolm and Vězda 1995). The only other rock-inhabiting member of the genus, *B. octomerum* Malcolm & Vězda, which is apparently endemic to New Zealand, has apothecia to 1 mm wide and (5–)7-septate ascospores 22–35 × 4–4.5 µm (Malcolm and Vězda 1995).

While apothecial morphology and anatomy vary little among the specimens examined, particularly the thickness and colour of the tissue layers, as well as asci, ascospores and the diagnostic, vestigial, byssoid margin of the proper excipulum, there is a rather broad continuum of thallus morphology. In the holotype, the effective unit of thallus development is a smooth, subglobose to oblong pseudoisidium that is 50–80(–100) µm in maximum extent. As the thallus grows, pseudoisidia divide, form clusters and, eventually, a pale grey-green thallus up to 0.5(–1) mm thick. The mature thallus has the appearance of being areolate, but individual areolae, irregular in shape and up to 1.5 mm wide, are simply aggregations of pseudoisidia, which barely adhere to the rock (some scarcely touching the substratum) and are held in place by their neighbours. As the thallus becomes thicker, older granules become compacted below, and an entire areole can be dislodged at the lightest touch. The whitish to pale grey specimen from the South Coast, New South Wales (*J.A. Elix 45223*) begins as a smooth, continuous, tightly adnate crust on which cracks develop, these forming small, plane then convex areoles that become uneven with ridges and convex verrucae. The thallus grows radially, and even has a faint and diffuse silvery grey prothallus inside which pycnidia develop in abundance; by contrast, and due to its more irregular development, the holotype lacks a discernible margin, and consequently lacks a prothallus and pycnidia. Collections from the Southern Tablelands (*W.H. Ewers 409*) and the North Coast, New South Wales (*J.A. Elix 44306*) are more similar to the South Coast material in their early thallus development, but their thalline verrucae develop into more prominent, smooth granules and, in the latter, eventually pseudoisidia very similar to those of mature thalli in the holotype.

Byssoloma australiense is known from siliceous rocks in the Southern Brigalow Belt in central Queensland, in *Eucalyptus* woodland in northern New South Wales, in *Callitris*-dominated vegetation in the Southern Tablelands and in coastal woodland on the South Coast.

SPECIMENS EXAMINED

New South Wales: ● North Coast, junction of Hickeys Creek Road and Kempsey–Armidale road, 38 km NW of Kempsey, 30°53’02”S, 152°35’55”E, 80 m alt., on sandstone in *Eucalyptus* woodland, *J.A. Elix 44306*, 8.viii.2008 (CANB); ● Southern Tablelands, 8 km SE of Araluen, 35°36’S, 149°48’E, *c.* 100 m alt., on siliceous rock in *Casuarina*-dominated vegetation, *W.H. Ewers 4090*, 3.ix.1989 (CANB); ● South Coast, Mummaga Lake Walk, Bodalla State Forest, 7 km SSE of Bodalla, 36°09’03”S, 150°05’46”E, 4 m alt., on siliceous rock in wet *Eucalyptus* woodland along inlet, *J.A. Elix 45223*, 10.iv.2010 (CANB).

2. Catillaria laevigata P.M.McCarthy & Elix, sp. nov. Figs 3, 4
MycoBank No. **MB 822599**

Thallus crustose, thin, smooth, continuous to rimose, grey-brown to dark brown, 30–50(–70) µm thick, containing argopsin. Apothecia black, subsessile to sessile, lecideine, 0.21–0.47 mm wide, with a plane to convex disc and a thin, persistent proper margin; proper excipulum dark brown to brown-black throughout; epihymenium dark brown, K+ purple-brown; hypothecium pale brown to yellowish brown above, inspersed with granules and oil globules; asci *Catillaria*-type, 30–40 × 8–12 µm; ascospores fusiform, narrowly ellipsoid or oblong, 1-septate, 7–11 × 2–3.5 µm. Pycnidia with narrowly ellipsoid, fusiform or bacilliform conidia 1.5–3 × 0.5–0.8 µm.

Type: Australia, Australia, New South Wales, Central Coast, Buladelah, Alum Mtn, 32°25’S, 152°12’E, *c.* 100 m alt., on rhyolite boulder in dry sclerophyll forest, *H. Streimann 44162*, 24.iv.1990 (holotype – CANB).

Thallus crustose, epilithic, ± determinate, continuous to sparingly or richly rimose, not areolate, smooth, slightly glossy, medium grey-brown to dark brown, 30–50(–70) µm thick, forming colonies to 5 cm wide, ecorticate, not containing calcium oxalate (H_2SO_4–). *Algae* green, globose, chlorococcoid, 6–12(–18) µm wide; interstitial mycobiont hyphae short-celled, (2–)2.5–3.5 µm wide. *Prothallus* not apparent. *Apothecia* very numerous, lecideine, mostly solitary, initially adnate, becoming subsessile to sessile, mostly rounded in outline, (0.21–)0.36(–0.47) mm diam. [*n* = 70]; disc usually plane, occasionally moderately convex, smooth, dull black, epruinose, the colour unchanged when wetted; margin concolorous with the disc, to 50 µm wide, entire, initially prominent, becoming less so but persisting even in the most convex apothecia. *Proper excipulum* annular, non-carbonized, laterally dark brown to brown-black, 17–30 µm thick, the outermost cells rounded, thick-walled and brown-black, 4–7 µm wide, K–, N+ green-black (but on standing changing to deep orange or red-brown), subtended by dark brown, radiating, prosoplectenchymatous hyphae 1.5–2.5 µm wide, these K–, N+ deep orange-brown to red-brown (slow reaction); excipulum base similarly pigmented and anatomically identical, 35–50 µm thick. *Hypothecium* with a pale yellowish brown or pale brown upper zone 20–30 µm thick and inspersed with minute granules and oil globules, K+ deep yellow to yellow-brown, N–, the cells variously oriented, rather thick-walled, 2.5–4 µm wide, subtended by an almost colourless and non-inspersed zone 60–100 µm deep in the centre of a medial section, penetrating the thallus as a blunt, hyaline to pale yellow-brown ‘root’ (K+ deep yellow in part, N+ red brown in part); ‘root’ hyphae vertically elongate, 2–3 µm wide. *Hymenium* uniformly hyaline, or with a few pale blue-green streaks, 35–45 µm thick, not inspersed with granules or oil globules, K–, N–, KI+ blue; subhymenium indistinct. *Epihymenium* dark brown, 7–10 µm thick, K+ purple-brown (fading), N–. *Paraphyses* not strongly conglutinate in water, simple below, sparingly dichotomously branched in and immediately below the epihymenium, short- to long-celled, 1–1.5(–2) µm wide, the septa frequently constricted; apices usually markedly and abruptly swollen, 2.5–4(–6) µm wide, rounded, rather flattened or irregular, most with a well-defined, dark brown, internal cap of pigment. *Asci* 8-spored, narrowly clavate or ± narrowly ellipsoid, 30–40 × 8–12 µm [*n* = 20], *Catillaria*-type (Hafellner 1984); apex rounded, with a thick, uniformly and deeply amyloid tholus, usually lacking an ocular chamber (occasionally a minute, low-conical invagination can be seen in immature asci), plane or convex against the ascoplasm. *Ascospores* colourless, irregularly biseriate in the ascus, 1-septate, mostly fusiform, occasionally narrowly ellipsoid or oblong, usually with acute or subacute ends, or the distal end more rounded, thin-walled, lacking a perispore, rarely slightly constricted at the septum, (7–)9.5(–11) × (2–)2.5(–3.5) µm [*n* = 60]; contents usually clear. *Pycnidia* solitary, sparse, semi-immersed in the thallus, convex and brown-black above, hyaline below, 60–80 µm wide; conidiophores unbranched, to 10 µm long. *Conidia* narrowly ellipsoid, fusiform or bacilliform, 1.5–2.5(–3) × 0.5–0.8 µm.
Chemistry: Thallus K−, C−, KC−, P+ orange, UV−; containing argopsin (major).

Etymology: The specific epithet refers to the smooth thallus of the type specimen.

Remarks

Catillaria laevigata is a member of the *C. chalybeia* (Borrer) A.Massal. group of species (*sensu* Kilias 1981) due to the apices of paraphyses being abruptly swollen and having an internal pigment cap. It is one of only two species in the genus containing lichen substances. The other, *C. austrolittoralis* Kantvilas & van den Boom, is known from siliceous seashore rocks in South Australia, Tasmania, Victoria and southern New South Wales, and it produces either argopsin or pannarin (Kantvilas & van den Boom 2013). However, *C. austrolittoralis* has a grey or brownish, areolate thallus up to 150 µm thick, the areoles being plane to convex or bullate, also a K– (rather than K+ purple-brown) epihymenium, a uniformly pale hypothecium with or without oil globules (these occupying a darker, distal, hypothecial zone in *C. laevigata*), as well as broader ascospores (7–)7.5–*9.8*–12.5(–13) × (3–)3.5–*4*–4.5(–5) µm, and broader conidia 2–3.5 × 0.8–1 µm (Kantvilas & van den Boom 2013).

Kantvilas and van den Boom (2013) noted two anomalous, argopsin-containing specimens from an inland locality in the south-west of Western Australia, these having a thicker and darker hypothecium, to 110 µm and red-brown to dark brown in the upper part, and narrower ascospores, 2.5–3.5 µm wide. The specimens (Mount Observation National Park, near summit of Mt Observation, 20 km W of York, 31°53'45"S, 116°33'26"E, 365 m alt., on laterite outcrops in *Eucalyptus* woodland, *J.A. Elix 31710, 31713*, 21.iv.2004, CANB), called '*Catillaria* sp. A' in the following key, have comparatively robust, pale to rather dark brownish grey, areolate thalli up to 0.2 mm thick. The areoles are 0.2–0.8(–1) mm wide, smooth to low-verrucose or irregularly rugose, separated by deep cracks, and the largest areoles are commonly constricted at the base, with slightly raised and scalloped margins, thus resembling minute squamules. The apothecia are 0.22–0.44 mm wide, dull black, adnate to sessile, with a plane to strongly convex disc and a thin, persistent proper margin. The upper hypothecium, distinctively darker than more basal parts, is not inspersed with granules or oil. While this entity is clearly distinct from *C. laevigata* and *C. austrolittoralis*, its circumscription is complicated by another Western Australian collection (Gairdner River, South Coast Highway, 5 km ENE of Jerramungup, 33°15'S, 118°58'E, 260 m alt., on granite outcrops in cleared grassy paddock with small scattered trees, *J.A. Elix 41535*, 18.ix.1994, CANB) that broadly matches it all respects, except for the critical difference of having a uniformly hyaline to very pale brown hypothecium. Of uncertain significance is the fact that the hypothecium in the Mt Observation specimens penetrates the thallus as a broad, shallow 'root', in contrast to the Gairdner River collection in which an 'upwelling' of thalline material appears to confine the hypothecium above the level of the excipular base.

The new species is known only from rhyolite rocks at the type locality in dry sclerophyll forest near Buladelah, New South Wales.

Key to saxicolous species of the *Catillaria chalybeia* group

[Based on Kilias 1981; Fryday & Coppins 1996; van den Boom 2002; Fryday 2004; Hertel *et al.* 2008; Fletcher & Coppins 2009; Kantvilas & van den Boom 2013; Kondratyuk *et al.* 2016; McCarthy & Elix 2017]

1 Thallus with black isidia [The Netherlands] ..... **C. nigroisidiata**
1: Thallus lacking isidia 2

2 Asci (12–)16-spored [Scotland] ..... **C. gilbertii**
2: Asci 8-spored 3

3 Thallus containing argopsin or pannarin 4
3: Thallus lacking lichen substances 6

4 Ascospores 3–5 µm wide; thallus containing argopsin or pannarin [southern Australia] ..... **C. austrolittoralis**
4: Ascospores 2–3.5 µm wide; thallus containing argopsin only 5

5 Upper hypothecium pale yellowish brown or pale brown, inspersed with minute granules and oil globules; thallus continuous to rimose, not areolate, 30–70 µm thick; surface smooth ..... **C. laevigata**
5: Upper hypothecium red-brown to dark brown, not inspersed; thallus areolate to subsquamulose, to 0.2 mm thick; surface smooth to rugulose or verruculose [Western Australia] ..... **Catillaria sp. A**

6 Pigmented zone of excipulum broad and black 7
6: Pigmented zone of excipulum narrow and with shades of green or brown, subtended by a much paler or colourless zone 10

7 Hypothecium colourless; apothecia 0.1–0.2 mm wide; apothecial disc paler than the margin when wet [North America, Europe, Macaronesia, South Africa, Siberia, Korea] ..... **C. atomarioides**
7: Hypothecium pale to dark brown or red-brown; apothecia 0.2–0.5(–1) mm wide; apothecial disc concolorous with the margin when wet [± cosmopolitan] 8

8 Ascospores 6–10 µm long; hymenium 35–40 µm thick; epihymenium and proper excipulum N– [Korea] ..... **C. ulleungdoensis**
8: Ascospores 7.5–15 µm long; hymenium 40–60 µm thick; epihymenium and proper excipulum N+ purple-red 9

9 Apothecia usually black; hymenium at least partly pale blue-green [± cosmopolitan] ..... **C. chalybeia** var. **chalybeia**
9: Apothecia usually grey to dark brown; hymenium uniformly colourless [Europe, Asia, South Africa] ..... **C. chalybeia** var. **chloropoliza**

10 On calcareous rocks 11
10: On siliceous rocks 12

11 Thallus immersed to thin and rimose; apothecia red-brown to dark brown; ascospores 2–4 µm wide [± cosmopolitan] ..... **C. lenticularis**
11: Thallus superficial and areolate, to 0.15 mm thick; areoles separated by deep cracks; apothecia black; ascospores 4–6 µm wide [Campbell Island (New Zealand)] ..... **C. glaucogrisea**
12 Apothecia 0.1–0.2(–0.3) mm wide, black, concave to plane; proper margin thin, persistent [W Europe, SW North America] ..... **C. subviridis**
12: Apothecia 0.23–0.48 mm wide, dull dark green to greenish black, convex to hemispherical; proper margin soon excluded [southern New South Wales] ..... **C. gerroana**

3. Cladia xanthocarpa Elix & P.M.McCarthy, sp. nov. Fig. 5
MycoBank No. **MB 822602**

Thallus foliose, monophyllous, to 25 mm wide, with ascending, often strongly recurved margins, attached to the substratum by a holdfast, containing atranorin and protocetraric acid. Apothecia abundant, 0.3–0.6 mm wide, marginal or submarginal, stipitate, biatorine, subglobose, yellow to yellow-brown, lacking thalline and proper margins; asci 8-spored, *Cladonia*-type; ascospores simple, colourless, narrowly ellipsoid, 5–9 × 2–3 µm.

Type: Australia, Queensland, Cape York Peninsula, Starcke to Mclvor River mouth road, 1.5 km E of Hopeville–Starcke road, 15°04'S, 145°09'E, on *Melaleuca arcana* in an acid-sand swamp, *K.R. Thiele 945*, 7.vii.1985 (holotype – CANB).

Thallus corticolous, foliose, ascending, attached by a well-delimited holdfast 2–5 mm wide, monophyllous, up to 25 mm wide, 0.5 mm thick laterally, to 1 mm thick at the fertile margins.

Lobes solid, subrotund, cartilaginous when dry, flaccid when wet, discrete, ascending and often strongly recurved at the margins. *Upper surface* white, smooth at first, dull to slightly glossy, becoming ribbed, grooved and/or pitted with age, eperforate, lacking vegetative propagules, corticate in part, the cortex 10–15 µm thick, cartilaginous, of compacted, periclinal hyphae. *Lower surface* white to pale grey-white, ecorticate, of compacted medullary hyphae in a periclinal arrangement, occasionally indistinctly pitted, lacking anchoring hyphae, rhizines or haptera. *Algae* beneath the upper surface, forming a combined layer 40–75 µm thick; cells chlorococcoid, globose, 5–10 µm wide, some rather thick-walled, mixed with long-celled hyphae 3–4 µm wide. *Medulla* white, a loose network of branched and anastomosing, long-celled hyphae (4–)5–7(–8) µm wide. *Apothecia* common, marginal or submarginal, biatorine, stipitate, subglobose, 0.3–0.6 mm diam.; stipe whitish, 0.3–1 mm high; disc yellow to yellow-brown, strongly convex to subglobose, glossy, epruinose; proper margin not apparent. *Thalline and proper excipulum* lacking. *Hypothecium* 50–60 µm thick, colourless, not inspersed with granules or oil globules; hyphae variously oriented, anastomosing, thick-walled, 2–3 µm wide, the lumina *c.* 1 µm thick. *Hymenium* 50–75 µm thick, colourless, not inspersed, IKI+ blue. *Epihymenium* 5–8 µm thick, yellow to yellow-brown, decolorized in K, N–. *Paraphyses* agglutinated in the hymenial gel, simple, 1–1.5 µm wide; apical cells yellow or yellow-orange, scarcely swollen in water, (1.5–)2–2.5(–3) µm wide. *Asci* clavate, 21–25 × 10–13 µm, 8-spored but frequently with up to 4 spores aborted, approximating the *Cladonia*-type (Kantvilas & Elix 1999); apical dome well-developed, amyloid, with a darker-staining central tube with a very narrow, weakly amyloid central zone. *Ascospores* colourless, simple, narrowly ellipsoid, 5–9 × (2–)2.5–3 µm [*n* = 50]; spore wall smooth. *Pycnidia* not seen.
Chemistry: Cortex K+ yellow; medulla K+ yellow, C–, KC–; P+ orange; containing atranorin (minor), protocetraric acid (major), convirensic acid (minor), conprotocetraric acid (minor), methyl protocetrarate (minor) by HPLC.

Etymology: The epithet *xanthocarpa* refers to the usually bright yellow colour of the abundant apothecia (Gk *xanthos*, yellow; *karpos*, a fruit).

Remarks

This striking new species is characterized by the small, foliose thallus with recurved margins bearing abundant, subglobose, yellow to yellow-brown biatorine apothecia 0.3–0.6 mm wide that are borne on short stipes, 0.3–1 mm high. Other distinctive features include the simple, colourless, narrowly ellipsoid ascospores, 5–9 × 2–3 µm, *Cladonia*-type asci, and the presence of atranorin and protocetraric acid. Molecular studies have recently confirmed that *Cladia* not only incorporates the traditional fruticose species, but also foliose species previously assigned to *Heterodea* Nyl. and a crustose species, previously *Ramalinora glaucolivida* Lumbsch, Rambold & Elix (Lumbsch *et al.* 2010; Parnmen *et al.* 2010). *Cladia xanthocarpa* represents an additional foliose species of the genus and exhibits the greatest similarity with *C. beaugleholei* (Filson) Parnmen & Lumbsch and *C. muelleri* (Hampe) Parnmen & Lumbsch (both formerly in *Heterodea*). In terms of thallus chemistry, atranorin is quite common in a number of *Cladia* species, and although protocetraric acid has been recorded in only trace quantities previously, its biosequential derivative, fumarprotocetraric acid, occurs as a major metabolite in *Cladia deformis* Kantvilas & Elix, *C. inflata* (F.Wilson) D.J.Galloway, *C. mutabilis* Kantvilas & Elix and *C. schizopora* (Nyl.) Nyl. Unfortunately, there have been no recent collections of this species and attempted molecular studies of the type material were unsuccessful (H.T. Lumbsch, pers. comm.).

The new species is known only from the type specimens collected in Cape York Peninsula, north-eastern Queensland, Australia. Associated lichens are likely to include *Buellia bahiana* Malme, *B. conspirans* (Nyl.) Vain., *Lecanora helva* Stizenb., *Pertusaria pycnothelia* Nyl., *P. scaberula* A.W.Archer, *Ramalina nervulosa* (Müll.Arg.) des Abbayes var. *nervulosa*, *R. tenella* Müll.Arg., *Relicina samoensis* (Zahlbr.) Hale, *R. terricrocodila* Elix and *Usnea dasaea* Stirt.

4. Japewiella variabilis Elix & P.M.McCarthy, sp. nov. Figs 6, 7
MycoBank No. **MB 822605**

Similar to *Japewiella pacifica* Printzen, but differs in having a blue-green epihymenium, smaller ascospores and in containing stenosporic and perlatolic acids or 2-*O*-methylstenosporic and 2-*O*-methylperlatolic acids.

Type: Australia, the Australian Capital Territory, Canberra Nature Park, Aranda Bushland, 4 km W of Canberra, 35°16'14"S, 149°04'34"E, 580 m alt., on dead twigs of *Leptospermum* shrubs in *Eucalyptus* woodland, *J.A. Elix 46471*, 29.vii.2017 (holotype – CANB) [the type contains atranorin, chloroatranorin, stenosporic and perlatolic acids].

Thallus crustose, epiphloeodal, continuous, forming irregular patches to *c.* 50 mm wide and 75–250 µm thick; upper surface white or pale grey-white, dull, often white-maculate, granular in part or becoming warted-verruculose with age; cortical layer indistinct or up to 10 µm thick; prothallus absent. *Photobiont* a unicellular green alga with ± globose cells 6–15 µm wide. *Apothecia* 0.2–0.7 mm wide, biatorine to lecideine, roundish, dispersed, broadly adnate to sessile and constricted at the base; disc medium brown to black or a mixture of both, matt to glossy, epruinose, plane at first, then weakly convex. *Proper excipulum* well developed, persistent, concolorous with the disc or paler below, composed of radiating, branched and anastomosing hyphae *c.* 1 µm thick, embedded in a gelatinous matrix; in section laterally 65–75 µm thick, basally 100–110 µm thick; outer part blue-green to blue-black laterally, fading to almost colourless at the base, K+ olive-green, N+ purple; inner part colourless, open beneath the hypothecium (annular). *Hypothecium* 25–55 µm thick, colourless to pale yellow, inspersed with sparse oil globules. *Hymenium* 50–70 µm thick, I+ blue, not inspersed with granules or oil globules, uppermost part concolorous with the epihymenium, lower part colourless; subhymenium colourless, 15–30 µm thick. *Epihymenium* 10–12 µm thick, deep blue-green, H+ deep blue to indigo, K+ olive-green, N+ purple. *Paraphyses* simple to sparingly branched, 1–2 µm thick; apices pigmented pale blue, occasionally swollen to 2.5 µm. *Asci* narrowly to broadly clavate, 35–65 × 16–25 µm, 8-spored, but frequently with up to 4 spores aborted, approximating the *Lecidella*-type (Hafellner 1984): tholus well-developed, intensely amyloid, with a ± barrel-shaped, weakly amyloid *masse axiale* with a rounded apex; ocular chamber poorly developed. *Ascospores* simple, colourless, broadly ellipsoid to ovate, 11–[*13.1*]–17 × 5–[*6.9*]–8 µm, with thick walls *c.* 1 µm wide. *Pycnidia* common, semi-immersed to superficial, globose, to 0.1 mm wide; wall bluish black and *c.* 15 µm thick above, greenish black and *c.* 7 µm thick at the sides and base, with terminal, Type III conidiogenous cells (Vobis 1980). *Conidia* mostly strongly curved-acicular, (12–)18–23(–30) × (0.5–)0.7–1(–1.2) µm. *Chemistry*: Thallus K+ yellow, C–, P+ yellow; containing atranorin, chloroatranorin, perlatolic acid, stenosporic acid (all major), rarely with accessory psoromic acid or 6-*O*-methylarthothelin or atranorin, chloroatranorin, 2-*O*-methylperlatolic acid, 2-*O*-methylstenosporic acid (all major).

Etymology: The species is named for its variable chemistry.

Remarks

The genus *Japewiella* was introduced by Printzen (1999) to accommodate three corticolous, crustose taxa characterized principally by their biatorine apothecia, thick-walled, simple ascospores, 8-spored asci with a conspicuous *masse axiale* (*Lecidella*-type asci), and a well-developed excipulum comprised of branched and anastomosing, gelatinized hyphae (Printzen 2004; James 2009). More recently Kantvilas (2011) reported the first Australian species of the genus, *J. pruinosula* (Müll.Arg.) Kantvilas. *Japewiella variabilis* is characterized by the thin, crustose, white to pale grey, granular to warty-verruculose thallus, the broadly adnate to sessile, biatorine to lecideine apothecia, the simple, broadly ellipsoid to ovate ascospores, 11–17 × 5–8 µm, and by the presence of atranorin, chloroatranorin, perlatolic and stenosporic acids or 2-*O*-methylperlatolic and 2-*O*-methylstenosporic acids. It resembles *J. pacifica*, but that species has larger ascospores, 13–20 × 7–10 µm, a red-brown to olive-brown epihymenium

that reacts HCl+ greenish, K+ greenish, N+ rose-red, and in containing atranorin, chloroatranorin, 3-chlorostenosporic and 3-chloroperlatolic acids (Printzen 1999). Interestingly, the collections from Western Australia contained the xanthone 6-*O*-methylarthothelin in addition to four depsides. *Japewiella pruinosula* differs from *J. variabilis* in having grey-white pruinose discs, a reddish brown, K+ dirty brown epihymenium that contains numerous crystals, larger ascospores, 12–[*15.4*]–20 × 8–[*10.6*]–14 µm, and in containing pannarin and a cohort of chlorinated xanthones.

The new species is widely distributed in southern Australia (Western Australia, South Australia, Queensland, the Australian Capital Territory and New South Wales) where it occurs on bark and twigs of various shrubs and trees in open *Eucalyptus* and *Callitris* woodland. Commonly associated species include *Austroparmelina endoleuca* (Taylor) A.Crespo, Divakar & Elix, *A. pseudorelicina* (Jatta) A.Crespo, Divakar & Elix, *Hypogymnia billardieri* (Mont.) Filson, *Pertusaria georgeana* A.W.Archer & Elix var. *georgeana*, *P. pertractata* Stirt., *Ramboldia laeta* (Stirt.) Kalb, Lumbsch & Elix, *Teloschistes sieberianus* (Laurer) Hillmann, *Usnea inermis* Motyka and *U. scabrida* subsp. *scabrida* Taylor.

SPECIMENS EXAMINED

Western Australia: ● Nature Reserve (unnamed), 46 km E of Merredin along the Great Eastern Highway, 31°22’30”S, 118°43’02”E, 380 m alt., on twigs of dead shrub in *Eucalyptus-Melaleuca* woodland, *J.A. Elix 31972*, 23.iv.2004 (CANB); ● Bullfinch–Evanston road, 51.3 km N of Bullfinch, 30°37’19”S, 119°13’37”E, 360 m alt., on dead *Acacia* in scattered *Eucalyptus-Callitris* woodland, *J.A. Elix 32495*, 28.iv.2004 (CANB).

South Australia: ● Mount Lofty Ranges, 6.5 km W of Springton along the High Eden road, 34°42’S, 139°02’E, 480 m alt., on *Callitris* in *Eucalyptus* woodland, *J.A. Elix 26325*, 23.ix.1991 (CANB); ● Eyre Peninsula, 13 km NE of Cleve, 33°39’S, 136°37’E, 380 m alt., on *Melaleuca* in dense *Leptospermum*-dominated regrowth, *H.T. Lumbsch 10865b, A. Dickhäuser, J.A. Elix & H. Streimann*, 23.ix.1994 (CANB).

Queensland: ● Darling Downs, Bringalily State Forest, 41 km S of Millmerran on the Millmerran–Inglewood road, 28°12’02”S, 151°10’35”E, 330 m alt., on base of *Callitris* in mixed *Eucalyptus-Callitris* woodland, *J.A. Elix 43649*, 8.v.2005 (CANB).

New South Wales: ● Bruxner Highway, 6 km E of Yetman, 28°54’22”S, 150°49’58”E, 315 m alt., on twigs of shrub in *Eucalyptus-Callitris* forest, *J.A. Elix 44089, 44096, 44104*, 9.v.2005 (CANB); ● Terraban Gap Nature Reserve, 31 km E of Dunedoo along Black Stump Way, 31°58’20”S, 149°20’22”E, 560 m alt., on *Allocasuarina* in *Eucalyptus-Callitris* woodland, *J.A. Elix 36139*, 25.v.2005 (CANB); ● Bomera, 7 km W of Premer, 31°27’19”S, 149°50’04”E, 420 m alt., on dead twigs of *Callitris* in *Eucalyptus-Callitris* woodland, *J.A. Elix 36201*, 26.v.2005 (CANB); ● Goonoo State Forest, Mogriguy Forest Road, 5 km E of Mogriguy, 23 km NNE of Dubbo, 32°04’16”S, 148°42’53”E, 330 m alt., on twigs of *Callitris* and *Melaleuca* in *Eucalyptus-Callitris* woodland, *J.A. Elix 36754, 36759, 36770, 36772*, 11.x.2005 (CANB); ● Goonoo State Forest, Goondy Creek, Mogriguy Forest Road, 11 km E of Modriguy, 25 km NNE of Dubbo, 32°03’07”S, 148°46’34”E, 350 m alt., on dead *Acacia* in *Eucalyptus-Allocasuarina* woodland, *J.A. Elix 37134*, 11.x.2005 (CANB); ● Goonoo State Forest, Ranters Creek, Cashels Dam Road, 33 km SE of Gilgandra, 31°58’25”S, 148°51’46”E, 360 m alt., on twigs of *Calytrix* in *Eucalyptus-Callitris* woodland, *J.A. Elix 37389*, 12.x.2005 (CANB); ● Goonoo State Forest, Denmire Creek, 32 km ESE of Gilgandra, 31°55’43”S, 148°59’32”E, 370 m alt., on twigs of *Leptospermum* and *Eucalyptus* in *Eucalyptus* woodland, *J.A. Elix 38196, 38211*, 12.x.2005 (CANB); ● 11 km E of Bungendore, 35°15’03”S, 149°34’24”E, 810 m alt., on dead shrub in open *Eucalyptus* woodland, *J.A. Elix 36843*, 5.i.2006 (CANB); ● Paul Harris Memorial Lookout, Blackheath, 33°38’S, 150°17’E, on twigs of *Prunus*, *W.H. Ewers 3543 pr.p., 3544*, 6.vii.1989 (CANB).

Australian Capital Territory: ● type locality, on twigs of *Leptospermum* in *Eucalyptus* woodland, *J.A. Elix 28811*, 13.iii.2005 (CANB); ● *loc. id.*, on branches of *Leptospermum* in *Eucalyptus* woodland, *J.A. Elix 38803*, 21.vi.2008 (CANB).

5. Lecidella meridionalis Elix & P.M.McCarthy, sp. nov. Figs 8, 10A
MycoBank No. **MB 822606**

Similar to *Lecidella xylogena* (Müll.Arg.) Kantvilas & Elix, but differs in having a densely inspersed, orange-brown hypothecium, a K+ pale violet, densely inspersed subhymenium and an indigo to blue-black epihymenium with sparse granules.

Type: Australia, South Australia, 3 km E of Callington, 35°06’41”S, 139°03’31”E, 25 m alt., on *Callitris* in remnant *Callitris* woodland, *J.A. Elix 37617*, 4.vi.2007 (holotype – CANB; isotype – AD) [the type contains atranorin and 3-*O*-methylasemone].

Thallus crustose, epiphloeodal, continuous, forming irregular patches to *c.* 45 mm wide and 50–120 µm thick, grey-white to pale yellow-grey, dull, rimose-areolate to verrucose-areolate; areoles irregular, 0.3–0.5(–1) mm wide, with scattered crateriform soralia; soredia occasionally eroding and leaving residual pits, or developing from cracks and spreading over the surface, farinose to granular, 15–30 µm wide, or rarely forming elevated pseudoisidia to 50 µm high; cortex indistinct or up to 10 µm thick; prothallus absent. *Photobiont* a unicellular green alga with ± globose cells 7–14 µm wide. *Apothecia* 0.2–0.8 mm wide, biatorine to lecideine, roundish, dispersed, broadly adnate to sessile; disc black, epruinose, weakly concave at first, then plane to convex. *Proper excipulum* well developed, persistent or excluded in older, convex apothecia, concolorous with the disc, composed of radiating, thick-walled hyphae, 5–7(–10) µm wide, that become darker at the outer edge, in section laterally 30–55 µm thick, basally 60–80 µm wide; outer part blue-black, H+ blue, K+ blue-grey, N+ purple; inner part orange-brown, N+ deep red-brown, open beneath the hypothecium (annular). *Hypothecium* 70–100 µm thick, orange-brown, K+ intensifying, N+ intensifying, densely inspersed with oil droplets and granules. *Hymenium* 45–65 µm thick, I+ blue, colourless, lower part inspersed; subhymenium colourless, 15–25 µm thick, K+ pale violet, densely inspersed with oil droplets. *Epihymenium* 10–13 µm thick, indigo to blue-black, H+ blue, K–, N+ crimson to purple, granules present, insoluble in K. *Paraphyses* simple to sparingly branched, 1–1.5 µm thick; apices pigmented blue-grey, often swollen to 4–6 µm wide. *Asci* clavate to cylindrical-clavate, 34–50 × 15–24 µm, 8-spored but frequently with up to 6 spores aborted, of the *Lecidella*-type (Hafellner 1984); apical dome well developed, intensely amyloid, with a ± conical, weakly amyloid *masse axiale* with a rounded apex; ocular chamber poorly developed. *Ascospores* simple, colourless, narrowly ellipsoid to oblong, 8–[*10.3*]–13 × 5–[*5.9*]–8 µm, rarely weakly curved; wall *c.* 1 µm thick. *Pycnidia* uncommon, semi-immersed to superficial, globose, to 0.1 mm wide; with terminal, Type III conidiogenous cells (Vobis 1980). *Conidia* mostly strongly curved, arcuate, 14–30 × 0.7–1 µm.

Chemistry: Thallus K– or K+ yellow, C–, KC–, P– or P+ pale yellow, UV+ orange; containing ±3-*O*-methylasemone (major or minor), ±3-*O*-methylthiophanic acid (minor), 4,5-dichloro-3-*O*-methylnorlichexanthone (minor), ±atranorin (major or minor), ±thuringione (trace), ±5,7-dichloro-3-*O*-methylnorlichexanthone (major or minor or trace), ±5-chloro-3-*O*-methylnorlichexanthone (major), ±2,5-dichloro-3-*O*-methylnorlichexanthone (major), thiophanic acid (minor).

Etymology: The specific epithet *meridionalis* (L, southern) refers to the known Australian distribution of the new lichen.

Remarks

This species can be recognized by the combination of the sorediate thallus containing xanthones, the presence of a blue-black pigment in the excipulum and epihymenium, the K+ pale violet subhymenium, the densely inspersed lower hymenium, subhymenium and hypothecium and the comparatively small ascospores. *Lecidella xylogena* is a sorediate species with similar-sized ascospores, but it has a non-inspersed hymenium, a colourless to pale yellow-brown, non-inspersed hypothecium, a K– subhymenium, a pale, dirty greenish blue or grey-green, granular epihymenium, and it contains thiophaninic acid as the major xanthone

(Kantvilas & Elix 2013, 2014). *Lecidella destituta* Kantvilas & Elix has similar apothecial pigments and inspersion to *L. meridionalis*, but it has an esorediate thallus that lacks xanthones, instead containing atranorin as a major lichen substance (Kantvilas & Elix 2013).

Lecidella meridionalis is known from several localities in southern Australia (Western Australia, South Australia, New South Wales and Victoria), where it grows on the bark of various trees and on dead wood in open *Eucalyptus* and *Callitris* woodland. Common associated species include *Austroparmelina pseudorelicina* (Jatta) A.Crespo, Divakar & Elix, *Caloplaca dahlii* Elix, S.Y.Kondr. & Kärnefelt, *Flavoparmelia rutidota* (Hook.f. & Taylor) Hale, *Lecidella flavovirens* Kantvilas & Elix, *Pertusaria pertractata* Stirt., *P. trimera* (Müll. Arg.) A.W.Archer, *Teloschistes sieberianus* (Laurer) Hillmann, *Usnea inermis* Motyka and *U. scabrida* Taylor subsp. *scabrida*.

SPECIMENS EXAMINED
Western Australia: ● 10 km SE of Corrigin on road to Kulin, 32°21'S, 117°53'E, on *Acacia acuminata* on roadside, *J.A. Elix 21656 & M.V. Sargent*, 19.viii.1987 (CANB); ● Charles Gardner Flora Reserve, central track, 20 km SW of Tammin along Old York Road, 31°47'24"S, 117°28'07"E, 305 m alt., on base of *Acacia* in *Eucalyptus* woodland with *Allocasuarina* and *Acacia*, in shallow gully, *J.A. Elix 38461*, 4.iv.2006 (CANB, PERTH).
South Australia: ● Ridley Conservation Park, N escarpment of Marne River Gorge, 14 km S of Swan Reach, 34°41'11"S, 139°32'35"E, 45 m alt., on old wood in mallee *Eucalyptus* scrub with limestone outcrops, *J.A. Elix 45951*, 13.iv.2013 (AD, CANB).
New South Wales: ● Mountain Creek, Jimbaroo State Forest, 14 km NNE of Rankins Springs, 33°43'S, 146°20'E, 280 m alt., on *Callitris* in *Eucalyptus*-*Callitris*-dominated creek flats, *J.A. Elix 25285*, 13.vi.1990 (CANB, NSW).
Victoria: ● Piangil Road, 3 km NE of Walpeup, 35°07'13"S, 142°03'01"E, 75 m alt., on Santalaceae in mallee *Eucalyptus* woodland, *J.A. Elix 43303*, 17.iv.2009 (CANB).

6. Lecidella occidentalis Elix & P.M.McCarthy, sp. nov. Figs 9, 10 B–E
MycoBank No. **MB 822607**

Similar to *Lecidella flavovirens* Kantvilas & Elix, but differs in having densely pruinose apothecial discs, an esorediate surface, smaller ascospores, 10–16 × 5–8 µm, and a dark brown to dark olive-brown, granular epihymenium.

Type: Australia: Western Australia, Kalbarri National Park, Murchison River Gorge, trail to Natures Window from The Loop carpark, 38 km NE of Kalbarri township, 27°33'25"S, 114°26'41"E, 150 m alt., on *Acacia* in *Allocasuarina*-*Acacia* heathland with sandstone outcrops, *J.A. Elix 33745*, 3.v.2004 (holotype – CANB; isotype – PERTH).

Thallus crustose, epiphloeodal, continuous, forming irregular patches to *c.* 35 mm wide and 75–120 µm thick, yellow to yellow-green or yellow-grey, dull, rimose-areolate to granular, the granules corticate; cortex indistinct or up to 10 µm thick; prothallus absent. *Photobiont* a unicellular green alga with ± globose cells 7–15 µm wide. *Apothecia* 0.2–0.8 mm wide, biatorine to lecideine, roundish, dispersed, immersed to broadly adnate; disc medium brown to black, densely pale yellow-pruinose, weakly concave at first, then plane to convex. *Proper excipulum* well developed, persistent, concolorous with the disc, raised above the disc at first, composed of radiating, thick-walled hyphae that become paraplectenchymatous and internally pigmented at the outer edge, in section laterally 30–65 µm thick, basally 70–90 µm wide; outer part brown-black, H+ grey-green, K+ greenish black, N+ deep red-brown; inner part brown, open beneath the hypothecium (annular). *Hypothecium* 70–90 µm thick, colourless to pale yellow. *Hymenium* 50–70 µm thick, I+ blue, colourless, not inspersed; subhymenium colourless, 10–15 µm thick. *Epihymenium* 10–13 µm thick, dark brown to dark olive-brown, H–, K+ grey-green, N+ red-brown, containing brownish granules that dissolve in K. *Paraphyses* simple to sparingly branched, 1–1.5 µm thick; apices brown, often swollen to 4–5 µm wide. *Asci* clavate, 32–60 × 13–20 µm, 8-spored but frequently with up to 5 spores aborted, of the *Lecidella*-type (Hafellner 1984); apical dome well-developed, intensely amyloid, with a ± barrel-shaped, weakly amyloid *masse axiale* with a rounded apex; ocular chamber poorly developed. *Ascospores* simple, colourless, narrowly ellipsoid to oblong, occasionally slightly curved or a little constricted, 10–[*13.1*]–16 × 5–[*5.9*]–8 µm; wall *c.* 1 µm thick. *Pycnidia* uncommon, semi-immersed to superficial, black, globose, to 0.1 mm wide; with terminal, Type III conidiogenous cells (Vobis 1980). *Conidia* mostly strongly curved, arcuate, 12–23 × 0.7–1 µm.
Chemistry: Thallus K–, C+ orange, KC–, P–, UV+ orange; containing thiophanic acid (major), isoarthothelin (minor), asemone (minor), ±3-*O*-methylthiophanic acid (minor), ±argopsin (minor).

Etymology: The specific epithet refers to the occurrence of this species in Western (L, *occidentalis*) Australia.

Remarks
This very distinctive species has a rather bright yellow to yellowish green, esorediate thallus and abundant densely yellow-pruinose apothecia. It is chemically identical to *L. flavovirens*, but that species has a sorediate surface, epruinose discs, somewhat larger ascospores, 12–18 × 6–10 µm, and an epihymenium that does not contain granules (Kantvilas & Elix 2013). *Lecidella occidentalis* could be confused with *L. leucomarginata* Kantvilas & Elix and *L. elaeochroma* (Ach.) Haszl., in that both species have similar-sized ascospores to *L. occidentalis* and contain granules in the epihymenium (Kantvilas & Elix 2013, 2014). However, both have epruinose discs and aeruginose (greenish blue), N+ crimson epihymenia. In addition, *L. leucomarginata* has a colourless to pale yellow-grey or mottled excipulum (black in *L. occidentalis*), while in Australia *L. elaeochroma* differs chemically, containing 2,5,7-trichloro-3-*O*-methylnorlichexanthone as a major lichen substance.

At present, the new species is known from several localities in the south-west of Western Australia, where it occurs on bark and twigs of various shrubs and trees and on dead wood in open *Eucalyptus* woodland and heathland. Commonly associated species include *Austroparmelina pseudorelicina* (Jatta) A.Crespo, Divakar & Elix, *Flavoparmelia rutidota* (Hook.f. & Taylor) Hale, *Lecidella flavovirens* Kantvilas & Elix, *Pertusaria pertractata* Stirt., *P. trimera* (Müll.Arg.) A.W.Archer, *Ramboldia brunneocarpa* Kantvilas & Elix, *Usnea inermis* Motyka and *U. scabrida* Taylor subsp. *scabrida*.

SPECIMENS EXAMINED
Western Australia: ● Wotto Nature Reserve, First North Road, 21 km by road NE of Eneabba, 29°42'29"S, 115°24'37"E, 275 m alt., on *Melaleuca* in *Eucalyptus* woodland with *Melaleuca* and laterite outcrops, *J.A. Elix 28877*, 5.v.2004 (CANB); ● Kalbarri National Park, Murchison River Gorge, below Ross Graham Lookout, 3 km ENE of Kalbarri township, 27°48'41"S, 114°28'22"E, 140 m alt., on twigs of dead shrub in gorge with scattered *Allocasuarina*, *Eucalyptus* and *Acacia* with sandstone outcrops, *J.A. Elix 33715*, 3.v.2004 (CANB); ● Great Northern Highway, 72 km NE of Wubin, 29°39'53"S, 117°07'11"E, 350 m alt., on *Acacia* in *Eucalyptus*-*Acacia* woodland, *J.A. Elix 33486*, 29.iv.2004 (CANB); ● Badgingarra National Park, Drummonds Reserve, Bibby Road, 30°29'15"S, 115°26'07"E, 200 m alt., on dead wood in open *Eucalyptus* woodland with *Xanthorrhoea* and *Calothamnus*, *J.A. Elix 28947*, 6.v.2004 (CANB).

New combination: *Lecidella leptolomoides* (Müll.Arg.) Elix, comb. nov.
MycoBank No. **MB 822609**
Basionym: *Lecidea leptolomoides* Müll.Arg., *Bull. Herb. Boissier* **1**, 44 (1893)
Type: Australia. Victoria, Sale, on bark of *Ailanthus* in garden, *F.R.M.Wilson 631*, 1892 (holotype – G, not seen; isotype – NSW!).
Lecidea minutula Müll.Arg., *Bull. Herb. Boissier* **1**, 44 (1893), *nom. illegit. non Lecidea minutula* Nyl., *Bull. Bot. Soc. France* **25**, 469 (1878), *syn. nov.*
Type: Australia. Victoria, Kew, on bark of *Platanus orientalis*, *F.R.M.Wilson 612*, 29.xii.1886

(holotype – G, not seen; isotype – NSW!).
Previously, this species was informally included within a broad concept of *Lecidella xylogena* (Kantvilas & Elix 2013), because the two species have similar ascospore dimensions and excipular pigmentation. However, *L. leptolomoides* differs in having a very thin, esorediate thallus (*c.* 50–70 µm thick) containing 2,5,7-trichloro-3-*O*-methylnorlichexanthone as the major secondary metabolite. In contrast, *L. xylogena sens. str.* has a much thicker, sorediate thallus (to 0.5 mm thick) with thiophaninic acid as the major lichen substance.

SPECIMEN EXAMINED
Australian Capital Territory: ● Aranda, 5 km W of Canberra, 35°16'S, 149°05'E, 650 m alt., on branches of *Prunus* in cultivated garden, *J.A. Elix 43021*, 17.vi.1998 (CANB).

Key to the corticolous and lignicolous species of *Lecidella* in Australia

1 Thallus sorediate 2
1: Thallus not sorediate 4

2 Ascospores 12–18 µm long ..... **L. flavovirens**
2: Ascospores 7–14 µm long. 3

3 Hypothecium and subhymenium densely inspersed with oil droplets; epihymenium deep blue to indigo ..... **L. meridionalis**
3: Hypothecium and subhymenium not inspersed with oil droplets; epihymenium pale greenish to olive-brown. ..... **L. xylogena**

4 Thallus UV–, containing atranorin only; subhymenium densely inspersed with oil droplets ..... **L. destituta**
4: Thallus UV+ orange, containing xanthones 5

5 Excipulum colourless to pale grey or mottled dark grey ..... **L. leucomarginata**
5: Excipulum black 6

6 Ascospores 15–24 × 8–13 µm ..... **L. montana**
6: Ascospores 7–15 × 3–8 µm 7

7 Apothecial discs densely pruinose ..... **L. occidentalis**
7: Apothecial discs epruinose 8

8 Ascospores 10–15 × 5–8 µm ..... **L. elaeochroma**
8: Ascospores 7–12 × 3–6 µm 9

9 Hypothecium and subhymenium densely inspersed with oil droplets; epihymenium deep blue to indigo ..... **L. sp. A**
9: Hypothecium and subhymenium not inspersed with oil droplets; epihymenium pale greenish to olive-brown ..... **L. leptolomoides**

7. Megalaria insularis P.M.McCarthy & Elix, sp. nov. Figs 11, 12
MycoBank No. **MB 822612**

Thallus pale greyish green to pale to medium green or pale yellowish green, (0.08–)0.1–0.2(–0.3) mm thick, continuous to abundantly and irregularly rimose, smooth, or granulose to verrucose, corticate, lacking lichen substances. Apothecia adnate to sessile and constricted at the base, 0.6–1.9 mm wide, with a thick and predominantly blue-black proper excipulum, K+ green-black or greenish indigo; hypothecium uniformly dark brown or with a dark brown to blue-black upper layer and pale yellow to medium brown below; hymenium not inspersed;

epihymenium dilute dark brown to purple-brown, K+ purple and darkening. Ascospores narrowly to broadly ellipsoid or oblong-ellipsoid, 1-septate, 16–30 × 7–15 µm. Conidia narrowly ellipsoid to bacilliform, 1.5–3.5 × 0.7–1 µm.

Type: Australia: Norfolk Island, Mount Pitt Reserve, Filmy Fern Trail, 29°01'S, 167°57'E, 130 m alt., on dead tree trunk in mixed subtropical rainforest, *J.A. Elix 18402 & H. Streimann*, 3.xii.1984 (holotype – CANB).

Thallus crustose, epiphloeodal, determinate, rounded to irregular in outline, to 8(–15) cm wide, dull pale greyish green to pale to medium green or pale yellowish green, continuous to abundantly and irregularly rimose but scarcely areolate, smooth, or granulose to verrucose, (0.08–)0.1–0.2(–0.3) mm thick; granules subglobose or irregular, smooth, corticate, 50–80(–100) µm wide; verrucae convex, to 0.15 mm wide; soredia and isidia absent; not containing calcium oxalate (H_2SO_4–). *Cortex* paraplectenchymatous, of periclinal, somewhat flattened cells, or the cells more rounded, thick-walled and 3–7(–10) µm wide, or apparently ecorticate, but the thallus with a hyaline, amorphous alga-free layer 10–15(–20) µm thick. *Algal layer* continuous, to 60–100(–150) µm thick; cells green, chlorococcoid, 6–12(–14) µm diam.; interstitial hyphae short-celled, thin-walled, 2–2.5 µm wide. *Medulla* indistinct or well-delimited; hyphae variously oriented, long-celled, ± thin-walled, 2–4(–5) µm wide; attachment hyphae long-celled, to 4(–5) µm wide. *Prothallus* thin, diffuse and paler than the thallus, or not apparent. *Apothecia* rounded or irregular in outline, occasionally rather elongate or somewhat undulate, solitary, paired or forming rosettes of 4–8 proliferating from a single apothecium, (0.6–)1.2(–1.9) mm wide [*n* = 159], adnate to sessile and constricted at the base; margin usually glossy black, occasionally brown-black, smooth, entire, often flexuous, prominent, to 120 µm thick, finally thinner but persistent, occasionally almost excluded by the most convex discs; disc initially concave to plane, later plane to slightly or, occasionally, strongly convex, dull black, sometimes medium to dark reddish brown when immature or strongly convex and proliferating, smooth, epruinose. *Proper excipulum* prosoplectenchymatous, cupulate in section, predominantly blue-black, K+ green-black or greenish indigo, H+ indigo or indigo-black, N+ deep crimson or deep purple, I–, 100–150(–200) µm thick laterally, 150–250(–300) µm thick at the base, the outermost (10–)15–30(–40) µm considerably paler but retaining a bluish tint, the hyphae radiating outwards laterally and downwards basally, anastomosing, tightly coherent, laterally 6–12 µm wide, thick-walled (the lumina 1–2.5(–3) µm wide), basally 4–8 µm wide, thick-walled (the lumina 1–1.5 µm wide); subtending tightly coherent, blue-black-pigmented hyphae with shorter and narrower hyphae, the cells 10–15 × 2–3 µm laterally, 8–15 × 3–5 µm at the base, the lumina comparatively broad; subhypothecial cells blue-black, shorter and broader still, variously oriented and tightly coherent. *Hypothecium* 50–70(–100) µm thick, not inspersed with oil droplets or granules, uniformly dark brown, or with an upper layer dark brown to blue-black, 20–30 µm thick, K+ greenish black, turning black, H+ indigo-black, N+ deep crimson to crimson-purple and I–, subtended by pale yellow to medium brown tissue that is K+ purple-brown to red-brown or patchily yellow-brown, H–, N+ crimson or pale brown to red-brown and I–. *Hymenium* 90–140(–170) µm thick, not inspersed with granules or oil globules, uniformly hyaline or with reddish purple, vertical streaks, I+ blue (pre-treated with K) or I+ blue-black, turning dark red-brown (not pre-treated); streaks K+purple, H+ brown, N+ red. *Epihymenium* usually well delimited, 15–20(–30) µm thick, occasionally pale brown, usually dilute dark brown to purple-brown, K+ purple, darkening to purple-brown or purple-black (after 5 minutes), H+ dilute brownish blue or purple-brown at first, becoming brown-black (after 5 minutes), N+ deep red to red-brown. *Paraphyses* usually simple to sparingly branched, occasionally more richly divided, with sparse anastomoses, short- to long-celled, tightly conglutinate in water, scarcely loosening in K, 1–1.5(–2) µm thick; apices not pigmented, only rarely slightly swollen (to 2 µm). *Asci* narrowly to broadly clavate or, most commonly, clavate-cylindrical, sometimes 4-spored but mostly 8-spored (occasional sections dominated by 4-spored asci), 80–120(–140) × 18–38 µm [*n* = 25], ± *Biatora*-type; tholus weakly to strongly amyloid, penetrated almost to the apical ascus wall by a conical *masse axiale*, this often bordered by a narrow, more deeply amyloid

zone; ocular chamber low-convex or not apparent. *Ascospores* narrowly to broadly ellipsoid or oblong-ellipsoid, occasionally almost ovoid, hyaline, 1-septate, overlapping-uniseriate to irregularly biseriate in the ascus, not or only slightly constricted at the median septum, rarely strongly constricted, slightly to distinctly thickened at the septum, straight or a little bent, (16–)24(–30) × (7–)11(–15) µm [*n* = 337]; apices rounded or subacute; wall smooth, 1–1.5(–2) µm thick; epispore to 1.5 µm thick or not apparent; spore contents clear. *Pycnidia* absent or sparse to numerous, semi-immersed to almost completely immersed in the thallus, 100–150 µm wide, obpyriform to subglobose; apex brown-black to black, with a minute, nondescript or pale brown ostiole; pycnidial wall hyaline, 7–10 µm thick; conidiogenous layer simple to convoluted; conidiophores unbranched, 15–25 µm long and 1–1.5 µm wide. *Conidia* narrowly ellipsoid to bacilliform, (1.5–)2–3(–3.5) × 0.7–1 µm.
Chemistry: Thallus K–, C–, KC–, PD–, UV–; no substances detected by TLC; one specimen (*J.A. Elix 27465*) contained zeorin (major) and an unknown terpene (Rf 50, minor) by TLC.

Etymology: The epithet *insularis* refers to the new species occurring on Norfolk Island in the south-western Pacific Ocean.

Remarks

Megalaria insularis is distinguished by its robust, greenish, corticate thallus, the thick, blue-black excipulum, the mainly brown hypothecium and medium-sized to rather large ascospores. The most similar species in terms of apothecial morphology and anatomy is *M. subintermixta* (Müll.Arg.) Kantvilas from lowland forest in Tasmania, southern Victoria and the Southern Tablelands, New South Wales (Kantvilas 2016). However, the latter has a thin, scurfy-areolate, creamy white to pale grey, ecorticate thallus that becomes coarsely schizidiate; the proper excipulum is dark blue-green (K+ intensifying greenish); the hypothecium is ± hyaline or discoloured brownish, or with tinges of blue-green pigment diffusing from the excipulum; and the hymenium is typically inspersed with minute oil globules, the epihymenium being K+ greenish intensifying (Kantvilas 2016).

Among recent collections of *Megalaria* from Norfolk Island is one (possibly two) as yet unidentified species. Cheel (1904) reported *M. grossa* (Pers. ex Nyl.) Hafellner and *M. versicolor* (Flot.) Kalb, Hafellner, Fryday & Lendemer, both as *Patellaria*, from the island, but neither one can be found among recent collections, and both taxa are very different from *M. insularis*. Thus, the mainly temperate *M. grossa* has a thin, greyish green thallus, *Lecanora*-type asci, and a layered excipulum with dark, opaque, inner and outer zones separated by a hyaline band of much looser hyphae, while the pantropical *M. versicolor* is most readily characterized in having a layered excipulum in combination with mostly bisporous asci and ascospores 40–65 × 15–22 µm (Sipman 1983).

The new species grows on the bark of shrubs, treelets and large trees in mixed subtropical rainforest and regrowth forest at elevations of 100–280 m on Norfolk Island, an Australian territory in the south-western Pacific Ocean. Associated species include *Crocodia poculifera* (Müll.Arg.) D.J.Galloway & Elix, *Cryptothecia bartlettii* G.Thor, *C. scripta* G.Thor, *Heterodermia subcomosa* (Nyl.) Elix, *Lecanora helva* Stizenb., *Parmotrema reticulatum* (Taylor) M.Choisy, *Pertusaria sublacerans* A.W.Archer, *Pseudocyphellaria pickeringii* (Tuck.) D.J.Galloway, *Pyrenula quassiaecola* Fée, *Ramalina meridionalis* Blanchon & Bannister, *R. stevensiae* Elix and *Usnea nidifica* Taylor.

SPECIMENS EXAMINED

Norfolk Island: ● Mount Pitt Reserve, near Broken Pine, 29°01'S, 167°56'E, 220 m alt., on tree trunk in mixed subtropical rainforest, *J.A. Elix 18314 & H. Streimann*, 2.xii.1984 (CANB); ● just S of Captain Cook Monument, Duncombe Bay, 29°00'00"S, 167°56'30"E, 100 m alt., on tree in regrowth forest margin, *J.A. Elix 18358 & H. Streimann*, 3.xii.1984 (CANB); ● Mount Pitt Reserve, Red Road Track to Mt Bates, 29°00'30"S, 167°56'30"E, 230 m alt., on base of *Araucaria heterophylla* in relatively natural forest on gentle slope, *H. Streimann 34464*, 6.xii.1984 (CANB); ● *loc. id.*, 220 m alt., on sapling in mixed subtropical rainforest, *J.A. Elix 18659 & H. Streimann*, 6.xii.1984 (CANB); ● Mount Pitt Reserve, slopes of Mt Bates above road from King Fern Valley Walk, 29°01'S, 167°56'E, 280 m alt., on bark in regrowth forest, *J.A. Elix 18701 & H. Streimann*, 7.xii.1984 (CANB); ● Norfolk Island National Park, track E of Mt Bates, 29°00'40"S, 167°56'20"E, 280 m alt., on *Nestigia* in subtropical forest on ridge, *J.A. Elix 27465*, 15.vi.1992 (CANB); ● Norfolk Island National Park, end of Marsh's Road (abandoned track), 29°00'48"S, 167°57'50"E, 180 m alt., on bark in subtropical forest on moderate slope, near head of creek, *J.A. Elix 29133*, 17.vi.1992 (B, CANB); ● Norfolk Island National Park, Marsh's Road (abandoned track), 29°00'36"S, 167°56'31"E, 230 m alt., on shaded treelet base in subtropical forest on gentle slope, *H. Streimann 53761*, 15.iv.1994 (B, CANB).

8. Micarea humilis P.M.McCarthy & Elix, sp. nov. Figs 13, 14
MycoBank No. **MB 822613**

Thallus crustose, terricolous, thin, effuse or determinate, pale to medium greenish grey, pale yellowish green or darker grey-green; algae micareoid, 4–9 µm wide. Apothecia black, adnate to subsessile, convex to hemispherical, 0.22–0.57 mm diam., with an excluded margin; hypothecium maroon-black, (85–)110–180(–250) µm thick, not inspersed, K+ deep red, N+ deep red; epihymenium blue-black, 7–12 µm thick, K+ indigo, N+ red-brown; asci clavate, 37–60 × 8–15 µm; ascospores (0–)1-septate, narrowly to broadly ellipsoid, narrowly fusiform or oblong-fusiform, 8–14 × 3–5 µm. Pycnidia rare, with bacilliform conidia 3–6 × 0.7–1 µm.

Type: Australia, Australian Capital Territory, The Pinnacle Nature Park, 9 km NW of Capital Hill, Canberra, 36°15′S, 149°02′E, 640 m alt., on bare soil in grazed paddock on southerly slope, *H. Streimann 42522*, 21.v.1989 (holotype – CANB; duplicates in B and ESS, not seen).

Thallus crustose, on consolidated clay or more sandy soil, effuse or determinate and forming colonies to 8 cm wide, almost completely immersed in the substratum and not apparent, or semi-immersed and dominated by soil material, then commonly membranaceous and less than 30 µm thick, or ± superficial, more substantial and up to 80 µm thick, dull pale to medium greenish grey, pale yellowish green or, most commonly, much darker grey-green, continuous, ecorticate; surface irregular, rather smooth to patchily granulose or verruculose; however, common cracks and pseudoareoles are usually artifacts caused by the action of the lichen on the substratum; cephalodia and goniocysts absent. *Algae* scattered and sometimes interspersed with cyanobacteria and scattered chlorococcoid algae, or forming a dense, well-delimited layer 30–50 µm thick; cells micareoid, yellowish green to green, globose to broadly ellipsoid, (4–)5–8(–9) µm wide. *Medulla* poorly defined; hyphae 2–3 µm wide, short-celled and thin-walled. *Prothallus* not apparent. *Apothecia* usually very numerous, dull black, mostly adnate, occasionally subsessile, rounded or irregular in outline, solitary or in short rows or in groups of up to 8, (0.22–)0.38(–0.57) mm diam. [*n* = 180]; disc moderately to strongly convex or hemispherical, smooth to minutely and irregularly uneven; subsessile apothecia often subglobose and slightly constricted at the base; proper margin not visible in surface view, excluded even in very immature apothecia. *Proper excipulum* narrowly annular, maroon-black in section, 15–20 µm thick laterally, 15–25 µm thick at the base, of radiating, periclinal, short-celled hyphae, the outermost cells almost rounded, 4–6 µm wide, inner cells narrower and more elongate, K+ purple-brown, N+ purple-brown. *Hypothecium* maroon-black, (85–)110–180(–250) µm thick, paraplectenchymatous below, distally with short-celled, vertically oriented hyphae 2–4 µm wide, not inspersed with granules or oil globules, K+ deep red, N+ deep red. *Hymenium* 45–70 µm thick, hyaline but with a few pale reddish patches or vertical streaks, not inspersed, I+ dark blue, C–, K– or K+ pale purple (patches and streaks), N– or N+ pale purple; subhymenium 20–40 µm thick, not inspersed, pale maroon-brown, K+ purple-brown, N+ purple-brown. *Epihymenium* blue-black, 7–12 µm thick, K+ indigo (indigo-purple or deep purple-brown on standing), N+ red-brown; epihymenial pigment sometimes penetrating 15–25 µm into the hymenium. *Paraphyses* tightly conglutinate in water and K, sparingly branched, not anastomosing, long-celled, 0.8–1.5(–2) µm wide; apices not pigmented, not or scarcely swollen, to 2 µm wide. *Asci* narrowly to more broadly clavate or

cylindroclavate, 37–60 × 8–15 µm [*n* = 25], 8-spored, with an amyloid outer coat; tholus well-developed, predominantly amyloid, with or without a short, conical ocular chamber subtending a paler, apical cushion bounded by a more darkly amyloid tube structure. *Ascospores* colourless, (0–)1-septate at maturity, narrowly to broadly ellipsoid, narrowly fusiform or oblong-fusiform, occasionally weakly soleiform, straight or slightly curved, irregularly biseriate in the ascus or overlapping-uniseriate below and clustered distally, not constricted at the septum, (8–)11.5(–14) × (3–)4(–5) µm [*n* = 262], thin-walled, lacking a perispore; apices rounded to subacute; contents clear. *Pycnidia* very rare (seen only in *J.A. Elix 39082*), semi-immersed, globose, greenish black above, somewhat paler below, 50–60 µm diam.; conidiogenous layer simple. *Conidia* simple, bacilliform, 3–6 × 0.7–1 µm.
Chemistry: Thallus K–, C–, KC–, PD–, UV–; no substances detected by TLC.

Etymology: The specific epithet *humilis* (L, of the soil) refers to the substratum of the new species.

Remarks

Micarea humilis is characterized by and distinguished from similar species of *Micarea* by a suite of attributes including thallus morphology, the pattern of apothecial pigments and their reactions to K and N, and the occurrence of comparatively small, mostly 1-septate ascospores. Thus, the new species has a very thin, continuous and often dark thallus, apothecia with a thick, maroon-black hypothecium (K+ deep red, N+ deep red), a blue-black epihymenium (K+ indigo, turning indigo-purple or deep purple-brown, N+ red-brown), a maroon-black proper excipulum (K+ purple-brown, N+ purple-brown), and ascospores 8–14 × 3–5 µm. *Micarea incrassata* (Nyl.) Coppins, known from peaty substrata especially in montane regions of northern and central Europe, North America and subantarctic islands, has a well-developed, grey-white, yellowish grey, grey-brown or dark grey, markedly convex-areolate or verrucose thallus, often with cephalodia, the hypothecium is dark red-brown, without purple tints, N+ orange-brown, and the mainly 1-septate spores are 10–17 µm long (Coppins 1983, 2009; Czarnota 2007). Another terricolous species, *M. assimilata* (Nyl.) Coppins, has a similar distribution and substratum and habitat preference. It can be distinguished from *M. humilis* by the thick, whitish, areolate thallus, also frequently cephalodiate, the hypothecium which is purple-brown and N+ purple-red, and the mainly simple spores 10–19 × 3–5 µm (Coppins 1983, 2009). Both taxa are known from alpine and subalpine areas of New South Wales (McCarthy 2017). Unlike many species of *Micarea*, which can have two or three anamorphic states, a few, including *M. humilis*, *M. assimilata* and *M. incrassata*, appear to have only one conidial type which, as pointed out by Coppins (1983), is intermediate in size between microconidia and mesoconidia.

The almost cosmopolitan *M. prasina* Fr., a widespread lichen in south-eastern Australia, can be found on a broad range of substrata including, rarely, consolidated mineral soil. The pale green to dark grey-green thallus is composed of minute goniocysts that are often aggregated into clusters or pseudoareoles, the apothecia are 0.2–0.4 mm wide with a pale hypothecium, and the 0–1-septate ascospores are 7–14 × 2.5–5.5 µm (Coppins 1983, 2009; Czarnota 2007). Finally, *M. almbornii* Coppins, described from sandstone in South Africa, and recently reported from consolidated soil in the Northern Tablelands, New South Wales (Elix 2012), has a scant thallus not unlike that of *M. humilis*. However, the hymenium is dull olive to greenish brown (K+ violet), it is subtended by a hyaline hypothecium, and the persistently simple ascospores are 7–11 × 4–6.5 µm (Coppins 1999; Elix 2012).

The new species is known from bare and consolidated mineral soil in grassland and forest at several localities in the Southern Tablelands and Central-Western Slopes of New South Wales and the Australian Capital Territory. Commonly associated species include *Paraporpidia leptocarpa* (C.Bab. & Mitt.) Rambold & Hertel, *Trapelia coarctata* (Sm.) M.Choisy, *T. crystallifera* Kantvilas & Elix, *Xanthoparmelia subprolixa* (Nyl. ex Kremp.) O.Blanco, A.Crespo, Elix, D.Hawksw. & Lumbsch and *X. substrigosa* (Hale) Hale.

SPECIMENS EXAMINED

New South Wales: ● 24 km N of Grenfell along Forbes road, 33°43’S, 148°04’E, on bare soil in dry-sclerophyll forest, *J.A. Elix 4816*, 16.vii.1978 (CANB); ● Tinderry Range, 9 km E of Michelago along the Captains Flat road, 35°44’S, 149°17’E, 1200 m alt., on soil along a roadbank, *J.A. Elix 9602*, 15.xi.1981 (CANB); ● Cookamidgera State Forest, 3.5 km SSW of Cookamidgera, 33°13’43”S, 148°16’54”E, 345 m alt., on bare soil in *Eucalyptus* woodland, *J.A. Elix 39082*, 4.viii.2008 (CANB); ● Scottsdale Bush Heritage Reserve, 4 km N of Bredbo, 35°55’06”S, 149°08’09”E, 855 m alt., on consolidated soil in remnant *Eucalyptus* woodland, *J.A. Elix 46092*, 7.v.2014 (CANB); ● Weddin State Forest, 17 km SW of Grenfell, 34°01’S, 148°03’E, 300 m alt., on bare, semi-shaded soil in *Callitris*-dominated forest on flats, *H. Streimann*, 16.vii.1988 (CANB; duplicates in B and NY, not seen).
Australian Capital Territory: ● Acton, 3 km NW of Capital Hill, Canberra, 35°17′S, 149°13′E, 600 m alt., on bare soil in grassland, *H. Streimann 5690*, 21.vii.1978 (CANB); ● Gudgenby Gorge, 33 km SSE of Canberra, 35°32′S, 149°05′E, 600 m alt., on bare, semi-exposed soil on *Eucalyptus*- and *Callitris*-dominated side of gorge with easterly aspect, *H. Streimann 15648*, 30.vii.1981 (CANB).

9. Porpidia littoralis P.M.McCarthy & Elix, sp. nov. Figs 15, 16
MycoBank No. **MB 822614**

Thallus crustose, very thin, effuse or determinate, pale grey to pale yellowish brown, non-amyloid, lacking lichen substances. Apothecia black, sessile, epruinose, 0.45–1.30 mm diam., with a persistent proper margin; exciple with a thin, brown-black outer zone, internally ± colourless and composed of narrow, radiating hyphae; epihymenium dark brown, K–, N+ red-brown; hypothecium pale to medium brown above, paler brown to hyaline below; asci *Porpidia*-type, with simple, ellipsoid ascospores 16–25 × 7–13 µm, with or without a perispore. Pycnidia with filiform conidia 7–15 × 0.5–1 µm.

Type: Australia: New South Wales, Jervis Bay, Callala Bay, 0.5 km W of Callala Point, 35°00’22”S, 150°43’07”E, 0.5–2 m alt., on unstable, vertical shale cliff receiving sea spray and soil runoff from above, *J.A. Elix 46369*, 19.iv.2017 (holotype – CANB).

Thallus crustose, subepilithic to epilithic, effuse and inconspicuous or determinate and forming colonies to 5(–8) cm wide, pale grey to pale yellow-brown, but often slightly paler towards the margin, to 50–100(–150) µm thick, continuous to very sparingly rimose, only patchily areolate, ecorticate, lacking soredia. *Areoles* angular, irregular, contiguous or scattered, (0.1–)0.15–0.5 mm wide, unevenly convex; surface dull, smooth to irregularly verrucose. *Algal layer* continuous, 20–40 µm thick; cells green, chlorococcoid, often rather thick-walled, 7–12(–14) µm diam.; interstitial hyphae short-celled, 2–3 µm wide. *Medulla* not well delimited, obscured by minute rock fragments and crystals, not containing calcium oxalate (H_2SO_4–), I–. *Prothallus* not apparent. *Apothecia* very numerous, lecideine, some adnate but most sessile and constricted at the base, rounded to rather irregular, (0.45–)0.87(–1.30) mm diam. [*n* = 100], scattered or in proliferating clusters of 3–5, with hints of concentric rings of apothecia towards the thallus margin; margin well defined and usually persistent, 70–100 µm thick, often prominent, concolorous with the disc, dull to slightly glossy, entire or coarsely and irregularly flexuous, occasionally partly crenate, the surface often faintly radially scored; disc initially shallow-concave to plane, usually remaining plane at maturity or becoming moderately convex, occasionally strongly convex and the margin almost excluded, dull blackish, dark brown when wetted, smooth to irregularly uneven, epruinose, not gyrose. *Thalline excipulum* absent. *Proper excipulum* well developed, annular, not inspersed with crystals, in thin section 60–100 µm thick laterally, 80–120 µm thick at the base; internally with a hyaline to pale yellow-brown zone 60–80 µm thick, the hyphae radiating outwards in a gelatinous matrix, anastomosing, thin-walled and 1–1.5(–2) µm wide; outer excipular zone brown-black, (12–)15–20(–30) µm thick (K–, N+ deep red-brown), with hyphae that are progressively darker, broader (2–3 µm) and shorter-celled towards the surface; outermost cells rounded and 3–5(–6) µm wide.

Hypothecium pale yellow-brown to medium brown, inspersed oil globules above, 60–80 µm thick laterally, 100–250 µm thick in the centre where it dominates a pale brown, non-inspersed 'root' (0.2–0.4 mm wide) that penetrates the thallus, K–, N–; hyphae tightly conglutinate, radiating laterally towards the excipulum and downwards into the 'root', 1.5–3 µm wide. *Hymenium* hyaline, 90–140 µm thick, not inspersed with granules or oil globules, I+ blue; subhymenium hyaline, 20–40 µm thick, densely inspersed with oil globules, K–, N–, I+ blue. *Epihymenium* dark brown, 10–20(–30) µm thick, K–, N+ red-brown. *Paraphyses* tightly conglutinate in water, only a little looser in K, unbranched for most of their length, sparingly to richly branched and anastomosing below the apices, long-celled, 0.8–1.2(–1.5) µm wide; most apices swollen, 2–4(–5) µm wide, their walls and those of 1 or 2 subtending cells pale to dark brown. *Asci* narrowly to broadly clavate or cylindroclavate, 8-spored, 65–100 × 14–26 µm [*n* = 30], *Porpidia*-type (Hafellner 1984); tholus with a more weakly amyloid lateral part, a weakly amyloid broadly diverging *masse axiale* with a strongly amyloid outer tube; ocular chamber lacking. *Ascospores* colourless, simple, narrowly to broadly ellipsoid, occasionally oblong-ellipsoid or obovoid, the ends usually rounded, or more rounded distally and subacute at the proximal end, irregularly biseriate in the ascus, or uniseriate below and biseriate or clustered distally, (16–)20(–25) × (7–)10.5(–13) µm [*n* = 120]; wall to 1 µm thick; contents with a single, large vacuole or with few to very numerous guttules; perispore not apparent or well-delimited around ascospores released from asci, 2–3 µm thick in water, with a sharper edge and up to 4–6 µm thick in a 2% erythrosin in ammonia solution. *Pycnidia* numerous, semi-immersed to almost completely immersed in the thallus, rounded to pyriform in section, 60–80(–100) µm wide; apex black, plane to convex, dark brown in section; lateral and basal walls colourless to pale or dark brown, 6–8 µm thick; conidiogenous layer simple; conidiophores swollen at the base and tapering distally, 8–12 µm long, 1.5–2 µm thick. *Conidia* filiform, usually straight, occasionally slightly curved, (7–)9–13(–15) × (0.5–)0.7–1 µm.
Chemistry: Thallus K–, C–, KC–, PD–, UV–; no substances detected by TLC.

Etymology: The epithet *littoralis* (L, pertaining to the seashore) alludes to the type locality.

Remarks

The new species is referable to *Porpidia* Körb. (Lecideaceae) due to its saxicolous thallus, sessile apothecia, *Porpidia*-type asci (*sensu* Hafellner 1984), and rather large, simple and frequently halonate ascospores. The variable occurrence of this last feature perhaps emphasizes the observation made by Rambold (1989) that the perispore in Porpidiaceae, rather than being an unambiguous generic character, is one that can be influenced by environmental and other factors.

This complex and moderately diverse genus has been studied in considerable detail in Europe (Clauzade & Roux 1985; Gowan & Ahti 1989; Fryday 2005; Fryday *et al.* 2009), North America (Gowan 1989), the Subantarctic (Hertel 1984; Fryday and Hertel 2014) and New Zealand (Galloway 2007). Australian *Porpidia* species were documented in a monograph by Rambold (1989) and, currently, 11 species and an additional variety are known from Australia, mainly at higher elevations in the south-east (McCarthy 2017).

Porpidia littoralis is readily distinguished from most other congeners because of its thin and comparatively poorly developed, non-amyloid thallus lacking lichen substances, combined with epruinose apothecia, a dark brown epihymenium, a pale to medium brown hypothecium, rather large ascospores and short-filiform conidia. Furthermore, the highly distinctive anatomy of the proper excipulum, with a pale inner zone of thin, radiating hyphae in a gelatinous matrix, subtending a narrow, brown-black outer zone, places it in the small but well-defined *P. albocaerulescens* (Wulfen) Hertel & Knoph group of species (Gowan 1989; Buschbom & Mueller 2004; Fryday 2005), along with the locally common and widely distributed *P. albocaerulescens* (Gowan 1989; Rambold 1989; Fryday 2005), with innate, pruinose apothecia and the thallus containing the stictic acid chemosyndrome, the soraliate *P. rugosa* (Taylor) Coppins & Fryday, containing 2'-*O*-methylsuperphyllinic acid (Fryday 2005; Fryday *et al.* 2009), as well as *P. chungii* (Zahlbr.) Hertel from China and Japan and *P. navarina* U.Rupr. & Türk from southern Chile, both containing the stictic acid chemosyndrome (Inoue 1983; Ruprecht *et al.* 2016). Moreover, the mainly Eurasian, semiaquatic species *P. hydrophila* (Fr.) Hertel & A.J.Schwab (Fryday 2005; Fryday *et al.* 2009), although lacking lichen substances, has a thick, smooth, often glossy thallus and apothecia with a bright, aeruginose epihymenium and upper hymenium. Thus, all species of this group exhibit suites of significant morphological, anatomical and/or chemical differences when compared with *P. littoralis*. It has been suggested that their shared and distinctive excipular attributes might warrant recognition as a separate genus (Gowan 1989; Buschbom & Mueller 2004; Fryday 2005).

Porpidia littoralis is known only from the type locality, *viz.* Callala Bay on the northern shore of Jervis Bay, South Coast, New South Wales, where it grows in considerable abundance on a 4–5 m tall, vertical shale cliff influenced both by the deposition of sea spray and soil leachates trickling from above. This is also the type locality of the recently described *Fellhanera robusta* P.M.McCarthy & Elix and *Ramboldia curvispora* P.M.McCarthy & Elix (McCarthy & Elix 2017). The cliff has a distinctive lichen flora on damp, soft, almost mud-like and crumbling shale. Other associated species include *Acarospora citrina* (Taylor) Zahlbr. ex Rech., *Amandinea julianeae* H.Mayrhofer & Elix, *Arthonia lapidicola* (Taylor) Branth & Rostrup, *Buellia* spp., *Opegrapha aff. diaphoriza* Nyl., *Physcia littoralis* Elix and *Scolicosporum umbrinum* (Ach.) Arnold.

SPECIMENS EXAMINED
New South Wales: ● South Coast, type locality, *P.M. McCarthy 4655*, 19.iv.2017 (CANB); ● *loc. id.*, *J.A. Elix 46385, 46386*, 23.v.2017 (CANB).

10. Ramboldia oxalifera P.M.McCarthy & Elix, sp. nov. Figs 17, 18
MycoBank No. **MB 822615**

Thallus crustose, epiphloeodal, pale yellow-grey, pale yellowish brown or pale brown, 0.1–0.25(–0.35) mm thick, bullate, corticate, lacking lichen substances. Apothecia subsessile to sessile, (0.58–)0.96(–1.48) mm diam., convex, pale to dark brown, with a persistent or excluded proper margin; proper excipulum annular, ± colourless to pale yellow-brown, ± paraplectenchymatous; epihymenium nondescript, hyaline; hypothecium pale to medium orange-brown; subhypothecium 100–250 µm deep, dominated by calcium oxalate; asci *Lecanora*-type, with simple, narrowly ellipsoid to oblong ascospores 8–13 × 2.5–3.5 µm. Pycnidia with filiform conidia *c.* 10–17 × 0.5–0.7 µm.

Type: Australia: New South Wales, Northern Tablelands, Diehard Creek, Mann River Nature Reserve, 50 km E of Glen Innes, 29°40'29"S, 150°05'19"E, 595 m alt., on bark of *Allocasuarina* in *Allocasuarina-Eucalyptus* woodland along stream, *J.A.Elix 37045A*, 1.v.2005 (holotype – CANB).

Thallus crustose, epiphloeodal, forming colonies up to several centimetres wide, pale yellow-grey, pale yellowish brown or pale brown, 0.1–0.25(–0.35) mm thick, irregularly and unevenly bullate, not cracked or areolate, lacking soredia, isidia and blastidia; surface smooth, dull to patchily glossy. *Cortex* bilayered; upper layer hyaline, 10–20(–25) µm thick, amorphous above, below with anticlinal hyphae 2–3 µm wide, inspersed with brownish granules; lower layer pale to medium brown, 15–30 µm thick, of rounded to slightly anticlinal, thick-walled cells 5–12 µm wide. *Algal layer* continuous, 30–60(–70) µm thick; cells green, chlorococcoid, often rather thick-walled, 8–12(–15) µm diam. *Medulla* well delimited, (25–)40–70(–150) µm thick, of loose, short- to long-celled, thin-walled hyphae 2.5–5 µm wide, not containing calcium oxalate (H_2SO_4–), except beneath apothecia when penetrated by the subhypothecium. *Prothallus* whitish or not apparent. *Apothecia* very numerous, subsessile to sessile and constricted at the base, lecideine, solitary and rounded to ellipsoid or more irregular, (0.58–)0.96(–1.48) mm diam. [*n* = 85], or in 2s or 3s, or forming tight, proliferating clusters of up to 8; disc pale to dark brown (paler when immature), usually becoming strongly convex, smooth, dull to slightly glossy, epruinose; margin distinct and persistent or becoming excluded, not prominent, usually paler than the disc, or concolorous, dull to glossy, entire, 80–120 µm thick

in surface view. *Thalline excipulum* absent. *Proper excipulum* well-developed, annular, ± colourless to pale yellow-brown in section, 40–60 µm thick laterally, 50–80 µm thick at the base, ± paraplectenchymatous; lateral excipular cells moderately thick-walled, rounded to slightly elongate and radiating towards the surface, 5–8 × 4–5 µm, the outermost cells rounded and contained by an amorphous layer 4–7 µm thick; basal excipular cells thicker-walled, more elongate and radiating downwards, 7–12 µm long; base commonly with sparse, *Byssoloma*-like hyphae projecting downwards, 10–25 µm long and 2–3 µm wide. *Epihymenium* non-descript, hyaline and indistinguishable from the hymenium, lacking pigment and granules, K–, N–. *Hypothecium* pale to medium orange-brown, the colour intensifying in K and N, not inspersed with granules or oil globules, 40–60 µm thick; cells rounded, thick-walled, tightly contiguous, 4–7 µm wide; subhypothecium strikingly white when the apothecium is cut vertically, dominated by a dense concentration of calcium oxalate (H_2SO_4+), 100–250 µm deep, to 350 µm deep when it penetrates the thallus, disrupting the algal layer; hyphae forming a loose reticulum, long-celled, thin-walled, 2–4 µm wide. *Hymenium* 45–60(–70) µm thick, not inspersed, the distal half hyaline, pale yellow-brown below; hymenial gel I–; subhymenium pale orange-brown, the colour intensifying in K and N, 20–30 µm thick, not inspersed; hyphae rounded below, elongate and anticlinal above. *Paraphyses* tightly conglutinate in water, scarcely loosening in K, mostly simple, very sparingly branched, lacking anastomoses, short- to long-celled, 2–3 µm wide, commonly constricted at the septa, with sparse granular inclusions; apices not or only very slightly swollen (globose or clavate and up to 3.5 µm wide), not pigmented. *Asci* narrowly clavate to cylindrical, rarely broadly clavate, 8-spored, 37–50 × 7–10 µm [*n* = 20], *Lecanora*-type (Hafellner 1984); tholus with a strongly amyloid lateral part, a non-amyloid or weakly amyloid and diverging *masse axiale* with a non-amyloid cap above; ocular chamber usually lacking, rarely narrowly tubercular or conical and up to 1.5 µm tall. *Ascospores* colourless, simple, narrowly ellipsoid to oblong-ellipsoid or oblong, usually straight and with rounded ends, irregularly biseriate in the ascus or obliquely arranged, (8–)11(–13) × (2.5–)3(–3.5) µm [*n* = 100], thin-walled, lacking a perispore at maturity (immature ascospores commonly with a perispore to 0.7 µm thick); contents clear. *Pycnidia* moderately numerous, immersed in the thallus, solitary and subglobose, or paired or in obpyriform groups of 3 or 4, 80–150(–180) µm wide; apex concave, pale brown, 50–70 µm wide; lateral and basal walls hyaline, 5–7(–10) µm thick; conidiophores unbranched, tapering, 5–10 × 2–2.5 µm; conidia filiform, simple, straight or very slightly curved, *c.* 10–17 × 0.5–0.7 µm; conidia not seen detached from the conidiophores or extruded from the pycnidia, the contents of which eventually become amorphous and yellowish brown.
Chemistry: Thallus K–, C–, KC–, PD–, UV–; no substances detected by TLC.

Etymology: The specific epithet refers to the very distinctive white, subhypothecial concentration of calcium oxalate.

Remarks

The new species is characterized by the thick, smooth, bullate and predominantly brownish thallus that lacks lichen substances, together with large, convex and mostly darker brown apothecia with a thick subhypothecium dominated by calcium oxalate, and narrowly ellipsoid to oblong ascospores, 8–13 × 2.5–3.5 µm. *Ramboldia brunneocarpa* Kantvilas & Elix, mainly known from southern Australia, also has brown apothecia, but the rimose and verrucose thallus is predominantly grey, and the thallus and apothecia contain norstictic acid (Kantvilas & Elix 1994; Elix 2009). A bullate thallus is also a primary diagnostic attribute of *R. crassithallina* Kalb, a species that is most common in lowland sclerophyll forest in mainland Australia. However, its thallus is thicker, areolate and contains thamnolic acid, and the apothecia have a glossy black disc, while the subhypothecium contains thamnolic acid in place of calcium oxalate (Kalb 2001; Elix 2009).

The recognition of *R. oxalifera* brings to 22 the number of species of *Ramboldia* known from Australia (Elix 2009; Elix & McCarthy 2017; McCarthy 2017), which is the centre of diversity for the genus globally. It is known only from the bark of *Allocasuarina* in *Allocasuarina-Eucalyptus* woodland along a stream in northern New South Wales. Associated species include *Cratiria subtropica* (Elix) Elix, *Crocodia aurata* (Ach.) Link, *Flavoparmelia euplecta* (Stirt.) Hale, *Heterodermia speciosa* (Wulfen) Trevis., *Lecanora achroa* Nyl., *Leptogium asiaticum* P.M.Jørg., *Parmotrema hiatense* (Hale) Hale, *Pertusaria commutata* Müll.Arg., *P. leioplacella* Müll.Arg., *Punctelia pseudocoralloidea* (Gyeln.) Elix & Kantvilas and *Usnea ceratina* Motyka.

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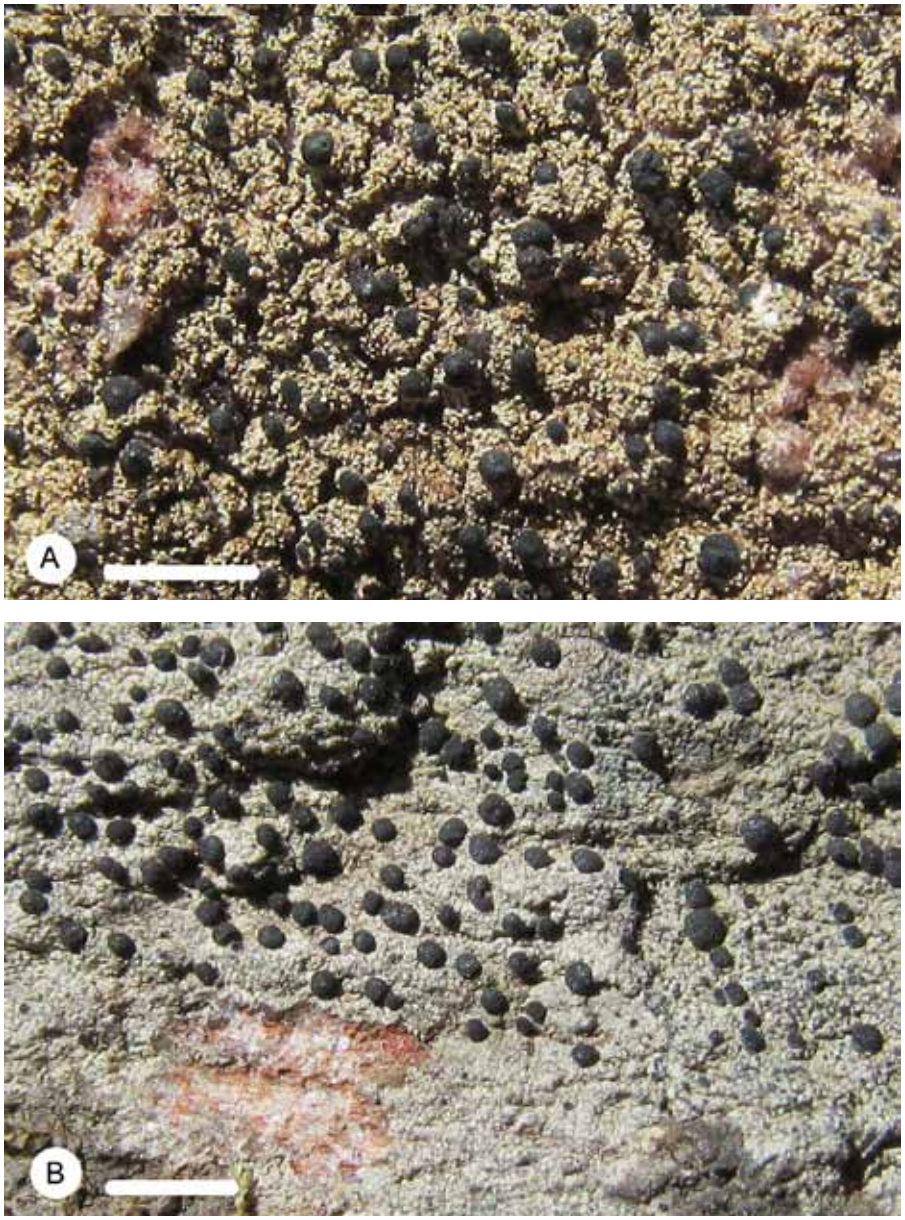

Figure 1. *Byssoloma australiense*. Variation in thallus morphology. A, holotype, composed of aggregated pseudoisidia; B, *J.A. Elix 45223*, paler and abundantly rimose and verrucose. Scale bars = 2 mm.

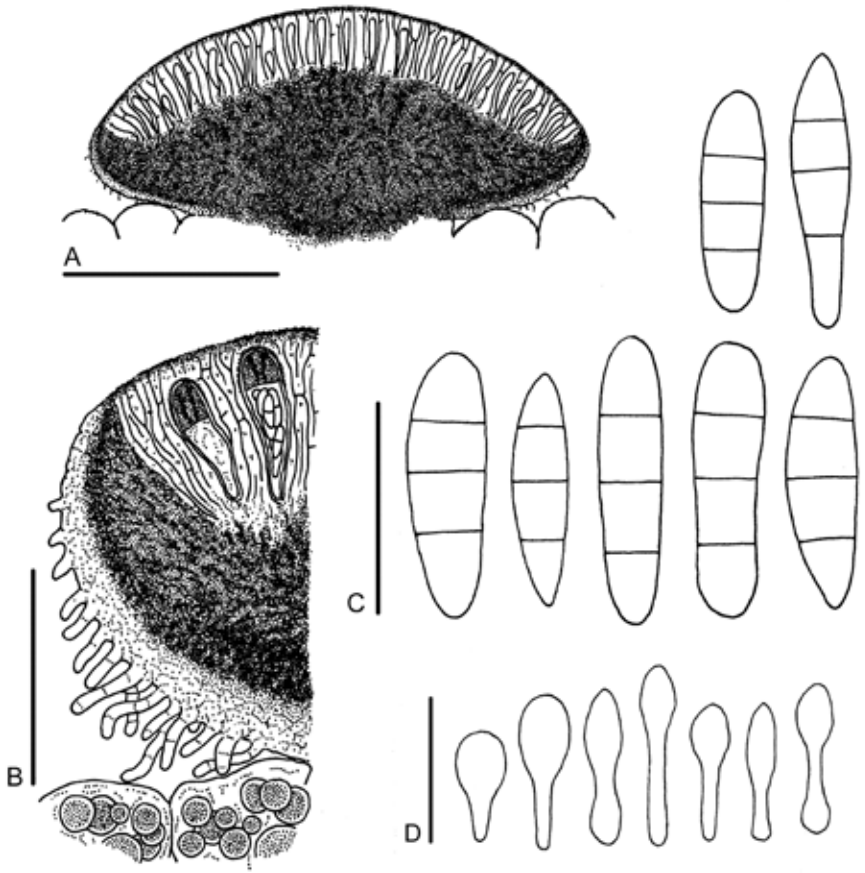

Figure 2. *Byssoloma australiense* (A–C, holotype; D, *J.A. Elix 45223*). A, sectioned, mature apothecium (semi-schematic); B, sectioned, immature apothecium (semi-schematic), showing vestigial, byssoid margin and mature and submature asci stained with Lugol's iodine after pre-treatment with K; C, ascospores; D, conidia. Scale bars: A = 0.2 mm; B = 50 µm; C = 10 µm; D = 5 µm.

Figure 3. *Catillaria laevigata* (holotype). Scale bar = 1 mm.

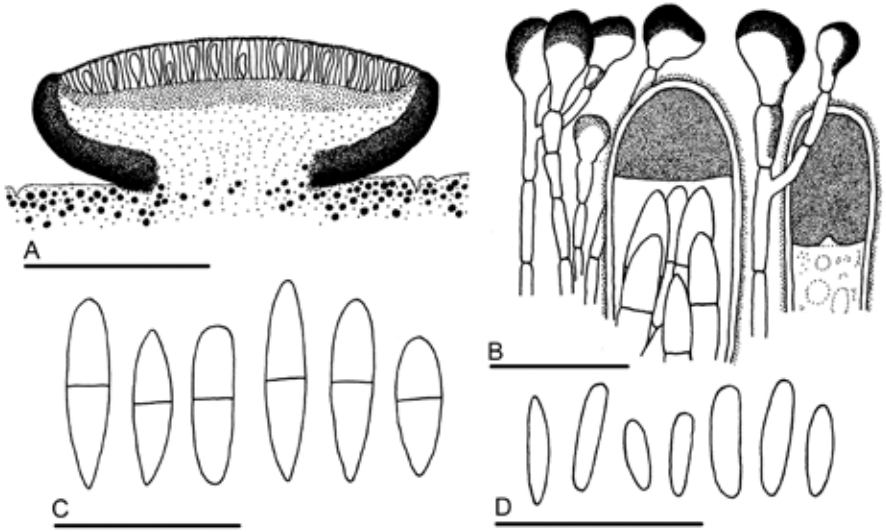

Figure 4. *Catillaria laevigata* (holotype). A, sectioned apothecium and adjacent thallus (semi-schematic); B, apices of mature and submature asci stained with Lugol's iodine after pre-treatment with K, and paraphyses; C, ascospores; D, conidia. Scale bars: A = 0.2 mm; B, C = 10 µm; D = 5 µm.

Figure 5. *Cladia xanthocarpa* (holotype). A, five monophyllous thalli; B; thallus margins with apothecia. Scale bars: A = 2 cm; B = 2 mm.

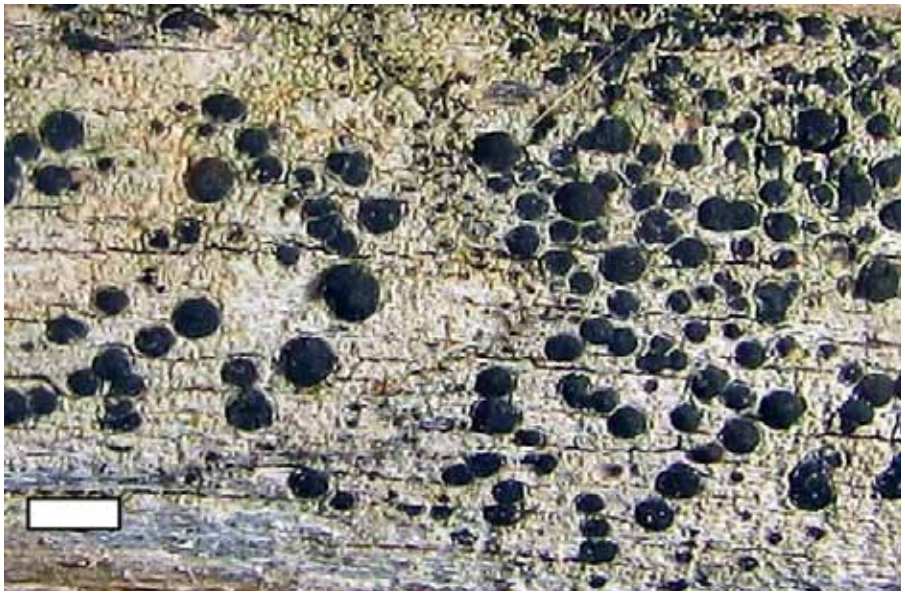

Figure 6. *Japewiella variabilis* (holotype). Scale bar = 1 mm.

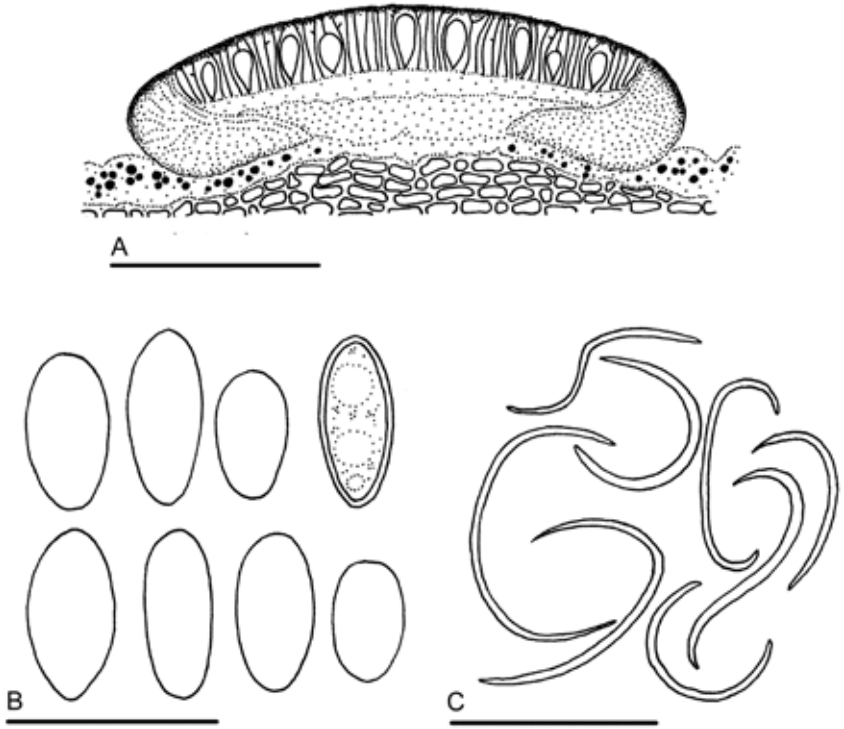

Figure 7. *Japewiella variabilis* (holotype). A, sectioned apothecium and adjacent thallus and substratum (semi-schematic); B, ascospores; C, conidia. Scale bars: A = 0.2 mm; B = 20 μm; C = 10 μm.

Figure 8. *Lecidella meridionalis* (holotype). Scale bar = 1 mm.

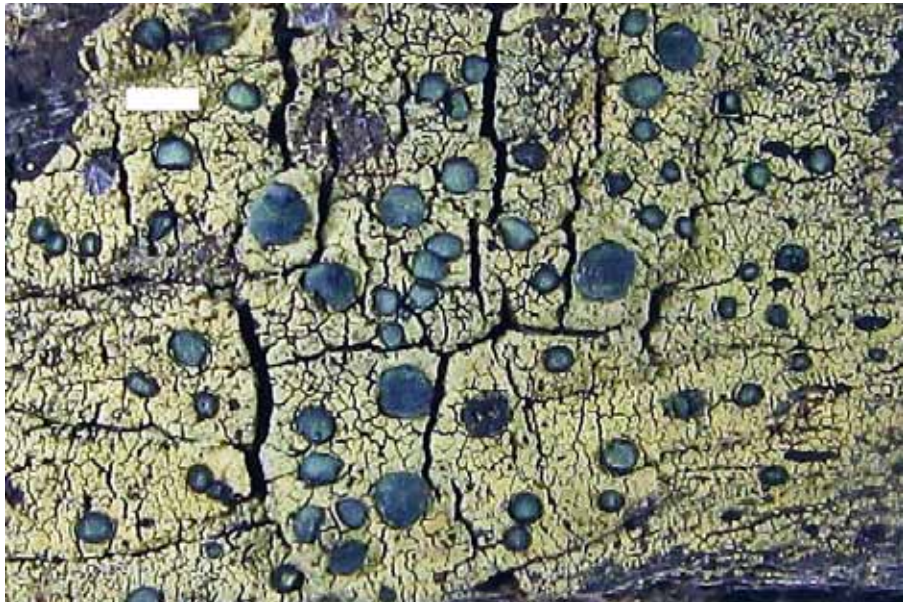

Figure 9. *Lecidella occidentalis* (holotype). Scale bars = 1 mm.

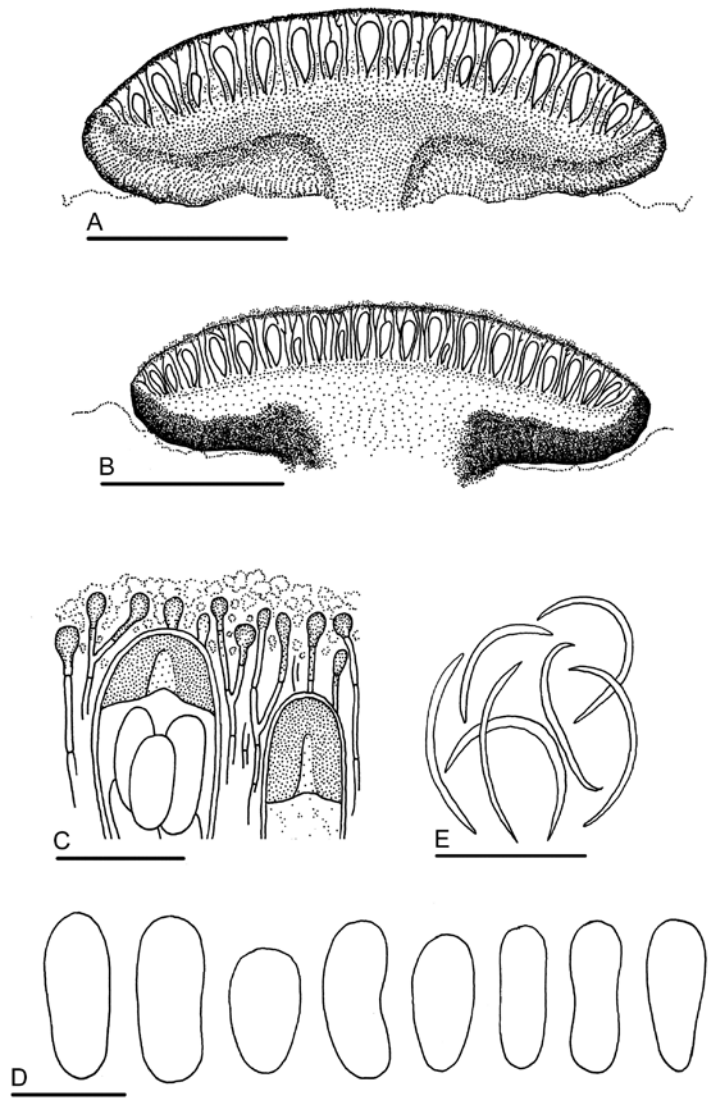

Figure 10. *Lecidella* species. A, *L. meridionalis* (holotype), sectioned apothecium (semi-schematic); B–E, *L. occidentalis* (holotype). B, sectioned apothecium (semi-schematic); C, apices of mature and submature asci stained with Lugol's iodine after pre-treatment with K, with paraphyses and pruina; D, ascospores; E, conidia. Scale bars: A, B = 0.2 mm; C = 20 µm; D, E = 10 µm.

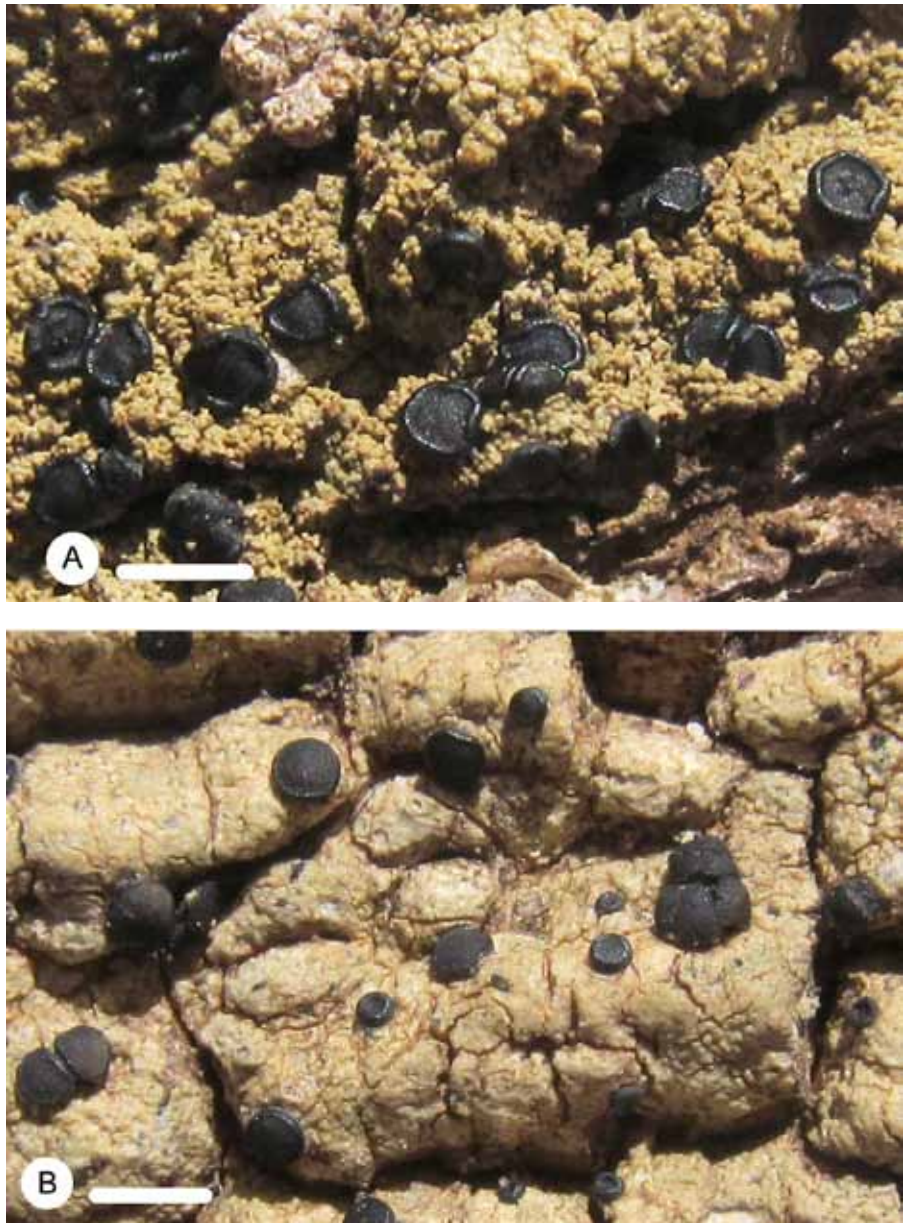

Figure 11. *Megalaria insularis*. Variation in thallus morphology. A, holotype, with a granulose thallus; B, *J.A.Elix 18358 & H.Streimann*, with a comparatively smooth thallus. Scale bars = 2 mm.

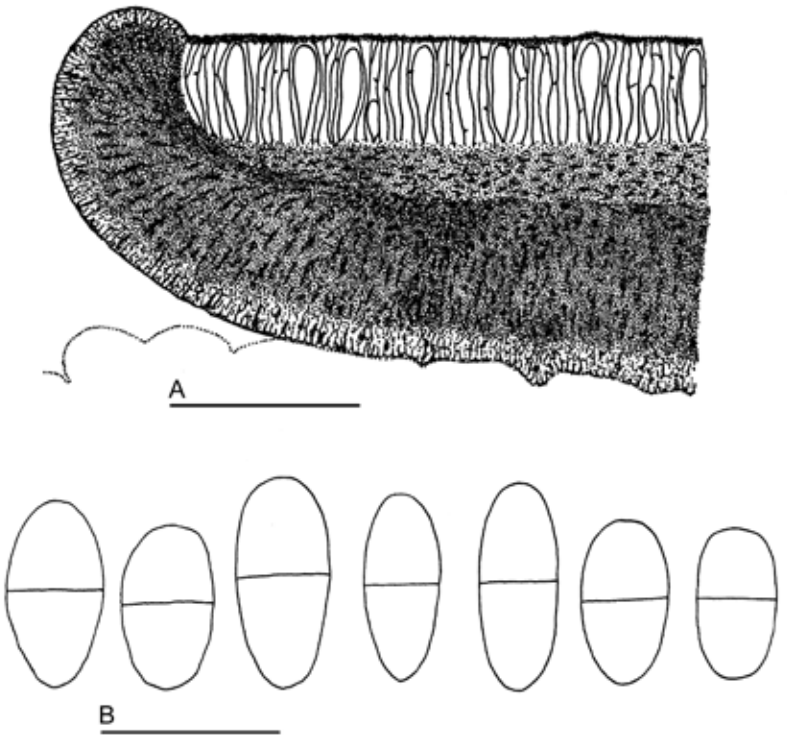

Figure 12. *Megalaria insularis* (holotype). A, half of a sectioned apothecium (semi-schematic); B, ascospores. Scale bars: A = 0.2 mm; B = 20 µm.

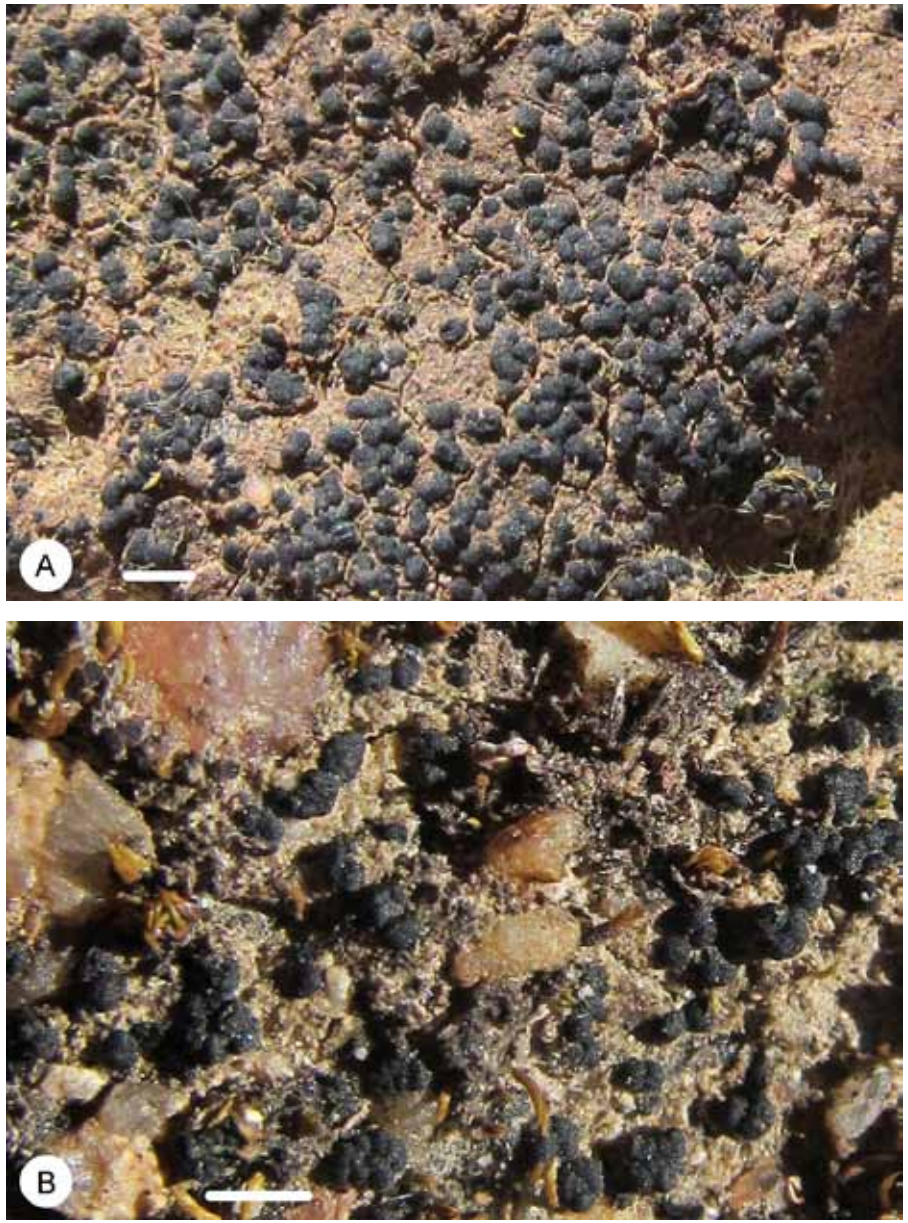

Figure 13. *Micarea humilis*. A, holotype; B, *H. Streimann 15648*. Scale bars = 1 mm.

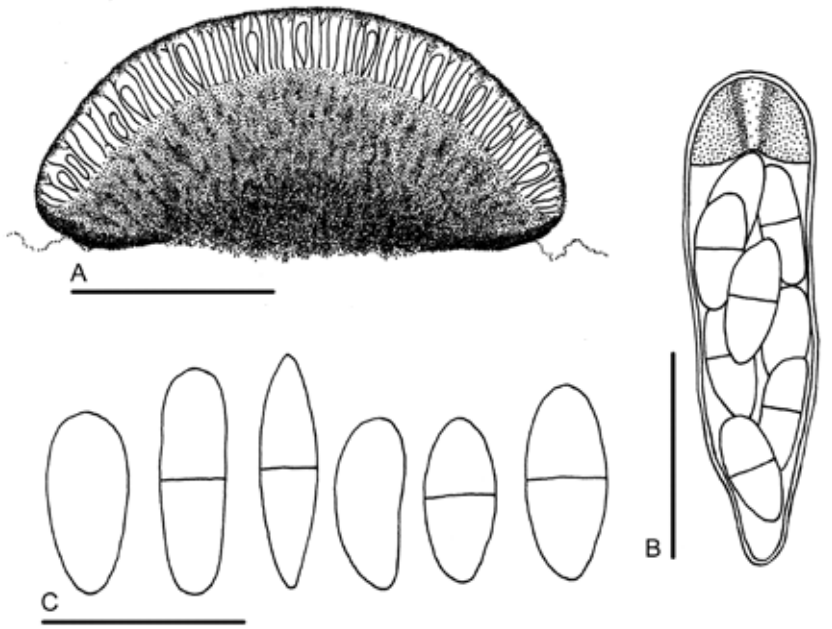

Figure 14. *Micarea humilis* (holotype). A, sectioned apothecium (semi-schematic); B, mature ascus, the tholus stained with Lugol's iodine after pre-treatment with K; C, ascospores. Scale bars: A = 0.2 mm; B = 20 µm; C = 10 µm.

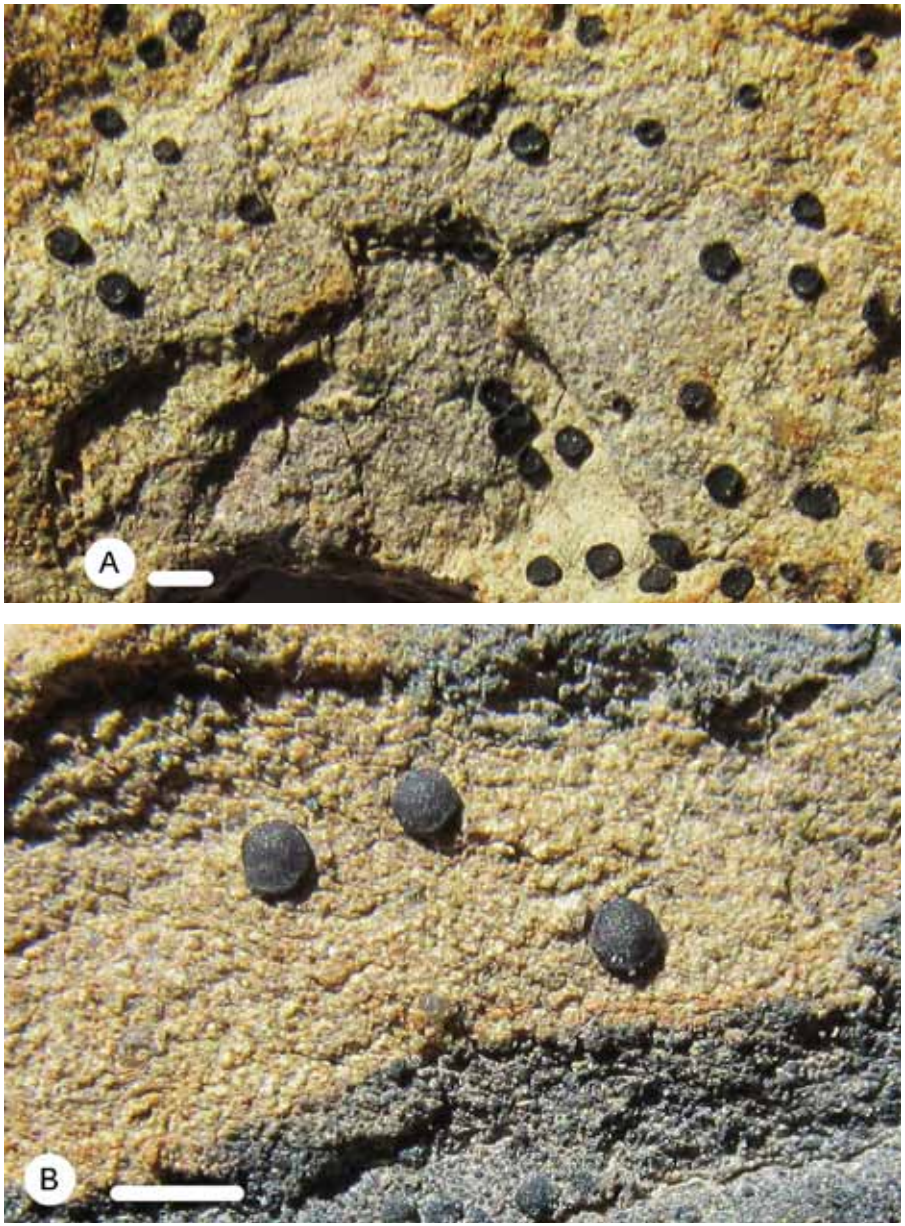

Figure 15. *Porpidia littoralis*. A, holotype; B, *P.M. McCarthy 4655*. Scale bars = 2 mm.

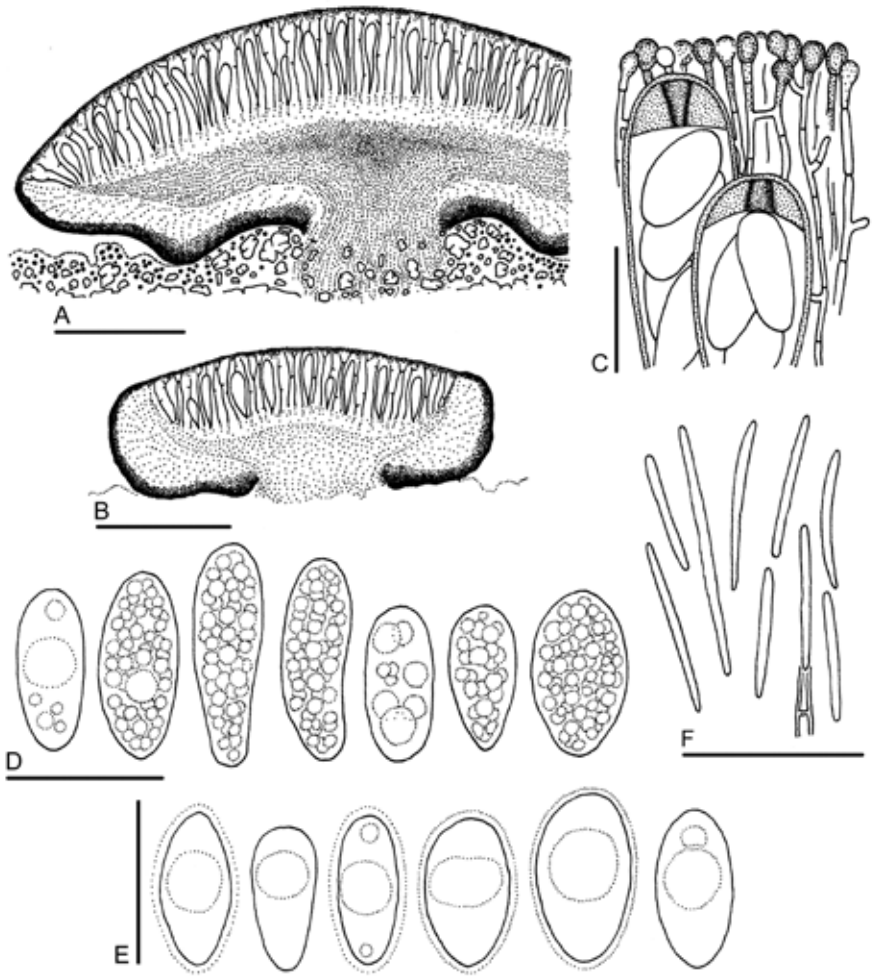

Figure 16. *Porpidia littoralis* (A–D, F, *P.M. McCarthy 4655*; E, holotype). A, sectioned, mature apothecium and adjacent thallus (semi-schematic); B, sectioned, immature apothecium (semi-schematic); C, asci, the tholi stained with Lugol's iodine after pre-treatment with K, and paraphyses; D, E, ascospores; F, conidia. Scale bars: A, B = 0.2 mm; C–E = 20 µm; F = 10 µm.

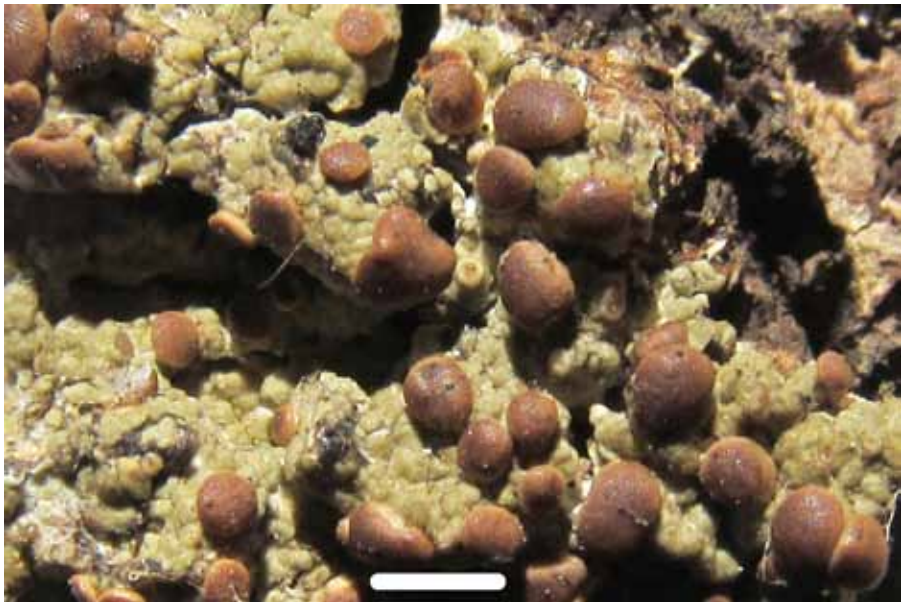

Figure 17. *Ramboldia oxalifera* (holotype). Scale bar = 2 mm.

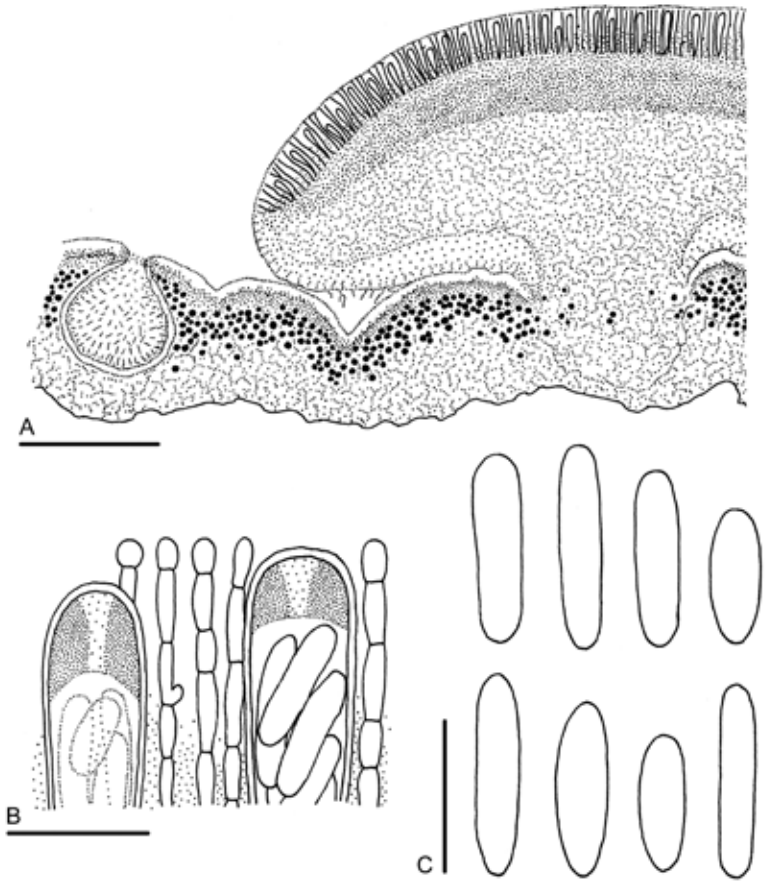

Figure 18. *Ramboldia oxalifera* (holotype). A, part of a sectioned, mature apothecium, a pycnidium and adjacent thallus (semi-schematic); B, submature and mature asci, the tholi stained with Lugol's iodine after pre-treatment with K, and paraphyses; C, ascospores. Scale bars: A = 0.2 mm; B, C = 10 µm.

Three new species and five new records of corticolous and lichenicolous buellioid lichens (Caliciaceae, Ascomycota) from New Zealand's subantarctic islands

John A. Elix
Research School of Chemistry, Building 137,
Australian National University, Canberra, A.C.T. 2601, Australia
e-mail: John.Elix@anu.edu.au

Abstract

Buellia campbelliana Elix, *B. thelotremicola* Elix and *Gassicurtia jamesii* Elix are described as new to science. *Amandinea dudleyensis* Elix & Kantvilas, *A. extenuata* (Müll. Arg) Marbach, *A. lignicola* var. *australis* Elix & Kantvilas, *Baculifera xylophila* (Malme) Marbach and *Orcularia insperata* (Nyl.) Kalb & Giralt are new records for New Zealand's subantarctic islands.

The Antipodes, Auckland, Campbell and Snares Islands and associated islets are located in the Southern Ocean between New Zealand and Antarctica. An introduction to the geology, landforms, vegetation and climate of these subantarctic islands has been provided by Elix (2017). Three corticolous and one lichenicolous species of buellioid lichens have previously been reported from the islands, namely *Amandinea adjuncta* (Th.Fr.) Hafellner, *A. diorista* var. *hypopelidna* (Stirt.) Marbach & Kalb and *A. porulosa* (Müll.Arg.) Elix (Fineran 1971; Galloway 2007). In this contribution, two new lichenicolous species, one corticolous species and five new records of corticolous/lignicolous buellioid lichens are described from these islands. Methods are as described in Elix (2017).

New species

1. Buellia campbelliana Elix, sp. nov. Figs 1, 2
MycoBank No. **MB 822569**

Thallus yellow, lichenicolous on basal squamules of a *Cladonia* species, with broadly adnate apothecia, 0.3–0.4 mm wide, that become crowded and distorted, with epruinose discs, constricted, *Buellia*-type ascospores, 10–[*13.4*]–16 × 6–[*7.2*]–9 µm and containing usnic and 2-*O*-methylsekikaic acids.

Type: New Zealand, Campbell Island, summit of Mt Fizeau, 52°31'01"S, 169°07'59"E, alt. 1655 feet [497 m], on soil in shingle feldmark, *H.A. Imshaug 46790*, 10.i.1970 (holotype – MSC).

Thallus lichenicolous, bright yellow, developed on the dense mat of squamules of the grey-brown host (escyphiferous *Cladonia* sp.), seemingly taking the form of the host. *Apothecia* 0.3–0.4 mm wide, abundant, lecideine, roundish, crowded and deformed by mutual pressure, broadly adnate; disc black, epruinose, plane; proper exciple thin, persistent, in section 50–60 µm thick, outer part dark aeruginose to dark brown, K–, N+ violet-brown, inner part brown. *Epihymenium* 7–12 µm thick, deep-aeruginose, K+ blue-green, N+ red-violet. *Hypothecium* 150–250 µm thick, dark brown to brown-black, K–. *Hymenium* 60–80 µm thick, colourless, not inspersed; subhymenium ill-defined, *c.* 20–25 µm thick, pale reddish brown, not inspersed; paraphyses 1–1.5 µm wide, sparingly branched, with apices 4–5 µm wide and aeruginose caps. *Asci* 8-spored, *Bacidia*-type. *Ascospores Buellia*-type, 1-septate, pale then dark brown, ellipsoid, 10–[*13.4*]–16 × 6–[*7.2*]–9 µm, commonly constricted at the septum, not curved; outer wall smooth to microrugulate. *Pycnidia* not seen.
Chemistry: Thallus K+ yellow, KC+ yellow, P+ yellow-orange, C–, UV–; containing usnic acid (minor), 2-*O*-methylsekikaic acid (major). The host lichen contains stictic acid (major), constictic acid (minor) and cryptostictic acid (trace).

Etymology: The species is named after the type locality.

Remarks

Buellia campbelliana is characterized by the small, crowded, adnate apothecia with epruinose discs, the bright yellow thallus containing usnic acid and the relatively small, constricted, 1-septate *Buellia*-type ascospores, 10–[*13.4*]–16 × 6–[*7.2*]–9 µm, with a smooth to microrugulate outer spore wall. The host species, an undetermined *Cladonia*, is clearly distinguished from the infecting species by its dull, grey-brown squamulose thallus, the absence of usnic acid and the presence of the stictic acid chemosyndrome. At present, usnic acid is known from only one other *Buellia* species, namely *B. sorediata* Filson from Antarctica. The latter is very different from *B. campbelliana*, in being autonomous on rocks and producing numerous capitate soralia. 2-*O*-Methylsekikaic acid has not been detected previously in *Buellia sens. lat.* At present the new species is known from only the type collection.

2. Buellia thelotremicola Elix, sp. nov. Fig. 3
MycoBank No. **MB 822570**

Thallus and prothallus absent, lichenicolous on a *Thelotrema* species, with broadly adnate to sessile apothecia 0.05–0.1 mm wide, with epruinose discs, 3-septate ascospores, 8–[*10.1*]–13 × 4–[*4.7*]–5 µm and no lichen substances.

Type: New Zealand, Auckland Island, west arm of Musgrave Harbour, E of Fleming Plateau, on *Thelotrema* over dead mosses, *H.A. Imshaug 57066*, 28.xii.1972 (holotype – MSC).

Thallus lichenicolous, developed on the thallus of the host (*Thelotrema* sp.). *Apothecia* 0.05–0.1 mm wide, scattered or in groups, lecideine, round, emerging from the host thallus and soon broadly adnate to sessile; disc black, epruinose, weakly concave to plane; proper excipulum persistent, black, initially raised above level of the disc, in section 20–25 µm thick, outer part dark brown to brown-black, K–, N+ orange-brown, inner part brown. *Epihymenium* 7–10 µm thick, dark brown, K–, N–. *Hypothecium* 70–90 µm thick, dark brown, K–. *Hymenium* 35–50 µm thick, colourless, not inspersed; paraphyses 1.5–1.7 µm wide, simple to sparingly branched, with apices 3–4 µm wide and brown caps. *Asci* of the *Bacidia*-type, 8-spored. *Ascospores* 3-septate or rarely 1-septate, brown, elongate-ellipsoid, 8–[*10.1*]–13 × 4–[*4.7*]–5 µm; outer spore-wall rugulate. *Pycnidia* not seen.
Chemistry: Thallus K–, P–, C–, UV–; no lichen substances detected by TLC.

Etymology: The epithet is derived from the host genus.

Remarks

Buellia thelotremicola is a distinctive species characterized by its lichenicolous habit, the dark brown epihymenium and hypothecium, the small, 3-septate ascospores and the absence of lichen substances. Superficially, it resembles *Tetramelas pulverulentus* (Anzi) A.Nordin & Tibell, a lichenicolous species occurring on species of *Physconia*, *Physcia* and *Phaeophyscia* in the Northern Hemisphere (Nordin 2000; Nordin & Tibell 2005). However, *T. pulverulentus* has much larger ascospores, 15–25 × 6–9 µm.

At present the new species is known from only the type collection.

3. Gassicurtia jamesii Elix, sp. nov. Fig. 4
MycoBank No. **MB 822571**

Similar to *Gassicurtia gallowayi* Elix & Kantvilas, but differs in having a sorediate upper surface and in lacking a pigmented medulla.

Type: New Zealand, Auckland Islands, Enderby Island, Sandy Bay, 50°30'04"S, 166°16'55"E, on rata (*Metrosideros*) and *Myrsine*, *P.W. James 1318b*, 18.i.1963 (holotype – BM).
Thallus crustose, ± continuous, to 35 mm wide and 0.1 mm thick, rimose-areolate to ver-

ruculose, individual areoles rounded, plane to weakly convex, 0.05–0.1 mm wide; upper surface grey-white to pale yellow or greenish yellow, sorediate, the soredia developing from erumpent verruculae or directly from the upper surface, sometimes spreading over the entire surface, soredia granular, granules 15–50 µm wide; prothallus usually black, marginal, to 0.5 mm wide, rarely absent; photobiont cells 6–16 µm wide; medulla white, H_2SO_4–, I–. *Apothecia* 0.2–1.2 mm wide, lecideine, scattered, round, immersed to broadly adnate or sessile, then basally constricted; disc black, epruinose or grey-white-pruinose, plane; proper excipulum persistent, glossy, black, in section 25–60 µm thick, mostly opaque dark brown to brown-black throughout, occasionally paler reddish brown in the inner part. *Hypothecium* 120–170 µm thick, dark brown to brown-black, K–. *Epihymenium* 10–12 µm thick, brown, K–, N–. *Hymenium* 50–70 µm thick, colourless, not inspersed; subhymenium pale brown, 25–35 µm thick, colourless, inspersed with oil droplets or not; paraphyses 1.5–2.0 µm wide, simple to sparsely branched, capitate, with apices dark brown, 4.5–5.5 µm wide. *Asci* of the *Bacidia*-type, 8-spored. *Ascospores* of the *Buellia*-type, 1-septate, olive-brown to brown, ellipsoid, 8–[*13.6*]–18 × 5–[*6.4*]–9 µm, becoming slightly constricted at the septum, when young with slight median wall thickenings and then of the *Physconia*-type; outer spore-wall smooth. *Pycnidia* immersed to subemergent; conidia fusiform, 4–7 × 1–1.5 µm.
Chemistry: Cortex K–, KC–, C+ orange, P–, UV+ orange; containing thiophanic acid (major), arthothelin (major), 6-*O*-methylarthothelin (trace) and 4,5-dichloronorlichexanthone (trace).

Etymology: This lichen is named in honour of the collector of the type specimen, the late Peter W. James.

Remarks

Morphologically, the new species resembles *Gassicurtia gallowayi* Elix & Kantvilas, a corticolous lichen known from Tasmania and Stewart Island, New Zealand (Elix & Kantvilas 2015). Both species are characterized by grey-white to pale yellow or greenish yellow, granular-verruculose thalli and ascospores that are relatively large for the genus *Gassicurtia*. However, *G. gallowayi* has an esorediate upper surface and a medulla with patchy dull purple-brown pigment (*G. jamesii* lacks pigments). Superficially, *G. jamesii* could be confused with *Amandinea efflorescens* var. *pseudohypopelida* Marbach in that both have a sorediate upper surface and contain xanthones (Marbach 2000). However, the latter differs in having curved, filiform conidia, 16–31 × 0.7–1 µm, and in containing thuringione and arthothelin as major xanthones. This is the first reported observation of conidia in the latter taxon.

SPECIMENS EXAMINED
New Zealand. *Auckland Island*. ● Cove of 1874 German Expedition, on bark of *Metrosideros* in large peat tussocks *H.A. Imshaug 56734*, 23.xii.1972 (MSC); ● Sealers Creek Cove, mouth of Laurie Harbour, on bark of *Metrosideros* in mature *Metrosideros* forest, *H.A. Imshaug 57687*, 9.i.1973 (MSC).

Amandinea efflorescens var. *pseudohypopelida* Marbach
Guyana. ● East Demerara District. Along western dyke at mouth of Mahaica River, 6°41–43'N, 57°55'W, sea level, on trunk of *Cocos nucifera* in cultivated coastal area, *H. Sipman & A. Aptroot 19509*, 5.iii.1985 (CANB).

New records from Antipodes and Campbell Islands

1. Amandinea dudleyensis Elix & Kantvilas, *Australas. Lichenol.* **72**, 6 (2013)
This species was previously known from Kangaroo Island, South Australia (Elix & Kantvilas 2013). It is characterized by its crustose, white to pale grey, weakly rimose-areolate to verruculose thallus, broadly adnate to rarely sessile, lecideine apothecia, 0.2–0.7 mm wide, relatively large, 1-septate *Orcularia*- then *Physconia*-type ascospores, 18–[*21.9*]–28 × 8–[*10.7*]–14 µm, which become weakly constricted at the septum, by the curved, filiform conidia, 20–30 × 0.7–1 µm, the finely inspersed hymenium and the lack of lichen substances. Older ascospores develop a markedly rugulate outer spore wall. A detailed description and illustrations are given in Elix & Kantvilas (2013).

SPECIMENS EXAMINED
New Zealand. *Auckland Islands*. ● Adams Island, Magnetic Station, SW of Camp Cove, Carnley Harbour, on branch of *Metrosideros* in *Metrosideros* forest, *H.A. Imshaug 57423, 57425*, 5.i.1973 (MSC); ● Auckland Island, cove E of Tagua Bay, W of Mt D'Urville, on twigs of *Metrosideros* in *Metrosideros* forest along shore, *H.A. Imshaug 57408 57411*, 4.i.1973 (MSC); ● Rose Island, central part of island, on twigs in dead *Metrosideros* forest, *H.A. Imshaug 56415*, 14.xii.1972 (MSC). *Campbell Island*. ● Northwest Beach, Northwest Bay, on twigs of *Dracophyllum* in *Dracophyllum* scrub, *H.A. Imshaug 46639, 46646, 46648*, 7.i.1970 (MSC).

2. Amandinea extenuata (Müll.Arg.) Marbach, *Biblioth. Lichenol.* **74**, 71 (2000)
This species was previously known from Australia, South Africa, South America and Fiji (Marbach 2000; Giralt *et al.* 2015). It is characterized by the crustose, thin, warty to verrucose-areolate, pale grey to grey-brown thallus, the broadly adnate to sessile apothecia, 0.3–0.5 mm wide, the 1-septate, *Physconia*-type ascospores with weak inner septal wall-thickenings (when young), becoming *Buellia*-type, 11–16 × 5.5–7.5 µm, with microrugulate outer spore-walls, curved, filiform conidia, 15–30 µm long, and the absence of lichen substances. A detailed description is given in Marbach (2000).

SPECIMEN EXAMINED
New Zealand. *Antipodes Island*. ● *c.* 0.4 km S of Hut Cove, alt. 46 m, on twigs of shrub in tussock grassland, *R.C. Harris 5773B*, 16.ii.1970 (MSC).

3. Amandinea lignicola var. **australis** Elix & Kantvilas, *Australas. Lichenol*. **72**, 7 (2013)
This taxon was previously known from Australia and the North Island of New Zealand (Elix & Kantvilas 2013; Mayrhofer *et al.* 2016). It is distinguished by having a typically conspicuous, well-developed, whitish to pale grey or olive-brown, crustose to squamulose thallus with a smooth to often granular or sorediate upper surface. It is further characterized by having a non-inspersed hymenium, *Physconia*- then *Buellia*-type, 1-septate, ellipsoid ascospores, (11–)13–20 × (5–)6–8 µm, with a smooth to weakly ornamented outer wall, curved, filiform conidia (12–)18–26 0.7–1 µm, and by the absence of lichen substances. A detailed description is given in Elix & Kantvilas (2013).

SPECIMEN EXAMINED
New Zealand. *Campbell Island*. ● Road to old Tucker Cove Station, on wood in disturbed area, *R.C. Harris 4478*, 23.xii.1969 (MSC).

4. Baculifera xylophila (Malme) Marbach, *Biblioth. Lichenol.* **74**, 148 (2000)
This species was known previously from South America and Hawai'i (Marbach 2000) and Australia (Elix & Kantvilas 2014). It is characterized by a white to grey, crustose thallus lacking lichen substances (K–), epruinose apothecia, a dark brown, olive-brown to dark olive-green epihymenium (containing *micromera*-green pigment), a non-inspersed hymenium, *Buellia*-type ascospores, 12–22 × 6–9 µm, with weak to moderate subapical wall-thickenings and a smooth or weakly ornamented outer spore-wall, and bacilliform conidia 8–12 × 1 µm. A detailed description is given in Marbach (2000).

SPECIMENS EXAMINED
New Zealand. *Campbell Island*. ● N side of Perserverance Harbour, 0.8 km N of Beeman Station, on twigs of *Dracophyllum* in *Dracophyllum* scrub, *R.C. Harris 5696, 5730, 5740*, 22.i.1970 (MSC).

5. Orcularia insperata (Nyl.) Kalb & Giralt, *Phytotaxa* **38**, 56 (2011)
This species was previously known from Africa, Australia, South America and the South Island of New Zealand (Galloway 2007; Kalb & Giralt 2011). It is characterized by the grey, ochre-grey to white-grey thallus, apothecia with an initial thalline margin that is excluded with age, *Orcularia*-type ascospores, 12–22 × 6–10 µm, curved, filiform conidia 12–20 × 0.7–1 µm, and the absence of lichen substances. A detailed description is given in Galloway (2007, as *Amandinea insperata*).

SPECIMENS EXAMINED
New Zealand. *Campbell Island*. ● Camp Cove, limestone ledges, on twigs of shrub, *H.A. Imshaug 46056*, 23.xii.1969 (MSC); ● Head of Camp Cove, on bark of spruce tree in disturbed area, *H.A. Imshaug 46813*, 11.i.1970 (MSC).

Key to the corticolous, lignicolous and lichenicolous species of buellioid lichens in New Zealand's subantarctic islands

1 Thallus corticolous or lignicolous..... **2**
1: Thallus lichenicolous **9**

2 Upper surface yellow or yellow-grey; thallus C+ orange; xanthones present..... **3**
2: Upper surface grey to grey-brown; lichen substances absent **4**

3 Upper surface sorediate; ascospores 5–9 µm wide; thiophanic acid present .....
.....**Gassicurtia jamesii**
3: Upper surface smooth to weakly verruculose; ascospores 4.5–5.5 µm wide;
thuringione present..... **Amandinea diorista** var. **hypopelidna**

4 Ascospores persistently *Orcularia*-type, or initially *Orcularia*-type then *Physconia*-type..... **5**
4: Ascospores initially *Physconia*-type then *Buellia*-type **6**

5 Ascospores *Orcularia*-type then *Physconia*-type, 18–28 × 8–14 µm.....
.....**Amandinea dudleyensis**
5: Ascospores persistently *Orcularia*-type, 12–22 × 6–10 µm.....**Orcularia insperata**

6 Epihymenium green to greenish black, K+ greenish, N+ purple-black or grey-black; conidia bacilliform, straight, 5–9 µm long..... **Baculifera xylophila**
6: Epihymenium brown, K–, N–; conidia curved, filiform, 16–30 µm long..... **7**

7 Thallus on wood; ascospores 13–20 µm long...**Amandinea lignicola** var. **australis**
7: Thallus on bark or wood; ascospores 11–16 µm long..... **8**

8 Subhymenium inspersed; locules of juvenile ascospores spherical.....
..... **Amandinea porulosa**
8: Subhymenium not inspersed; locules of juvenile ascospores clavate.....
.....**Amandinea extenuata**

9 Ascospores 3-septate; on *Thelotrema* sp..... **Buellia thelotremicola**
9: Ascospores 1-septate; on *Caloplaca* or *Cladonia* sp. **10**

10 On *Caloplaca* sp.; thallus absent; ascospores 14–18 µm long .....
..... **Amandinea adjuncta**
10: On *Cladonia* sp.; thallus bright yellow; ascospores 10–16 µm long .....
.....**Buellia campbelliana**

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Figure 1. *Buellia campbelliana* (holotype). Scale bar = 1 mm.

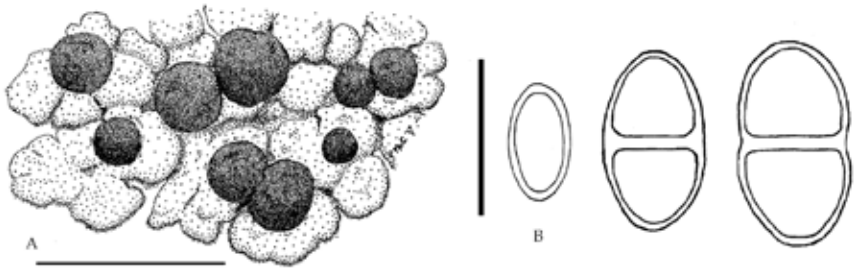

Figure 2. *Buellia campbelliana*. A. Apothecia on host thallus. B. Ascospore ontogeny. Scale bars: A = 1 mm; B = 10 µm.

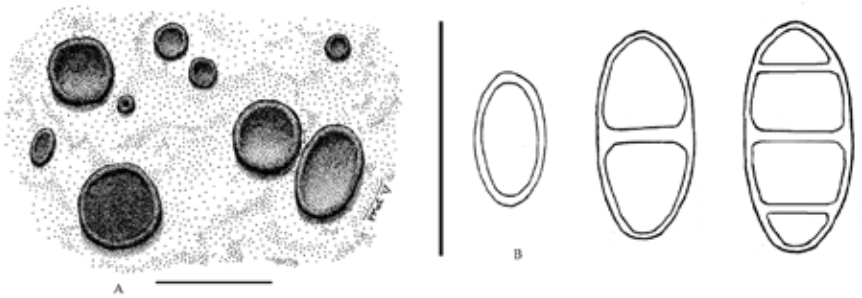

Figure 3. *Buellia thelotremicola* (holotype). A. Apothecia. B. Ascospore ontogeny. Scale bars: A = 0.2 mm; B = 10 µm.

Figure 4. *Gassicurtia jamesii* (holotype). Scale bar = 1 mm.

Three new species and ten new records of buellioid lichens (Ascomycota, Caliciaceae) from New Zealand

John A. Elix
Research School of Chemistry, Building 137,
Australian National University, Canberra, A.C.T. 2601, Australia
e-mail: John.Elix@anu.edu.au

Helmut Mayrhofer
Institut für Pflanzenwissenschaften, NAWI-Graz,
Karl-Franzens-Universität Graz, Holteigasse 6, 8010 Graz, Austria
e-mail: helmut.mayrhofer@uni-graz.at

Abstract

Amandinea okainensis Elix & H.Mayrhofer, *Buellia porphyrilica* Elix & H.Mayrhofer and *Tetramelas kopuwaianus* Elix & H.Mayrhofer are reported as new to science, and the new combination *Amandinea discreta* (Darb.) Elix & H.Mayrhofer is proposed. *Amandinea discreta*, *A. prothallinata* Elix & H.Mayrhofer, *Buellia aeruginosa* A.Nordin, Owe-Larsson & Elix, *B. epiaeruginosa* Elix, *B. georgei* Trinkaus, H.Mayrhofer & Elix, *B. poimenae* Elix & Kantvilas, *B. straminea* Tuck., *B. subadjuncta* Elix & Kantvilas, *Endohyalina arachniformis* Elix & Kantvilas and *Orcularia elixii* Kalb & Giralt are reported for the first time from New Zealand.

This paper continues our investigation of *Buellia*-like lichens in New Zealand, and follows from the previous accounts of *Buellia* and related genera (Elix *et al.* 2015, 2017a, 2017b; Elix 2015, 2016a, 2017a, 2017b; Elix & Kantvilas 2016a; Elix & Knight 2017; Elix & Mayrhofer 2016, 2017) and our additions and revisions to *Amandinea* (Blaha *et al.* 2016; Mayrhofer *et al.* 2016). In this paper, we deal with a further three new saxicolous species of *Buellia* in the broad sense. Methods are as described in previous papers cited above.

New species

1. Amandinea okainensis Elix & H.Mayrhofer, sp. nov. Figs 1, 2
MycoBank No. **MB 823943**

Similar to *Amandinea austroconiops* Elix & Kantvilas, but differs in having smaller ascospores and white-pruinose discs, and in containing variolaric acid.

Type: New Zealand, South Island, Canterbury, Banks Peninsula, Okains Peak, 43°44'25"S, 172°59'15"E, 514 m alt., on basalt, *J. Blaha 0027*, 15.iii.2001 (holotype – GZU).

Thallus crustose, to 15 mm wide and 1 mm thick, epilithic, rimose-areolate to verrucose-areolate; individual areoles irregular, angular, 0.1–1 mm wide; upper surface off-white to pale grey, matt, cracked, chinky; prothallus black, marginal when abutting other lichens or not apparent; photobiont cells 10–17 µm wide; medulla lacking calcium oxalate (H_2SO_4–), I+ indigo-purple. *Apothecia* 0.2–0.8 mm wide, abundant, lecideine, roundish, scattered, broadly adnate to sessile; disc black, white- to pale grey-pruinose, plane to weakly convex; proper exciple thick and persistent, in section 75–85 µm thick, outer part dark brown to brown-black, K–, N–, inner part brown. *Epihymenium* 12–15 µm thick, olive-brown, K–, N–. *Hypothecium* 90–150 µm thick, dark brown to brown-black, K–. *Hymenium* 100–150 µm thick, colourless, weakly inspersed; subhymenium 30–40 µm thick, pale brown, densely inspersed with oil droplets; paraphyses 1–2.2 µm wide, sparingly branched, with apices 5–7 µm wide and brown caps. *Asci* 8-spored or with 3–6 spores, *Bacidia*-type. *Ascospores Physconia*- then *Buellia*-type, 1-septate, pale then dark brown, ellipsoid, 14–[*16.1*]–18 × 7–[*8.4*]–10 µm, becoming constricted at the septum, sometimes curved; outer wall rugulate. *Pycnidia* common, punctiform, immersed; ostiole black. *Conidia* curved, filiform, 16–25 × 0.7–1 µm.
Chemistry: Thallus K–, P–, C–, UV–; containing variolaric acid.

Etymology: The species is named after the type locality.

Remarks

Amandinea okainensis is characterized by the crustose, rimose-areolate to verrucose-areolate, off-white to pale grey thallus, the strongly amyloid medulla, the inspersed subhymenium, white- to pale grey-pruinose discs, the *Physconia*- then *Buellia*-type ascospores that become constricted at the septum and have a rugulate outer wall, and by the presence of variolaric acid. It is superficially similar to *A. austroconiops*, a common saxicolous species in New Zealand and Tasmania (Elix & Kantvilas 2016a). However, *A. austroconiops* differs in having epruinose discs, larger ascospores (15–[*19.6*]–25 × 8–[*11.2*]–14 µm) and in lacking lichen substances. The common New Zealand species *A. nitrophila* (Zahlbr.) Elix has similar-sized ascospores and an inspersed subhymenium, but differs in having a non-amyloid medulla, mainly immersed apothecia with epruinose discs and in lacking lichen substances (Blaha *et al.* 2016).

At present the new species is known from only the type collection.

2. Buellia porphyrilica Elix & H.Mayrhofer, sp. nov. Figs 3, 4
MycoBank number: **MB 823944**

Similar to *Buellia fallax* Elix & Kantvilas, but differs in having a pruinose upper surface and in containing porphyrilic acid rather than hafellic acid.

Type: New Zealand, South Island, Canterbury, Banks Peninsula, Tumbledown Bay on road to Te Oka, 43°51'20"S, 172°46'20"E, 0–10 m alt., on coastal rocks, *H. Mayrhofer 6858, H. Hertel, C.D. Meurk & H.D. Wilson*, 19.i.1985 (GZU – holotype).

Thallus crustose, verrucose-areolate, chinky to markedly bullate, to 40 mm wide and *c.* 1.5 mm thick; individual areoles convex, contiguous, 0.5–2 mm wide, becoming agglomerate and sometimes subeffigurate at the margins; upper surface white to whitish grey or pale yellow, matt, esorediate, pruinose in part; prothallus absent; photobiont cells 8–19 µm wide; medulla white, containing calcium oxalate (H_2SO_4+), I–. *Apothecia* 0.3–1 mm wide, lecideine, broadly adnate to sessile; disc black, epruinose, weakly concave at first, then plane to weakly convex, often crowded and distorted by mutual pressure; proper exciple distinct, persistent, black, in section 40–50 µm thick, outer part brown-black, brown within, K–. *Epihymenium* 10–15 µm thick, dark brown to olive-brown, K–, N–. *Hypothecium* 80–175 µm thick, dark brown to brown-black. *Hymenium* 70–100 µm thick, colourless, not inspersed; subhymenium 40–50 µm thick, brown, not inspersed; paraphyses 1.5–2.5 µm wide, simple to weakly branched, capitate, with apices 3.5–5 µm wide and dark brown caps. Asci of the *Bacidia*-type, 8-spored. *Ascospores* initially of the *Callispora*-type, then *Buellia*-type, 1-septate, olive-brown to brown, ellipsoid, 15–[*21.1*]–25 × 7–[*8.4*]–11 µm, constricted at the septum, sometimes slightly curved, often pointed at the apices, with medial and weak subapical wall-thickenings; outer spore-wall smooth. *Pycnidia* immersed; conidia bacilliform, straight, 4.5–6 × 0.7–1 µm.
Chemistry: Thallus K+ yellow, P+ pale yellow, C–, UV+ blue-white; atranorin (major), porphyrilic acid (major).

Etymology: The species is named for the presence of porphyrilic acid, the first reported occurrence of this substance in a buellioid lichen.

Remarks

Buellia porphyrilica is characterized by the crustose, verrucose-areolate, chinky to markedly bullate, white to whitish grey or pale yellow thallus, the *Callispora*- then *Buellia*-type

ascospores with a smooth outer wall, and the presence of medullary calcium oxalate, atranorin and porphyrilic acid. *Buellia fallax* is very similar to *B. porphyrilica*, but differs in having an epruinose upper surface and in containing atranorin and hafellic acid (Elix & Kantvilas 2016b). At present, the new species is known from only the type locality. Associated species include *Buellia aethalea* (Ach.) Th.Fr., *B. ocellata* (Flot.) Körb., *Lecanora farinacea* Fée, *Rinodina oleae* Bagl. and *Xanthoparmelia australasica* D.J.Galloway.

SPECIMEN EXAMINED
South Island: ● Type locality, on coastal rocks, *H. Mayrhofer 6835, H. Hertel, C.D. Meurk & H.D. Wilson*, 19.i.1985 (GZU).

3. Tetramelas kopuwaianus Elix & H.Mayrhofer, sp. nov. Figs 5, 6
MycoBank No. **MB 823945**

Similar to *Tetramelas papillatus* (Sommerf.) Kalb, but differs in having smaller ascospores, 13–[*15.2*]–17 × 6–[*7.4*]–9 µm, and an amyloid medulla.

Type: New Zealand, South Island, Otago, Hyde Rock, Old Man Range, SW of Alexandra, 45°23'30"S, 169°11'40"E, *c.* 1670 m alt., on dead mosses, *H. Mayrhofer 9746, H. Hertel & P. Child*, 3.ii.1985 (holotype – GZU).

Thallus crustose, to 20 mm wide, granular; granules 0.05–0.5 mm wide, compacted and becoming areolate to verrucose-areolate; upper surface white to pale grey-white; prothallus not apparent; photobiont cells 10–16 µm wide; medulla lacking calcium oxalate (H_2SO_4–), I+ blue-violet. *Apothecia* 0.05–0.5 mm wide, abundant, lecideine, roundish, scattered or crowded, broadly adnate to sessile; disc black, epruinose, plane to markedly convex; proper exciple thin, excluded in older, convex apothecia, in section 45–55 µm thick, outer part dark olive-brown to brown-black, K–, N–, inner part brown. *Epihymenium* 12–15 µm thick, olive-brown to dark brown, K–, N–. *Hypothecium* 70–150 µm thick, dark brown to brown-black, K–. *Hymenium* 50–65 µm thick, colourless, not inspersed; subhymenium 15–25 µm thick, pale olive-brown, not inspersed; paraphyses 1–2.5 µm wide, sparingly branched, with apices 4–5 µm wide and brown caps. *Asci* 8-spored or with fewer spores (4), *Bacidia*-type. *Ascospores* initially of the *Callispora*-type, then of the *Buellia*-type, 1-septate, brown, ellipsoid to broadly fusiform, 13–[*15.2*]–17 × 6–[*7.4*]–9 µm, becoming constricted at the septum, sometimes curved, rarely 2–3-septate; outer spore-wall finely ornamented (microrugulate). *Pycnidia* uncommon, punctiform, immersed, ostiole brown. Conidia straight, bacilliform, 5–7 × 1 µm.
Chemistry: Thallus K+ yellow, P+ pale yellow, C–, UV–; containing atranorin.

Etymology: The species is named after the type locality, *kopuwai*, the traditional Southern Maori name for the Old Man Range.

Remarks
Tetramelas kopuwaianus is characterized by the crustose, granular to verrucose-areolate, white to whitish grey thallus, the amyloid medulla which lacks calcium oxalate, the *Callispora* then *Buellia*-type ascospores with a microrugulate outer wall, and the presence of medullary atranorin. *Tetramelas papillatus* has identical chemistry, but differs in having a thicker and more coherent thallus, a non-amyloid medulla and significantly larger ascospores, 15–[*20.2*]–27 × 7–[*8.7*]–12 µm (Nordin 2005). *Tetramelas kopuwaianus* is most likely to be confused with *T. confusus* A.Nordin which occurs in similar habitats. However, *T. confusus* has a distinctly papillate thallus, a non-amyloid medulla, larger ascospores 14–[*18.5*]–25 × 5–[*6.4*]–8 µm, and it contains atranorin and 6-*O*-methylarthothelin (Nordin 2005).

At present, the new species is known only from the type locality. Associated species include *Frutidella caesioatra* (Schaer.) Kalb, *Lepraria neglecta* (Nyl.) Lettau, *Megaspora verrucosa* (Ach.) Hafellner & V.Wirth and *Rinodina olivaceobrunnea* C.W.Dodge & G.E.Baker.

New records for New Zealand

1. Amandinea discreta (Darb.) Elix & H.Mayrhofer, comb. nov. Fig. 7
MycoBank number: **MB 823946**
Buellia discreta Darb., *Wissenschaftliche Ergebnisse der Schwedischen Südpolar-Expedition 1901–1903* **4**, 14 (1912).
Type: Falkland Islands, Port Louis, *C. Skottsberg 88.89*, 25.vii.1901 (S – holotype!).

Thallus crustose, forming extended patches to *c.* 30 mm wide, endolithic and not apparent, or epilithic, discontinuous, white or pale grey, thin, membranaceous or rarely rimose-areolate; prothallus black or absent; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 7–17 µm wide. *Apothecia* 0.2–0.4 mm wide, lecideine, broadly adnate to sessile, scattered or crowded, rounded or distorted through mutual pressure; disc black, epruinose, weakly concave to plane; proper exciple distinct, thin, persistent, raised above the disc, in section 25–30 µm thick, with the outer zone dark brown to black-brown, K–, brown within. *Epihymenium* 7–10 µm thick, dark brown, K–, N–. *Hypothecium* 60–100 µm thick, dark brown to black-brown, in part K+ yellow solution, N+ orange-brown. *Hymenium* 50–70 µm thick, colourless, not inspersed; subhymenium 15–20 µm thick, pale brown, not inspersed with granules or oil droplets; paraphyses 1.2–1.5 µm wide, simple to moderately branched, apices 4–5 µm wide with dark brown caps. Asci of the *Bacidia*-type, 8-spored. *Ascospores* of the *Physconia*- then *Buellia*-type, 1-septate, brown, ellipsoid, 12–[*13.9*]–16 × 6–[*7.9*]–10 µm, older spores very rarely constricted at the septum; outer spore wall microrugulate. *Pycnidia* immersed, black; conidia filiform, curved, 14–18 × 0.7–1 µm.
Chemistry: Thallus K–, P–, C–, UV–; no lichen substances detected by TLC.

This species was previously known from the Falkland Islands (Darbishire 1912). It is characterized by an endolithic or inconspicuous, off-white to pale grey, crustose thallus lacking lichen substances, a non-amyloid medulla that lacks calcium oxalate, adnate to sessile, lecideine apothecia, 0.2–0.4 mm wide, a brown N– epihymenium, broad, ellipsoid *Physconia*-then *Buellia*-type ascospores, 12–16 × 6–10 µm, which are usually not constricted at the septum, having a microrugulate outer wall, and curved, filiform conidia, 14–18 µm long.

SPECIMEN EXAMINED
South Island: ● Otago, Clutha River valley, Old Man Range, road to Obelisk TV station, 14 km S of Alexandra, 45°20'13"S, 169°15'16"E, 900 m alt., on N-exposed schist rocks in pasture near the road, *M. Lambauer 0173*, 8.ix.2003 (GZU).

2. Amandinea prothallinata Elix & H.Mayrhofer, *Australas. Lichenol.* **80**, 28 (2016)
This species was previously known from Australia and Norfolk Island (Elix *et al.* 2016). It is characterized by the crustose, rimose to rimose-areolate, pale grey to grey-brown or dark grey thallus, the prominent, marginal, dark brown to black prothallus, the immersed then broadly adnate to sessile apothecia, the non-amyloid medulla, the 1-septate, *Buellia*-type ascospores, 10–[*13.1*]–17 × 5–[*7.1*]–9 µm, curved, filiform conidia and the absence of lichen substances. Illustrations and a detailed description are provided in Elix *et al.* (2017c).

SPECIMEN EXAMINED
South Island: ● Nelson, on Lookout Track, coming from Brook Track over the water dam, 41°18'43"S, 173°17'26"E, 180–200 m alt., on N-exposed silicious rocks In open forest rocks, *M. Lambauer 0211, N. & B. Malcolm*, 20.xi.2003 (GZU).

3. Buellia aeruginosa A.Nordin, Owe-Larsson & Elix, *Mycotaxon* **71**, 400 (1999)
This species was previously known from Australia (South Australia, New South Wales, Victoria and Tasmania) (McCarthy 2017). It is characterized by the crustose, rimose to rimose-areolate, whitish to yellow-white thallus, the prominent, marginal, dark brown to black prothallus, the immersed then broadly adnate to sessile apothecia with white-pruinose discs,

the amyloid medulla containing calcium oxalate (H_2SO_4+), the intensely aeruginose epihymenium and outer excipulum (N+ red-violet), the submuriform ascospores, 13–[*16.2*]–19 × 7–[*9.1*]–10 µm, short bacilliform conidia and the presence of isoarthothelin and 2,5-dichloronorlichexanthone. Illustrations and a detailed description are provided in Nordin *et al.* (1999) and Elix (2011).

SPECIMEN EXAMINED
South Island: ● Marlborough, Ward Beach E of Ward, SW of Cape Campbell, 41°50'S, 174°11'E, on coastal rocks, *H. Mayrhofer 12190*, 30.viii.1992 (GZU).

4. Buellia epiaeruginosa Elix, *Australas. Lichenol.* **78**, 32 (2016)
This species was previously known from alpine or subalpine areas of Australia (Victoria and Tasmania) (Elix 2016b). It is characterized by the crustose, areolate, pale to dark grey thallus, the immersed then broadly adnate to sessile, lecideine apothecia with epruinose discs, a non-amyloid medulla lacking calcium oxalate (H_2SO_4–), the aeruginose epihymenium and outer excipulum (N+ red-violet), the *Buellia*-type ascospores, 12–20 × 7–11 µm, which become constricted at the septum and have microrugulate outer spore-walls, elongate, bacilliform conidia, 6.5–12 × 0.8–1 µm, and the absence of lichen substances. An illustration and detailed description are provided in Elix (2016b).

SPECIMEN EXAMINED
South Island: ● Canterbury, Foggy Peak, Torlesse Range, Porters Pass W of Springfield, 43°17'S, 171°44'E, 1200–1500 m alt., on rocks, *H. Mayrhofer 7474, H. Hertel & C. Meurk*, 25.i.1985 (GZU).

5. Buellia georgei Trinkaus, H.Mayrhofer & Elix, *Lichenologist* **33**, 55 (2001)
This species was previously known from Australia (Western Australia, South Australia, New South Wales, the Australian Capital Territory, Victoria and Tasmania) (McCarthy 2017). It is characterized by the subcrustose to effigurate, rosette-forming, chalky white thallus with short marginal lobes, the immersed then broadly adnate to sessile, lecideine to cryptolecanorine apothecia, often with white-pruinose discs, a medulla containing calcium oxalate (H_2SO_4+), the intensely aeruginose epihymenium and outer excipulum (N+ red-violet), the large ellipsoid ascospores, 16–24 × 9.5–14 µm, with rugulate outer spore-walls, filiform conidia and the presence of arthothelin. Illustrations and a detailed description are provided in Trinkaus *et al.* (2001) and Elix (2011).

SPECIMENS EXAMINED
South Island: ● Otago, Fortification Road, *c.* 5 km S of Oamaru, on limestone outcrops, *H. Mayrhofer 7471, 10499 & H. Hertel*, 14.ii.1985 (GZU).

6. Buellia poimenae Elix & Kantvilas, *Australas. Lichenol.* **73**, 29 (2013)
This species was previously known from Australia (Western Australia, New South Wales, Victoria and Tasmania) (McCarthy 2017). It is characterized by the crustose, rimose-areolate, pale grey to pale blue-grey, more rarely brown thallus, the immersed or rarely adnate, lecideine apothecia 0.3–0.9 mm wide, with epruinose discs, a non-amyloid medulla lacking calcium oxalate (H_2SO_4–), the brown, N– epihymenium and outer excipulum, the large *Physconia*-then *Buellia*-type ascospores, 11–20 × 6–10 µm, with microrugulate outer spore-walls, elongate, bacilliform conidia 5–10(–15) × 1 µm) and the presence of gyrophoric acid. Illustrations and a detailed description are provided in Elix & Kantvilas (2013).

SPECIMENS EXAMINED
South Island: ● Otago, Butters Peak, Dunedin, 45°48'45"S, 170°33'42"E, 603 m alt., on N face of basalt outcrop on ridge E of peak, *A. Knight s.n.*, 21.vi.2016 (OTA 069119 *pr.p.*, 069121); ● Otago, Little Valley Road, 5 km E of Alexandra, 45°15'55"S, 169°25'34"E, 350 m alt., on siliceous rock outcrops in grassland near road, SE exposed, *M. Lambauer 0183*, 8.ix.2003 (GZU); ● Otago, Flagstaff Hill near Dunedin, 44°50'S, 170°28'E, *c.* 650 m alt., on rock outcrops near summit, *H. Mayrhofer 13688 & H. Hertel*, 1.ii.1985 (GZU).

7. Buellia straminea Tuck., in B.L.Robinson, *Proc. Amer. Acad.* **38**, 84 (1902)
This species was previously known from the Galapagos Islands and Central America (Imshaug 1955). It is characterized by the pale yellow crustose thallus comprising contiguous or dispersed areoles which sometimes become sublobate at the margins, the lack of a prothallus, a non-amyloid medulla lacking calcium oxalate (H_2SO_4–), immersed then adnate apothecia 0.15–0.3 mm wide with epruinose discs, a dark brown epihymenium and hypothecium, a non-inspersed hymenium, the *Buellia*-type ascospores, 11–[*12.4*]–15 × 5–[*6.3*]–8 µm which do not become constricted with age, and the presence of arthothelin. An illustration is available (Aptroot & Sparrius 2013), and a description is provided in Imshaug (1955).

SPECIMENS EXAMINED
New Zealand: ● North Island, Coromandel Peninsula, N of Coromandel township, E of Port Jackson, Fletchers Bay, 36°28'35"S, 175°23'25"E, 0–3 m alt., on coastal greywacke rocks, *J. Blaha 0205*, 17.iv.2001 (GZU). *Ecuador*: ● Galapagos Islands, Isla Santiago, along the shore opposite Sombrero Chino, on semiconsolidated tufa, *W.A. Weber & H. Beck*, 5.i.1983 (Lichenes Exsiccati no. 642, University of Colorado Museum, CANB).

8. Buellia subadjuncta Elix & Kantvilas, *in* Elix *et al.*, *Australas. Lichenol.* **81**, 37 (2017)
This lichenicolous species was previously known from South Australia (Elix *et al.* 2017). It occurs on *Caloplaca* species, and is characterized by the dark brown epihymenium and hypothecium, bacilliform conidia (4–5 × 1–1.2 µm), the *Physconia*- then *Buellia*-type ascospores, 12–[*13.7*]–16 × 7–[*7.5*]–10 µm that become constricted with age, and the lack of lichen substances. Illustrations and a detailed description are provided in Elix *et al.* (2017).

SPECIMEN EXAMINED
North Island: ● Auckland, Kawakawa Bay E of Auckland, Papanui Point, 36°56'S, 175°13'E, 0–20 m alt., on coastal rocks, *H. Mayrhofer 5886 pr.p. & G.J. Samuels*, 8.i.1985 (GZU).

9. Endohyalina arachniformis Elix & Kantvilas, *Australas. Lichenol.* **76**, 16 (2015)
This species was previously known from Tasmania (Elix & Kantvilas 2015). It is characterized by the crustose to areolate-subsquamulose or bullate, yellow to pale yellow-brown thallus, the small, adnate to sessile lecideine apothecia, the 8-spored asci, the brown, 1-septate, broadly fusiform, *Dirinaria*-type grading into *Mischoblastia*- or *Physcia*-type ascospores, 13–23 × 6–12 µm, which are not constricted at the septum and often have paler apices, with ontogeny of type-B, bacilliform conidia, 4–7 × 1–1.4 µm, and by the presence of diploicin and xanthonepinone A. A detailed description and illustrations are given in Elix & Kantvilas (2015).

SPECIMEN EXAMINED
North Island: ● Auckland, Kawakawa Bay E of Auckland, Papanui Point, 36°56'S, 175°13'E, 0–20 m alt., on coastal rocks, *H. Mayrhofer 5885 & G.J. Samuels*, 8.i.1985 (GZU).

10. Orcularia elixii Kalb & Giralt, *Phytotaxa* **38**, 56 (2011)
This species was previously known from New South Wales (Kalb & Giralt 2011) and Hawaií (Elix 2015). It is characterized by the grey to brownish grey, thin, crustose thallus, the small, adnate to sessile lecideine apothecia, the 8-spored asci, the pale brown, 1-septate, *Orcularia*-type ascospores, 10–16 × 5–8 µm, and by the absence of lichen substances. It is close to *Orcularia insperata* (Nyl.) Kalb & Giralt, but is distinguished by smaller ascospores with larger lumina. A detailed description and illustrations are given in Kalb & Giralt (2011).

SPECIMEN EXAMINED
South Island: ● Marlborough, Pelorus Bridge, Blenheim–Nelson road, 41°18'30"S, 173°34'06"E, 50 m alt., on twigs, *W. Malcolm 2325*, 21.v.1995 (CANB).

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

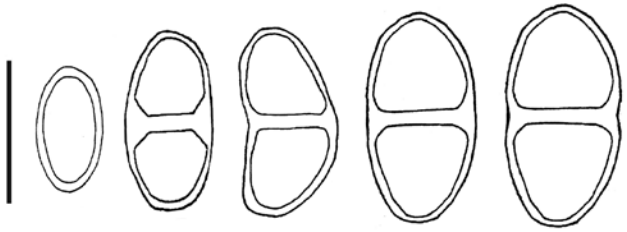

Figure 2. Ascospore ontogeny of *A. okainensis*. Scale bar = 10 µm.

Figure 3. *Buellia porphyrilica* (holotype in GZU). Scale bar = 2 mm.

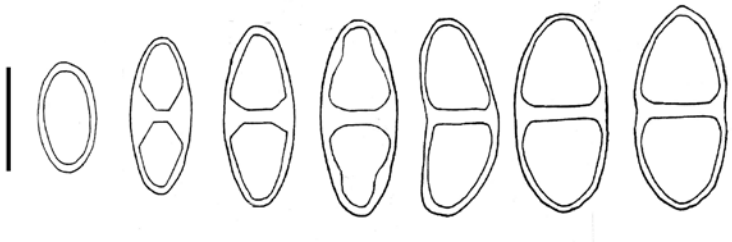

Figure 4. Ascospore ontogeny of *B. porphyrilica.* Scale bar = 10 µm.

Figure 5. *Tetramelas kopuwaianus* (holotype in GZU). Scale bar = 1 mm.

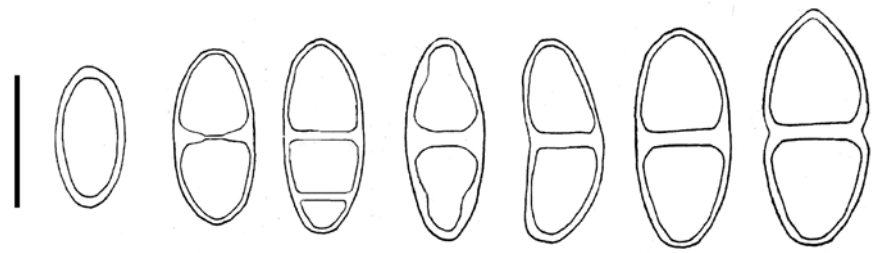

Figure 6. Ascospore ontogeny of *T. kopuwaianus.* Scale bar = 10 µm.

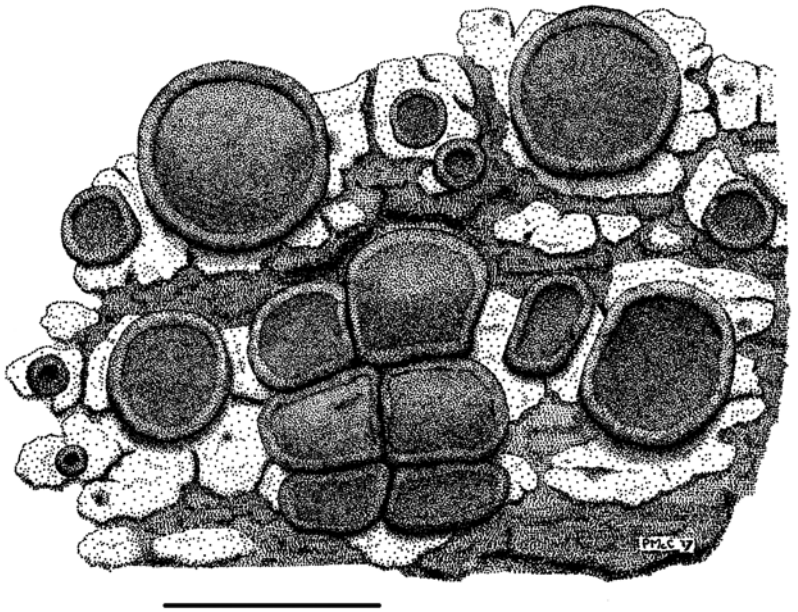

Figure 7. *Amandinea discreta* (*M. Lambauer 0173* in GZU). Scale bar = 0.5 mm.

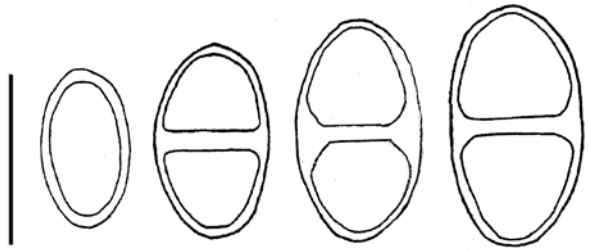

Figure 8. Ascospore ontogeny of *A. discreta.* Scale bar = 10 µm.

A new species of *Sculptolumina* (Caliciaceae, Ascomycota) from Queensland, Australia

John A. Elix
Research School of Chemistry, Building 137,
Australian National University, Canberra, A.C.T. 2601, Australia
e-mail: John.Elix@anu.edu.au

Helmut Mayrhofer
Institut für Pflanzenwissenschaften, NAWI-Graz,
Karl-Franzens-Universität Graz, Holteigasse 6, 8010 Graz, Austria
e-mail: helmut.mayrhofer@uni-graz.at

Abstract
Sculptolumina ramboldii Elix & H.Mayrhofer, the first known saxicolous species in the genus, is described as new to science.

This paper continues our investigations into *Buellia*-like lichens in Australia, following on from the first accounts of *Buellia* and related genera (Elix 2009, 2011) and our additional revisions of *Amandinea* (Elix & Kantvilas 2013a, 2016a; Blaha *et al.* 2016), *Buellia sens. lat.* (Elix & Kantvilas 2013b; Elix 2015b, 2016a, 2016c; Elix *et al.* 2017a,b,c), *Buellia sens. str.* (Elix & Kantvilas 2014a), *Baculifera* (Elix & Kantvilas 2014b), *Cratiria* (Elix 2014), *Monerolechia* (Elix 2015a) and other crustose Physciaceae (Elix & Kantvilas 2015, 2016b; Elix 2016b). The genus *Sculptolumina* Marbach was segregated from *Buellia* by Marbach (2000), who included two species characterized by their crustose thalli, lecideine apothecia with epruinose discs, excipula that lacked secondary lichen substances, brown hypothecia, hymenia densely inspersed with oil droplets, paraphyses with long and weakly expanded apical cells and ascospores with small funnel-shaped or rounded lumina (with thickened inner walls, of the *Mischoblastia*- or *Serotina*-types). The two species of *Sculptolumina* were subsequently found to be further characterized by having long, straight to weakly curved, filiform conidia (Giralt *et al.* 2009; Elix *et al.* 2017c). In this paper we describe a new saxicolous species of *Sculptolumina* from Queensland. Methods are as described in previous papers cited above.

The new species

Sculptolumina ramboldii Elix & H.Mayrhofer sp. nov. Figs 1, 2
MycoBank number: **MB 823038**

Similar to *Sculptolumina japonica* (Tuck.) Marbach, but differs in having larger ascospores, in containing gyrophoric and 5-*O*-methylhiascic acids and in growing on rock.

Type: Australia, Queensland, Mt Archer, 7 km NE of Rockhampton, 23°20'S, 150°35'E, 480 m alt., on vertical and overhanging surfaces of exposed, E-facing, rocky outcrops, *G. Rambold 4461 pr.p.*, 13.ii.1986 (M – holotype).

Thallus crustose, areolate to subsquamulose; areoles 0.5–1 mm wide and to 0.5 mm thick, dispersed or rarely contiguous, sometimes becoming lobulate at the margins. Upper surface dirty white to pale grey-brown, dull, smooth; prothallus not apparent; photobiont cells 7–15 µm wide; medulla white, lacking calcium oxalate (H_2SO_4–), I–; *Apothecia* 0.4–0.7 mm wide, lecideine, scattered, ± round, broadly adnate to sessile and constricted at the base; disc black, epruinose, plane to markedly convex; proper exciple distinct, glossy, black, initially elevated above the disc, excluded in older convex apothecia, in section 60–75 µm thick, the outer part brown-black, K–, N–, brown within. *Hypothecium* dark brown to brown-black, 100–250 µm thick, K–, N+ orange-brown. *Epihymenium* 12–15 µm thick, olive-brown to dark brown, K–, N–. *Hymenium* 100–130 µm thick, colourless, densely inspersed with oil droplets; subhymenium 20–30 µm thick, brown; paraphyses 1.5–2 µm wide, simple to sparsely branched, with long and weakly expanded apices (to 3 µm wide) and brown caps. *Asci* 8-spored, or with 4 or 6 spores, *Bacidia*-type. *Ascospores* of the *Serotina*-, *Pachysporaria*- or *Mischoblastia*-type, 1-septate, olive-brown to brown, ellipsoid, 16–[*19.8*]–24 × 9–[*11.5*]–14 µm, not constricted at the septum, the spore walls with a microrugulate or rugulate outer surface; ontogeny of type B (Giralt & Mayrhofer 1995). *Pycnidia* rare, punctiform, immersed; ostiole black. *Conidia* filiform, straight to weakly curved, 13–21 × 0.7–1 µm.
Chemistry: Thallus K–, C+ red, KC+ red, P–, UV–; containing gyrophoric acid (major), 5-*O*-methylhiascic acid (major).

Etymology: The species is named after Prof. Dr Gerhard Rambold, the collector of the type specimen.

Remarks

The new species is characterized by the dispersed, areolate to subsquamulose, dirty white to pale grey-brown, saxicolous thallus containing gyrophoric and 5-*O*-methylhiascic acids, broadly adnate to sessile, lecideine apothecia, 0.4–0.7 mm wide, asci with 4–8 spores, a densely inspersed hymenium, 1-septate ascospores of the *Serotina*-, *Pachysporaria*- or *Mischoblastia*-type, 16–24 × 9–14 µm, and the straight to slightly curved, filiform conidia, 14–20 × 0.7–1 µm. Anatomically it resembles *S. japonica* and *S. serotina* (Malme) Marbach, in that all three have densely inspersed hymenia, dark brown hypothecia, paraphyses with long and weakly expanded apical cells, ± similar sized *Serotina*-, *Pachysporaria*- or *Mischoblastia*-type ascospores and long, straight to weakly curved, filiform conidia. However, both *S. japonica* and *S. serotina* differ in growing on bark and in having crustose thalli. All three species differ chemically; *S. japonica* contains the anthraquinones 7-chloroemodin, skyrin and flavo-obscurin derivatives, whereas *S. serotina* contains lobaric acid. The thalline areoles and the size and development of the ascospores of *S. ramboldii* closely resemble those of the saxicolous *Buellia posthabita* (Nyl.) Zahlbr. from India, Central and South America (Imshaug 1955; Singh & Awasthi 1981). However, *B. posthabita* has a non-inspersed hymenium, and a colourless or very pale hypothecium, and it reacts K+ yellow, C –, KC–, (Imshaug 1955). Another saxicolous species, *B. siphoniatula* Zahlbr. from the Juan Fernández Islands, has somewhat similar ascospores and a dark brown hypothecium, but it has a non-inspersed hymenium and a crustose thallus that reacts K–, C –, KC– (Zahlbruckner 1924).

At present, the new species is known from only the type locality. Associated species include *Pertusaria subventosa* Malme var. *subventosa*, *P. xanthoplaca* Müll.Arg. and *Tephromela* cf. *atra* (Huds.) Hafellner.

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Figure 1. *Sculptolumina ramboldii* (holotype in M). Scale bar = 1 mm.

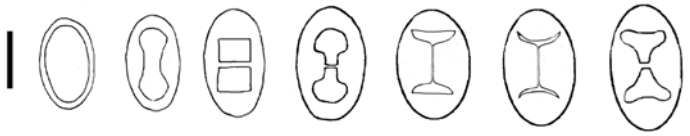

Figure 2. Ascospore ontogeny of *S. ramboldii*. Scale bar = 10 µm

Six new lichen species from Australia

Klaus Kalb
Lichenological Institute Neumarkt, Im Tal 12, D-92318 Neumarkt, Germany
e-mail: klaus.kalb@arcor.de

André Aptroot
ABL Herbarium, G. v.d. Veenstraat 107, NL-3762 XK Soest, The Netherlands
e-mail: andreaptroot@gmail.com

Abstract

Carbacanthographis uniseptata Kalb & Aptroot (Graphidaceae; Queensland), *Coenogonium bryophilum* Kalb & Aptroot (Coenogoniaceae; Borneo, Queensland), *Coniarthonia minima* Kalb & Aptroot (Arthoniaceae; New South Wales), *Punctonora brunneosorediata* Kalb & Aptroot (Lecanoraceae; New South Wales), *Roccellinastrum leprocauloides* Kalb & Aptroot (Pilocarpaceae; Queensland) and *Traponora flavothallina* Kalb & Aptroot (Lecanoraceae; Queensland) are described as new to science.

Among hitherto unidentified collections of Australian lichens, we have encountered several new taxa, six of which are described in the present paper. Chemical constituents were identified by thin-layer chromatography (Elix 2014).

The new species

1. Carbacanthographis uniseptata Kalb & Aptroot, sp. nov. Fig. 1
Mycobank No. **MB 824617**

Carbacanthographis with 1-septate ascospores, 7–8 × 3–4 µm.

Type: Australia, Queensland, Fitzroy Island, 16°56′S, 146°00′E, *c.* 20 m alt., on tree bark in rain forest, *K.Kalb & A.Kalb 21255*, 25.viii.1988 (holotype – CANB).

Thallus dull, granular, more or less continuous, chalky to pale ochraceous white, not corticate, without hypothallus; algae trentepohlioid, cells 7–10 µm diam. Apothecia sessile, white, linear to curved or a few times branched, arranged in rather dense groups, basally and laterally covered by a thalline cover, apically with a thick, dense white pruina, not striate, *c.* 0.3–1.3 mm long, 0.2–0.3 mm wide. Exciple completely carbonized, in the upper part with spiny periphysoids. Hymenium not inspersed. Paraphyses unbranched, partly with spiny tips. Asci cylindrical, *Graphis*-type (Staiger & Kalb 1999: 73), 40–50 × 8–9 µm; ascospores 8 per ascus, almost uniseriate in the ascus, 1-septate, hyaline, 7–8 × 3–4 µm, ends rather pointed. Pycnidia unknown.
Chemistry: Thallus UV–, C–, K+ brownish yellow, P+ red. TLC: Protocetraric acid (major).

This species is unique in the genus (Lücking *et al.* 2009) in having 1-septate ascospores. *Carbacanthographis* is a comparatively small genus in Graphidaceae (26 species described), characterized by having lirelliform ascomata laterally or completely covered by a conspicuous white thalline margin, a laterally or completely carbonized exciple and spiny periphysoids. Four species are known from Australia, viz. *C. hertelii* Kalb & Staiger, an endemic, corticolous species in rainforests in south-eastern Qld and eastern N.S.W., *C. marcescens* (Fée) Staiger & Kalb, which is widely distributed in the tropics and uncommon in rainforests in north-eastern Qld., *C. salazinica* (A.W.Archer) A.W.Archer, which is rare in rainforests in north-eastern N.S.W. and also occurs in Indonesia, and the here described *C. uniseptata* from Qld. The latter is most similar to *C. hertelii* in having a completely carbonized exciple, only transseptate ascospores and in producing protocetraric acid, but *C. uniseptata* is easily separated in having 1-septate ascospores (3-septate in *C. hertelii*) and in lacking isidia.

2. Coenogonium bryophilum Kalb & Aptroot sp. nov. Fig. 2
Mycobank No. **MB 824618**

Coenogonium growing on *Fissidens* sp. with medium sized apothecia and small, broadly ellipsoid ascospores.

Type: Malaysia. Borneo: Sabah; Kota Kinabalu, Gaya Island, coastal rainforest on trail embarkment on *Fissidens crassinervius*, 10–20 m alt., 6°00’ N, 116°00’ E, *K. Kalb & A. Mertens 40467*, 6 viii. 2014 (holotype – B; isotype NY).

Thallus crustose, muscicolous (*Fissidens* sp.), thin, smooth, greyish green to olive-green, dull. Apothecia sessile, rounded in outline, up to 0.9 mm diam., up to 300 µm high; disc plane or slightly concave, pale orange to yellow-orange, margin prominent, slightly denticulate in young apothecia, becoming smooth with age. Exciple paraplectenchymatous with irregularly arranged cells, laterally up to 80 µm broad, basally up to 130 µm high. Hypothecium up to 20 µm high, colourless. Hymenium 60–80 µm high, I+ blue, then quickly reddish brown. Asci *c.* 45 × 5 µm, 8-spored. Ascospores oblique-uniseriate, broadly ellipsoid (for definition see Kalb *et al.* 2016: 102), 1-septate, 7–10 × 2–3 µm, 2.5–4.2 times as long as broad. Pycnidia wart-shaped, *c.* 0.1 mm diam., light cream. Conidia bacillar, 2.5–3 × 1–1.2 µm.

ADDITIONAL SPECIMEN EXAMINED:
Queensland: ● A few km N of Noosa Heads, edge of coastal rainforest on road embarkment on *Fissidens oblongifolius*, alt. 10 m, 26°24’ S, 153°06’E, *K. Kalb & A. Mertens 39777*, 7.viii.2012 (paratype – hb. K. Kalb).

In the global key presented by Rivas Plata *et al*. (2006), this species would key out at couplet 64, *Coenogonium frederici* (Kalb) Kalb & Lücking, but that species grows on bark and differs further in having larger ascospores (8–12 × 3–4 µm, 2.2–3.1 as long as broad) and smaller apothecia (up to 0.6 mm diam). Another species similar to *C. bryophilum* is the epiphyllous *C. geralense* (P. Henn.) Lücking, but it differs in having thinner apothecia (up to 175 µm high), broader pycnidia (1.7–2 µm broad) and asci with irregularly biseriate ascospores.

3. Coniarthonia minima Kalb & Aptroot, sp. nov. Fig. 3
Mycobank No. **MB 824619**

Coniarthonia without a thallus, apothecia 0.1–0.2 mm diam., ascospores clavate, 1–septate, 9.5–10.5 × 2.5–3.0 µm.

Type: Australia, New South Wales, Morton National Park, 8 km NE of Nerriga, 35°07′S, 150°08′E, *c.* 650 m alt., on tree bark in rain forest, *K. Kalb, A. Kalb & J.A.Elix 26648*, 5.viii.1992 (holotype – CANB).

Thallus absent. Apothecia sessile, convex, immarginate, 0.1–0.2 mm diam., bright red. Hymenium hyaline, without gel. Asci clavate, *c.* 30 × 15 µm, interascal filaments paraphysoids, *c.* 2 µm wide, branched and anastomosing. Hymenium not inspersed. Epihymenium with bright orange crystals. Hypothecium hyaline. Ascospores clavate, 1–septate, hyaline, 9.5–10.5 × 2.5–3.0 µm, with rounded ends, not curved, without a gelatinous sheath. Pycnidia unknown.
Chemistry: apothecia UV–, C–, K+ blood red (almost black). An unidentified anthraquinone.

This species is the smallest known in the genus (Grube 2001; Aptroot *et al.* 2015), and the only one that is not lichenized. *Coniarthonia* is a very small genus with only twelve species described worldwide, and only one from Australia, namely *C. wilmsiana* (Müll.Arg.) Grube, which is known from a single corticolous collection in a rainforest in north-eastern Qld. It occurs also in South Africa and Central and South America, and has 3-septate ascospores, 22–38 µm long, 11–16 µm wide. *C. minima* is very similar to *C. pulcherrima* (Müll.Arg.)

Grube in having rounded ascomata and 1-septate ascospores, thus belonging in the *C. pulcherrima* group (Grube 2001), but the latter is easily separated by broader ascospores (3.5–5 µm broad) and much larger ascomata (0.5–1.5 mm in diam.).

4. Punctonora brunneosorediata Kalb & Aptroot, sp. nov. Fig. 4
Mycobank No. **MB 824620**

Punctonora with soredia.

Type: Australia, New South Wales, Patonga Creek, 40 km N of Sydney, 33°33′S, 151°16′E, alt. 1 m, on bark of *Casuarina* sp. in mangrove, *K.Kalb, A.Kalb, A.Archer & P.Archer 41151*, 10.viii.1992 (holotype – CANB).

Thallus slightly shiny, pale yellowish grey, originating as isolated minute granules becoming more or less continuous, thin, not surrounded by a hypothallus, mostly obscured by soredia. Soralia brownish, initially punctiform, but soon coalescent, with farinose soredia. Algae chlorococcoid, 5–10 µm diam. Apothecia sessile, glossy, initially flat, later somewhat convex, round to lobate, 0.3–0.5 mm diam.; disc dark brown (almost black); margin dark brown (almost black), not higher than the disc, *c.* 0.05 mm wide. Excipulum brown outside, hyaline inside, structure somewhat gelatinous. Hymenium not inspersed. Paraphyses with brown clavate top cells of *c.* 7 × 3.5 µm. Asci of *Lecanora*-type (Aptroot *et al.* 1997: 152), 30–35 × 9–11 µm; ascospores 8 per ascus, hyaline, simple, 8–10 × 3.5–5 µm. Pycnidia unknown.
Chemistry: Thallus UV–, C–, K+ yellow. TLC: sekikaic acid (major).

This is only the second species attributed to this rare genus, and the first report of the genus in Australia. The large pigmented apical cells of the paraphyses are characteristic. It differs from the type species, *P. nigropulvinata* Aptroot (Aptroot *et al.* 1997) in having soredia. *Punctonora* was described as a monotypic genus (Aptroot *et al.* 1997) with *P. nigropulvinata* Aptroot as the only species from Papua New Guinea.

5. Roccellinastrum leprocauloides Kalb & Aptroot, sp. nov. Fig. 5
Mycobank No. **MB 824622**

Roccellinastrum with norstictic, connorstictic, hypoconstictic and protocetraric acids and dispersed pseudoisidia and a surface with many extruding hyphae.

Type: Australia, Queensland, a few km N of Noosa Heads, at the edge of a tropical rainforest, 26°23′S, 153°05′E, *c*. 40 m alt., on tree bark in rain forest, *K.Kalb 40537*, 10.viii.2015 (holotype – CANB).

Thallus dull, whitish grey, more or less continuous, thin, with pseudoisidia, not surrounded by a hypothallus. Pseudoisidia rather dispersed, upright, densely branched, *c.* 0.2 mm wide and up to 1.5 mm high, of thallus colour, surface hyphal with many extruding hyphae; hyphae densely encrusted with tiny crystals (probably of the secondary chemistry components). Algae chlorococcoid, 6–8 µm diam. Apothecia and pycnidia unknown.
Chemistry: Thallus UV–, C–, K+ yellow then red, P+ red. TLC: Norstictic, connorstictic, hypoconstictic and protocetraric acids.

The species is not known to be fertile, but it most probably belongs to *Roccellinastrum* because of the byssoid thallus with thick-walled hyphae. It differs from the few species known in that genus (Henssen *et al.* 1982; Kantvilas 1990) by its chemistry and pseudoisidium morphology. Hafellner & Vězda (1992) give an overview and key to lichen genera with a byssoid thallus. This new species differs from most genera by the presence of extruding hyphae. The only other genus that is somewhat similar is *Crocynia*, but the few species currently accepted in that genus have more clearly delimited thalli, usually with a black prothallus, and they are closely

appressed, unlike species of the genus *Roccellinastrum,* including our new species. The new species superficially somewhat resembles the historical concept of *Leprocaulon*, but that genus is not considered byssoid by Hafellner & Vězda (1992), and it has been segregated into several genera by Lendemer & Hodkinson (2013), none of which contains species close to our new species, nor any species with pseudoisidia.

6. Traponora flavothallina Kalb & Aptroot, sp. nov. Fig. 6
Mycobank No. **MB 824623**

Traponora with a yellowish thallus containing atranorin and thiophaninic acid and sessile apothecia with dentate margins.

Type: Australia, Queensland, 12 km SE of Mareeba, along Davies Creek road, 17°00′08”S, 145°34′05”E, *c*. 450 m alt., on tree bark in dry *Eucalyptus* forest, *K.Kalb & D.Kalb 40557*, 21.viii.2015 (holotype – CANB).

Thallus dull, pale yellowish green, continuous, not corticate, not surrounded by a hypothallus. Algae chlorococcoid, 5–8 µm diam. Apothecia sessile, dark brown, dull, initially flat, later somewhat convex, round to lobate, 0.3–1.1 mm diam.; disc dark brown, not pruinose; margin pale yellowish green, irregular and somewhat coronate, evanescent, not higher than the disc, *c.* 0.05 mm wide. Hymenium not inspersed. Paraphyses with greenish black tips. Hypothecium brownish. Asci of *Lecanora*-type (Aptroot *et al.* 1997: 200), 40–50 × 13–18 µm; ascospores 8 per ascus, simple, hyaline, ellipsoid, 14–16 × 7–8 µm, wall 1 µm thick. Pycnidia unknown.
Chemistry: Thallus UV–, C–, K+ yellow. TLC: Atranorin (minor), thiophaninic acid (major)

The coronate apothecia resembling a *Trapelia* and the pigmented paraphyse tips are characteristic of the genus. This species differs from the other species in the genus (Aptroot 2009) by the combination of sessile apothecia and a dentate apothecium margin. The thallus colour (and chemistry) are also unique within the genus. Most similar is the pantropical *T. globosa* Aptroot in having sessile apothecia and a non-inspersed hymenium, but the two species are readily separated by smaller ascospores (10–12 × 5–6 µm) and the lack of thiophaninic acid in the latter. The genus was originally described as monotypic from Papua New Guinea, with *T. asterella* Aptroot as the type species (Aptroot *et al.* 1997). A 2009 monograph of the genus (Aptroot 2009), described four further species and reported further findings of *T. asterella* (expanding its distribution to pantropical). Subsequently, Kalb & Kalb (2017) reported *T. macrospora* Aptroot as new for Thailand, and combined the neotropical *Lecidea varians* Ach. into *Traponora* as well. *Traponora* is newly reported here from Australia.

Acknowledgements
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Fig. 1. *Carbacanthographis uniseptata*, scale bar = 0.25 mm.

Fig. 2. *Coenogonium bryophilum*, scale bar = 0.5 mm.

Fig. 3. *Coniarthonia minima*, scale bar = 0.15 mm.

Fig. 4. *Punctonora brunneosorediata*, scale bar = 0.3 mm.

Fig. 5. *Roccellinastrum leprocauloides*, scale bar = 1 mm.

Fig. 6. *Traponora flavothallina*, scale bar = 0.25 mm.

New species and new records of Australian lichens

Harrie J. M. Sipman
Free University of Berlin, Botanic Garden and Botanical Museum Berlin-Dahlem
Koenigin-Luise-Str. 6-8, D-14195 Berlin, Germany
e-mail: H.Sipman@bgbm.org

Abstract
Leucodecton granulosum Sipman and *Myriotrema protofrustillatum* Sipman (Graphidaceae) are described as new from New South Wales. *Bellemerea cinereorufescens* (Ach.) Clauzade & Cl.Roux and *Mazosia carnea* (Eckfield) Aptroot & M.Cáceres are new records for Australia. New State, Territory and oceanic island records are provided for 33 other taxa.

Introduction

Toward the end of the 20th century, the exploration of the lichens of Australia was greatly accelerated by Australian researchers. Their efforts resulted in five splendid lichen volumes for the *Flora of Australia*. That increase in knowledge was based mainly on the collecting activities of John A. Elix and Heinar Streimann. Within a few decades they had collected and curated some 100,000 lichen specimens from all over Australia. They also prepared many thousands of duplicates of those specimens, which they then sent to various lichen specialists abroad. Thanks especially to Heinar Streimann, some 7000 of them arrived in the Botanical Museum in Berlin. Unfortunately, that number exceeded the Museum's capacity to study them, and many specimens remained unstudied for years. Only recently have they been investigated and curated. During their processing, numerous species proved to be new records for Australia or its States, Territories, or oceanic islands, and two new species were also discovered. The new taxa and records are reported here.

Material and methods

Morphology and anatomy of the specimens were investigated in the usual way using a Wild M7 stereomicroscope and a Zeiss Axioskop compound microscope. The chemistry was investigated by TLC (Orange *et al.* 2001), and compared with extracts from lichens with known chemical composition. For the identifications, the *Flora of Australia* was used unless otherwise indicated. The results were compared with the online checklist (McCarthy 2017) and the ANHSIR database of herbarium specimens in CANB (http://www.anbg.gov.au/cgi-bin/anhsir). Duplicates of all specimens studied are in CANB. Some packets containing more than one species were separated in B and denoted by the low-case letter "a" following the collection number.

New species

1. Leucodecton granulosum Sipman sp. nov. Figs 1–3
MycoBank No. **MB 824679**

Similar to *Leucodecton glaucescens* (Nyl.) Frisch, but the thallus is thin and largely granular, and the ascospores are 2–4 per ascus and *c.* 19–25 µm long.

Type: Australia, New South Wales, Moppy Lookout, Barrington Tops State Forest, 40 km WNW of Gloucester, 31°53'S, 151°32'E, alt. 1200 m, *Nothofagus*-dominated forest on gentle slope, on *Nothofagus*, *J.A. Elix 24817*, 26.iv.1990 (holotype – B 60 0198154, isotype – CANB).

Thallus epiphloeodal, *c.* 0.1 mm thick, more than 10 cm diam., greenish grey, dull to slightly glossy, continuous or somewhat fissured, smooth to verrucose; protocortex thin, *c.* 5 µm; algal layer continuous, occupying most of the thallus, filled with tiny crystals; medulla scarce, whitish; vegetative propagules covering most of the thallus, granular, *c.* 50 µm diam., produced initially on top of pustule-like thallus warts. Ascomata aggregated in *c.* 2–5 mm wide patches, apothecioid, with *c.* 100 µm wide, roundish, greyish, white-rimmed discs separated by a fissure from the slightly raised, gaping, thalline margin, with an externally free, thin, lateral excipulum lacking periphyses; hymenium *c.* 100 µm thick, hyaline; hypothecium pale brown; ascospores oblong-elliptic, submuriform, hyaline when young, turning brown when old, 2–4 per ascus, *c.* 19–25 × 6–8 µm, 8 × 2-loculate, with thin septa and angular lumina, non-amyloid. Pycnidia not seen.
Chemistry: hypostictic acid (trace), stictic, hyposalazinic and constictic acids (TLC).

Etymology: Named after the numerous granular propagules that cover most of the thallus.

Remarks

The glaucescentoid apothecia (*sensu* Rivas-Plata *et al.* 2010) and the stictic acid chemosyndrome place this species clearly in the genus *Leucodecton*. Among congeneric species with these characters related to *L. glaucescens* (Nyl.) Frisch, its propagules are unique (Rivas Plata *et al.* 2010; Sipman *et al.* 2012; Lendemer & Harris 2014; Lücking 2015). As is often the case in lichen species with predominantly vegetative reproduction, the ascospores are not well developed, and possibly the description will have to be modified when better material becomes available. The hyaline ascospores could be juvenile and possibly turn greyish with age before the brownish, shriveled stage seen in our material.

The vegetative propagules seem to be of a distinctive type. They originate from cracks in pustules. The prominent pustule parts alongside the cracks continue growing, but divide finely into pieces 50–100 µm wide, which remain more or less connected to each other in somewhat cylindrical structures, and do not have a felt-like surface as do true soredia. The initially roundish pustular spots coalesce and cover most of the ascoma-free parts of the thallus.

The propagules appear similar to those of *L. sorediiferum* Frisch, which however were called soredia and were said to be produced in soralia (Frisch 2006). That species also differs in having larger ascospores, 35–50 × 13–19 µm, 9–13 × 3–4-loculate, and emergent, elongate ascomata.

Known from only the type specimens, which were collected in montane *Nothofagus* forest in the Central Tablelands, New South Wales, Australia.

2. Myriotrema protofrustillatum Sipman, sp. nov. Figs 4, 5
MycoBank No. **MB 824681**

Similar to *Myriotrema frustillatum* Mangold, from which it differs by its saxicolous habit and the absence of isidia.

Type: Australia, New South Wales, Urumbilum River, Jersey Bull Forest Road, Orara West State Forest, 15 km WNW of Coffs Harbour, 30°17'S, 152°57'E, alt. 160 m, wet sclerophyll forest beside a rocky stream, dominated by *Tristaniopsis* and *Casuarina*, on shady rock face, *H. Streimann 63736*, 16.vi.1999 (holotype – B 60 0201606, isotypes – CANB, NY, H, TU).

Thallus epilithic, *c.* 100–200 µm thick, pale yellowish grey (after 18 years of herbarium storage), slightly glossy, smooth to rugulose, rimose-areolate, the areoles of very variable size, *c.* 0.3–1 mm wide; pseudocortex *c.* 10 µm thick; algal layer occupying the rest of the thallus, with small crystals and scattered large crystals that can in part originate from the substratum; vegetative propagules absent. Ascomata abundant, perithecioid, immersed in hemispherical thalline warts when fully developed, with an apical pore that is depressed and *c.* 50 µm wide; proper exciple fused with thallus and hymenium, pale brown, *c.* 50 µm thick, near the pore to 100 µm thick, subglobose, *c.* 600 µm diam.; hymenium clear; ascospores 1 per ascus, muriform, oblong-elliptic, *c.* 160 × 30 µm, *c.* 50 × 8-loculate, non-amyloid, with thin septa, angular lumina and thin outer wall, with *c.* 20 primary septa, which are thin but visible in fully mature spores. Pycnidia not seen.
Chemistry: norstictic acid (TLC).

Etymology: Named after the related species *M. frustillatum*, from which it differs by the absence of vegetative propagules.

Remarks

The new species resembles *M. frustillatum* with its large, emergent, perithecioid ascocarps, the monosporous asci, large, muriform, hyaline, non-amyloid ascospores with thin septa and wall, a fused, apically orange proper exciple, and the presence of norstictic acid. It differs in the absence of isidia, the numerous ascocarps and the rock substratum. The discussion by Mangold *et al.* (2009) on the taxonomic position of *M. frustillatum* applies equally to *M. protofrustillatum*, which also has a proper excipulum lacking substratum inclusions.

Known from only the type collection on shaded rock along a stream in lowland wet sclerophyll forest in New South Wales.

New records for Australia

1. Bellemerea cinereorufescens (Ach.) Clauzade & Cl.Roux, *Bull. Soc. Bot. Centre-Ouest, nouv. sér.* **15**, 129 (1984) Fig. 6

This species was found in a sample with *Lecidea sens. latu*. Its generic placement is easily confirmed by the *Porpidia*-type asci and the simple, halonate, I+ blue ascospores. Within this small, alpine genus the species is set apart by the combination of a grey, K– thallus, dark brown apothecia and rather small ascospores (*c.* 13 × 6 µm in our specimen) (Clauzade & Roux 1985). The species is widespread in the Northern Hemisphere, and is also known from North America, Europe and Asia (Stenroos *et al.* 2016). *Bellemerea alpina* (Sommerf.) Clauzade & Cl.Roux, the only species of the genus reported previously from Australia, forms much larger, *Aspicilia*-like thalli, and its thallus contains norstictic acid (thallus K+ yellow turning red). The specimen of *B. cinereorufescens* was too small for TLC, and the absence of norstictic acid was demonstrated only by the K– reaction of the apothecium section. For an English description and another illustration, see Stenroos *et al.* (2016).

SPECIMEN EXAMINED

Victoria: ● Mt Hotham, 32 km SE of Bright, 36°59'S, 147°8'E, alt. 1800 m, subalpine meadow on moderate slope with small rock outcrops, on scattered stones, *H. Streimann 49419a*, 2.v.1992 (B 60 0107907).

2. Mazosia carnea (Eckfeldt) Aptroot & M.Cáceres, *Lichenologist* **46**, 564 (2014) Fig. 7

Pantropical. Species of *Mazosia* usually grow on leaves in rainforest understorey, but a few species are known from bark (Aptroot *et al.* 2014). Thus the discovery of a specimen on rock in Australia is surprising. However, many normally corticolous lichens are known to grow on rock occasionally, and the specimen is a good match for one of the corticolous species. The Australian specimen, collected in rainforest in north-eastern Queensland, was found in a community on a flat stone dominated by *Porina*, evidently from a humid spot. It is easily recognized by its rounded ascocarps with reduced exciple and transversely 3-septate ascospores with swollen supramedian cells.

SPECIMEN EXAMINED

Queensland: ● Home Rule Falls, Slaty Creek, 22 km SSE of Cooktown, 15°44'S, 145°19'E, alt. 250 m, tropical forest dominated by *Tristaniopsis*, beside permanent creek in gorge, on exposed boulder, *H. Streimann 64552*, 29.viii.1999 (B 60 0198155).

New State, Territory and island records

1. Brigantiaea tricolour (Mont.) Trevis., *Spighe Paglie*: 9 (1853)

This species is widespread in the Palaeotropics, and in Australia was previously reported from the Northern Territory, Queensland and New South Wales. See Hafellner (1997) and Elix, *Flora of Australia* **57** (2009).

SPECIMEN EXAMINED

Norfolk Island: ● Track east of Mount Bates, Mount Pitt National Park, 29°0.7'S, 167°56.3'E, alt. 280 m, subtropical forest on ridge, on *Nestigia*, *J.A. Elix 27471*, 15.vi.1992 (B 60 0201313).

2. Buellia reagenella Elix, *Fl. Australia* **57**, 660 (2009)

This species has a rather southerly distribution in Australia, and the new record extends its range to south-eastern Queensland. The collection was identified in 2012 by J.A. Elix (in ANHSIR database), but the record has not been published previously.

SPECIMEN EXAMINED

Queensland: ● Carnarvon Highway, 4 km S of Bullaroo River Bridge, 68 km N of Injune, 25°14'S, 148°36'E, alt. 380 m, monsoon forest with *Denhamia* and *Brachychiton* on flats, on fallen twigs, *J.A. Elix 34072*, 19.viii.1993 (B 60 0103633).

3. Bunodophoron formosanum (Zahlbr.) Wedin, *Pl. Syst. Evol.* **187**, 233 (1993)

In Australia, this widespread species was previously reported from Queensland, New South Wales and Lord Howe Island. The presence of sphaerophorin, stictic acid and traces of cryptostictic and constictic acids was demonstrated by TLC.

SPECIMEN EXAMINED

Victoria: ● Coast Range Road, 18 km SSE of Bendoc, 37°17'S, 148°58'E, alt. 900 m, in *Atherosperma moschatus* and *Elaeocarpus holopetalus* forest on slope, with tree ferns, on tree fern stem, *H. Streimann 36662*, 10.iv.1986 (B 60 0201467).

4. Coccotrema cucurbitula (Mont.) Müll.Arg., *Nuovo Giorn. Bot. Ital.* **21**, 51 (1889)

The species is widespread in the temperate Southern Hemisphere, and it occurs in eastern Australia from Tasmania to Queensland. The specimens contain stictic, menegaziaic, cryptostictic and constictic acids (TLC).

SPECIMENS EXAMINED

Lord Howe Island: ● Track to Goat House Cave, at base of Mt Lidgebird escarpment, 31°33.8'S, 159°5.2'E, alt. 380 m, moist, subtropical forest with *Dracophyllum* and *Cyathea*, on buttress roots, *J.A. Elix 42101*, 7.ii.1995 (B 60 0201630); ● *loc. id.,* alt. 420 m, on *Cyathea* stump, *J.A. Elix 42260*, 7.ii.1995 (B 60 0201631); ● *loc. id.*, *J.A. Elix 42263*, 7.ii.1995 (B 60 0201446).

5. Coenogonium luteum (Dicks.) Kalb & Lücking, in Lücking & Kalb, *Bot. Jahrb.* **122**, 32 (2000)

New to Norfolk Island. The species has a worldwide distribution, and in Australia was previously reported from Queensland, New South Wales, Victoria and Tasmania.

SPECIMEN EXAMINED

Norfolk Island: ● West Palm Glen Track, Mount Pitt National Park, 29°01.1'S, 167°56.5'E, alt. 140 m, subtropical forest on moderate slope, on dead *Cyathea* stump, *J.A. Elix 29081*, 16.vi.1992 (B 60 0201424).

6. Collema glaucophthalmum Nyl., *Flora* **41**, 377 (1858)

The species is widespread in the tropics and the temperate Southern Hemisphere (Degelius 1974), and has a rather southerly distribution in Australia. The new record extends its range to south-eastern Queensland.

SPECIMEN EXAMINED

Queensland: ● Fraser Island, Kingfisher-Eurong Road, near Eurong, 25°29'S, 153°06'E, alt. 60 m, on sandy flats in forest dominated by *Syncarpia*, *Eucalyptus*, *Acmena* and *Agathis*, on semi-shaded *Acacia* stem, *H. Streimann 64098*, 17.viii.1999 (B 60 0201538).

7. Collema rugosum Kremp., in Fenzl, *Reise Österr. Novara Bot.* **1**, 128 (1870)
The species is widespread in the Palaeotropics (Degelius 1974), and in Australia it has previously been reported from the Northern Territory, Queensland and New South Wales.

SPECIMEN EXAMINED
Norfolk Island: ● "Old Stables", near airstrip, 29°02.7'S, 167°56.5'E, alt. 85 m, cultivated grassland area with some regrowth shrubs, on planted exotic cypress pines, *H. Streimann 53711*, 14.iv.1994 (B 60 0201532).

8. Cratiria lauricassiae (Fée) Marbach, *Biblioth. Lichenol.* **74**, 160 (2000)
This species is widely distributed in the tropics (Nordin 2000), and is known throughout the wet-tropics and subtropics of Australia. The collection was identified in 2014 by J.A. Elix (in the AHNSIR database), but it has not been published.

SPECIMEN EXAMINED
New South Wales: ● Lord Howe Island, near junction of tracks to Mutton Bird Point and Intermediate Hill, 31°32.57'S, 159°04.8'E, alt. 60 m, on dead palm in dry lowland forest with basalt outcrops, *J.A. Elix 32744A,* 21.vi.1992 (B 60 0120173).

9. Cresponea plurilocularis (Nyl.) Egea & Torrente, *Mycotaxon* **48**, 322 (1993)
This species was previously known in Australia from Queensland, Victoria and Tasmania. For a key, see Egea & Torrente (1993).

SPECIMEN EXAMINED
New South Wales: ● Tooloom National Park, 23 km WSW of Woodenbong, 28°29'S, 152°23'E, alt. 630 m, temperate forest on moderate slope, on semi-exposed treelet stem, *H. Streimann 60932*, 23.iv.1998 (B 60 0201413).

10. Dendriscocaulon dendriothamnodes Dughi ex D.J.Galloway, *New Zealand J. Bot.* **21**, 192 (1983)
This entity, probably the cyanobacterial phycotype of several *Sticta* species, is known from southern temperate latitudes and, in Australia, from Victoria and Tasmania.

SPECIMEN EXAMINED
New South Wales: ● Devil's Lookout, Barrington Tops National Park, 44 km WNW of Gloucester, 31°55'S, 151°29'E, alt. 1400 m, wet sclerophyll forest on escarpment with *Banksia*, on semi-shaded *Nothofagus* trunk, *H. Streimann & T. Pocs 65198*, 12.ix.1999 (B 60 0201521).

11. Endocarpon simplicatum (Nyl.) Nyl. var. **simplicatum**, in Hue, in Hue, *Rev. Bot. Courrensan* **6**, 104 (1888)
This very distinctive species with its strong, black rhizomorphs, blackish squamule margins and monosporous asci is widespread in southern Australia, and was previously known from Tasmania, Victoria, South Australia, Western Australia and New South Wales.

SPECIMEN EXAMINED
Australian Capital Territory: ● Gudgenby River Gorge, 27 km S of Canberra, 35°37'S, 149°05'E, alt. 700 m, open *Eucalyptus-Callitris endlicheri* woodland on NW slope, on damp soil amongst *Leptospermum* shrubs, *J. Johnston 2686*, 27.x.1989 (B 60 0201505).

12. Enterographa subgelatinosa (Stirt.) Redinger, *Rep. Nov. Spec. Regni Veg.* **43**, 66 (1938)
This species is known only from a few collections from New Zealand and Western Australia (Sparrius 2004). TLC: psoromic acid. The ANHSIR database gives the name *Sclerophyton circumscriptum* for this collection, but the specimen in B deviates clearly from that species by its hyaline, not grey to brown ascospores and its elongate, rather than punctiform, ascomata.

SPECIMEN EXAMINED
Lord Howe Island: ● between Little Island and The Cross, 31°34.3'S, 159°4.5'E, alt. 120 m, large boulders with scattered large *Ficus*, small shrubs and ferns, on basalt rocks, *J.A. Elix 42310*, 7.ii.1995 (B 60 0191076).

13. Eschatogonia marivelensis (Vain.) Kalb, *Biblioth. Lichenol.* **88**, 310 (2004)
This species is widespread in tropical Asia, and in Australia it was reported previously from the Northern Territory and Queensland. The ANHSIR database gives the name *Phyllopsora confusa* for this collection, but the specimen in B has squamules with a corticate lower side, which places it in *Eschatogonia*.

SPECIMEN EXAMINED
Norfolk Island: ● Mount Pitt Reserve, track leading W from Mt Bates, 29°00.5'S, 167°56.7'E, alt. 240 m, poor forest on ridge, base of *Araucaria heterophylla*, *H. Streimann 34332*, 6.xii.1984 (B 60 0069965).

14. Graphis cincta (Pers.) Aptroot, *Fl. Australia* **57**, 651 (2009)
The species is widespread in the tropics and subtropics worldwide, and in Australia it was known previously from the Northern Territory, Queensland and New South Wales. The specimen is on a twig fragment with a mixture of several *Graphis* species, probably including *G. librata*, which is listed in the ANHSIR database. The thallus contains norstictic acid (TLC).

SPECIMEN EXAMINED
Lord Howe Island: ● Anderson Road, 31°31.7'S, 159°4.2'E, alt. 40 m, disturbed lowland forest beside road, on dead bark of treelet (*Erythrina*). *H. Streimann 49973*, 22.vi.1992 (B 60 0191088).

15. Heterodermia obscurata (Nyl.) Trevis., *Nuovo Giorn. Bot. Ital.* **1**, 114 (1869)
This species is very widespread in tropical to warm-temperate regions worldwide, and in Australia was known previously from all states and territories, except for the Northern Territory and oceanic islands. The specimen contains atranorin and zeorin (TLC).

SPECIMEN EXAMINED
Lord Howe Island: ● between Little Island and The Cross, 31°34.3'S, 159°4.5'E, alt. 10 m, on steep slope with very large basalt boulders, dominated by *Ficus*, on shaded boulder, *H. Streimann 50114*, 24.vi.1992 (B 60 0198167).

16. Jackelixia elixii (S.Y.Kondr. & Kärnefelt) S.Y.Kondr., Fedorenko, S.Stenroos, Kärnefelt & A.Thell, in Fedorenko *et al.*, *Biblioth. Lichenol.* **100**, 77 (2009)
The world distribution of this member of the *Xanthoria parietina* aggregate is poorly understood because of changing taxonomic concepts. In Australia it appears to be common and widespread, and has been reported from all states and territories, except for the Northern Territory and oceanic islands.

SPECIMEN EXAMINED
Norfolk Island: ● picnic area, end of Martins Road, 29°03'S, 167°59'E, alt. 80 m, open *Araucaria* woodland, on base of *Araucaria heterophylla*, *J.A. Elix & H. Streimann 18130*, 1.xii.1984 (B 60 0198161).

17. Lobaria hartmannii (Müll.Arg.) Zahlbr., *Cat. Lich. Univ.* **3**, 302 (1925)
This endemic species previously was known only from Queensland. The specimen is rather scrappy, but the dense lobuli and C+ red underside are diagnostic.

SPECIMEN EXAMINED
Lord Howe Island: ● Mt Gower track, between The Saddle and Mt Gower, 31°35.1'S,

159°4.8'E, alt. 700 m, shrubs with few trees on steep escarpment, on exposed dead shrub branches, *H. Streimann 56086*, 11.ii.1995 (B 60 0109043).

18. *Megalaria subintermixta* (Müll.Arg.) Kantvilas, *Herzogia* **29**, 429 (2016)
This endemic species was described and illustrated by Kantvilas (2016), and is easily recognized by its schizidiate thallus surface, ascospores *c.* 20 µm long, and its dark brown hypothecium. It is already known from Tasmania, southern Victoria and south-eastern New South Wales. The specimen contains no lichen substances (TLC).

SPECIMENS EXAMINED
Queensland: ● Track to top of Mt. Cordeaux, Cunninghams's Gap, 90 km SW of Brisbane, 28°03'S, 152°24'E, alt. *c.* 1000 m, on bark, *A.W. Archer 1163*, 17.x.1981 (B 60 0012918); ● Conway State Forest, 18 km E of Proserpine, 20°21'S, 148°45'E, alt. 180 m, on tree trunk in lowland rain forest, *J.A. Elix 20198*, 28.vi.1986 (B 60 0104963).

19. Mycoblastus coniophorus (Elix & A.W.Archer) Kantvilas & Elix, in Kantvilas, *Lichenologist* **41**, 163 (2009)
When sterile, this species can be recognized by its dense cover of slender, branched, fragile isidia which give it a sorediate look, in addition to its whitish colour and the presence of perlatolic, confluentic and 2-*O*-methylconfluentic acids (Elix *et al.* 1997, sub *Pertusaria*). The species appears to be restricted to but widespread in southern Australia, and so far has been reported from New South Wales, Victoria and Tasmania, as well as Macquarie Island. Determination of the specimens as belonging to *Mycoblastus* is confirmed by their ascocarps. TLC: perlatolic and secalonic acids (major).

SPECIMENS EXAMINED
Western Australia: ● The Cascade, 4 km S of Pemberton, 34°29'S, 116°02'E, alt. 180 m, in disturbed wet sclerophyll forest (karri-dominated), on dead *Leptospermum*, *J.A. Elix 41113*, 13.ix.1994 (B 60 0108834); ● Big Brook Arboretum, off Tramway Trail, 6 km NNW of Pemberton, 34°24'S, 116°00'E, in *Pinus*-dominated plantation on gentle slope, on dead branches of *Pinus*, *J.A. Elix 41132*, 13.ix.1994 (B 60 0108837); ● Warren National Park, 11 km SW of Pemberton, 34°30'S, 115°56'E, alt. 100 m, dry heathy sclerophyll forest beside stream, on dead branch, *J.A. Elix 41234*, 14.ix.1994 (B 60 0108835, B 60 0108836); ● Trail to Toolbrunup Peak, Stirling Ranges, Stirling Range National Park, 40 km SW of Borden, 34°23'S, 118°3'E, alt. 700 m, dry sclerophyll forest with pockets of denser shrub vegetation, on dead wood, *J.A. Elix 41456*, 17.ix.1994 (B 60 0109278); ● Ravensthorpe Range, South Coast Highway, 9 km E of Ravensthorpe, 33°35'S, 120°8'E, alt. 160 m, dry sclerophyll forest with scattered *Callitris*, on base of *Eucalyptus*, *J.A. Elix 41572*, 18.ix.1994 (B 60 0109279).

20. Pannaria elatior Stirt., in Bailey, *Queensland Agric. J.* **5**, 486 (1899)
A widespread species in the tropics worldwide, and in Australia known from eastern Queensland, New South Wales and Norfolk Island. The Victorian specimen had been misidentified before as *P. elixii* P.M.Jørg. & D.J.Galloway, but it differs clearly by the presence of pannarin (TLC) and by the coralloid-branched isidia. The isidia have a smooth surface, but their cortex looks thinner than in specimens from Queensland and Norfolk Island.

SPECIMEN EXAMINED
Victoria: ● Mouth Yeerung River, 29 km SE of Orbost, 37°59'S, 148°45'E, alt. 10 m, on large sand dune in vegetation dominated by *Leptospermum*, on *Casuarina* stem, *H. Streimann 39689*, 2.x.1988 (B 60 0079322).

21. Pertusaria clarkeana A.W.Archer, in Elix, Malcolm & Archer, *Mycotaxon* **53**, 280 (1995)
The species is found mainly on mangroves in New South Wales and Queensland. The present specimen was collected at high elevation in Victoria, and lacks ascospores. It contains lichexanthone and picrolichenic acid (TLC), which is highly atypical. However, the

combination of discoid ascocarps and picrolichenic acid and lichexanthone excludes other taxa. The collection was identified previously as *P. truncata* Kremp. (in ANHSIR database), a species that lacks lichexanthone.

SPECIMEN EXAMINED
Victoria: ● Mt Donna Buang, 4.5 km NNW of Warburton, 37°42'S, 145°41'E, alt. 1150 m, regrowth *Nothofagus* in moist depression, on *Nothofagus* stem, *H. Streimann 36278*, 3.i.1986 (B 60 0079430).

22. Pertusaria erubescens (Hook.f. & Taylor) Nyl., *Mém. Soc. Imp. Sci. Nat. Cherbourg* **5**, 117 (1858)
This species is widespread in the temperate Southern Hemisphere, and in Australia it has previously been reported from Victoria and New South Wales. The South Australian specimen contains norstictic acid (TLC). It has a very similar counterpart in the temperate Northern Hemisphere, *P. chiodectonoides* Bagl. ex A.Massal., which is also *Aspicilia*-like, with 8 small spores per ascus, and the presence of norstictic acid without xanthones.

SPECIMEN EXAMINED
South Australia: ● Kangaroo Island, mouth of De Male River, 18 km SSE of Cape Borda, 35°43'S, 136°46'E, alt. 20 m, dry sclerophyll forest with *Casuarina* on rocky slopes, on semi-shaded boulder on side of track, *H. Streimann 55081*, 30.ix.1994 (B 60 0110795).

23. Pertusaria trimera (Müll.Arg.) A.W.Archer, *Telopea* **4**, 179 (1991)
Because this species is so far known only from southern Australia, the identification is provisional. The specimen contains thiophaninic and 2-*O*-methylperlatolic acid (TLC). The collection had been identified as *P. pertusella* Müll.Arg. earlier (in ANHSIR database), but our specimen has 4 spores per ascus and contains a depside instead of the stictic acid agg.

SPECIMEN EXAMINED
Queensland: ● Forty Mile Scrub National Park, 53 km E of Mount Surprise, 18°18'S, 144°49'E, alt. 770 m, in basalt-flow scrub dominated by *Brachychiton* and *Pleiogonium*, on dead treelet, *H. Streimann 46812*, 18.xii.1990 (B 60 0088145).

24. Placopsis argillacea (C.Knight) Malcolm & Vězda in A. Vězda, *Lichenes Rariores Exsiccati* Fasc. **34**, No. 340 (1997)
Galloway (2013) reported this species from New Zealand and Tasmania.

SPECIMENS EXAMINED
Victoria: ● Grey River Road, Angahook-Lorne State Forest, 28 km NE of Apollo Bay, 38°39'S, 143°49'E, alt. 300 m, regrowth of *Acacia* and *Pomaderris* on semi-exposed rocky road cutting, *H. Streimann 58924A*, 5.xii.1996 (B 60 0198242, B 60 0131351, B 60 0198241).

25. Poeltidea perusta (Nyl.) Hertel & Hafellner, in Hertel, *Beih. Nova Hedwigia* **79**, 463 (1984)
The species is widely distributed in the austral zone, and is readily recognized by its brown, areolate thallus with raised apothecia. For a description, see Rambold (1989).

SPECIMEN EXAMINED
Victoria: ● Mt McKay, Alpine National Park, 16 km SSE of Mt Beauty, 36°52'S, 147°14'E, alt. 1840 m, exposed subalpine grasslands with gneiss outcrops, growing on exposed rocks, *J.A. Elix & H. Streimann 40595*, 18.ii.1994 (B 60 0198232).

26. Pyrenula balia (Kremp.) R.C.Harris, *Lichenogr. Thomsoniana* 141 (1998)
A widespread pantropical species); in Australia previously reported from only Tasmania and Queensland, under the name *Pyrenula santensis* (Nyl.) Müll.Arg. (Aptroot 2009).

SPECIMEN EXAMINED
Victoria: ● Head of Franklin River, Thora-Gunyah Gunyah Road, 16 km NE of Foster, 38°33'S, 146°19'E, alt. 440 m, *Nothofagus cunninghamii*-dominated forest in shallow broad valley with *Atherosperma* and tree ferns, on partly shaded *Nothofagus* stem, *H. Streimann & T. Pocs 65293*, 29.ix.1999 (B 60 0190254).

27. Pyrenula pyrenuloides (Mont.) R.C.Harris, *Mem.New York Bot. Gard.* **49**, 99 (1989)
A widespread, pantropical species; in Australia previously reported from Queensland, Victoria and Tasmania (Aptroot 2009).

SPECIMEN EXAMINED
Northern Territory: ● Melville Island: Conder Point, 11°44'S, 131°17'E, alt. 2 m, strand vegetation dominated by *Acacia auriculaeformis*, *Gyrocarpus*, *Thespesia* and *Diospyros maritima*, on *Heritiera littoralis* stem, *H. Streimann 42484a*, 27.iv.1989 (B 60 0079176).

28. Pyrenula ravenelii (Tuck.) R.C.Harris, *Mem. New York Bot. Gard.* **49**, 99 (1989)
A widespread, pantropical species (Aptroot 2012); in Australia reported previously from Queensland, Victoria and Tasmania, sub *Pyrenula santensis* (Nyl.) Müll.Arg. (Aptroot 2009). The collection has been identified as *Anthracothecium toowoombense* (Müll.Arg.) Aptroot (in ANHSIR database), but the specimen in B has *Pyrenula*-type ascospores with rounded lumina.

SPECIMEN EXAMINED
Lord Howe Island: ● Track to Goat House Cave, base of Mt Lidgebird escarpment, 31°33.8'S, 159°05.2'E, alt. 380 m, moist, semi-tropical forest with *Dracophyllum* and *Cyathea*, on trunk of fallen tree, *J.A. Elix 42132*, 7.ii.1995 (B 60 0190259).

29. Ramboldia brunneocarpa Kantvilas & Elix, *Bryologist* **97**, 297 (1994)
This Australian endemic was reported previously from West Australia, New South Wales, Victoria and Tasmania.

SPECIMEN EXAMINED
Queensland: ● Mt Marley, 1 km NE of Stanthorpe, 28°39'S, 151°57'E, alt. 900 m, woodland with large granite outcrops, dominated by *Eucalyptus* and *Callitris*, on *Callitris*, *J.A. Elix 35640*, 5.ix.1993 (B 60 0198274).

30. Sarcogyne hypophaea (Nyl.) Arnold, *Flora, Regensburg* **53**, 475 (1870)
In Australia, this widespread species was known previously from Western Australia.

SPECIMEN EXAMINED
South Australia: ● South Mt Lofty Ranges, along Saunders Creek, 6.5 km E of Springton, 34°42'S, 139°10'E, alt. 300 m, pasture and dry *Eucalyptus* woodland, with numerous rock outcrops, on schist rocks, *J.A. Elix 23501*, 2.i.1990 (B 60 0116262).

31. Sculptolumina japonica (Tuck.) Marbach, *Biblioth. Lichenol.* **74**, 296 (2000)
This widespread tropical lichen was known previously in Australia from Queensland.

SPECIMEN EXAMINED
Northern Territory: ● Green Ant Creek, 35 km SSE of Adelaide River Settlement, 13°31'S, 131°15'E, alt. 160 m, on charred wood in remnant forest in gully with permanent water, containing *Calophyllum* and *Carallia*, *J.A. Elix 28171*, 19.vii.1991 (B 60 0115760).

32. Septotrapelia usnica (Sipman) Kalb & Bungartz, *Phytotaxa* **150**, 11 (2013)
A widespread tropical lichen, in Australia previously reported from Queensland, the Northern Territory and Western Australia.

SPECIMEN EXAMINED
New South Wales: ● Careys Cave, 4.5 km NNE of Wee Jasper, 35°5'S, 148°39'E, alt. 380 m, grazing lands with scattered *Brachychiton*, on soil, *J.A. Elix & H. Mayrhofer 22726*, 10.viii.1988 (B 60 0201584).

33. Trapelia coarctata (Sm.) Choisy, in Werner, *Bull. Soc. Sci. Nat. Maroc* **12**, 160 (1932)
A cosmopolitan lichen in temperate to tropical regions, and reported in Australia from all States and Territories.

SPECIMEN EXAMINED
Norfolk Island: ● Ilwyn Pine Road, 29°01.3'S, 167°56.7'E, alt. 65 m, olive- and guava-infested roadside, on semi-exposed road bank, *H. Streimann 53717*, 14.iv.1994 (B 60 0198349).

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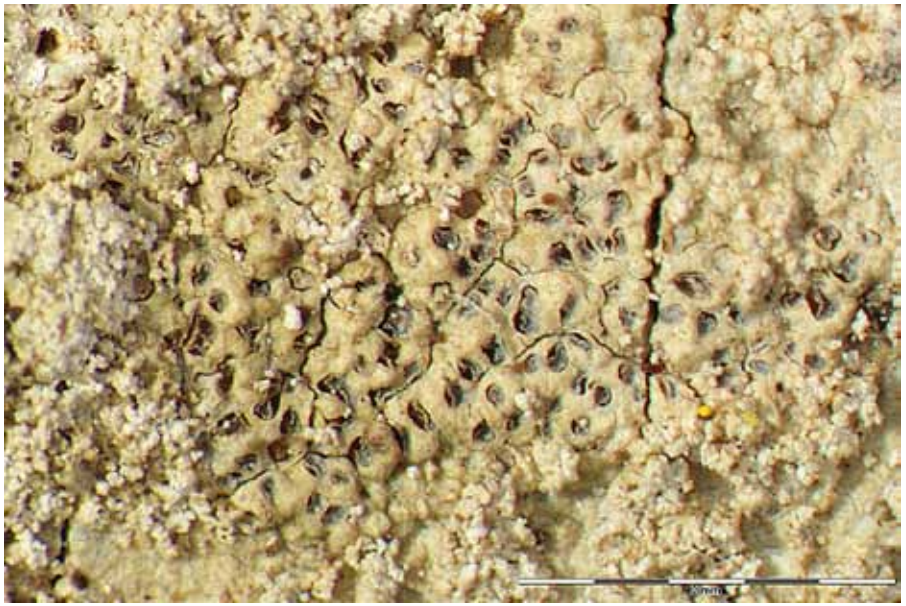

Fig. 1. *Leucodecton granulosum*, type specimen: ascomata and granules. Scale bar = 2 mm.

Fig. 2. *Leucodecton granulosum*, type specimen: granular thallus surface. Scale bar = 1 mm.

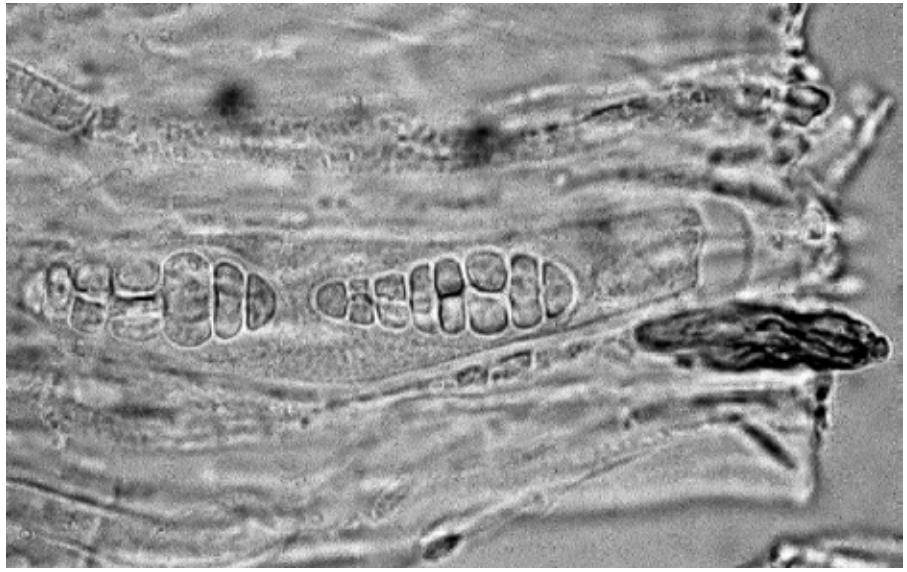

Fig. 3 *Leucodecton granulosum*, ascus with two spores, plus free overmature degenerated brownish spore to the right. Magnification: middle spore length = 23 µm.

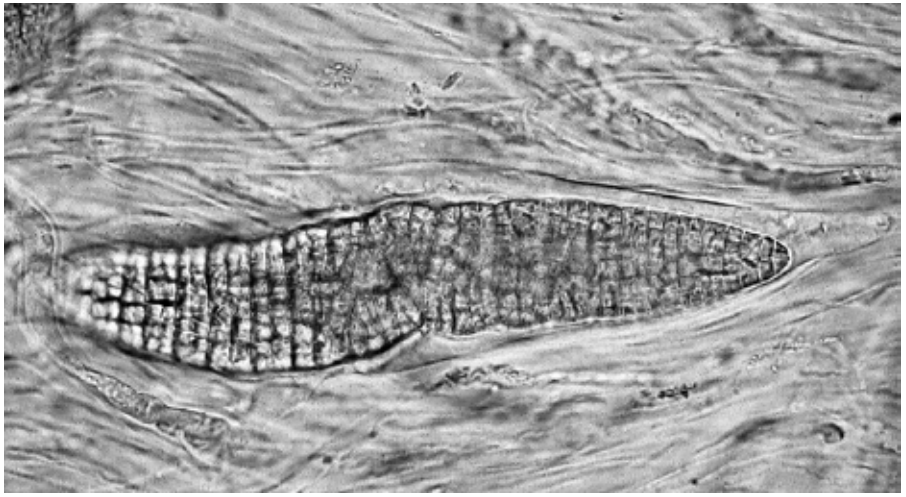

Fig. 4 *Myriotrema protofrustillatum*, ascospore in ascus. Magnification: spore length = 160 µm.

Fig. 5. *Myriotrema protofrustillatum*, type specimen. Ascomata. Scale bar = 2 mm.

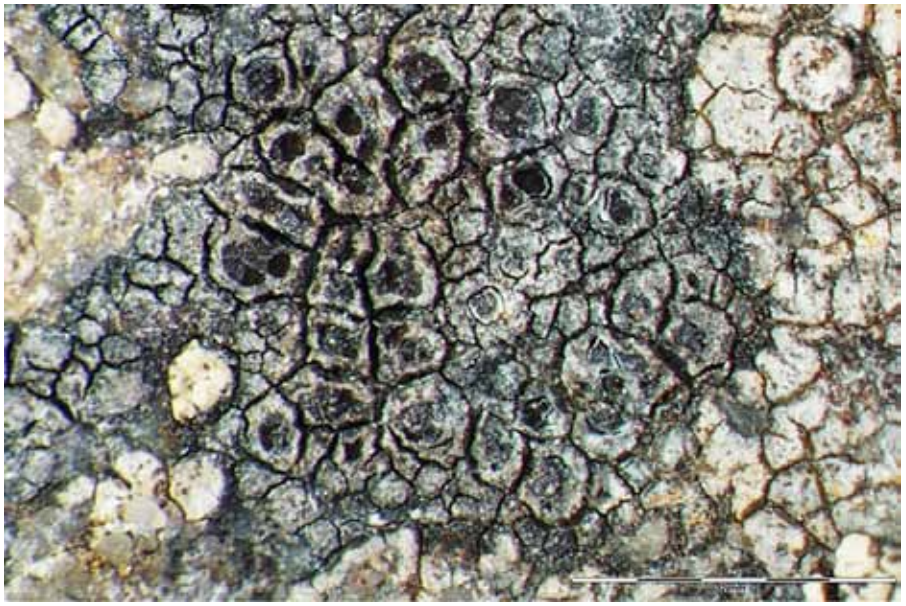

Fig. 6. *Bellemerea cinereoatra* (*Streimann 49419a*). Scale bar = 2 mm.

Fig. 7. *Mazosia carnea* (*Streimann 64552*). Scale bar = 1 mm.

Three new lichen species and 48 new records from Vanuatu

Harrie J.M. Sipman
Free University of Berlin, Botanic Garden and Botanical Museum Berlin-Dahlem
Koenigin-Luise-Str. 6-8, D-14195 Berlin, Germany
email: H.Sipman@bgbm.org

Abstract

Three lichens from Vanuatu are described as new species: *Crocynia didymica* Sipman (also in Papua New Guinea), *Crypthonia streimannii* Sipman (also in Indonesia) and *Herpothallon alae* Sipman. Another 48 taxa are listed as new records for Vanuatu.

Introduction

Vanuatu is an archipelago in the south-western Pacific Ocean located at about 15°S, 167°E. A literature survey in 1998 (Elix & McCarthy 1998) listed 41 lichens for the country. In 1998, the late H. Streimann and P. Ala collected 435 specimens and sent full or partial sets of duplicates to several specialists. The study of those specimens resulted in numerous publications (McCarthy 2000, 2003; Ferraro *et al.* 2001; Lücking *et al*. 2001; Archer 2004; Sérusiaux & Lücking 2007; Aptroot *et al.* 2009; Archer & Elix 2009; Elix 2016). Further collecting in 2000 resulted in a treatment of the family Graphidaceae (Nakanishi *et al.* 2002a, 2002b). An on-line checklist of Pacific Island lichens, updated by J.A. Elix & P.M. McCarthy, listed 120 species (Elix & McCarthy 2008).

A partial set of duplicates of the 1998 Streimann & Ala collections was sent to the herbarium in Berlin-Dahlem (B). Results from the study of that material are presented here.

Material and methods

Morphology and anatomy were examined with a Wild M7 stereomicroscope and a Zeiss Axioskop compound microscope. The chemistry was investigated by TLC (Orange *et al.* 2001), using solvents A, B' and C, and comparison with extracts from lichens with known chemical composition. For the iodine reactions, Lugol's solution was used. Because the chemistry was not confirmed by HPLC, only the major substances were identified. The identification results were compared with the on-line checklist and the ANHSIR database of herbarium specimens in CANB (http://www.anbg.gov.au/cgi-bin/anhsir). The specimens are lodged in B, with duplicates in CANB. Some collections with more than one species were separated in B and denoted by the low-case letter "a" following the collection number.

New species

1. Crocynia didymica Sipman sp. nov. Figs 1, 2
MycoBank **MB824683**

Similar to *Crocynia gossypina* (Sw.) A.Massal. in thallus colour and structure, differing most clearly in chemistry, containing didymic, barbatic and 4-*O*-demethylbarbatic acids.

Type: Vanuatu. *Éfaté*: • Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 300 m, lowland rainforest on broad undulating ridge, on shaded tree buttress, *H. Streimann & P. Ala 62991*, 25.x.1998 (B 60 0182360 – holotype; CANB (*n.v.*), B 60 0191180 – isotypes).

Thallus crustose, leprose, continuous, placodioid, pale greenish to brownish or blue-greenish grey, with a sparse, white medulla, without a prothallus, *c.* 100 µm thick, seemingly consisting of aggregated granules, on the underside with more loose hyphae appearing to attach the thallus to the substratum and give the impression of a medulla; margin slightly raised, weakly lobed or with *c.* 0.2–0.4 mm wide microlobules; hyphae hyaline, 2.5–3.5 µm thick, net-forming, branched and anastomosing, more densely so in algiferous parts, covered with small crystals; calcium oxalate crystals absent; photobiont green, coccoid, cells subglobose, *c.* 4–7 µm in diam., clustered in *c.* 20–25 µm wide groups, increasing to *c.* 40 µm diam. towards the upper side of the thallus; free granules on thallus surface *c.* 50–100 µm wide, often attached to each other and forming loose, coralloid structures that can be up to 200 µm wide, on the surface with scattered, erect, often straight hyphae *c.* 40–70 µm long and gradually tapering from 2.5 µm to 1.0 µm at the tip. Ascomata and pycnidia absent.
Chemistry: didymic, barbatic and 4–*O*–demethylbarbatic acids (TLC).

Etymology: Named after one of its major metabolites, didymic acid.

Remarks

The new species is placed in the genus *Crocynia* because of its remarkable internal thallus structure (Fig. 2), which shows net-like thallus hyphae with many anastomoses, and photobiont cells in clusters. *Crocynia gossypina* (Sw.) A.Massal. has a similar fluffy thallus with net-like hyphae, but its photobiont clusters are larger and more continuous.

All the species accepted in *Crocynia* in recent publications differ chemically from *C. didymica*. Thus, *C. glaucescens* (F.Wilson) S.Y.Kondr., Elix & Kärnefelt contains atranorin (Kondratyuk *et al.* 2011), *C. microphyllina* Aptroot contains protocetraric acid (Lumbsch *et al.* 2011), *C. minutiloba* Aptroot contains hypoprotocetraric and protocetraric acids (Aptroot 2014), and *C. pyxinoides* Nyl. contains atranorin and stictic acid (Kalb 1996). Analysis of eight specimens of *C. gossypina* lodged in B showed that it has a very variable chemistry including one or more of the following substances: barbatic acid, other depsides, protocetraric acid and norstictic acid.

A fluffy thallus structure is also known from the genus *Botryolepraria*. However, that genus differs chemically by the presence of the terpenoids zeorin and lesdainin (Kukwa & Pérez-Ortega 2010).

Crocynia didymica resembles also the genus *Lepraria* in its granular thallus. However, the fluffy structure with net-like hyphae is not known from that genus, and didymic acid is absent (Saag *et al.* 2009; Elix 2009; Kashiwadani *et al.* 2009; Kukwa & Flakus 2009; Øvstedal *et al.* 2009; Perez-Ortega & Spribille 2009; Elix, Spielmann & Øvstedal 2010; Flakus *et al.* 2010; Flakus & Kukwa 2011; Fryday & Øvstedal 2012; Bungartz *et al.* 2013; Elix 2013; Lendemer 2010, 2013; Lendemer & Tønsberg 2014). *Lepraria squamatica* Elix is rather similar morphologically, but differs chemically by the presence of baeomycesic and squamatic acids. *Lepraria barbatica* Lendemer is similar to *C. didymica* in containing barbatic acid, but it differs in also containing usnic acid, and it lacks didymic and 4-*O*-demethylbarbatic acids (Lendemer 2010).

The tapering and often straight hyphae on the surface of *C. didymica* (Fig. 2) is possibly a unique trait. In other species with erect, superficial hyphae on their soredia [*Lepraria rigidula* (B.de Lesd.) Diederich and *L. squamatica* Elix examined], the hyphae attenuate only slightly and are not straight. Moreover, the net-like structure of the thallus hyphae is not evident in those species.

The specimens from Papua New Guinea differ slightly in their smoother thallus with less granular to isidioid outgrowths and a scarcity of tapering hyphae. However, they are chemically indistinguishable.

The new species occurs on buttresses, trunks and branches in tropical lowland forest. It is so far known from a single collection from Vanuatu and three from the province of New Britain in Papua New Guinea. It is likely to be widespread in coastal forests throughout Malesia.

ADDITIONAL SPECIMENS EXAMINED

Papua New Guinea. NEW BRITAIN: ● Nakanai Mountains, 48 km SE of Hoskins, 05°34'S, 150°46'E, alt. 480 m, ridge forest dominated by *Castanopsis*, *Elaeocarpus* and *Garcinia*, on treelet stem, *H. Streimann 40425*, 19.ii.1989 (B 60 0088609); ● Geleo-Lasilai Logging Area, Laliti Mountain, Nakanai Mountains, 40 km SE of Hoskins, 05°42'S, 150°41'E, alt. 240 m, lowland forest on pumice on gentle slope dominated by Meliaceae, *Pometia* and *Garcinia*, on treelet branch, *H. Streimann 41220*, 21.ii.1989 (B 60 0088607); ● Nakanai Mountains, 45 km SE of Hoskins, 05°44'S, 150°44'E, alt. 320 m, lowland ridge forest dominated by *Spondias* and *Pometia*, on treelet (*Amoora*) branch, *H. Streimann 41335*, 22.ii.1989 (B 60 0088608).

2. Crypthonia streimannii Sipman sp. nov. Figs 3, 4
MycoBank **MB824684**

Similar to *C. palaeotropica* Frisch & G.Thor in the colour of its thallus and hypothallus, its ascocarps and its pseudoisidia, but differs in its chemistry (containing terpenoids instead of psoromic acid).

Type: Vanuatu, Espíritu Santo: Big Bay-Luganville road, 29 km NW of Luganville, 15°18'S, 167°01'E, alt. 290 m, lowland forest dominated by *Pometia* and *Dysoxylum*, on gentle slope beside seasonal stream, on shaded tree trunk (*Dysoxylum*), *H. Streimann & P. Ala 62742*, 21.x.1998 (B 60 0191157 – holotype; CANB (*n.v.*) – isotype).

Thallus crustose, to more than 10 cm diam., pale greenish to blue-greenish grey to almost white, I+ blue, felty, continuous, loosely attached to the substratum by the hypothallus, *c.* 100 µm thick, without a cortex; margins white, free of algae, often slightly swollen, raised above the substratum, sometimes more appressed and thin, and forming a prothallus; photobiont cells in upper *c.* 50 µm of the thallus, lower part algae-free and white (medulla), *c.* 50 µm; photobiont cells 7–10 µm diam., in indistinct chains (*Trentepohlia*-like); fungal hyphae 1.5–2.5 µm thick, covered by tiny crystals; calcium oxalate crystals present, regularly scattered, *c.* 10 µm in diam.; hypothallus dark brown to blackish, *c.* 50 µm thick but patchy, composed of very loose, brown-pigmented hyphae *c.* 4 µm thick. Pseudoisidia numerous, usually white, irregularly globular with a constricted base, mostly 0.3–0.5 mm in diam., of looser structure than the thallus, sometimes greenish and containing photobiont cells, occasionally elongated and clavate. Ascomata whitish, raised to wart-like, not constricted at the base, top flattened with irregular, compact, pale brownish areas, when small *c.* 0.3 mm wide and rounded, becoming very irregular in shape, the largest ones to over 2 mm long; asci *Arthonia*-type, 30–35 × 15–16 µm, I–; ascospores narrowly obovoid, with 1 central, transverse septum, *c.* 8–9 × 4 µm, *c.* 6 per ascus. Pycnidia not seen.
Chemistry: Unidentified substances causing terpenoid-like spots; main spots at Rf classes a5, b3, c3 and a6, b4, c5 (TLC).

Etymology: Named after Heinar Streimann (1938–2001), who contributed greatly to the lichenological exploration of Vanuatu.

Remarks
Crypthonia streimannii differs from all known *Crypthonia* species (Frisch & Thor 2010; Menezes *et al.* 2013; Aptroot *et al.* 2014; Cáceres & Aptroot 2016) in containing only terpenoids. It strongly resembles *C. palaeotropica* in the colour of its hypothallus and pseudoisidia (Frisch & Thor 2010), but that species contains the psoromic acid aggregate. Unfortunately, the numerous asci in the two available fertile specimens (*7275* and *62742*) are mostly empty, and no well-developed ascospores were seen outside the asci, so the spore shape and septation remain uncertain, and can not be clearly illustrated. Some spores are possibly biseptate, as is suggested by the inclusion of one of the available specimens (*Groenhart 7275*) in *Stirtonia biseptata* Aptroot & Wolseley by Wolseley & Aptroot (2009).
The new species occurs on shaded tree trunks in tropical lowland forest. It is so far known from Vanuatu and Java, but it is probably widespread in the Malesian region.

ADDITIONAL SPECIMENS EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 300 m, lowland rainforest on broad undulating ridge, on shaded tree (*Antiaris toxicarya*) buttress, *H. Streimann & P. Ala 62997*, 25.x.1998 (B 60 0191159); *Espíritu Santo*: type locality, *H. Streimann & P. Ala 62743*, 21.x.1998 (B 60 0191158).
Indonesia. *East Java*: ● Bay of Nglijep, S of Donomoljo, alt. 0–10 m, on charred bark of tree, *P. Groenhart 7275*, 4.x.1936 (B 60 0183103).

3. **Herpothallon alae** Sipman sp. nov. Figs 5, 6
MycoBank **MB824685**

Similar to *H. queenslandicum* (Elix) Elix in its thallus structure, colour and chemistry, but differs in having pustular rather than cylindrical pseudoisidia.

Type: Vanuatu. Éfaté: Ridge below Mt McDonald, 15 km NNE of Port Vila, 17°35'S, 168°21'E, alt. 600 m, lowland tropical forest on narrow limestone ridge, on shaded tree trunk, *H. Streimann & P. Ala 63281*, 28.x.1998 (B 60 0201617 – holotype; CANB (*n.v.*) – isotype).

Thallus crustose, to more than 10 cm in diam., pale blue-greenish grey, I+ blue, felty, continuous, loosely attached to the substratum by the hypothallus, *c.* 100 µm thick, without a cortex; margins pale red and lacking algae, often slightly swollen, free from the substratum and only rarely grading into a thin, appressed prothallus; thallus with free hyphae on top, with photobiont cells in the upper *c.* 50 µm; photobiont cells subglobose, 7–10 µm diam., in indistinct chains (*Trentepohlia*-like); fungal hyphae 1.5–2.0 µm thick; calcium oxalate crystals present, regularly scattered, *c.* 10 µm diam. Lower part (medulla) algae-free and white with scattered red pigment, *c.* 30–100 µm thick; hyphae 1.5–2.0 µm thick; hypothallus dark greenish grey, *c.* 50 µm thick but patchy, composed of very loose, pale brown-pigmented hyphae *c.* 3–3.5 µm thick. Pseudoisidia numerous, apically white, lower part concolorous with the thallus, resembling pustular isidia but ecorticate and composed only of loose hyphae. Ascomata and pycnidia absent.
Chemistry: psoromic, 2'-*O*-methylpsoromic (trace), chiodectonic acids (trace) (TLC).

Etymology: Named after P. Ala, who accompanied Heinar Streimann during fieldwork in Vanuatu in October 1998.

Remarks
The inclusion of this sterile lichen in *Herpothallon* is based on its loose, ecorticate thallus, the presence of a hypothalline layer of dark, loose hyphae, and the presence of chiodectonic acid in the medulla. Apart from the last character, the species would fit just as well in *Crypthonia* (Frisch & Thor 2010). Recent keys to *Herpothallon* (Aptroot *et al.* 2009; Jagadeesh Ram 2015) lead to the species *H. queenslandicum* (Elix) Elix, which differs in having cylindrical pseudoisidia. However, in *H. alae* the thallus forms pustule-like structures, where the loose thallus hyphae are grouped in somewhat coralloid pseudoisidia (see Fig. 5). Specimen *63199* was reported by Aptroot *et al.* (2009) as *Herpothallon albidum* (Fée) Aptroot, Lücking & G.Thor, probably because the scarce pigment was overlooked.
The new species occurs on tree trunks in tropical, lowland forest. So far it is known only from Vanuatu.

ADDITIONAL SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Track to Mt McDonald, 14 km N of Port Vila, 17°36'S, 168°19'E, alt. 500 m, lowland tropical forest on narrow limestone ridge, on semi-shaded tree trunk, *H. Streimann & P. Ala 63199*, 25.x.1998 (B 60 0182518).

New records

1. Anthracothecium interlatens (Nyl.) Aptroot, *Lichenologist* **44**, 35 (2012)
Reported by Aptroot (2012) as pantropical, the perithecial wall is richly folded so that it resembles several perithecia sharing a common ostiole. The ascospores are 2 per ascus, are *c.* 170 × 38 µm, and have thick outer walls and thin septa, as is usual in the genus. *Anthracothecium gregale* (C.Knight) Aptroot, with Australasian distribution, is very similar, but its asci are 6–8-spored and the ascospores are 100–150 µm long (specimens in B).

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Logging area near Lavatmas (N of Sara), 48 km NNW of Luganville, 15°07'S, 167°01'E, alt. 300 m, poor lowland forest on flats dominated by *Endospermum medullosum*, *Antiaris toxicarya* and *Pometia pinnata*, on upper branches of a large felled tree (*Endospermum medullosum*), *H. Streimann & P. Ala 62791*, 22.x.1998 (B 60 0190251).

2. Anthracothecium prasinum (Eschw.) R.C.Harris, *in* Egan, *Bryologist* **90**, 163 (1987)
Identified using Aptroot (2012), who gives its distribution as pantropical. In all perithecia, the hymenium is decayed, and the empty perithecia are partially filled with loose ascospores, a common occurrence in the genus. The spores are 6–8 per ascus and measure 50–140 × 22–28 µm. In the very similar *A. macrosporum* (Hepp) Müll.Arg., with 1–4 spores per ascus, they are always well over 100 µm long (measured in specimens in B).

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Logging area near Lavatmas (N of Sara), 48 km NNW of Luganville, 15°07'S, 167°01'E, alt. 300 m, poor lowland forest on flats dominated by *Endospermum medullosum*, *Antiaris toxicarya* and *Pometia pinnata*, in upper branches of a large felled tree (*Endospermum medullosum*), *H. Streimann & P. Ala 62780*, 22.x.1998 (B 60 0190252).

3. Astrothelium meristosporum (Mont. & Bosch) Aptroot & Lücking, *Lichenologist* **48**, 871 (2016)
Aptroot & Lücking (2016) regarded this species as pantropical, but it is more accurately described as eastern Palaeotropical (India to Oceania), because a duplicate in B of the only specimen from outside that range (French Guiana) deviates strongly. The ascospores measure *c.* 175 × 35 µm, have a pronounced and constricted primary median septum, and *c.* 25 further transverse septa. The presence of lichexanthone is evident by its orange fluorescence in UV.

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Big Bay-Luganville road, 26 km NW of Luganville, 15°19'S, 167°01'E, alt. 380 m, regrowth on limestone dominated by *Alphitonia* and *Macaranga*, on a semi-exposed *Macaranga* stem, *H. Streimann & P. Ala 62268*, 18.x.1998 (B 60 0191190).

4. Astrothelium heterophorum Nyl., *Bull. Soc. Linn. Normandie*, sér. 2, **2**, 133 (1868)
Identified using Aptroot & Lücking (2016), who describe its distribution as eastern Palaeotropical (Philippines, New Caledonia). The structure of the ascocarps is difficult to assess, because they are deeply immersed in the strongly pitted bark. The ascospores are transversely septate, *c.* 75 × 12 µm and 14-locular, unusual in the genus.

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● logging area near Lavatmas (N of Sara), 48 km NNW of Luganville, 15°07'S, 167°01'E, alt. 300 m, poor lowland forest on flats dominated by *Endospermum medullosum*, *Antiaris toxicarya* and *Pometia pinnata*, on upper branches of a large felled tree (*Endospermum medullosum*), *H. Streimann & P. Ala 62787*, 22.x.1998 (B 60 0190248).

5. Chrysothrix xanthina (Vain.) Kalb, *Biblioth. Lichenol.* **78**, 144 (2001)
As documented by Kalb (2001), this common, sterile leprose lichen, forming large, yellow patches on trunks along roads all over the tropics, differs from the widespread *C. candelaris* (L.) J.R.Laundon in its finer, denser soredia.

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Ussa Plantation, Luganville-Navota road, 7 km SE of Luganville, 15°34'S, 167°08'E, alt. 8 m, coconut plantation on flats with small limestone outcrops, on exposed coconut trunk with scattered Caliciales (HS 62973), *H. Streimann & P. Ala 62974*, 24.x.1998 (B 60 0164248).

6. Cladonia didyma (Fée) Vain., *Acta Soc. Fauna Fl. Fennica* **4**(1), 137 (1887)
This pantropical species occurs wherever humid forest is disturbed. TLC: didymic, barbatic and thamnolic acids (*63104* pr.p.).

SPECIMENS EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 340 m, lowland rainforest on broad undulating ridge, on upper branches in crown of large tree, *H. Streimann & P. Ala 63104A*, 25.x.1998 (B 60 0191176), *63104 pr. p.* (B 60 0191175).

7. Cladonia ramulosa (With.) J.R.Laundon, *Lichenologist* **16**, 225 (1984)
The specimen resembles *C. subradiata* (Vain.) Sandst., and a duplicate was identified as such by S. Hammer in 2000, but the podetial surface of the specimen in B lacks soredia, so the specimen is provisionally determined here as *C. ramulosa*, pending a revision of the group in the Palaeotropics. TLC: Fumarprotocetraric acid.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 340 m, lowland rainforest on broad undulating ridge, on upper branches in crown of large *Syzygium*, *H. Streimann & P. Ala 63118*, 25.x.1998 (B 60 0191174).

8. Cladonia subradiata (Vain.) Sandst., *Abh. Naturwiss. Ver. Bremen* **25**, 230 (1922)
This species resembles *C. didyma* in its pantropical distribution and preference for disturbed forest. It is sorediate, but the soredia can coalesce into microsquamules (Ahti 2000).

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 340 m, lowland rainforest on broad undulating ridge, on upper branches in crown of large tree, *H. Streimann & P. Ala 63104*, 25.x.1998 (B 60 0191175).

9. Coccocarpia pellita (Ach.) Müll.Arg., *Flora* **65**, 320 (1882)
The identification follows Arvidsson (1982). The lobulate isidia are not well developed, and the specimen seems parasitized. The species has a pantropical distribution.

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Forestry Demonstration Area, Butmas, 25 km NW of Luganville, 15°22'S, 167°00'E, alt. 620 m, tropical forest on moderate slope, dominated by *Myristica fatua* with dense ground cover of ferns and herbaceous Urticaceae, on branches of medium-sized, spreading *Hibiscus tiliaceus*, *H. Streimann & P. Ala 62358*, 19.x.1998 (B 60 0191177).

10. Coenogonium linkii Ehrenb., in Nees von Esenbeck (ed.), *Horae Phys. Berol.* 120, tab. 27 (1820)
Rivas Plata *et al.* (2006) provide a key and description of this characteristic pantropical species with shelf-like thalli and bilocular ascospores.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Track to Mt McDonald, 14 km N of Port Vila, 17°36'S, 168°19'E, alt. 500 m, lowland tropical forest on narrow limestone ridge, on partly shaded upper tree trunk (*Garcinia*), *H. Streimann & P. Ala 63227*, 28.x.1998 (B 60 0191178).

11. Collema actinoptychum Nyl., *Bull. Soc. Linn. Normandie*, sér. 2, **2**, 43 (1868)
This eastern Palaeotropical, broad-lobed species has diagnostic, sharp and often radiate folds. The identification follows Degelius (1974).

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 340

m, lowland rainforest on broad undulating ridge, on shaded upper treelet stem, *H. Streimann & P. Ala 63084*, 25.x.1998 (B 60 0164832).

12. Cresponea proximata (Nyl.) Egea & Torrente, Mycotaxon **48**, 328 (1993)
For a key and description, see Egea & Torrente (1993). The ascospores are 30–35 × 4–5 µm and (6–)8-loculate.

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Luganville-Hog Harbour road (over river) past Matevala Plantation, 16 km N of Luganville, 15°22'S, 167°11'E, alt. 0 m, strand/mangrove vegetation dominated by *Calophyllum inophyllum* and *Barringtonia asiatica*, on semi-shaded *Barringtonia* trunk, *H. Streimann & P. Ala 62950*, 24.x.1998 (B 60 0191172).

13. Dichosporidium boschianum (Mont.) G.Thor, *Opera Bot.* **103**, 64 (1991)
The specimen agrees with the description by Thor (1990) in the absence of pseudoisidia, the presence of protocetraric acid and ascospores measuring 60–70 × 3 µm. The species has an eastern Palaeotropical distribution.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Ridge below Mt McDonald, 15 km NNE of Port Vila, 17°35'S, 168°21'E, alt. 600 m, lowland tropical forest on narrow limestone ridge, on shaded tree trunk, *H. Streimann & P. Ala 63275*, 28.x.1998 (B 60 0191181).

14. Dictyonema thelephora (Spreng.) Zahlbr., *Cat. Lich. Univ.* **7**, 748 (1931)
This species has long been known as *Dictyonema sericeum* (Sw.) Berk., and the duplicate of our specimen in CANB was identified as such by H. Lepp in 2003.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Track to Mt McDonald, 14 km N of Port Vila, 17°36'S, 168°19'E, alt. 500 m, lowland tropical forest on narrow limestone ridge, on semi-shaded tree trunk, *H. Streimann & P. Ala 63194*, 28.x.1998 (B 60 0191182).

15. Dirinaria aegialita (Ach.) B.Moore, *Bryologist* **71**, 248 (1968)
A widespread species in the tropics and subtropics worldwide, it differs from the equally common and widespread *D. applanata* (Fée) D.D.Awasthi and *D. picta* (Sw.) Clem. & Shear by the presence of dactyls instead of soralia. The dactyls superficially resemble soralia, but they do not produce soredia.

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Navota-Luganville road, 12 km SE of Luganville, 15°35'S, 167°02'E, alt. 3 m, edge of mangrove lagoon, on semi-exposed tree trunk, *H. Streimann & P. Ala 62912*, 23.x.1998 (B 60 0165017).

16. Dyplolabia afzelii (Ach.) A.Massal., *Neag. Lich.* 6 (1854)
This conspicuous pantropical species is easily recognized by the presence of lecanoric acid on the lirellae, reacting C+ red (Kalb & Staiger 2000).

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Logging area near Lavatmas (N of Sara), 48 km NNW of Luganville, 15°07'S, 167°01'E, alt. 300 m, poor lowland forest on flats dominated by *Endospermum medullosum*, *Antiaris toxicarya* and *Pometia pinnata*, in upper branches of large felled tree (*Endospermum medullosum*), *H. Streimann & P. Ala 62773*, 22.x.1998 (B 60 0191113).

17. Fulvophyton subseriale (Nyl.) Ertz & Tehler, *Fungal Diversity* **49**, 54 (2011)
A pantropical species. For a description see Sparrius (2004), as *Enterographa subserialis* (Nyl.) Redinger.

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Luganville-Hog Harbour road (over river) past Matevala Plantation, 16 km N of Luganville, 15°22'S, 167°11'E, alt. 0 m, strand/mangrove vegetation dominated by *Calophyllum inophyllum*, *Barringtonia asiatica*, on shaded leaning tree trunk, *H. Streimann & P. Ala 62932*, 24.x.1998 (B 60 0191183).

18. Graphis furcata Fée, *Essai Crypt. Exot.* 40 ('1825') [1824]
For a description and keys for this pantropical species, see Lücking *et al.* (2008, 2009). TLC: nil.

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Logging area near Lavatmas (N of Sara), 48 km NNW of Luganville, 15°07'S, 167°01'E, alt. 300 m, poor lowland forest on flats, dominated by *Endospermum medullosum*, *Antiaris toxicarya* and *Pometia pinnata*, in upper branches of large felled tree (*Endospermum medullosum*), *H. Streimann & P. Ala 62766*, 22.x.1998 (B 60 0191111).

19. Graphis insulana (Müll.Arg.) Lücking & Sipman, in Lücking, Chaves, Sipman, Umaña & Aptroot, *Fieldiana, Bot.* **46**, 84 (2008)
For a description and keys for this pantropical species, see Lücking *et al.* (2008, 2009). *Graphis subserpentina* Nyl., also reported from Vanuatu (Elix & McCarthy 2008), is very similar and differs only in the absence of hymenial granules. TLC: norstictic acid (*61983*, *61996*).

SPECIMENS EXAMINED
Vanuatu. *Éfaté*: ● Iririki Island (Port Vila Harbour), 17°45'S, 168°18'E, alt. 10 m, disturbed monsoon forest with exotics dominated by *Gyrocarpus americanus*, *Pterocarpus indicus*, *Leucaena glauca*, *Acacia* and coconuts on gentle slope, on semi-shaded *Gyrocarpus* trunk, *H. Streimann & P. Ala 61983*, 15.x.1998 (B 60 0191109); • *loc. id.*, on semi-exposed *Acacia* stem, *H. Streimann & P. Ala 61996*, 15.x.1998 (B 60 0191086).

20. Graphis sundarbanensis Jagadeesh & G.P.Sinha, in Jagadeesh Ram, Sinha & Singh, *Lichenologist* **39**, 231 (2007)
This pantropical species is very similar to *G. dendrogramma* Nyl., but differs in having exposed rather than closed discs (Lücking *et al.* 2009). TLC: stictic, with traces of cryptostictic and constictic acids.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Iririki Island (Port Vila Harbour), 17°45'S, 168°18'E, alt. 10 m, disturbed monsoon forest with exotics dominated by *Gyrocarpus americanus*, *Pterocarpus indicus*, *Leucaena glauca*, *Acacia* and coconuts on gentle slope, on semi-shaded *Gyrocarpus* trunk, *H. Streimann & P. Ala 61987*, 15.x.1998 (B 60 0191110).

21. Heterodermia flabellata (Fée) D.D.Awasthi, *Geophytology* **3**, 113 (1973)
For a key and description, see Mongkolsuk *et al.* (2015). TLC: atranorin, terpenoids, incl. zeorin and leucotylin. Apothecia are absent, so the specimen could be the less common *H. paradoxa* Schumm & Schäfer-Verwimp.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Track to Mt McDonald, 14 km N of Port Vila, 17°36'S, 168°19'E, alt. 500 m, lowland tropical forest on narrow limestone ridge, on semi-shaded tree trunk, *H. Streimann & P. Ala 63200*, 28.x.1998 (B 60 0191185).

22. Heterodermia japonica (M.Satô) Swinscow & Krog, *Lichenologist* **8**, 122 (1976)
For a key and description, see Mongkolsuk *et al.* (2015, as *Polyblastidium japonicum* (M.Satô) Kalb). TLC: atranorin and terpenoids, incl. zeorin.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Ridge below Mt McDonald, 15 km NNE of Port Vila, 17°35'S, 168°21'E, alt. 600 m, lowland tropical forest on narrow limestone ridge, on shaded leaning treelet stem, *H. Streimann & P. Ala 63350*, 28.x.1998 (B 60 0191188).

23. Heterodermia propagulifera (Vain.) J.P.Dey, in Parker & Roane, *Distr. Hist. Biota S. Appal.* **4**, 403 (1977)
For a key and description, see Mongkolsuk *et al.* (2015, as *Polyblastidium propaguliferum* (Vain.) Kalb). TLC: atranorin, norstictic acid and terpenoids, incl. zeorin.

SPECIMENS EXAMINED
Vanuatu. *Espíritu Santo*: ● Forestry Demonstration Area, Butmas, 25 km NW of Luganville, 15°22'S, 167°00'E, alt. 620 m, tropical forest on moderate slope, dominated by *Myristica fatua* with dense ground cover of ferns and herbaceous Urticaceae, on branches of medium-sized spreading *Hibiscus tiliaceus*. *H. Streimann & P. Ala 62354*, 19.x.1998 (B 60 0191187); ● Mt Tanakar plateau, Butmas, 26 km NW of Luganville, 15°22'S, 166°59'E, alt. 720 m, tropical forest on limestone on moderate slope dominated by *Myristica fatua* and *Dysoxylum*, fallen from tree crown (*Dysoxylum*), *H. Streimann & P. Ala 62607A*, 20.x.1998 (B 60 0191186); ● Ridge below Mt McDonald, 15 km NNE of Port Vila, 17°36'S, 168°21'E, alt. 400 m, advanced regrowth on ridge, on semi-exposed treelet stem, *H. Streimann & P. Ala 63430*, 28.x.1998 (B 60 0191189).

24. Lepidocollema brisbanense (C.Knight) P.M.Jørg., in Ekman, Wedin, Lindblom & Jørgensen, *Lichenologist* **46**, 650 (2014)
Syn.: *Parmeliella brisbanensis* (C.Knight) P.M.Jørg. & D.J.Galloway
A distinctive lichen with strongly elongated, radiating marginal lobes on a conspicuous, thick, black, byssoid prothallus, and with cylindrical isidia, widespread in cultivated, humid tropical areas. Two specimens, *63420* and *63427*, deviate in that the isidia are not cylindrical but strap-shaped and phyllidium-like. They resemble the Neotropical *Parmeliella pannosa* (Sw.) Müll. Arg. but, in the absence of apothecia, they are provisionally treated here as atypical *L. brisbanensis*.

SPECIMENS EXAMINED
Vanuatu. *Espíritu Santo*: ● Hasevaia (near mouth of Adsone River), 23 km NNW of Luganville, 15°35'S, 166°58'E, alt. 3 m, disturbed strand vegetation and old coconut plantation, on stem of large semi-shaded palm (*Carpoxylon*), *H. Streimann & P. Ala 62838*, 23.x.1998 (B 60 0191223). *Éfaté*: ● Ridge below Mt McDonald, 15 km NNE of Port Vila, 17°35'S, 168°20'E, alt. 450 m, transition forest on ridge between regrowth and tropical forest, on shaded tree trunk, *H. Streimann & P. Ala 63420*, 28.x.1998 (B 60 0191225); ● Ridge below Mt McDonald, 15 km NNE of Port Vila, 17°36'S, 168°21'E, alt. 400 m, advanced regrowth on ridge, on shaded shrub stem, *H. Streimann & P. Ala 63427*, 28.x.1998 (B 60 0191226).

25. Leptogium azureum (Sw.) Mont., in Webb & Berthelot, *Hist. Nat. Iles Canaries* **3**(2), 129 (1840)
The taxonomy of the genus *Leptogium* is not well understood, and the name *L. azureum* is used here provisionally for one of the commonest and most conspicuous lichens in Vanuatu. The thallus is foliose with large, blue-grey, thin, non-hairy, mostly smooth lobes. It lacks propagules, and the apothecia are frequent and sessile on the lobes. The excipulum is bordered by a paraplectenchymatous layer *c.* 50 µm thick, visible when dry as a whitish layer, whereas the hypothecium lacks such a layer (the subhypothecium is euthyplectenchymatous). See Swinscow & Krog (1988, fig. 63).

SPECIMENS EXAMINED
Vanuatu. *Espíritu Santo*: ● Sevua Village near Nambauck Village, 12 km NW of Luganville, 15°27'S, 167°04'E, alt. 175 m, moderately disturbed tropical forest on moderate slope with small garden patches, on semi-exposed coconut trunk, *H. Streimann & P. Ala 6213*, 17.x.1998 (B 60 0191193); ● Navota Farm, 20 km ESE of Luganville, 15°35'S, 167°00'E, alt. 15 m, small *Swietenia* (mahogany) plantation in grazed paddocks on flats, on semi-shaded mahogany buttresses, *H. Streimann & P. Ala 62166*, 17.x.1998 (B 60 0191194); ● Forestry Demonstration Area, Butmas, 25 km NW of Luganville, 15°22'S, 167°00'E, alt. 620 m, tropical forest on moderate slope dominated by *Myristica fatua* with dense ground cover of ferns and herbaceous Urticaceae, on branches of medium-sized spreading *Hibiscus tiliaceus*, *H. Streimann & P. Ala 62351*, 19.x.1998 (B 60 0191195); ● Luganville-Hog Harbour road (over river) past Matevala Plantation, 16 km N of Luganville, 15°22'S, 167°11'E, alt. 0 m, strand/mangrove vegetation dominated by *Calophyllum inophyllum* and *Barringtonia asiatica*, on shaded large tree trunk (*Calophyllum*) leaning over the bay, *H. Streimann & P. Ala 62921*, 24.x.1998 (B 60 0191200). *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 300 m, lowland rainforest on broad undulating ridge, on partly shaded vine, *H. Streimann & P. Ala 63027*, 25.x.1998 (B 60 0191204); • *loc. id.*, *H. Streimann & P. Ala 63030* (B 60 0191205); ● Track to Mt McDonald, 14 km N of Port Vila, 17°36'S, 168°19'E, alt. 500 m, lowland tropical forest on narrow limestone ridge, on partly shaded tree trunk, *H. Streimann & P. Ala 63191*, 28.x.1998 (B 60 0191207).

26. Leptogium javanicum (Mont. & Bosch) Mont., *Gatlung Asterina*, 379 (1856)
This foliose species has thin, blue-grey, smooth, non-hairy lobes lacking propagules, but the lobes are smaller than in *L. azureum* and form tall, columnar bubbles on top of which the apothecia are immersed. The apothecia lack a paraplectenchymatous layer below the hypothecium (the subhypothecium is euthyplectenchymatous), whereas the excipulum cortical layer below the apothecium (not lateral on the apothecium margin) is several locules thick and paraplectenchymatous (Swinscow & Krog 1988).

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 300 m, lowland rainforest on broad undulating ridge, on large branch fallen from tree crown, *H. Streimann & P. Ala 63006*, 25.x.1998 (B 60 0191203).

27. Leptogium propaguliferum Vain., *Ann. Acad. Sci. Fenn.*, Ser. A **15**(6), 40 (1920)
This species has thin, blue-grey, non-hairy lobes, but the lobes are smaller than in *L. azureum*, thicker, and when dry finely and densely wrinkled. Propagules are present, in the form of phyllidia, on the wrinkles or the thallus margin. Apothecia not seen. The name is rarely used, but treated in the *Flora of Australia* (Verdon 1992), and the specimens fit the original description of the species, based on material from the Philippines (Vainio 1920).

SPECIMENS EXAMINED
Vanuatu. *Espíritu Santo*: ● Belenu (Beleruxe), 9 km NW of Luganville, 15°30'S, 167°05'E, alt. 160 m, severely disturbed forest, on flats with regrowth and gardens, on partly shaded tree base (*Dracontomelon fijense*), *H. Streimann & P. Ala 62039*, 17.x.1998 (B 60 0191192); ● Luganville-Hog Harbour road (over river) past Matevala Plantation, 16 km N of Luganville, 15°22'S, 167°11'E, alt. 0 m, strand/mangrove vegetation dominated by *Calophyllum inophyllum* and *Barringtonia asiatica*, on shaded *Barringtonia* roots, *H. Streimann & P. Ala 62948a*, 24.x.1998 (B 60 0201094).

28. Leptogium vesiculosum (Sw.) Malme, *Ark. Bot.* **19**(8), 14 (1924)
This species resembles *L. javanicum* in having a foliose thallus with thin, blue-grey, smooth, non-hairy lobes lacking propagules, with smaller lobes forming tall, columnar, often plicate bubbles on top of which the apothecia are immersed. The apothecia differ by having a paraplectenchymatous layer below the hypothecium (subhypothecium is euthyplectenchymatous),

whereas the excipulum cortical layer is only one locule thick, like the thalline cortical layer (Swinscow & Krog 1988).

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Forestry Demonstration Area, Butmas, 25 km NW of Luganville, 15°22'S, 167°00'E, alt. 620 m, tropical forest on moderate slope, dominated by *Myristica fatua* with dense ground cover of ferns and herbaceous Urticaceae, on branches of medium-sized spreading *Hibiscus tiliaceus*, *H. Streimann & P. Ala 62355*, 19.x.1998 (B 60 0191196).

29. Leucodecton occultum (Eschw.) Frisch, *Biblioth. Lichenol.* **92**, 157 (2006)
This pantropical crustose lichen has minute, immersed apothecia that open through a *c.* 0.1 mm wide pore, which shows the excipulum as a white ring surrounding the hymenium, and separated from the thalline margin by a fissure. The ascospores are up to 8 per ascus, grey when fully ripe, muriform, *c.* 25 × 14 µm, with 8 × 1–3 locules and a thick outer wall. For a key, see Rivas Plata *et al.* (2010). TLC: norstictic acid.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Iririki Island (Port Vila Harbour), 17°45'S, 168°18'E, alt. 10 m, very disturbed monsoon forest with exotics dominated by *Gyrocarpus americanus*, *Pterocarpus indicus*, *Leucaena glauca*, *Acacia* and *Cocos* on a gentle slope, on partly shaded *Gyrocarpus* trunk, *H. Streimann & P. Ala 61981*, 15.x.1998 (B 60 0191219).

30. Lobaria discolor (Bory) Hue, *Nouv. Arch. Mus. Hist. Nat.*, sér. 4 **3**, 23 (1901)
For a key see Yoshimura (1971). This is a greenish grey *Lobaria* with an undulating, not ridged, sinuose thallus, lacking propagules, with green algae as the photobiont, the lower side glabrous or short-tomentose in the centre. The two available specimens differ considerably. One has a white, glabrous lower side, whereas the other has a pale brown, centrally tomentose lower side that turns black in older thallus parts. The first fits the typical variety of the species, whereas the second fits var. *subsinuosa* (Vain.) Yoshimura.

SPECIMENS EXAMINED
Vanuatu. *Éfaté*: ● Ridge below Mt McDonald, 15 km NNE of Port Vila, 17°35'S, 168°21'E, alt. 600 m, lowland tropical forest on narrow limestone ridge, on shaded tree roots, *H. Streimann & P. Ala 63385*, 28.x.1998 (B 60 0191138); ● *loc. id.*, on shaded tree trunk, *H. Streimann & P. Ala 63331*, 28.x.1998 (B 60 0191135).

31. Megalospora atrorubricans (Nyl.) Zahlbr., *Cat. Lich. Univ.* **4**, 86 ('1926') [1927] subsp. **atrorubicans**
A distinctive species with a yellowish thallus and rather large, brown apothecia with single, bicellular ascospores *c.* 85 × 25 µm and an orange-brown epithecium. This lichen is widespread in the Palaeotropics (Sipman 1983).

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 340 m, lowland rainforest on broad undulating ridge, on upper branches in crown of large tree, *H. Streimann & P. Ala 63105*, 25.x.1998 (B 60 0191212).

32. Megalospora sulphurata Meyen, in Meyen & Flotow, *Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur.*, Suppl. 1, **19**, 228 (1843)
This species differs from the foregoing by its ascopores, which number 3–6 per ascus, and are bilocular, curved and reniform, 60–70 × 25–35 µm. The apothecia are slightly larger with thicker margins. Currently, the subdivision of the species by Untari (2006) has no consequences for Vanuatu in that all specimens examined are referable to *M. sulphurata s. str.*

SPECIMENS EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 340 m, lowland rainforest on broad undulating ridge, on upper branches in crown of large tree, *H. Streimann & P. Ala 63096*, 25.x.1998 (B 60 0191211); ● Track to Mt McDonald, 14 km N of Port Vila, 17°36'S, 168°19'E, alt. 500 m, lowland tropical forest on narrow limestone ridge, on partly shaded tree trunk, *H. Streimann & P. Ala 63196*, 28.x.1998 (B 60 0191213); ● *loc. id.*, on partly shaded treelet stem, *H. Streimann & P. Ala 63232*, 28.x.1998 (B 60 0191214).

33. Nitidochapsa leprieurii (Mont.) Parnmen, Lücking & Lumbsch, *Bryologist* **116**, 131 (2013)
A conspicuous crustose forest lichen with a cartilaginous, greenish brown thallus and contrasting, white, stellate ascocarps. The ascospores are grey, 8 per ascus, *c.* 15 × 6 µm and 4-loculate. For a key, see Rivas Plata *et al.* (2010, as *Chapsa leprieurii*). TLC: no substances detected.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Ridge below Mt McDonald, 15 km NNE of Port Vila, 17°35'S, 168°21'E, alt. 600 m, lowland tropical forest on narrow limestone ridge, on shaded tree trunk, *H. Streimann & P. Ala 63273*, 28.x.1998 (B 60 0191162).

34. Pallidogramme chrysenteron (Mont.) Staiger, Kalb & Lücking, in Lücking, Chaves, Sipman, Umaña & Aptroot, *Fieldiana, Bot.* **46**, 9 (2008)
A characteristic script lichen with a brownish, cartilaginous thallus and whitish, striate lirellae. The ascospores are grey and muriform, but usually absent. For a key, see Staiger (2002, as *Hemithecium*).

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Logging area near Lavatmas (N of Sara), 48 km NNW of Luganville, 15°07'S, 167°01'E, alt. 300 m, poor lowland forest on flats dominated by *Endospermum medullosum*, *Antiaris toxicarya* and *Pometia pinnata*, in upper branches of large felled tree (*Endospermum medullosum*), *H. Streimann & P. Ala 62773a*, 22.x.1998 (B 60 0191120).

35. Pannaria elatior Stirt., in Bailey, *Queensland Agric. J.* **5**, 486 (1899)
This species is the isidiate member of the *Pannaria* group in which the algal layer becomes gelatinous in the central parts of the thallus, which also turns brownish. For a key and description, see Jørgensen & Galloway (1992). TLC: pannarin.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Track to Mt McDonald, 14 km N of Port Vila, 17°36'S, 168°19'E, alt. 500 m, lowland tropical forest on narrow limestone ridge, on partly shaded tree trunk, *H. Streimann & P. Ala 63195*, 28.x.1998 (B 60 0191222).

36. Pannaria fulvescens (Mont.) Nyl., *Mém. Soc. Imp. Sci. Nat. Cherbourg* **5**, 109 (1857)
This is the sorediate relative in the same group of *Pannaria*, with conspicuous sinuous, marginal soralia. For a key and description, see Jørgensen & Galloway (1992).

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 340 m, lowland rainforest on broad undulating ridge, on upper branches in crown of large tree, *H. Streimann & P. Ala 63097*, 25.x.199 (B 60 0191221).

37. Parmotrema reticulatum (Taylor) M. Choisy, *Bull. Mens. Soc. Linn. Soc. Bot. Lyon* **21**, 148 (1952)
Syn.: *Rimelia reticulata* (Taylor) Hale & A.Fletcher
This widespread species was identified by J.A. Elix in 1999, according to an annotation label on the specimen.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Ridge below Mt McDonald, 15 km NNE of Port Vila, 17°36'S, 168°21'E, alt. 400 m, advanced regrowth on ridge, on partly exposed treelet stem, *H. Streimann & P. Ala 63432*, 28.x.1998 (B 60 0145943).

38. Pertusaria ceylonica Müll.Arg., *Flora* **67**, 351 (1884)
The verruciform ascocarps are often confluent in raised, poorly delimited groups of a dozen or so, and the ascospores are smooth-walled, 2–3 per ascus, 110–160 × 30–36 µm. TLC: weak xanthone spot, perhaps 2,4,5–trichlorolichexanthone, with stictic acid and traces of cryptostictic, menegazziaic and constictic acids.

SPECIMENS EXAMINED
Vanuatu. *Espíritu Santo*: ● Luganville-Hog Harbour road (over river) past Matevala Plantation, 16 km N of Luganville, 15°22'S, 167°11'E, alt. 0 m, strand/mangrove vegetation dominated by *Calophyllum inophyllum* and *Barringtonia asiatica*, on shaded *Barringtonia* roots, *H. Streimann & P. Ala 62949*, 24.x.1998 (B 60 0191220); ● *loc. id.*, on partly shaded *Barringtonia* trunk, *H. Streimann & P. Ala 62951*, 24.x.1998 (B 60 0191125).

39. Polymeridium siamense (Vain.) Aptroot, *Nova Hedwigia* **98**, 24 (2014)
This species was identified using Aptroot & Lücking (2016). It is distinguished by its 4-locular ascospores measuring *c.* 21 × 7 µm, an inspersed hymenium and the absence of lichexanthone.

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Logging area near Lavatmas (N of Sara), 48 km NNW of Luganville, 15°07'S, 167°01'E, alt. 300 m, poor lowland forest on flats dominated by *Endospermum medullosum*, *Antiaris toxicarya* and *Pometia pinnata*, in upper branches of large felled tree (*Antiaris toxicarya*), *H. Streimann & P. Ala 62806*, 22.x.1998 (B 60 0191126).

40. Pseudocyphellaria intricata (Delise) Vain., *Hedwigia* **37** (Beibl.), 35 (1898)
For a key and description, see Galloway (1994). The scrappy specimen of this very widespread species has white pseudocyphellae on its upper side that produce blue-grey granular propagules.

SPECIMEN EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 340 m, lowland rainforest on broad undulating ridge, on upper branches in crown of large tree (*Syzygium*), *H. Streimann & P. Ala 63112*, 25.x.1998 (B 60 0191129).

41. Pseudocyphellaria semilanata (Müll.Arg.) D.J.Galloway, *Lichenologist* **17**, 306 (1985)
This eastern Palaeotropical species has a greenish to brownish thallus with sinuous lobes, a white medulla, and white pseudocyphellae on both surfaces; the photobiont is *Nostoc* in glomerules. Apothecia are common but propagules are absent. For a key and description see Galloway (1994).

SPECIMENS EXAMINED
Vanuatu. *Éfaté*: ● Forari Logging Area, 17 km ENE of Port Vila, 17°38'S, 168°27'E, alt. 340 m, lowland rainforest on broad undulating ridge, on upper branches in crown of large tree, *H. Streimann & P. Ala 63101*, 25.x.1998 (B 60 0191128); ● *loc. id.,* on shaded upper tree trunk, *H. Streimann & P. Ala 63120*, 25.x.1998 (B 60 0191130).

42. Pyxine copelandii Vain., *Philipp. J. Sci.*, C, Bot. **8**(2), 110 (1913)
This sorediate *Pyxine* has a cortex with atranorin but not lichexanthone, a white medulla, no patchy pruina, and the same terpenoids as *P. philippina* Vain. TLC: atranorin, norstictic acid, same array of terpenoids as *Streimann 62938* (*see* below). For details, see Mongkolsuk *et al.* (2012).

SPECIMENS EXAMINED
Vanuatu. *Espíritu Santo*: ● Piria, 7.5 km ENE of Luganville, 15°30'S, 167°14'E, alt. 0 m, mangroves dominated by *Rhizophora* and *Avicennia*, on semi-shaded *Rhizophora* prop root, *H. Streimann & P. Ala 62756*, 21.x.1998 (B 60 0191139); • Hasevaia (near mouth of Adsone River), 23 km NNW of Luganville, 15°35'S, 166°58'E, alt. 3 m, disturbed strand vegetation and old coconut plantation, on stem of large semi-shaded palm (*Carpoxylon*), *H. Streimann & P. Ala 62837*, 23.x.1998 (B 60 0191140).

43. Pyxine farinosa Kashiw., *Bull. Natl Sci. Mus.*, Tokyo, B, **3**, 67 (1977)
This species has an eastern Palaeotropical distribution, and it differs from *P. copelandii* in having strongly raised, capitate soralia, an absence of norstictic acid, and an orange-pigmented medulla. TLC: atranorin, terpenoids (array different from that of *P. copelandii*). For details, see Mongkolsuk *et al.* (2012).

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Luganville-Hog Harbour road (over river) past Matevala Plantation, 16 km N of Luganville, 15°22'S, 167°11'E, alt. 0 m, strand/mangrove vegetation dominated by *Calophyllum inophyllum* and *Barringtonia asiatica*, on semi-shaded tree trunk (*Barringtonia*), *H. Streimann & P. Ala 62964*, 24.x.1998 (B 60 0191142).

44. Pyxine philippina Vain., *Philipp. J. Sci.*, C, Bot., **8**(2), 110 (1913)
This is the primary counterpart of *P. copelandii*, and differs only in the absence of soralia. Its distribution is reported as pantropical. TLC: atranorin, norstictic acid, same array of terpenoids as that of *P. copelandii*. For details, see Mongkolsuk *et al.* (2012).

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Luganville-Hog Harbour road (over river) past Matevala Plantation, 16 km N of Luganville, 15°22'S, 167°11'E, alt. 0 m, strand/mangrove vegetation dominated by *Calophyllum inophyllum* and *Barringtonia asiatica*, on semi-shaded tree trunk (*Barringtonia*), 24.x.1998, *H. Streimann & P. Ala 62938* (B 60 0191141).

45. Relicina samoensis (Zahlbr.) Hale, *Phytologia* **28**, 485 (1974)
The specimens have an annotation indicating that they were identified by J.A. Elix in 2000. The distribution of the species is eastern Palaeotropical. For a description and key see Elix (1996). The difference with *R. terricrocodila* Elix & J.Johnst. is unclear to me. TLC: usnic, echinocarpic acids.

SPECIMENS EXAMINED
Vanuatu. *Espíritu Santo*: ● Navota-Luganville road, 16 km SE of Luganville, 15°35'S, 167°02'E, alt. 10 m, exposed roadside in coconut plantation, on exposed coconut trunk, *H. Streimann & P. Ala 62907*, 23.x.1998 (B 60 0131606); ● Luganville-Piria road, 6 km NE of Luganville, 15°29'S, 167°13'E, alt. 4 m, remnant coconut plantation left as median strip in divided road, on exposed coconut trunks, *H. Streimann & P. Ala 62748*, 21.x.1998 (B 60 0131607).

46. Sarcographa heteroclita (Mont.) Zahlbr., in Rechinger, *Denkschr. Kaiserl. Akad. Wiss. Wien*, Math.-*Naturwiss. Kl.* **88**, 19 (1911)
A polymorphic species of the *Phaeographis* aggregate with inspersed hymenium and bacillar, 6–8-locular ascospores measuring 24–33 × 10 µm. The ascocarps are notoriously variable, reflecting a development stage or regeneration after damage. Thus they range from narrow and branched with sharp ends, often very elongate, to broad with rounded ends, often short. In wider lirellae, the hymenium is divided by dense transverse and longitudinal fissures, and along the fissures marginal tissue can regenerate. Consequently, it can be assumed that the specimens listed below are conspecific with *S. macrohydrina* M.Nakan., Kashiw. & K.H.Moon, which represents a morph with broad, full-grown ascocarps.

SPECIMENS EXAMINED
Vanuatu. *Espíritu Santo*: ● Logging area near Lavatmas (N of Sara), 48 km NNW of Luganville, 15°07'S, 167°01'E, alt. 300 m, poor lowland forest on flats dominated by *Endospermum medullosum*, *Antiaris toxicarya* and *Pometia pinnata*, in upper branches of large felled tree (*Endospermum medullosum*), *H. Streimann & P. Ala 62775* (B 60 0191148), *62266*, 22.x.1998 (B 60 0191146).

47. Thelotrema porinoides Mont. & Bosch, in Miquel, *Pl. Jungh.* **4**, 484 (1855)
Our specimen of this pantropical species has bacillar, hyaline ascospores, *c.* 80 × 10 µm, 24-locular, with a thickened outer wall. They remain hyaline, and stain blue in iodine solution. The ascocarps are small and remain immersed in the thallus. TLC: stictic and constictic acids. For a key, see Rivas Plata (2010).

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Big Bay-Luganville road, 26 km NW of Luganville, 15°19'S, 167°01'E, alt. 380 m, regrowth on limestone dominated by *Alphitonia* and *Macaranga*, on semi-exposed *Macaranga* stem, *H. Streimann & P. Ala 62270*, 18.x.1998 (B 60 0191161).

48. Traponora cf. **globosa** Aptroot, *Biblioth. Lichenol.* **100**, 24 (2009)
Species of the genus *Traponora* are among the smallest tropical corticolous lichens, and are easily overlooked. The specimen cited below shows just such minute apothecia with simple ascospores. It has a granular thallus more than 5 cm wide; the apothecia are up to 0.3 mm wide, pale brown (black when older), with a persistent but not raised margin and slightly convex disc; the hymenium is 60 µm tall, the epithecium yellowish and the hypothecium colourless; the asci are of the *Lecidella*-type, the ascospores simple, thick-walled and short, *c.* 10 × 6 µm. These characters fit *T. globosa* but not convincingly, and the identification is provisional. See Aptroot (2009, 2010), who provided a key and descriptions for several species.

SPECIMEN EXAMINED
Vanuatu. *Espíritu Santo*: ● Logging area near Lavatmas (N of Sara), 48 km NNW of Luganville, 15°07'S, 167°01'E, alt. 300 m, poor lowland forest on flats dominated by *Endospermum medullosum*, *Antiaris toxicarya* and *Pometia pinnata*, in upper branches of large felled tree (*Endospermum medullosum*), *H. Streimann & P. Ala 62802*, 22.x.1998 (B 60 0191173).

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Figure 1a. *Crocynia didymica*, type specimen. Aggregated granules forming isidioid structures.

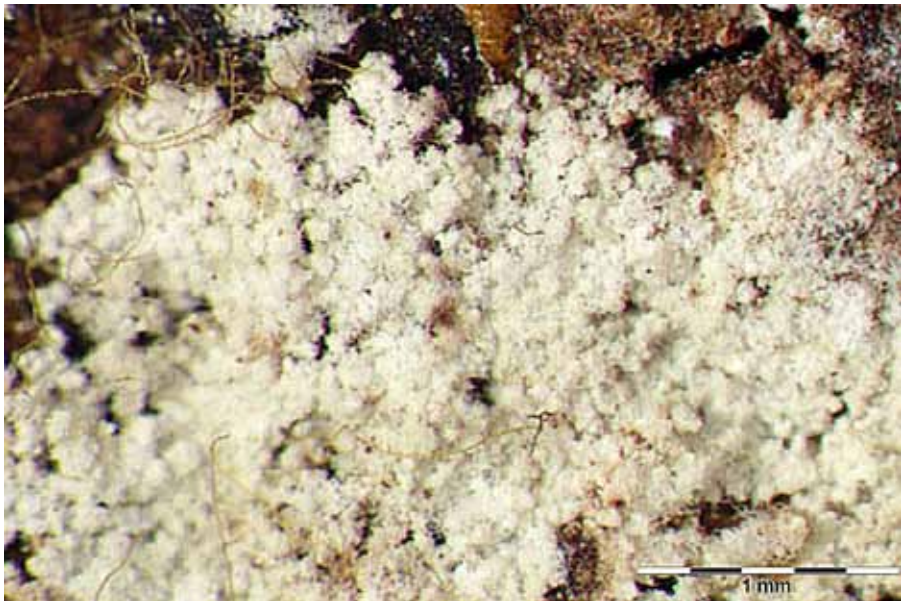

Figure 1b. *Crocynia didymica*, type specimen. Granular soredia and microlobulate thallus margin at a higher magnification.

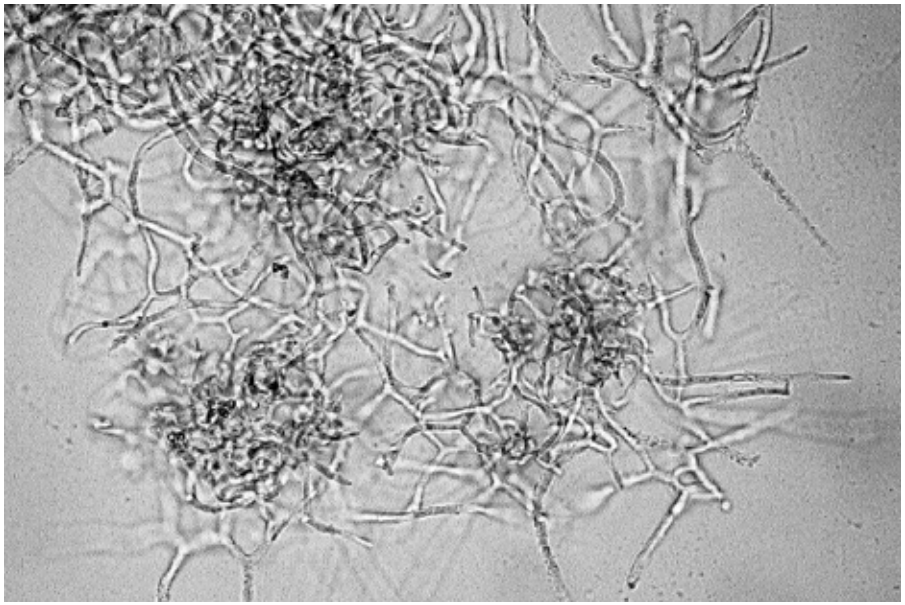

Figure 2. *Crocynia didymica*, type specimen. Net-forming thallus hyphae and clustered photobiont cells; tapering hyphae are present in the lower and right side. Scale: lower left algae cluster = 25 µm in diam.

Figure 3a. *Crypthonia streimannii*, type specimen. Ascomata.

Figure 3b. *Crypthonia streimannii*, type specimen. Pseudoisidia.

Figure 4a. *Crypthonia streimannii*, type specimen. Black hypothallus.

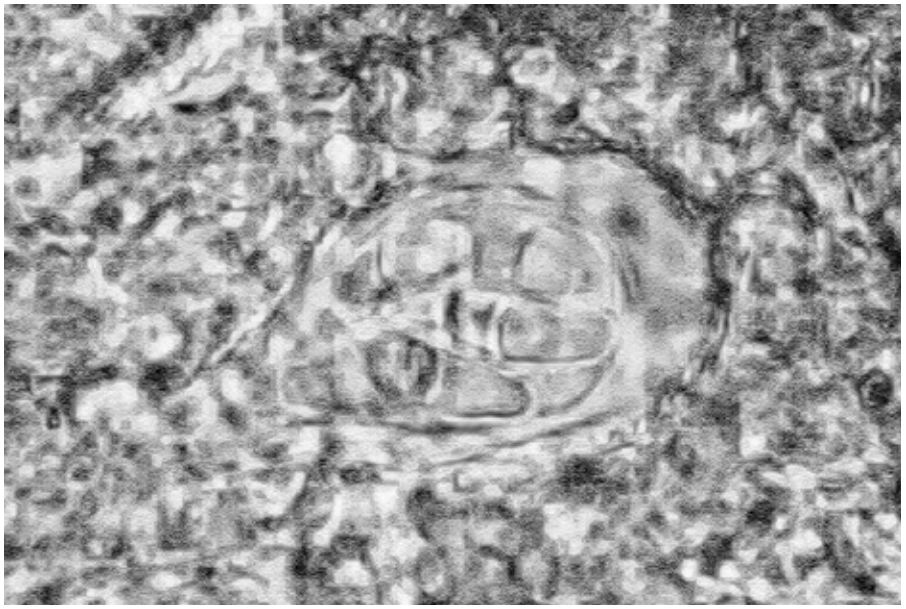

Figure 4b. *Crypthonia streimannii*, Asci with spores (*Groenhart 7275*).

Figure 5a. *Herpothallon alae*, type specimen. Coralloid pseudoisidia.

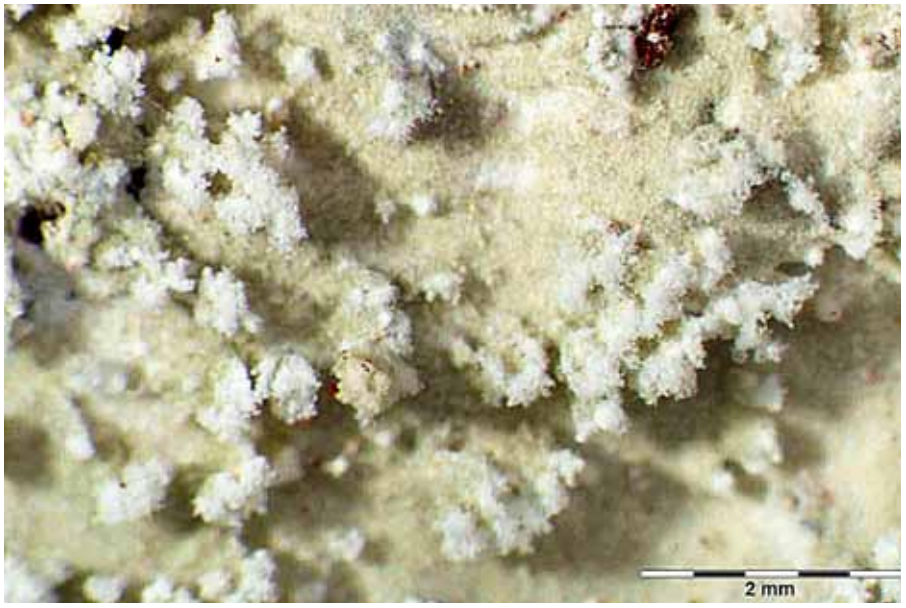

Figure 5b. *Herpothallon alae*, *Streimann & Ala 63199*. Coralloid pseudoisidia.

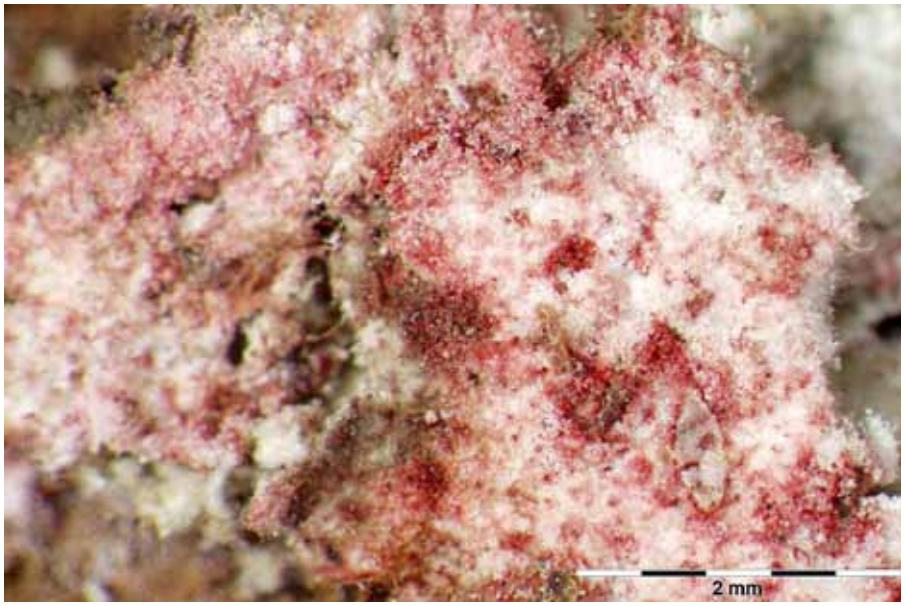

Figure 6a. *Herpothallon alae*, type specimen, underside. White medulla with spotted red pigment; right: dark greenish hypothallus (with red pigment and substratum fragments).

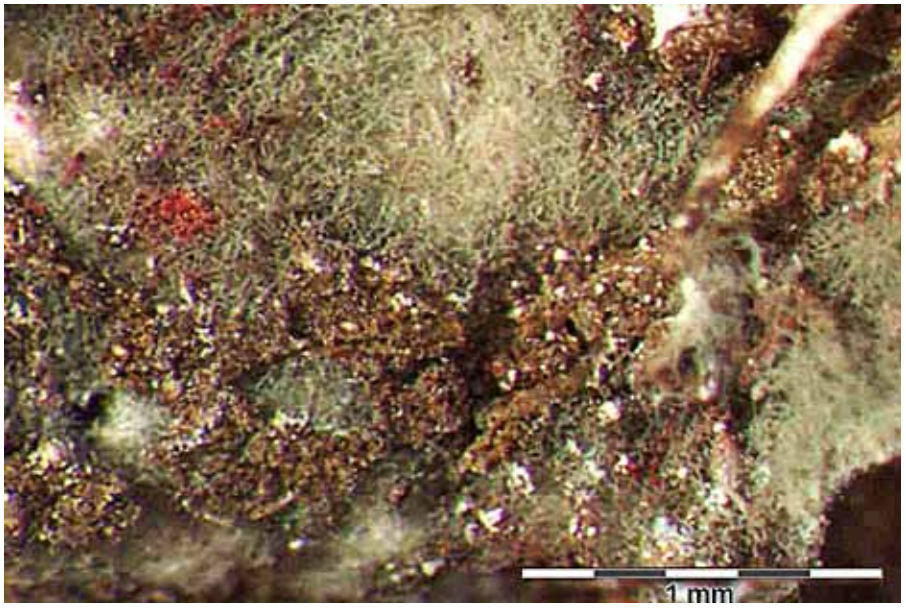

Figure 6b. *Herpothallon alae*, type specimen, underside. Dark greenish hypothallus (with red pigment and substratum fragments).

New combinations of Australian species in the genus *Lepra* Scop.

Alan W. Archer
National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust,
Mrs Macquaries Road, Sydney, N.S.W. 2000, Australia
e-mail: alanw.archer@bigpond.com

John A. Elix
Research School of Chemistry, Building 137
Australian National University, Canberra, A.C.T. 2601, Australia
e-mail: John.Elix@anu.edu.au

Abstract

Twenty-two species of the lichen genus *Pertusaria sens. lat*. formerly included in *Pertusaria* subg. *Monomurata* A.W.Archer are transferred to the recently resurrected genus *Lepra* Scop. A key to the species present in Australia is provided.

Introduction

Pertusaria DC. subg. *Monomurata* A.W.Archer was originally proposed to distinguish species with disciform apothecia from those of *Pertusaria* subg. *Pertusaria* with verruciform apothecia (Archer 1993). The species present in subg. *Monomurata* can be corticolous or saxicolous, fertile with disciform apothecia, or sterile with isidia or soredia. The ascospores when present can be large and 1 (or rarely 2) per ascus or small and 8 per ascus. Taxa in subg. *Monomurata* exhibit a diverse secondary chemistry, and can contain the depsone picrolichenic acid and its homologues, depsidones related to fumarprotocetraric acid, norstictic acid, stictic acid and neotricone, β-orcinol *m*-depsides such as thamnolic and hypothamnolic acids, β-orcinol *p*-depsides such as barbatic and squamatic acids, fatty acids and lichexanthone. Chlorinated xanthones and orcinol *p*-depsides such as perlatolic acid and its derivatives are absent. Those latter compounds are characteristic lichen compounds present in *Pertusaria sens. str*. (Schmitt & Lumbsch 2004). Similar taxa with lecanoric acid belong to the genus *Varicellaria* Nyl. (Schmitt *et al.* 2012).

In 2015, Kondratyuk *et al.* proposed the new genus *Marfloraea* S.Y.Kondr., L.Lökös & J.-S. Hur for some species previously included in subg. *Monomurata* on the basis of phylogenetic analyses (Kondratyuk *et al.* 2015), and transferred the Australian species *Pertusaria erythrella* Müll.Arg., *P. excludens* Nyl., *P. scaberula* A.W.Archer and *P. subventosa* Malme to that new genus. We do not accept the genus *Marfloraea*.

In the course of preparing a revised checklist of the lichenised fungi of Austria, Hafellner & Türk (2016) discovered that the earlier generic name *Lepra* Scop. (Scopoli 1777) already existed for the species of *Pertusaria* outside the *Pertusaria sens. str.* group, and listed subg. *Monomurata* as a synonym of *Lepra*. Among the new combinations were a further two species present in Australia, namely *Lepra dactylina* (Ach.) Hafellner and *L. excludens* (Nyl.) Hafellner.

More recently, Lendemer & Harris (2017) transferred a number of North American species of *Pertusaria* to *Lepra*, including *P. commutata* Müll.Arg. and *P. subdactylina* Nyl., both present in Australia. Additional species present in Thailand (Buaruang *et al*. 2017), were also transferred to *Lepra*, including *Pertusaria patellifera* A.W.Archer and *P. subventosa* Malme, both of which occur in Australia. Further species were transferred to *Lepra* by Wei *et al*. (Wei *et al.* 2017) including *Pertusaria variabilis* Elix & A.W.Archer (Elix *et al.* 2008). However, we do not accept that last transfer, because *P. variabilis* contains the methyl ester of the orcinol *p*-depside 2'-*O*-methylmicrophyllinic acid (as a major compound), which is a member of a class of compounds excluded from *Lepra* (*vide supra*).

This paper makes further combinations in *Lepra*, and provides a key to the species of the genus in Australia. In addition to the Australian species that have already been transferred to *Lepra* (*vide supra*), 22 further combinations are proposed below.

Lepra albopunctata (A.W.Archer & Elix) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822545
Basionym: *Pertusaria albopunctata* A.W.Archer & Elix, *Australas. Lichenol.* **65**, 30 (2009)

Lepra amnicola (Elix & A.W.Archer) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**, 7/14
Mycobank no: 820750
Basionym: *Pertusaria amnicola* Elix & A.W.Archer, *Mycotaxon* **64**, 18 (1997)

Lepra asiana (Vain.) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822546
Basionym: *Pertusaria asiana* Vain., *Ann. Bot. Soc. Zool.-Bot. Fenn. "Vanamo"* I, **3**, 44 (1921)

Lepra barbatica (A.W.Archer & Elix) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**, 7/14
Mycobank no: 820752
Basionym: *Pertusaria barbatica* A.W.Archer & Elix*, Biblioth. Lichenol.* **69**, 178 (1997)

Lepra clarkeana (A.W.Archer) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**, 7/14
Mycobank no: 820754
Basionym: *Pertusaria clarkeana* A.W.Archer*, Mycotaxon* **53**, 280 (1995)

Lepra commutata (Müll.Arg.) Lendemer & R.C.Harris, *Bryologist* **120**, 187 (2017)
Mycobank no: 821147
Basionym: *Pertusaria commutata* Müll.Arg, *Flora* **67**, 269 (1884)

Lepra dactylina (Ach.) Hafellner, *Stapfia* **104**, 171 (2016)
Mycobank no: 818752
Basionym: *Pertusaria dactylina* (Ach.) Nyl., *Acta Soc. Sci. Fenn.* **7**, 447 (1863)
Ochrolechia dactylina (Ach.) S.Y.Kondr., L.Lökös & J.-S.Hur, *Studia Bot. Hung*. **46**, 106

Lepra dactylinella (Kantvilas & Elix) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822547
Basionym: *Pertusaria dactylinella* Kantvilas & Elix, *Sauteria* **15**, 250 (2008)

Lepra erubescens (Hook.f. & Taylor) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822568
Basionym: *Urceolaria erubescens* Hook.f. & Taylor, *London Journal of Botany* **3**, 640 (1844)
Pertusaria erubescens (Hook.f. & Taylor) Nyl., *Mem. Soc. Nat. Cherbourg* **5**, 117 (1858)

Lepra erythella (Müll.Arg.) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**, 8/14
Mycobank no: 820756
Basionym: *Pertusaria erythrella* Müll.Arg., *Bull. Herb. Boissier* **1**, 41 (1893)
Marfloraea erythrella (Müll.Arg.) S.Y.Kondr., L.Lökös & J.-S.Hur, *Studia Bot. Hung*. **46**, 105 (2015)

Lepra excludens (Nyl.) Hafellner, *Stapfia* **104**, 171 (2016)
Mycobank no: 818753
Basionym: *Pertusaria excludens* Nyl., *Flora* **68**, 296 (1885)
Marfloraea excludens (Nyl.) S.Y.Kondr., L.Lökös & J.-S.Hur, *Studia Bot. Hung*. **46**, 105 (2015)

Lepra gymnospora (Kantvilas) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**, 8/14
Mycobank no: 820759
Basionym*: Pertusaria gymnospora* Kantvilas, *Lichenologist* **22**, 292 (1990)

Lepra lacerans (Müll.Arg.) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**(7), 8/14
Mycobank no: 820760
Basionym: *Pertusaria lacerans* Müll.Arg., *Flora* **67**, 270 (1884)

Lepra lacericans (A.W.Archer) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822548
Basionym: *Pertusaria lacericans* A.W.Archer, *Mycotaxon* **41**, 230 (1991)

Lepra leucosorodes (Nyl.) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**(7), 8/14
Mycobank no: 820762
Basionym: *Pertusaria leucosorodes* Nyl., *Acta Soc. Sci. Fenn.* **26**(10), 16 (1900)

Lepra miniatescens (A.W.Archer & Elix) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822549
Basionym: *Pertusaria miniatescens* A.W.Archer & Elix, *Telopea* **6**, 20 (1994)

Lepra miscella (A.W.Archer) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**(7), 8/14
Mycobank no: 820764
Basionym: *Pertusaria miscella* A.W.Archer *Mycotaxon* **41**, 232 (1991)

Lepra muricata (J.C.David) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822550
Basionym: *Pertusaria muricata* J.C.David, *Biblioth. Lichenol.* **57**, 102 (1995)

Lepra neotriconica (Elix & A.W.Archer) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822551
Basionym: *Pertusaria neotriconica* Elix & A.W.Archer*, Australas. Lichenol.* **60**, 22 (2007)

Lepra nerrigensis (A.W.Archer & Elix) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**(7), 9/14
Mycobank no: 820766
Basionym: *Pertusaria nerrigensis* A.W.Archer & Elix*, Biblioth. Lichenol.* **69**, 195 (1997)

Lepra novaezelandiae (Szatala) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**(7), 9/14
Mycobank no: 820767
Basionym: *Pertusaria novaezelandiae* Szatala*, Borbásia* **1**, 60 (1939)

Lepra oahuensis (H.Magn,) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822552
Basionym: *Pertusaria oahuensis* H.Magn., *Ark. Bot.* **31A**(6), 57 (1944)

Lepra parathalassica (Kantvilas & Elix) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822553
Basionym: *Pertusaria parathalassica* Kantvilas & Elix*, Sauteria* **15**, 258 (2008)

Lepra patellifera (A.W.Archer) Schmitt & Lumbsch, *MycoKeys* **23**, 82 (2017)
Mycobank no: 820272
Basionym: *Pertusaria patellifera* A.W.Archer, *Mycotaxon* **41**, 237 (1991)

Lepra pseudodactylina (A.W.Archer) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822554
Basionym: *Pertusaria pseudodactylina* A.W.Archer, *Mycotaxon* **41**, 238 (1991)

Lepra psoromica (A.W.Archer & Elix) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822555
Basionym: *Pertusaria psoromica* A.W.Archer & Elix, *Mycotaxon* **50**, 206 (1994)

Lepra roseola (A.W.Archer & Elix) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822556
Basionym: *Pertusaria* A.W.Archer & Elix, *Telopea* **12**, 269 (2008)

Lepra scaberula (A.W.Archer) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**(7), 9/14
Mycobank no: 820772
Basionym: *Pertusaria scaberula* A.W.Archer *Mycotaxon* **41**, 240 (1991)
Marfloraea scaberula (A.W.Archer) S.Y.Kondr., L.Lökös & J.-S.Hur, *Studia Bot. Hung*. **46**, 106 (2015)

Lepra sordida (A.W.Archer) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822557
Basionym: *Pertusaria sordida* A.W.Archer*, Mycotaxon* **41**, 241 (1991)

Lepra subdactylina (Nyl.) Lendemer & R.C.Harris, *Bryologist* **120**, 188 (2017).
Mycobank no: 821152
Basionym*: Pertusaria subdactylina* Nyl., *Flora* **68**, 603 (1885)

Lepra sublacerans (A.W.Archer) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822558
Basionym*: Pertusaria sublacerans* A.W.Archer*, Mycotaxon* **41**, 242 (1991)

Lepra subventosa* var**. ***subventosa (Malme) Schmitt & Lumbsch, *MycoKeys* **23**, 82 (2017)
Mycobank no: 820274
Basionym: *Pertusaria subventosa* Malme, *Ark. Bot.* **28A**, 7 (1936)
Marfloraea subventosa (Malme) S.Y.Kondr., L.Lökös & J.-S.Hur, *Studia Bot. Hung*. **46**, 106 (2015)

Lepra subventosa* var**. ***deficiens (A.W.Archer & Elix) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822559
Basionym: *Pertusaria subventosa* var. *deficiens* A.W.Archer & Elix, *Mycotaxon* **49**, 146 (1993)

***Lepra subventosa* var**. ***hypothamnolica* (**A.W.Archer & Elix) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822560
Basionym: *Pertusaria subventosa* var. *hypothamnolica* A.W.Archer & Elix, *Mycotaxon* **49**, 147 (1993)

Lepra thamnolica (A.W.Archer) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822561
Basionym: *Pertusaria thamnolica* A.W.Archer*, Mycotaxon* **44**, 16 (1992)

Lepra trichosa (Elix & A.W.Archer) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822562
Basionym: *Pertusaria trichosa* Elix & A.W.Archer*, Australas. Lichenol* **67**, 15 (2010)

Lepra tropica (Vaino) Lendemer & R.C.Harris, *Bryologist* **120**, 189 (2017)
Mycobank no: 821156
Basionym: *Pertusaria tropica* Vain.*, Catal. Welw. Afr. Pl.* **2**, 404 (1901)

Lepra truncata (Kremp.) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822563
Basionym: *Pertusaria truncata* Kremp.*, Verhandl. Zool.-Bot. Ges. Wien* **26**, 452 (1876)

Lepra umbricola (A.W.Archer & Elix) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822564
Basionym: *Pertusaria umbricola* A.W.Archer & Elix*, Biblioth. Lichenol.* **69**, 158 (1997)

Lepra verdonii (A.W.Archer) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**(7), 10/14
Mycobank no: 820784
Basionym: *Pertusaria verdonii* A.W.Archer*, Proc. Linn. Soc. New South Wales* **113**, 68 (1992)

Lepra wallamanensis (Elix & A.W.Archer) A.W.Archer & Elix, *comb. nov.*
Mycobank no: 822565
Basionym: *Pertusaria walllamanensis* Elix & A.W.Archer*, Hedwigia* **88**, 5 (2009)

Lepra wirthii **(**Elix & A.W.Archer) I.Schmidt, Hodkinson & Lumbsch, *PloS ONE* **12**(7), 10/14
Mycobank no: 820788
Basionym: *Pertusaria wirthii* Elix & A.W.Archer*, Telopea* **15**, 116 (2013)

Key to the species of *Lepra* found in Australia

1 Thallus corticolous 2
1: Thallus saxicolous 29

2 Thallus fertile; with disciform apothecia 3
2: Thallus lacking apothecia; with isida or soralia 16

3 Asci with 1 ascospore 4
3: Asci with 2 or 8 ascospores 13

4 Thallus K+ yellow or red 5
4: Thallus K+ violet or K– 7

5 Thallus K+ red, norstictic acid present; ascospores 150–175 µm long ..... *L. sublacerans*
5: Thallus K+ yellow; thamnolic or haemathamnolic acid present 6

6 Thamnolic acid and lichexanthone present ..... *L. miscella*
6: Haemathamnolic acid present with ± lichexanthone ..... *L. commutata*

7 Thallus K+ violet; hypothamnolic acid present 8
7: Thallus K–; hypothamnolic acid absent 9

8 Ascospores 140–170 µm long; lichexanthone absent; temperate ..... *L. novaezelandia*
8: Ascospores 150–180 µm long; ± lichexanthone; tropical ..... *L. tropica*

9 Thallus KC –, Pd+ orange; protocetraric acid present 10
9: Thallus KC+ violet, Pd–; picrolichenic acid present 11

10 Thallus isidiate; ascospores 85–180 µm long ..... *L. gymnospora*
10: Thallus not isidiate; ascospores 170–180 µm long ..... *L. lacericans*

11 Thallus UV+ yellow; lichexanthone present; ascospores 135–150 µm long ..... *L. clarkeana*
11: Thallus UV–; lichexanthone absent 12

12 Thallus K+ yellow; atranorin present; ascospores 150–170 µm long ..... *L. patellifera*
12: Thallus K–; atranorin absent; ascospores 170–180 µm long ..... *L. lacerans*

13 Ascospores 2 per ascus; K+ red; norstictic acid present 14
13: Ascospores 8 per ascus; K– or K+ yellow; norstictic acid absent 15

14 Ascospores 80–100 µm long ..... *L. amnicola*
14: Ascospores 120–145 µm long ..... *L. asiana*

15 Thallus K+ yellow, KC–; thamnolic acid present; ascospores 22–32 µm long ..... *L. thamnolica*
15: Thallus K–, KC+ violet; picrolichenic acid present; ascospores 19–27 µm long ..... *L. truncata*

16 Thallus isidiate 17
16: Thallus sorediate 24

17 Depsides present (barbatic or thamnolic acid) 18
17: Depsidones present (fumarprotocetraric, protocetraric, stictic or norstictic acid) 19

18 Thallus K–; barbatic acid present ..... *L. barbatica*
18: Thallus K+ yellow; thamnolic acid present ..... *L. trichosa*

19 Thallus K– or K+ dirty yellow-brown; protocetraric or fumarprotocetraric acid present 20
19: Thallus K+ yellow or red; norstictic or stictic acid present 21

20 Protocetraric acid present ..... *L. umbricola*
20: Fumarprotocetraric acid present ..... *L. dactylina*

21 Thallus K+ yellow; stictic acid present ..... *L. muricata*
21: Thallus K+ red; norstictic acid present 22

22 Only norstictic acid present ..... *L. roseola*
22: Norstictic acid present with other compounds 23

23 Norstictic acid and neotricone present ..... *L. neotriconica*
23: Norstictic acid and salazinic acid present ..... *L. wallamanensis*

24 Lichexanthone present 25
24: Lichexanthone absent 27

25 Stictic acid present ..... *L. oahuensis*
25: Thamnolic or picrolichenic acid present 26

26 Lichexanthone and thamnolic acid present ..... *L. scaberula*
26: Lichexanthone and picrolichenic acid present ..... *L. verdonii*

27 Thallus K+ red; norstictic acid present ..... *L. erythrella*
27: Thallus K+ yellow; stictic or psoromic acid present 28

28 Thallus K+ intense yellow; PD+ yellow; psoromic acid present ..... *L. psoromica*
28: Thallus K+ yellow-orange; PD+ orange; stictic acid present ..... *L. albopunctata*

29 Thallus fertile with disciform apothecia 30
29: Thallus lacking apothecia, with isidia or soralia 32

30 Ascospores 8 per ascus, acospores 30–40 µm long ..... *L. erubescens*
30: Ascospores 1 per ascus 31

31 Thallus UV+ yellow; lichexanthone present; rarely fertile; ascospores 120–160 µm long ..... *L. subventosa* var. *subventosa*
31: Thallus UV–, lichexanthone absent; ascospores 195–280 µm long .... *L. parathalassica*

32 Thallus isidiate 33
32: Thallus sorediate 36

33 Thallus K–; squamatic acid present ..... *L. nerrigensis*
33: Thallus K+ red or violet; norstictic, salazinic or hypothamnolic acids present 34

34 Thallus K+ violet; hypothamnolic acid present ..... *L. subdactylina*
34: Thallus K+ red; salazinic or norstictic acid present 35

35 Norstictic acid present ..... *L. dactylinella*
35: Salazinic acid present ..... *L. pseudodactylina*

36 Thallus K+ red; norstictic acid present 37
36: Thallus K+ yellow or violet, or K–; norstictic acid absent 38

37 Thallus off-white; soralia ill-defined ..... *L. excludens*
37: Thallus pale green; soralia subglobose ..... *L. miniatescens*

38 Thallus K+ yellow or violet 39
38: Thallus K– 40

39 Thallus K+ yellow, thamnolic acid present ..... *L. subventosa* var. *subventosa*
39: Thallus K+ violet, hypothamnolic acid present ..... *L. subventosa* var. *hypothamnolica*

40 Thallus UV+ yellow; lichexanthone and picrolichenic acid present .....
..... *L. subventosa* var. *deficiens*
40: Thallus UV–; atranorin and fumarprotocetraric acid present ..... *L. sordida*

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Fissurina virensica, a new species in the Australian Graphidaceae (Lichenized Ascomycota, Ostropales) containing virensic acid

John A. Elix
Research School of Chemistry, Building 137,
Australian National University, Canberra, A.C.T. 2601, Australia
e-mail: John.Elix@anu.edu.au

Alan W. Archer
National Herbarium of New South Wales, Royal Botanic Gardens and Domain Trust,
Mrs Macquaries Road, Sydney, N.S.W. 2000, Australia
e-mail: alanw.archer@bigpond.com

Abstract

Fissurina virensica, characterized by fissurine apothecia, 4-locular ascospores and the presence of virensic acid, is reported as new to science. This is the first report of virensic acid in the genus *Fissurina*.

Introduction

The genus *Fissurina* was first described by Fée (1825). A detailed discussion of the 43 known species was given by Staiger in 2002. Since then, 31 additional taxa have been reported from tropical and subtropical regions (Makhija & Adawadkar 2007; Lumbsch *et al.* 2011; Sharma *et al*. 2012; Lendemer & Harris 2014; Mangold *et al.* 2014; Mercado-Diaz *et al.* 2014; Sipman 2014; Joshi *et al*. 2015; Komposch 2016). Fifteen species are known from Australia (McCarthy 2017).

Fissurina species are characterized by the presence of fissurine apothecia, usually simple but occasionally branched, immersed or sometimes opening and the lips thickening to form conspicuous lirellae. The proper exciple is non-carbonized, and the hymenium is not inspersed. Ascospores are usually 8 per ascus, ellipsoid, hyaline, 4-locular or submuriform to muriform.

The majority of *Fissurina* species lack lichen compounds, but some contain 2'-*O*-demethylpsoromic acid, 2-methoxypsoromic acid, psoromic acid, stictic acid or salazinic acid.

Fissurina virensica A.W.Archer & Elix, sp. nov. Figs 1, 2
Mycobank no: **MB 823828**

Similar to *Fissurina subcontexta* (Nyl.) Nyl., but differs in having smaller lirellae and in containing virensic acid.

Type: Australia, New South Wales, Buckenbowra River, 7.5 km WNW of Batemans Bay, 35°32'S, 150°07'E, alt. 2 m, on *Casuarina* in *Avicennia-Aegiceras*-dominated riverside, *J.A. Elix 26560*, 15.iii.1992; holotype – CANB.

Thallus corticolous, pale fawn; surface somewhat shiny, conspicuously tuberculate. Apothecia numerous, crowded, initially hemispherical, 0.5–1.5 mm diam., becoming elongate and fissurine, the lips thin, brown, rarely branching. Proper exciple non-carbonized, pale brown; hymenium not inspersed, iodine-negative. Ascospores hyaline, ellipsoid, 6–8 per ascus, uniseriate, 16–20 µm long and 8–10 µm wide, 4-locular, I+ blue.
Chemistry: virensic acid (major) and subvirensic acid (major).

OTHER SPECMEN EXAMINED
Type locality: ● *J.A. Elix 26562*, 15.iii.1992 (CANB).

Discussion

Fissurina virensica is characterized by a corticolous thallus, fissurine apothecia of Type V, "*subcontexta* type" (Staiger 2002:125), with small 4-locular ascospores and, in particular, the presence of virensic acid. This acid, a β-orcinol depsidone related to protocetraric acid, was first isolated from *Alectoria virens* Taylor, and characterized by Aghoramurthy *et al*. (1961). Virensic acid is known to occur in the Graphidaceae in *Phaeographis lecanographa* (Nyl.) Staiger (Staiger 2002: 334), but it has not been reported from the genus *Fissurina*.

The species occurs by the banks of the Buckenbowra River in south-eastern New South Wales, and is so far known only from this locality.

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Fig. 1. *Fissurina virensica*, holotype (CANB); scale bar = 1 mm

Fig. 2. *Fissurina virensica*, ascospores, in iodine; scale bar = 20 µm

The structure of japonene, a hopane triterpene from *Heterodermia* lichens (Physciaceae, Ascomycota)

John A. Elix, Li Liao and Russell A. Barrow
Research School of Chemistry, Building 137,
Australian National University, Canberra, A.C.T. 2601, Australia
e-mail: John.Elix@anu.edu.au

Abstract

The triterpene japonene [hopane-6α,16α,22-triol] (1) has been isolated from the lichen *Heterodermia propaguligera*, and its structure established by mass spectrometry and NMR spectroscopy.

Introduction

Japonene was first detected in the lichen *Heterodermia japonica* (Sato) Swinscow & Krog (Elix 2011a), but has since been found to be widely distributed in the genus *Heterodermia* (Elix 2011b; Mongkolsuk *et al.* 2015). It was initially called japonin (Elix 2011a), but that name had to be abandoned because it had been introduced earlier for an alkaloid present in the higher plant *Orixa japonica* (Rutaceae) by Ha-Huy-Kê & Luckner (1970). Although japonene could readily be characterized by thin-layer chromatography (Elix 2011a; Mongkolsuk *et al.* 2015), its structure remained unknown. This paper describes the elucidation of its structure.

Methods

All nuclear magnetic resonance spectra (NMR) were recorded on a Bruker Biospin GmbH spectrometer at 300 K with probe 5 mm PABBO BB/19F-1H/D Z-GRD Z116098/0258. ^{1}H and ^{13}C NMR experiments were undertaken at 400 MHz and 100 MHz respectively. Low-resolution electrospray mass spectra (LRESIMS) were recorded on a Waters Micromass ZMD single quadrupole mass spectrometer using an ionization field of 3500V, source temperature 100°C, desolvation temperature 150°C, coupled to a Waters Alliance 2995 HPLC system. High resolution electrospray mass spectra (HRESIMS) were recorded on a Waters LCT Premier mass spectrometer using an ionization field of 2500 V, source temperature 100°C, desolvation temperature 150°C, coupled to a Waters Alliance 2995 HPLC system. All MS used positive electron ionization mode.

Fluorescent active thin-layer chromatographic (TLC) plates (silica gel 60 F_{254}) and silica gel (230–400 mesh) for flash chromatography were supplied by Merck Millipore Pty Ltd, Bayswater, Victoria 3153, Australia.

Extraction of *Heterodermia propagulifera* (Vain.) Dey

The lichen *Heterodermia propaguligera* was collected on shaded granite rocks at Mount Chudalup, 17 km SSE of Northcliffe, Western Australia, 34°46'S, 116°05'E, 165 m alt., *J.A. Elix 41219, H.T. Lumbsch & H. Streimann*, 14.ix.1994 (CANB). The dried lichen thallus (19.90 g) was extracted in a Soxhlet extractor with anhydrous diethyl ether (350 mL) for 48 h. The ether extract was filtered, the filtrate concentrated to 30 mL, and then filtered again. The final filtrate was concentrated to dryness to yield 770 mg of a colourless solid. A portion of that solid (66 g) was purified by sequential column chromatography over silica gel using ethyl acetate and then 70% ethyl acetate / light petroleum as eluant. Three major bands developed, and they were collected and concentrated in turn. The faster moving band afforded zeorin [hopane-6α,22-diol] (2), and the subsequent band yielded 16β-acetoxyhopane-6α,22-diol (3) with m/z $[M+Na]^+$ 467.4 and m/z $[M+Na]^+$ 525.5 on ESIMS respectively. The TLC behaviour of those two compounds was identical with that of authentic material. The third band from the chromatographic column afforded japonene [hopane-6α,16α,22-triol] (1) as a white solid, $[\alpha]_D^{24}$ +28.0 (c = 0.16, $CDCl_3$), with chromatographic properties identical to that reported previously (Elix 2011a; Mongkolsuk *et al.* 2015).

Structural elucidation of japonene

Japonene [hopane-6α,16α,22-triol] (1) was obtained as a colourless, crystalline solid with m/z $[M+Na]^+$ 483.3814 on high-resolution ESIMS with a sodiated adduct ion corresponding to $C_{30}H_{52}O_3Na$, thus establishing the molecular formula of japonene as $C_{30}H_{52}O_3$. The spectroscopic properties of japonene were consistent with its being a hopanetriol, but its Rf values differed significantly from those of leucotylin [hopane-6α,16β,22-triol] (4) on TLC. Leucotylin (4) is also widely distributed in *Heterodermia* species. Assignments in the ^{1}H-NMR spectrum of japonene are summarized in Table 1. As expected, the ^{13}C-NMR spectrum of japonene (Table 2) exhibited thirty carbon signals. In the HSQC spectrum, carbon signals assigned to C6 (δ 69.45) and C16 (δ 69.52) were associated with the corresponding oxymethine proton signals due to H6 (δ 3.96) and H16 (δ 4.69) respectively, which indicates that two secondary hydroxy groups are present in japonene.

In addition, eight carbon signals (δ 17.22–29.23) were strongly correlated with eight singlet CH_3 proton signals (δ 0.87, 1.01, 1.02, 1.11, 1.16, 1.18, 1.34, 1.39), indicating that the methyl groups are bonded to quaternary carbon atoms. Because japonene is isomeric with leucotylin (4), their respective ^{13}C-NMR spectral data have been compared in Table 2. The carbon chemical shifts of those two compounds are well matched except for C15, 16, 17, 18, 19, 21, 22, 23 and 28, the majority of which are located in rings D and E and are centred around C16, suggesting that their structural differences most likely occur in that region.

Correlations in the gHMBC spectrum are illustrated in Figure 2. All the observations are consistent with structure (1) for japonene, with the same carbon skeleton as leucotylin (4) but with a 16α- rather than a 16β-hydroxy group.

In the NOESY spectrum of japonene, H24 (δ 1.02), H25 (δ 0.87) and H26 (δ 1.01), protons are correlated with one another, whereas the H23 (δ 1.16) proton exhibits no association with H25 and H26. In addition, there is no correlation between the H26 and H27 (δ 1.34) protons, but the methine proton signal H6 (δ 3.96) is correlated with the H24, H25 and H26 protons (Figure A). Those correlations confirm that C24, C25 and C26 have β-stereochemistry, whereas C23, C27 and the 6-OH have α-configuration. This established that japonene (1) possessed the same stereochemistry in rings A, B and C as does leucotlyin (4). Further, the methine proton signal H16 (δ 4.69) was correlated with H30 (δ 1.39), and in addition the H27 (δ 1.34), H28 (δ 1.11) and H29 (δ 1.18) signals were correlated with one another. Similarly, protons H29 and H30 were correlated with each other (Figure 3B). Those observations confirm that C30 has β-configuration, whereas C28, C29 and the 16-OH have α-configurations. The configuration of C22 in japonene (1) was confirmed by the comparison of the ^{13}C-NMR data for compounds 1 and 4, with 22-hydroxyhopane (5) and 22-hydroxyisohopane (6) (Table 2). Because the C30 chemical shift changes significantly from approximately δ 30 (α-side chain at C21 in 5) to *c.* δ 26 (β-side chain at C21 in 6) (Ageta *et al.* 1993), both japonene (1) (δ 31.2) and leucotylin (4) (δ 30.2) have α-side chains at C21. The apparent difference in chemical shift between C23 in japonene (δ 36.9) and leucotylin (δ 29.8) was found to be due to the incorrect assignment of the latter (Brahmachari & Chatterjee 2002), and was confirmed by the comparison with compound 2 (δ 36.8) (Table 2) (Elix *et al.* 1982).

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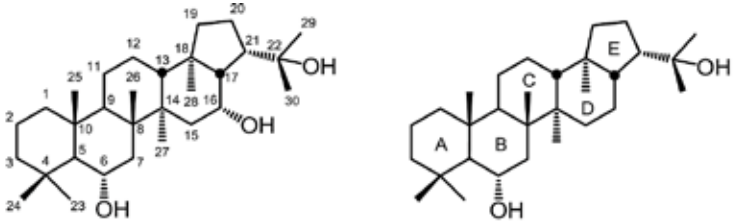
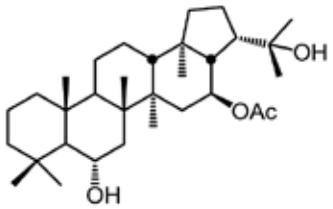
Table 1 ^{1}H-NMR data (400MHz, $CDCl_3$) of japonene (1)

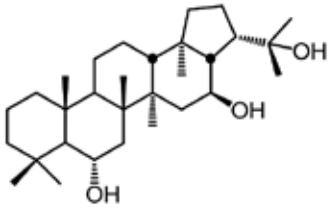
H-5	0.84
H-6	3.96
H-7	1.54
H-15	1.54, 1.75
H-16	4.69
H-17	1.55
H-23	1.16
H-24	1.02
H-25	0.87
H-26	1.01
H-27	1.34
H-28	1.11
H-29	1.18
H-30	1.39

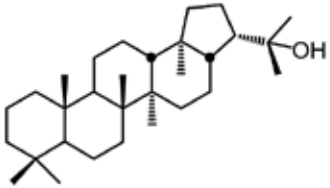
Table 2 ^{13}C-NMR data (100MHz, $CDCl_3$) of compounds 1,2,4,5 and 6

	1	4	5	6	2
C-1	40.44	40.4	40.29	40.31	40.4
C-2	18.67	18.4	18.69	18.69	18.5
C-3	43.93	43.6	42.10	42.10	43.8
C-4	33.78	33.4	33.25	33.25	33.6
C-5	61.27	61.1	56.08	56.11	61.1
C-6	69.45	69.2	18.69	18.69	69.3
C-7	45.6	45.3	33.21	33.25	45.5
C-8	43.27	42.8	41.90	41.87	42.9
C-9	48.8	49.5	50.34	50.42	49.5
C-10	39.47	39.1	37.38	37.39	39.4
C-11	21.21	20.9	20.89	20.91	21.1
C-12	23.93	23.9	24.13	23.80	24.0
C-13	50.09	49.5	49.83	48.56	49.8
C-14	41.7	41.6	41.84	41.72	41.9
C-15	40.65	44.9	34.37	32.67	34.3
C-16	69.52	66.8	21.95	23.21	21.9
C-17	55.93	57.4	53.91	52.07	54.0
C-18	43.35	46.2	44.09	44.90	44.0
C-19	42.59	39.3	41.23	39.50	41.3
C-20	26.39	25.5	26.60	24.82	26.6
C-21	50.21	51.4	51.11	51.05	51.1
C-22	72.31	70.7	73.96	73.62	73.9
C-23	36.89	29.8	33.41	33.41	36.8
C-24	22.27	21.8	21.60	21.60	22.1
C-25	17.22	17.1	15.83	15.88	17.1
C-26	18.62	17.7	16.71	16.73	18.3
C-27	18.05	17.3	17.03	16.70	17.1
C-28	17.41	15.6	16.14	15.37	16.1
C-29	29.23	28.2	28.72	29.45	28.7
C-30	31.15	30.2	30.85	26.49	30.9









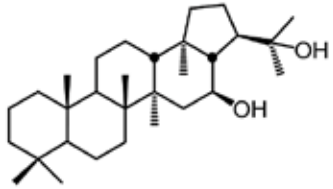


Figure 1. Structure of triterpenes

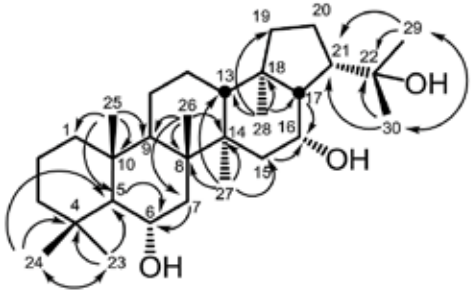


Figure 2. HMBC correlations of japonene (1)

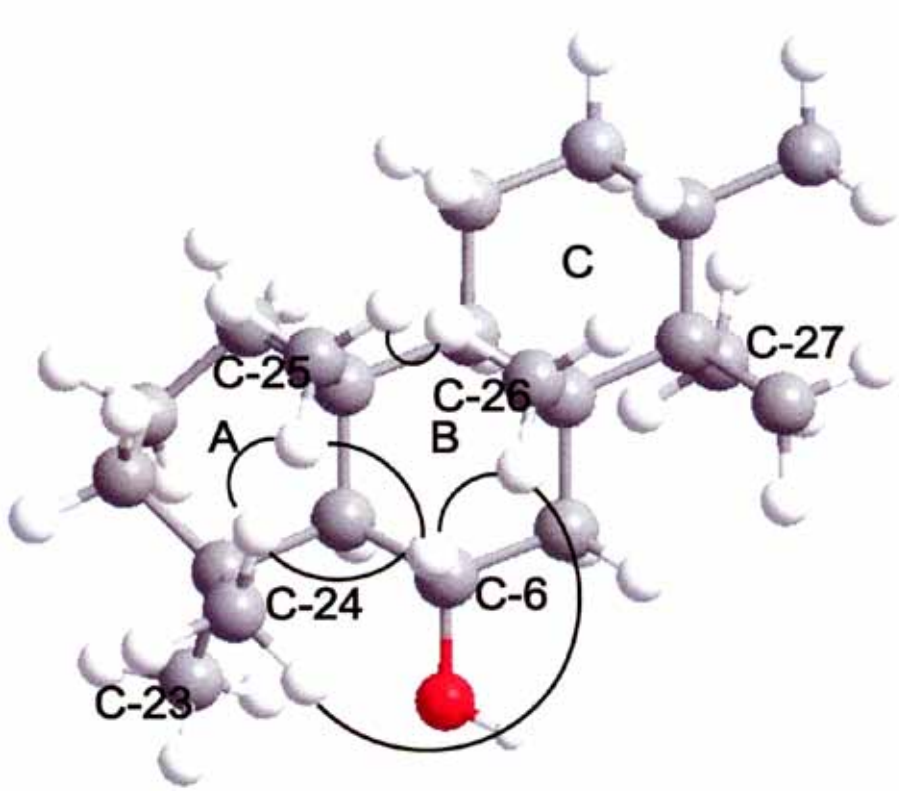


Figure 3A. NOESY associations of compound 1 in ring A, B and C

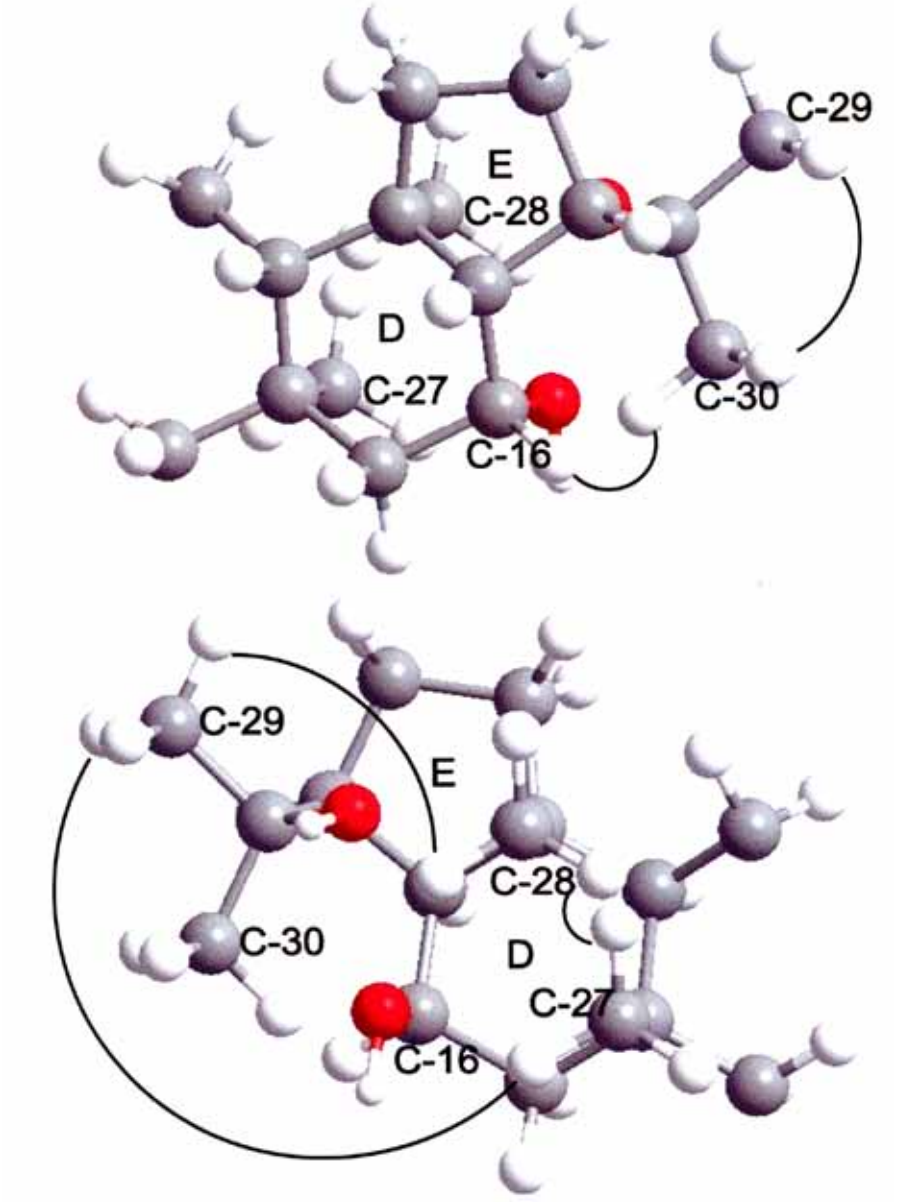


Figure 3B. NOESY associations of compound 1 in ring D and E (upper is frontal, lower is rear)

Maritime species of the genus *Verrucaria* in Kerguelia

Dag Olav Øvstedal
The University Museum, University of Bergen
Allégt. 41, N-5007 Bergen, Norway

Abstract

Twenty maritime species of *Verrucaria* are reported from Kerguelia (Kerguelen, Heard Island and Prince Edward Islands), including the new species *V. placodioides* Øvstedal. Taxonomy, ecology and distribution are discussed.

Introduction

The term Kerguelia was first introduced by Tuckerman (1875) for the island of Kerguelen. Dodge later (1948) added Crozet Island, Heard Island and the Prince Edward Islands (no material from Crozet Island was examined in the present work).

Kerguelen is situated in the Southern Indian Ocean at 48°27'–50°01'S, 68°25'–70°33'E. The main island, Grande Terre, is surrounded by many smaller islands. It is among the remotest places on earth, 450 km from Heard Island and 2400 km from the Prince Edward Islands. Grande Terre covers *c.* 6680 km², and with the smaller islands has an extensive coastline. The origin of the bedrock is volcanic, at least 30 Ma old (Wallace *et al.* 2002). The climate is oceanic and subantarctic, with strong winds throughout the year.

Heard Island is situated at 52°05'S, 73°30'E, and is a small island of 368 km². The continent nearest to it is Antarctica, 1650 km to the south, with Australia 3500 km to the north-west, and Africa 4800 km to the north-east. The island consists of a relatively young volcanic complex, less than 1 million years old, on a basement of much older formations (Quilty & Wheller 2000). The climate is cold and oceanic, usually with very strong winds.

Marion and Prince Edward Islands (47°S, 38°E) are situated in the Southern Indian Ocean some 2000 km southeast of the southernmost point of Africa. The nearest land is the Crozet archipelago. Marion Island covers 290 km², and reaches an elevation of 1230 m. It is situated 22 km from Prince Edward Island, which covers 90 km² and reaches an elevation of 672 m. The islands represent the summits of shield volcanoes rising from the West Indian Ocean Ridge (Verwoerd 1971), and geologically are relatively young. The climate is oceanic, with strong winds.

Material and methods

The collections by Imshaug and his collaborators (Imshaug 1971; Fryday & Prather 2001) studied for the present work are lodged in MSC. They were examined using a Zeiss Stemi 2000C microscope and a Zeiss Axiolab compound microscope. No lichen substances were detected in the material. Recent molecular data have supported separating several small genera from *Verrucaria*. However, because many of the species in the present work have not been sequenced, I have taken a conservative approach and retained them all in *Verrucaria* sens. lat.

The species

1. Verrucaria aethioboliza Nyl., *C. r. hebd. Séanc. Acad. Sci., Paris* **81**, 726 (1875)
Thallus thin, gelatinous, non-rimose, violet-brown. Fertile portions black, up to 0.8 mm wide, slightly thicker than the non-fertile portions, stroma-like, with 1–3 protruding ostioles. Involucrellum in only the upper part, spreading laterally. Exciple entire, brown. Ascospores 10–15 × 4–6 µm.
Ecology: upper littoral zone?
Distribution: St. Paul Island, Heard Island (Øvstedal & Gremmen 2006).

Remarks

Described from St. Paul Island. The extended black, stroma-like areas laterally surrounding the perithecia are characteristic.

2. Verrucaria bubalina P.M.McCarthy, *Muelleria* **7**, 327 (1991)
Thallus up to 10 cm wide but usually smaller, dark brown, with fine secondary cracks. Perithecia immersed in the thallus up to halfway, the protruding portion black, sometimes with fine striae. Involucrellum entire to subentire. Exciple brown. Ascospores 15–16 × 8–10 µm.
Ecology: upper littoral zone.
Distribution: Macquarie Island (McCarthy 1991b), New Zealand, Prince Edward Islands (Øvstedal & Gremmen 2014).

3. Verrucaria ceuthocarpa Wahlenb. in E. Acharius, *Methodus* 22 (1803)
Thallus blackish to grey-brown, strongly areolate, the areolae 0.2–0.3 mm across, rimae concolorous with the thallus. Perithecia almost entirely immersed in the thallus, with only the black ostiole protruding. Involucrellum in only the upper part. Exciple colourless. Ascospores 9–12 × 6–7 µm.
Ecology: upper littoral zone.
Distribution: bipolar. Kerguelia distribution: Heard Island (Øvstedal & Gremmen 2006), Kerguelen (see below), Prince Edward Islands (Øvstedal & Gremmen 2001).

Remarks
Verrucaria ceuthocarpa is variable in colour, but always has rimae. Its relationship with *V. werthii* and *V. psychrophila* should be studied more closely.

SPECIMENS EXAMINED
Kerguelen: ● Bras de la Fonderie, coastal rocks and cliffs W of Mt. Gergovie, sea level, *G.C. Bratt 395*, 3.iii.1971 (MSC); ● Presqu' Île Jeanne D'Arc, point at N end of Anse Île Sabine, sea level, *R.C. Harris 6677*, 21.ii.1971 (MSC).

4. Verrucaria dagolavii Fryday, *Bothalia* **45***,* 2 (2015)
= *V. umbilicata* Øvstedal, *South African J. Bot.* **67**, 569 (2001), non *V. umbilicata* Hoffm. *Deutsch. Flora* 171, 1796
Thallus umbilicate, 1–3 mm wide, attached to the rock centrally; margins free. Upper surface greyish ochre, non-rimose, lower surface black, irregularly papillose. Perithecia black, semi-immersed, to 0.2 mm diam. Involucrellum black, reaching halfway down the perithecium. Exciple dark brown in upper part, colourless in lower part. Ascospores 9–10 × 5–7 µm.
Ecology: in or just above the intertidal zone.
Distribution: Prince Edward Islands (Øvstedal & Gremmen 2001), Heard Island (Øvstedal & Gremmen 2006), Kerguelen (see below).

SPECIMEN EXAMINED
Kerguelen: ● Presqu' Île Jeanne D'Arc, small bay SE of Halage des Swains, sea level, *R.C. Harris 6689*, 21.ii.1971 (MSC).

5. Verrucaria ditmarsica Erichsen*, Sch. Naturw. Ver. Schl.-Holst.* **22**, 90 (1937)
Thallus gelatinous, very thin, 2–3 mm wide, without a prothallus, green-grey, with numerous punctae that sometimes coalesce into uneven ridgelike structures. Perithecia half-sessile, 0.2–0.3 mm diam., with a rugulose surface. Involucrellum reaching the exciple base. Exciple pale. Ascospores 8–9 × 5–6 µm.
Ecology: on intertidal rocks.
Distribution: bipolar. Kerguelia distribution: Prince Edward Islands (Øvstedal & Gremmen 2001).

Remarks
The rugulose surface of the perithecia is not mentioned in European Floras, including Orange *et al.* (2009), but is also seen in some northern European specimens (material in BG).

6. Verrucaria durietzii M.Lamb, *Lilloa* **14**, 205 (1948)
Thallus effigurate, to several cm diameter, margin thick, with radiating lobes separated by black cracks, smooth, pale brownish grey to dark brown. Perithecia immersed, up to 0.3 mm diam. Involucrellum entire, black. Exciple pale. Ascospores 13–15 × 8–9 µm.
Ecology: rocks from intertidal zone to further inland, but always within the saltspray zone.
Distribution: circumantarctic-subantarctic. Kerguelia distribution: Kerguelen (see below).

SPECIMEN EXAMINED
Kerguelen: ● Istme du Lac, along shore at head of Anse de St. Malo, sea level, *H.A. Imshaug 48987 p.p.*, 8.iii.1971 (MSC).

7. Verrucaria efflorescens Øvstedal, *Nova Hedwigia* **85**, 254 (2007)
Thallus composed of small, fertile corticate areas with perithecia, dispersed in a vegetative thallus dissolved into goniocysts. Fertile areas up to 5 mm wide, thick, secondarily cracked, pale grey-ochre; upper part of perithecia black, irregularly star-shaped, up to 0.3 mm wide. Vegetative portion covered by goniocysts, somewhat greener than the fertile parts. Goniocysts 20–28 µm diam., coalescing to larger structures 250–300 µm wide. Hypothallus massive, with irregular extensions up into the thallus. Involucrellum prominent, reaching down to and merging with the hypothallus. Exciple dark brown. Ascospores 9–10 × 7–9 µm.
Ecology: upper littoral zone.
Distribution: found in only the Prince Edward Islands (Øvstedal & Gremmen 2007).

8. Verrucaria evanidula Nyl., *Flora* **70**, 136 (1887)
Thallus irregular, very thin, brownish, gelatinous. Perithecia up to 0.2 mm diam, semiglobose, shiny, black. Involucrellum prominent, reaching down to the base. Exciple colourless. Ascospores 7–9 × 2–3 µm.
Ecology: on limestone, not clear whether it is a maritime or lacustrine/terrestrial species.
Distribution: Kerguelen endemic.

Remarks
Verrucaria cylindrophora Vain. from the Antarctic (Lamb 1948; Øvstedal & Lewis Smith 2001) is very similar; the only apparent difference is the form of the ascospores.

SPECIMEN EXAMINED
Kerguelen: ● H–NYL 2776 (holotype).

9. Verrucaria halizoa Leight., *Lich. Fl. Gr. Brit*. 436 (1871)
Thallus gelatinous, very thin, brown-green, generally smooth but sometimes secondarily cracked, up to 5 cm diam., occasionally only as a narrow rim around the perithecia. Perithecia emergent, black, smooth, up to 0.2 mm diam. Involucrellum in upper part only. Exciple brownish, pale in lower part. Ascospores 7–12 × 4–5 µm.
Ecology: in intertidal zone.
Distribution: bipolar. Kerguelia distribution: Kerguelen (see below).

SPECIMEN EXAMINED
Kerguelen: ● Bras de la Fonderie, shore W of Mt. Gergovie, sea level, *H.A. Imshaug 48734 p.p.*, 3.iii.1971 (MSC).

10. Verrucaria hebena C.W.Dodge*, B.A.N.Z. Ant. Res. Exp. 1929–31, Rep. Ser. B* **3**, 40 (1948)
Thallus black, minutely areolate, without punctae. Perithecia immersed, covered by the thallus. Involucrellum extensive. Ascospores 15–16 × 7–8 µm.
Ecology: littoral zone.
Distribution: Kerguelen endemic.

Remarks
Not seen; the description is taken from Dodge (1948), who did not give perithecia dimensions. This could be a form of *V. maura* in which the punctae are suppressed. The type or any other material has not yet been found (M. Schmull, pers. com. 2017)

11. Verrucaria maura Wahlenb. in E. Acharius, *Methodus* **19** (1803)
Thallus black, 3–4 cm wide, rimose, cracks concolorous with the thallus, areolae up to 1 mm diam., with black punctae. Perithecia externally variable, from about level with the thallus to distinctly protruding with a conical shape, 0.6–0.9 mm diam. Involucrellum entire, black. Exciple pale. Ascospores 16–19 × 8–13 µm.
Ecology: delimits the upper edge of the littoral zone.
Distribution: bipolar. Kerguelia distribution: Kerguelen (see below), Prince Edward Islands (Øvstedal & Gremmen 2001).

SPECIMENS EXAMINED
Kerguelen: ● Presqu' Île Jeanne D'Arc, small bay at mouth of stream 1 km W of Port-Jeanne D'Arc, sea level, *R.C. Harris 6794*, 24.ii.1971 (MSC); ● Peninsule Courbet, E side of base of Pointe Molloy peninsula, sea level, *R.C. Harris 6561,* 16.ii.1971 (MSC).

12. Verrucaria mawsonii C.W.Dodge*, B.A.N.Z. Ant. Res. Exp. 1929–31, Rep. Ser. B* **3**, 40 (1948)
Thallus up to 2 cm diam., 0.2–0.3 mm thick, strongly rimose, green-brown. Rimae black, partly with raised edges. Areolae with small black punctae that sometimes coalesce into irregular ridges. Perithecia completely immersed in the thallus, inner diameter *c.* 130 µm. Involucrellum entire, irregular and expanded in the upper part, thin and regular in the lower part. Excipulum colourless. Ascospores 12–14 × 6–7 µm.
Ecology: upper littoral zone.
Distribution: Heard Island (Øvstedal & Gremmen 2006).

13. Verrucaria mucosa Wahlenb. in E. Acharius*, Methodus* 23 (1803).
Thallus subgelatinous, relatively thick, continuous, smooth, olive-green to black-green, 3–4 cm diam. Perithecia immersed, to 0.3 mm diam. Involucrellum only in uppermost part. Exciple colourless. Ascospores 9–13 × 6–7 µm.
Ecology: mid-littoral zone.
Distribution: bipolar. Kerguelia distribution: Prince Edward Islands (Øvstedal & Gremmen 2001).

14. Verrucaria obfuscata Nyl. in Crombie, *J. Linn. Soc. London, Bot.* **15**, 191 (1876)
Syn. *V. kerguelensis* C.W.Dodge, *B.A.N.Z. Ant. Res. Exp. 1929–31, Rep. Ser. B* **3**, 38 (1948)
Thallus effuse, gelatinous, 6–7 cm wide, smooth, non-rimose, grey-brown with a violet tinge. Perithecia half-emergent, black, 0.1–0.3 mm wide. Involucrellum thin, reaching down to base of perithecium; exciple yellowish. Ascospores 23–32 × 9–11 µm, sometimes with oil droplets.
Ecology: upper littoral zone, or supralittoral. The type of *V. kerguelensis* grows on the lower side of a small pebble, with *Steinera glaucella* on the upper side. Nylander (in Crombie, 1876) stated: "On rock. Royal Sound".
Distribution: Kerguelen, Heard Island (Øvstedal & Gremmen 2006).

Remarks
The type of *V. kerguelensis* conforms with the type of *V. obfuscata* and the other material studied, except that the ascospores are somewhat shorter (mean value 25 × 11 µm) and the exciple is almost black. *Gremmen 846* from Kerguelen differs in having distinct black plates on the surface of the perithecia; otherwise it is similar to the other material.

SPECIMENS EXAMINED
Type (H–NYL), type of *V. kerguelensis* C.W.Dodge (*Banzare B 177–1*, FH), *Gremmen 846* (Kerguelen, BG), *Gremmen H–3000*, (Heard Island, BG).

15. Verrucaria placodioides Øvstedal sp. nov. Fig. 1
MycoBank No. **MB 822530**
Diagnosis: Characterized by a placodioid thallus with a thick, black hypothallus and black radiating jugae. No perithecia seen.

Type: Kerguelen, Presqu' Île Jeanne D'Arc; small bay at mouth of stream 1 km W of Port-Jeanne D'Arc, sea level, *R.C. Harris 6785*, 24.ii.1971 (holotype – MSC).

Thallus placodioid, up to 10 mm diam, with radiating lobes, 0.3–0.1 mm wide at the margin. Surface shiny brown, margins of lobes with elongate, sparsely branched, elevated black jugae. No perithecia seen. In section the thallus is 250–270 µm tall, lowermost 170–190 µm a black hypothallus, composed of a textura intricata; the jugae are extensions of the hypothallus. Lower margin composed of scattered hyphal tips, *c.* 8 µm long and 3 µm broad; Between jugae a vegetative tissue, 75–80 µm high; cells angular, 2–3 µm diam., uppermost brownish. Photobiont difficult to observe (old specimen), yellow-green, 3–4 µm diam.
Ecology: in *V. maura* zone, partially overgrowing *V. maura.*
Distribution: endemic.

Remarks
The ecology and the anatomy of the thallus (in particular the jugae) indicate that this is a *Verrucaria*, although no perithecia could be found. The other placodioid/effigurate maritime *Verrucaria* known are (1) *V. epimaura* Brodo, from Canada (Brodo & Santesson 1997), a quite different species (specimens in MSC and BG seen), that is, effigurate with a greyish colour, thallus regularly cracked and without jugae, and (2) *V. durietzii*, also effigurate, from pale brownish grey to dark brown and black fissures, but with no jugae.

ADDITIONAL SPECIMEN EXAMINED
Kerguelen: ● Bras de la Fonderie, shore W of Mt Gergovie, sea level, *H.A. Imshaug 48734* (growing with *V. halizoa* and *V. tesselatula* var. *dermoplaca*), 3.iii.1971 (MSC).

16. Verrucaria psychrophila I.M.Lamb, *Discovery Reports* **25**, 18 (1953)
Thallus dull brown-grey to blackish, cracked, to 4 cm. Rimae irregular, not blackened, dividing the thallus into areolae *c.* 1.5 mm wide. Perithecia protruding only slightly, the visible portion dark brown, *c.* 0.1 mm diam. Involucrellum in only the upper part, brown-black. Exciple colourless. Ascospores 10–15 × 6–9 µm.
Ecology: intertidal, near high water mark.
Distribution: Antarctica, Prince Edward Islands (Øvstedal & Gremmen 2001), Kerguelen (see below).

Remarks
The specimen (*Harris 6569*, MSC) from Kerguelen has perithecia that are entirely immersed in the areolae, and thus might be determined as *V. mucosa*, but the dark brown, rimose thallus indicates that it belongs in *V. psychrophila*.

SPECIMEN EXAMINED
Kerguelen: ● Peninsule Courbet, E side of base of Pointe Molloy Peninsula, sea level, *R.C. Harris 6569*, 16.ii.1971 (MSC).

17. Verrucaria subdiscreta P.M.McCarthy, *Muelleria* **7**, 327 (1991)
Thallus subgelatinous, olive-green, in patches up to 4 cm wide, smooth, thin, with small, black punctulae. Perithecia sessile, up to 0.3 mm diam., ostiole slightly depressed. Involucrellum

extending halfway down; exciple pale brown. Ascospores 9–11 × 4.5–6 µm.
Ecology: upper littoral zone.
Distribution: Marion Island (Øvstedal & Gremmen 2014), Australia and Macquarie Island (McCarthy 1991a).

18. Verrucaria tesselata (C.W.Dodge) Øvstedal, *South Afr. J. Bot*. **67**, 570 (2001) Fig. 2
Hypothallus black, of variable thickness. Thallus milky white to pale ochre or grey-brown, fairly thick (up to *c*. 0.8 mm), effuse, secondarily cracked, thalli up to 4–5 cm diam., margin not effigurate; surface often with numerous minute pits or dark brown spots that appear to be either pycnidia ostioles or young parasymbionts. Photobiont green. Perithecia semiglobose, raised above the thallus, half-covered by thalline tissue, up to 0.7 mm diam., uppermost part black, 0.1–0.4 mm diam., often star-shaped. Involucrellum extensive, spreading laterally; exciple black, entire. Ascospores narrowly ellipsoid, 15–22 (17.3 ± 1.7) × 6–8 (7.5 ± 0.2) µm.
Ecology: upper littoral zone.
Distribution: Heard Island, Kerguelen (see below).

Remarks
Verrucaria tesselata appears to be related to *V. durietzii*, which has a very thick, black hypothallus, a thick, pale brownish grey to dark brown thallus, an entire, brown-black exciple and an involucrellum that spreads laterally. However**,** *V. durietzii* differs in its effigurate thallus, which has prominent, longitudinal black cracks, perithecia that are smaller and less protruding and smaller ascospores.

SELECTED SPECIMENS EXAMINED
Kerguelen: ● Peninsule Courbet, E side of base of Pointe Molloy Peninsula, sea level, *R.C. Harris 6571*, 16.ii.1971 (MSC); ● Kerguelen, Île Haute, coastal rocks along bay NE of Anse des Rennes, sea level, *R.C. Harris 6607*, 18.ii.1971 (MSC); ● Kerguelen, Isthme du Lac, along shore at head of Anse de St Malo, sea level, *H.A. Imshaug 48987*, 8.iii.1971 (MSC).

19. Verrucaria tesselatula Nyl. in Crombie, *J. Bot. London* **13**, 335 (1875)
Thallus pale to medium brown-grey, to 0.5 mm thick, 1–3 cm wide, with an irregular system of dark rimae. Thallus sometimes coalescing to form larger composite thalli. Perithecia emergent to 1/3–1/4, visible part blackish, to 0.3 mm diam. Involucrellum weakly developed, dark brown, in uppermost part only; exciple colourless. Ascospores 11–13 × 6–8 µm.
Ecology: upper littoral zone.
Distribution: circumantarctic-subantarctic. Kerguelia distribution: Kerguelen (see below), Prince Edward Islands (Øvstedal & Gremmen 2001).

Remarks
Common. The variety *V. tesselatula* var. *dermoplaca* (Nyl.) I.M.Lamb is present on Kerguelen. It differs from the nominate form in having isolated, unconnected rimae. It is a distinct and uniform taxon that should be studied more closely.

SELECTED SPECIMENS EXAMINED
Verrucaria tesselatula var. *dermoplaca*: Kerguelen: ● Bras de la Fonderie, shore W of Mt Gergovie, sea level, *H.A. Imshaug 48734 p.p.*, 3.iii.1971 (MSC).
Var. *tesselatula*: Kerguelen: ● Bras de la Fonderie, coastal rocks and cliffs W of Mt Gergovie, sea level, *G.C. Bratt 404*, 3.iii.1971 (MSC).

20. Verrucaria werthii Zahlbr., *Deutsche Südpolar. Exp*. **8**, 31 (1906)
Thallus small, tartareus, subareolate-rimose, grey-brown ("cinerascenti umbrinus vel rufescenti-cinereus" in Zahlbruckner 1906). Perithecia semiglobose, 0.3–0.5 mm wide, involucrellum brown, disappearing at base. Ascospores 16–22 × 6–8 µm.
Ecology: upper littoral zone?
Distribution: Kerguelen.

Remarks
Neither the type nor any other specimens were available; the description is based on Zahlbruckner (1906). *Verrucaria werthii* resembles pale forms of *V. ceuthocarpa*, but its ascospores are almost twice as long (9–12 µm *versus* 16–22 µm). Pale forms of *V. ceuthocarpa* have been observed from the Antarctic (own observations); it has been described as "grey- or green-brown to black" in Great Britain (Orange *et al.* 2009).

Discussion
Eight of the 20 maritime *Verrucaria* species in Kerguelia are endemic. That compares with three out of 17 in New Zealand (Galloway 2007), three out of 12 in Australia (McCarthy & Kantvilas 2015), and three out of 11 in Antarctica (including South Georgia) (Øvstedal & Lewis-Smith 2001). The percentage of endemics in Kerguelia seems too high in comparison with that of the other provinces, suggesting that many of the species in Kerguelia are likely to occur in those other provinces as well. Alternatively, some species currently considered endemic could turn out to be synonymous with other taxa.

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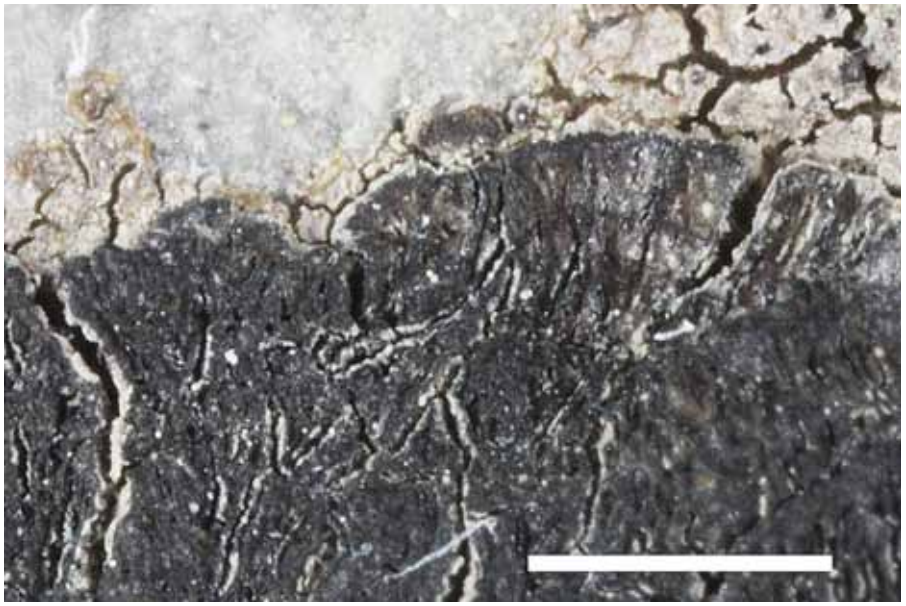

Figure 1: *Verrucaria placodioides* Øvstedal sp. nov. Holotype. Scale bar = 1 mm.

Figure 2: *Verrucaria tesselata*. *Imshaug 48987* (MSC). Scale bar = 1 mm

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