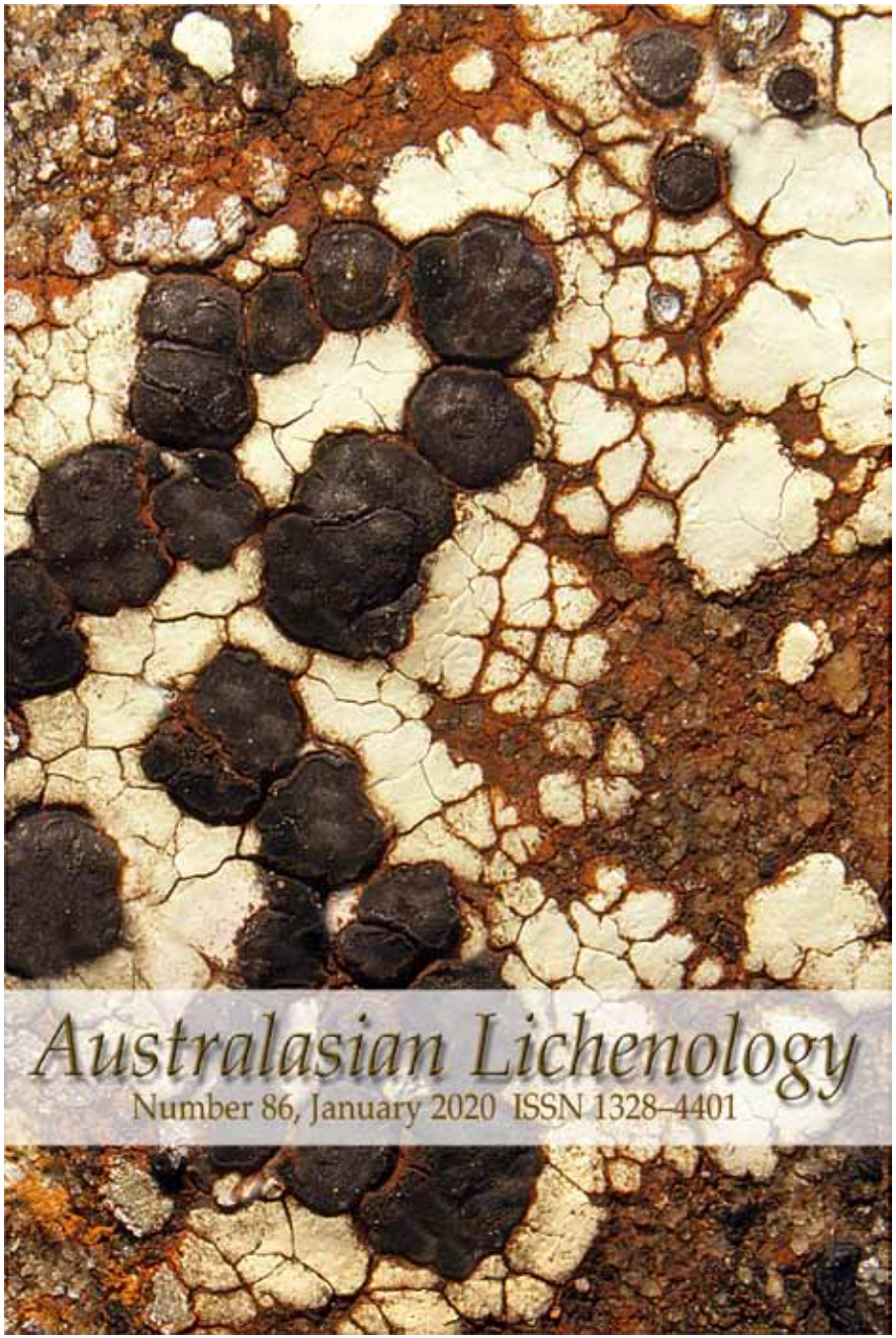

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The vivid yellow colour of *Poeltiaria coromandelica* is caused by usnic acid. The species is the only lecideoid lichen with a *Porpidia*-type ascus structure that's known to produce usnic acid. It grows on siliceous rock at alpine elevations in New Zealand and Australia (Tasmania, Victoria and New South Wales).

1 mm

CONTENTS

ARTICLES

McCarthy, PM—*Verrucaria kowenensis* (lichenized Ascomycota, Verrucariaceae), a new species on soil in the Australian Capital Territory 3

Kalb, K; Schumm, F; Elix, JA—Pigments and new lichen substances in the lichen genus *Dirinaria* 6

Archer, AW; Elix, JA—Six new species, a new variety, a new report and two new records in the Australian Pertusariaceae (Pertusariales, lichenized Ascomycota) 14

Elix, JA; McCarthy, PM—Three new species of buellioid lichens (Caliciaceae, Ascomycota) from south-eastern Australia 30

McCarthy, PM; Elix, JA; Kantvilas, G—New species and new records of the lichen genus *Rhizocarpon* from Tasmania, with a key to the Australian taxa 36

Elix, JA; Mayrhofer, H—Four new species and a new record of buellioid lichens (Caliciaceae, Ascomycota) from Australia 62

Elix, JA; Øvstedal, DO; Broady, PA—A new sorediate species of *Amandinea* (Caliciaceae, Ascomycota) from Antarctica 70

McCarthy, PM; Elix, JA—Three new species of *Sarcogyne* (Acarosporaceae) from the Australian Capital Territory 74

Elix, JA; Mayrhofer, H—A new species of *Cratiria* (Caliciaceae, Ascomycota) from Ascension Island, South Atlantic Ocean 87

McCarthy, PM; Elix, JA—A new species of *Circinaria* (Megasporaceae) from New South Wales, Australia 90

Elix, JA; Edler, C; Mayrhofer, H—Two new corticolous species of *Rinodina* (Physciaceae, Ascomycota) from New Zealand 95

Elix, JA; McCarthy, PM—Three new species of *Trapelia* (lichenized Ascomycota, Trapeliaceae) from eastern Australia 102

McCarthy, PM; Kantvilas, G—*Thelidium carbonaceum* (Verrucariaceae) a new saxicolous lichen from Tasmania 109

ADDITIONAL RECORDS OF LICHENS FROM NEW ZEALAND

Bannister, J; Harrold, P; Blanchon, D—Additional lichen records from New Zealand (**51**). *Usnea dasaea* Stirt. 114

ADDITIONAL RECORDS OF LICHENS FROM AUSTRALIA

McCarthy, PM; Elix, JA—Additional lichen records from Australia (**86**). *Hymenelia ceracea* (Arnold) M.Choisy and *Thelenella fernandeziana* (Zahlbr.) H.Mayrhofer 118

RECENT LITERATURE ON AUSTRALASIAN LICHENS 123

Verrucaria kowenensis (lichenized Ascomycota, Verrucariaceae), a new species on soil in the Australian Capital Territory

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Abstract

Verrucaria kowenensis P.M.McCarthy (lichenized Ascomycota, Verrucariaceae) is described from consolidated, siliceous soil in the Australian Capital Territory. It has a pale greyish green or pale to medium greenish grey, areolate to pseudosquamulose thallus that is corticate, comparatively thick and dominated by algae. Perithecia are numerous, exceptionally minute, non-involucrellate and largely immersed in the thallus, with a black apex, the excipulum being colourless at the sides and base. The ascospores are 11–20 × 5–7.5 µm.

Introduction

Soil-inhabiting taxa form a very small minority among species of *Verrucaria sens. lat.*, most of which occupy terrestrial, freshwater and coastal rocks in temperate and cooler regions of the world. Among the Australian members of the genus, the usually saxicolous *V. nigrescens* Pers. and *V. compacta* (A.Massal.) Jatta can sometimes be found on compacted soil, while the endemic *V. solicola* P.M.McCarthy occurs on moist boggy soil in Mount Kosciuszko National Park, New South Wales and in southern and central Tasmania (McCarthy 1996, 2012). In this paper, a new and exceptionally diminutive species of *Verrucaria* is documented from consolidated, siliceous soil at two localities in the Australian Capital Territory.

Methods

Observations and measurements of photobiont cells, thalline and ascomatal anatomy, asci and ascospores were made on hand-cut sections mounted in water. Asci were also observed in Lugol's Iodine (I), with and without pretreatment with potassium hydroxide (K).

Verrucaria kowenensis P.M.McCarthy, sp. nov. Figs 1 & 2
MycoBank No.: **MB 832140**

Broadly similar to the terricolous Australian endemic *V. solicola*, but differs in having a thicker, areolate or ± minutely pseudosquamulose thallus with a bilayered cortex, much smaller perithecia with a thinner, paler exciple laterally and at the base, and shorter asci.

Type: Australia, Australian Capital Territory, Kowen Road, Kowen Forest, 11.7 km E of Canberra, 35°19'02"S, 149°15'07"E, 700 m alt., on consolidated, siliceous soil on an old road bank bordering dry *Eucalyptus* woodland, *P.M. McCarthy 4865*, 31.vii.2019; holotype – CANB.

Thallus terricolous, very inconspicuous, superficial, areolate or minutely pseudosquamulose (pseudosquamules distinguished by being slightly attenuated at the base), forming small, scattered colonies to 5 mm wide, pale greyish green or pale to medium greenish grey. *Areoles/pseudosquamules* rounded, ± ellipsoid or rounded-irregular, not angular, contiguous or scattered, 0.2–0.6(–0.9) mm wide, to 0.3 mm thick, corticate; surface smooth to minutely and irregularly uneven. *Cortex* usually distinctly bilayered in thin section; outer layer prosoplectenchymatous, ± hyaline to pale greenish grey, (8–)10–15 µm thick, the individual hyphae periclinal, long-celled, 1–1.5 µm thick; inner layer paraplectenchymatous, dark grey-brown, 6–12 µm thick, the individual cells rounded, thick-walled, 4–6 µm wide. *Photobiont cells* dominating the thallus, forming a layer 80–150(–200) µm deep; cells pale green, unicellular, ± globose, thin- to thick-walled, 5–13(–15) µm diam.; interstitial mycobiont cells (2–)2.5–3(–3.5) µm wide. *Medulla* nondescript, dominated by soil material; hyphae loose, 1.5–2 µm wide. *Lower cortex* and rhizohyphae absent. *Prothallus* not apparent; hypothallus absent. *Ascomata* perithecia, numerous, usually solitary, occasionally semi-immersed, mostly 2/3–3/4-immersed in the thallus, 1–5(–12) per areole/pseudosquamule, *c.* 80–130(–150) µm wide (immersed part);

perithecial apex dull black, smooth, convex to subconical, (70–)100(–120) µm wide [*n* = 50]; ostiole inconspicuous, usually in a minute, shallow depression 10–20 µm wide. *Involucrellum* absent. *Excipulum* 25–35 µm thick at and near the perithecial apex and mostly dark brown to blackish, with the cells ellipsoid to globose, thick-walled, 4–6 µm wide; lateral excipulum colourless, 20–25 µm thick; excipulum base colourless, 12–15 µm thick; sides and base consisting of elongate, moderately thick-walled, periclinal cells 7–10 × 1.5–2 µm. *Subhymenium* hyaline, 5–8(–10) µm thick. *Paraphyses* absent. *Periphyses* unbranched, 12–20(–25) × (1.5–) 2–3 µm, thick-walled and rather long-celled, with narrow lumina, the end-cells often narrowly clavate. *Hymenial gel* I+ red-brown, KI+ red-brown. *Asci* 8-spored, narrowly ellipsoid or narrowly to broadly clavate, 35–48 × 14–18 µm [*n* = 10], the apex lacking an ocular chamber; ascoplasm I+ orange-brown, KI–. *Ascospores* irregularly biseriate in the ascus, simple, colourless, narrowly to broadly ellipsoid or oblong-ellipsoid, occasionally the distal end slightly broader, ± straight, with rounded ends, (11–)16(–20) × (5–)6(–7.5) µm [*n* = 78]; wall *c.* 0.5 µm thick, lacking an epispore; contents clear or minutely granulose, often with 1 or 2 large vacuoles. *Pycnidia* not seen.

Etymology: The species epithet is derived from the type locality.

Remarks

Verrucaria kowenensis is characterized by the soil substratum, the comparatively thick, areolate or minutely pseudosquamulose thallus with a bilayered cortex, as well as minute, simple perithecia, each with a brown-black excipulum apex, but with colourless sides and base. By contrast, *V. solicola* has a rather thin, ecorticate thallus, 30–70(–120) µm thick, small areoles, 0.1–0.25(–0.4) mm wide, larger perithecia, 0.11–0.25 mm diam., having a thicker and much darker excipulum and longer asci (48–60 µm long).

Comparing this lichen with the few terricolous species known from the Northern Hemisphere, the perithecia of *V. kowenensis* are very much smaller than those of the boreal *V. geophila* Zahlbr. and *V. sibirica* Zahlbr. (Clauzade & Roux 1985). Furthermore, the ascospores are larger than the subglobose propagules of *V. bernaicensis* Malbr. and *V. terrigena* Zschacke, but are smaller than in *V. bryoctona* (Th.Fr.) Orange (Clauzade & Roux 1985; Orange 1991, 2013). The northern European species *V. xyloxena* Norman has somewhat similar perithecial morphology and dimensions, but the thallus of that species is granular-verrucose and composed of brown-pigmented goniocysts (Orange 1991, 2013).

The type specimen of *V. kowenensis* inhabited a dry, consolidated, siliceous soil bank beside *Eucalyptus*-dominated woodland in the Australian Capital Territory. It formed part of a species-poor lichen community along with extensive colonies of *Trapelia concentrica* Elix & P.M.McCarthy and an undescribed species of *Sarcogyne* Flot., and small thalli of a doubtfully lichenized *Arthonia* species. The second collection, a small fragment, was collected fortuitously.

ADDITIONAL SPECIMEN EXAMINED

Australian Capital Territory: ● Canberra Nature Park, Aranda Bushland, Powerline Track, *c.* 4 km W of Canberra, 35°16’00”S, 149°04’54”E, 690 m alt., on siliceous soil in open *Eucalyptus* woodland, *P.M. McCarthy 4869*, 14.viii.2019 (CANB).

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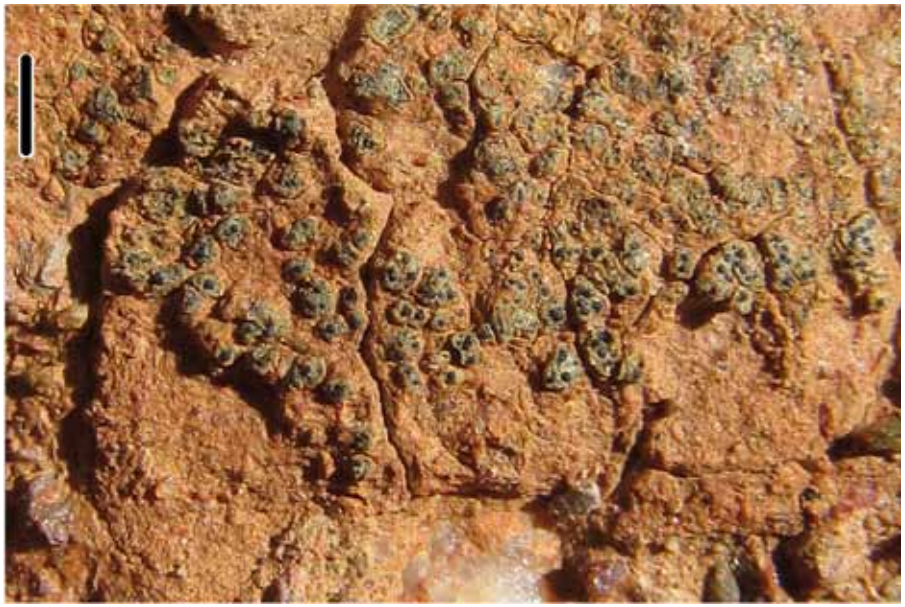

Figure 1. *Verrucaria kowenensis* (holotype). Scale: 1 mm.

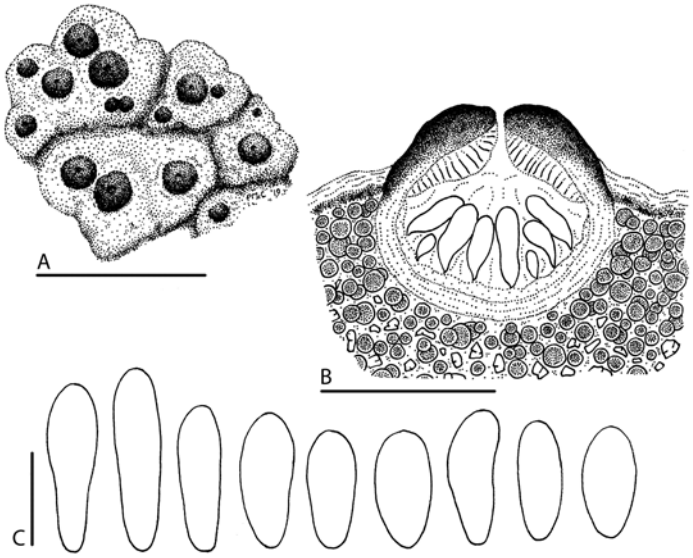

Figure 2. *Verrucaria kowenensis* (holotype). A, Habit of thallus and perithecial apices; B, Sectioned perithecium, with adjacent thallus (semi-schematic); C, Ascospores. Scales: A = 0.5 mm; B = 0.1 mm; C = 10 µm.

Pigments and new lichen substances in the lichen genus *Dirinaria*

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Abstract
The new combination *Dirinaria endocrocea* (D.D.Awasthi) Kalb, Schumm & Elix is proposed for *Dirinaria confusa* var. *endocrocea* D.D.Awasthi, and the new name *Dirinaria rhodocladonica* Kalb, Schumm & Elix is proposed for *Dirinaria confluens* var. *coccinea* (Lynge) D.D.Awasthi. Melanoclinin A & B, two pigments of unknown structure, were found in the apothecial pruina of *Dirinaria melanoclina*, *D. pruinosa* and *D. purpurascens*. The anthraquinone diacetylgraciliformin was identified in the lower medulla of most *Dirinaria* species. The naphthaquinones canarione and rhodocladonic acid were detected in the medulla of *Dirinaria leopoldii* and *D. coccinea*, and the latter substance was also found in the medulla of *D. endocrocea* and *D. rhodocladonica*. The relative Rf values for the pigments are recorded, and a key is provided to the *Dirinaria* species treated in this paper.

Introduction
Prior to the publication of "Some Lichens from tropical Africa. V" (Dodge 1971) and the world monograph of *Dirinaria* (Awasthi 1975), various species of *Dirinaria* were included in the genus *Pyxine* as *Pyxine* sect. *Dirinaria* (Tuckerman 1877) or in *Physcia* either as *Physcia* sect. *Dirinaria* (e.g. Vainio 1890; Zahlbruckner 1907, 1926, 1931) or as *Physcia* subgen. *Hypomelaena* (e.g. Lynge 1925; Thomson 1963). Although several species are difficult to distinguish (e.g. *Dirinaria picta* (Sw.) Schaer. ex Clem. and *D. applanata* (Fée) D.D.Awasthi or *D. confluens* (Fr.) D.D.Awasthi and *D. subconfluens* D.D.Awasthi), others are readily differentiated by the orange-red or brownish red pigments present in their thalline medulla or as a pruina on their apothecial discs. In this paper, we report on our efforts to identify those pigments.

Material and methods
Thin-layer chromatographic (TLC) studies were performed in solvents A, B′ and C (Elix 2014). To confirm the identity of the pigments, co-chromatograms with authentic samples of rhodocladonic acid and canarione (from an extract of *Lethariella canariensis*) were performed.

Results
Apart from several species with a pale lower cortex (*viz. D. complicata* D.D.Awasthi and *D. melanocarpa* (Müll.Arg.) C.W.Dodge, all the *Dirinaria* species examined produce an ochraceous, K+ purple pigment in the lower part of the medulla (Figures 1 and 2). However, it often eludes TLC investigations because in most specimens it is present in low concentration and is not evenly distributed in the thallus. To determine its TLC properties, we used a specimen of *Dirinaria aegialita* (Ach.) B.J.Moore (*Schumm 20315*) with the pigment present at the lobe apices in relatively high concentration (Figure 3). It produced a yellow spot on the TLC plates with relative Rf values 38, 34, 24, and was identified as the anthraquinone diacetylgraciliformin, first described from *Cladonia graciliformis* Zahlbr. (Ejiri *et al*. 1975).

Three *Dirinaria* species are known to have a reddish, reddish brown or purplish brown pruina on their apothecial discs, *viz*. *D. melanoclina* (C.Knight) D.D.Awasthi (Figure 4), *D. pruinosa* Kalb (Figure 5) and *D. purpurascens* (Vain.) B.J.Moore (Figure 6), while other species have non-pruinose or greyish-pruinose discs. In TLC the pruina produced two bluish grey spots on the plates after treatment with sulfuric acid and charring, spots that in daylight are almost invisible. We have called them melanoclinin A (Rf values: 33, 19, 28 in solvents A, B′ and C) and melanoclinin B (Rf values: 52, 31, 37). On addition of 10% KOH to a section of an apothecium seen under a microscope, the pruina turns greenish yellow.

***Dirinaria* species with an orange-red to coccineous pigment in the upper medulla**

Dirinaria coccinea (Müll.Arg.) D.D.Awasthi, *Bibliotheca Lichenologica* **2**, 53 (1975)
Physcia picta var. *coccinea* Müll.Arg., *Flora* **68**, 503 (1885).

Type: Africa. Kenya, Tchamtei in Duruma, Jan. 1877, *J.M.Hildebrandt 2350*, i.1877 (M – lectotype!, designated by D.D.Awasthi 1975: 53).

Chemistry: Atranorin (submajor), sekikaic acid (major), 4′-*O*-demethylsekikaic acid (minor), rhodocladonic acid (minor), canarione (submajor), terpenes.

Dirinaria endocrocea (D.D.Awasthi) Kalb, Schumm & Elix, comb. nov.
MycoBank No. **MB 831496**

Basionym: *Dirinaria confusa* var. *endocrocea* D.D.Awasthi, *Bibliotheca Lichenologica* **2**, 60 (1975).

Type: Brazil. Rio de Janeiro, Boa Vista (in horto), *G.O.A. Malme 105*, 18.vii.1892 (S – holotype!; UPS – isotype!).

Chemistry: Atranorin (submajor), sekikaic acid (major), 4′-*O*-demethylsekikaic acid (minor), 3-hydroxynordivaricatinic acid (major; Rf values: 5, 3, 5), rhodocladonic acid (submajor), terpenes.

Remarks
As in other genera of the Physciaceae (e.g. *Hyperphyscia* [Moberg 1987] and *Phaeophyscia* [Moberg 1995]), the presence or absence of the red anthraquinione skyrin is used to delimit taxa at the species level. The species *Hyperphyscia pandani* (H.Magn.) Moberg, *Phaeophyscia endococcinea* (Körg.) Moberg, *P. pyrrhophora* (Poelt) Awasthi & Joshi and *P. rubropulchra* (Degel.) Essl. are all distinguished from other members of the two genera by their orange to red medulla due to the presence of skyrin. With *Dirinaria*, we are similarly using the presence or absence of the red naphthaquinone rhodocladonic acid as a diagnostic character at the species level. Thus, in our opinion the presence of rhodocladonic acid in *Dirinaria confusa* var. *endocrocea* warrants its recognition as a separate species (a description of it is given by Awasthi (1975)).

Dirinaria leopoldii (Stein) D.D.Awasthi, *Bibliotheca Lichenologica* **2**, 89 (1975) Figure 7
Crocynia leopoldii Stein, *Jahresberichte der Schlesischen Gesellschaft für vaterländische Cultur* **66**, 140 (1888).

Type: Democratic Republic of the Congo [Belgisch Congo]. Vivi, an *Ficus*-Ästen, *Ledien s.n*., 1885/86 (G – lectotype, designated by D.D.Awasthi 1975: 89, not seen).

Chemistry: Atranorin (submajor), sekikaic acid (major), 4'-*O*-demethylsekikaic acid (minor), rhodocladonic acid (major), canarione (submajor), terpenes.

Remarks
Our TLC results confirm that the type specimens of *Dirinaria leopoldii* and *D. coccinea* have identical chemistry, and therefore the two species can be regarded as a species pair (Poelt 1970). Whereas the primary species (*D. coccinea*) is known from Africa only, its sorediate counterpart is known from south-eastern U.S.A., South America, Cuba and Africa. Two photographs showing the distribution of pigments in its thallus are presented in Schumm & Elix (2014: 277), and a full description is given in Awasthi (1975).

Dirinaria rhodocladonica Kalb, Schumm & Elix, nom. nov. Figure 8
MycoBank No. **MB 831497**
Basionym: *Physcia aegialita* f. *coccinea* Lynge, *Videnskapsselskapets Skrifter I. Mat.-Naturv. Klasse* 1924, **16**, 43 (1925).
Synonym: *Dirinaria confluens* var. *coccinea* (Lynge) D.D.Awasthi, *Bibliotheca Lichenologica* **2**, 31 (1975).

Type: Brazil. Mato Grosso, Corumbá ad Cereum arborescentem [*Cereus* sp.], *G.O.A. Malme*, 26.vii.1894 (S – lectotype!, selected by D.D.Awasthi 1975: 31; LD, UPS – isolectotypes, not seen); Mato Grosso, Corumbá, in silva clara regionis calcariae, *G.O.A. Malme*, 8.viii.1894 (H – paratype!).

Chemistry: Atranorin (major), divaricatic acid (major), nordivaricatic acid (minor to trace), rhodocladonic acid (submajor to minor), terpenes.

Remarks
Here we propose raising *Dirinaria confluens* var. *coccinea* to species level using the same argument that we did with *Dirinaria endocrocea*. However, we could not use the epithet *coccinea*, because *D. coccinea* (Müll.Arg.) D.D.Awasthi already exists.

The epithet is derived from the chemistry of the species. A description is given in Awasthi (1975, as *Dirinaria confluens* var. *coccinea*).

Key to *Dirinaria* species with reddish brown, purplish brown, red-purple or coccineous pigments

1 Pigments restricted to the discs of the apothecia; divaricatic acid present 2
1: Pigments located in the medulla of the thallus; divaricatic or sekikaic acid present 4

2 Thallus without vegetative propagules; North and South America, South Africa, Australia ..... ***Dirinaria purpurascens***
2: Thallus with soralia or polysidiangia..... 3

3 Thallus with soralia; South Africa, Australia..... ***Dirinaria melanoclina***
3: Thallus with polysidiangia; South America..... ***Dirinaria pruinosa***

4 Thallus with soralia; sekikaic acid present; south-eastern U.S.A., South America, Cuba and Africa..... ***Dirinaria leopoldii***
4: Thallus without vegetative propagules; divaricatic or sekikaic acid present 5

5 Divaricatic acid present; South America ..... ***Dirinaria rhodocladonica***
5: Sekikaic acid present, South America or Africa..... 6

6 Medulla with rhodocladonic acid and canarione; Africa ..... ***Dirinaria coccinea***
6: Medulla with rhodocladonic acid only; South America ..... ***Dirinaria endocrocea***

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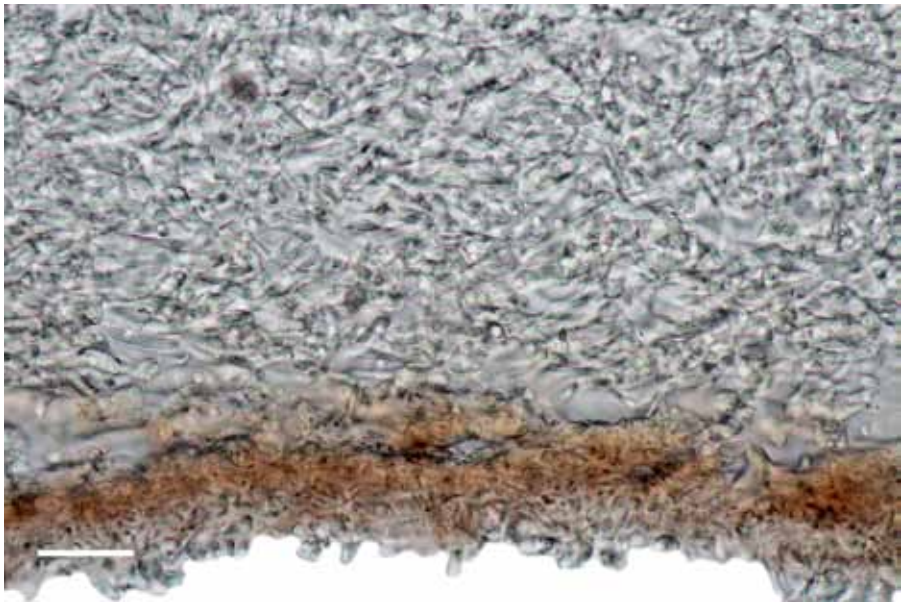

Figure 1. *Dirinaria aegialita* (*Schumm 20315* – herb. F. Schumm); longitudinal section through lower part near the lobe apex, showing the ochraceous layer with the anthraquinone diacetylgraciliformin. Bar = 20 μm.

Figure 2. *Dirinaria aegialita* (*Schumm 20315* – herb. F. Schumm); lower side of lobe apices, showing the K+ purple reaction (arrow) of diacetylgraciliformin. Bar = 0.5 mm.

Figure 3. *Dirinaria aegialita* (*Schumm 20315* – herb. F. Schumm); lower side of lobe apices, showing the high concentration of the ochraceous pigment diacetylgraciliformin and the hapters. Bar = 1 mm.

Figure 4. *Dirinaria melanoclina* (*Kalb 33905* – herb. K.Kalb). Apothecia, showing the thick purplish brown pruina with melanoclinin A and melanoclinin B. Bar = 0.5 mm.

Figure 5. *Dirinaria pruinosa* (*Kalb 26837* – herb. K.Kalb). Apothecia, showing the granular purplish brown pruina with melanoclinin A and melanoclinin B. Bar = 0.5 mm.

Figure 6. *Dirinaria purpurascens* (*Kalb 21119* – herb. K.Kalb), showing the thin purplish-brown apothecial disc pruina with melanoclinin A and melanoclinin B. Bar = 0.5 mm.

Figure 7. *Dirinaria leopoldii* (*Kalb 11346* – herb. K.Kalb). Subdichotomously or pinnately divided lobes with flabellate apices and cinnabar-red coloured soralia, caused by a mixture of rhodocladonic acid and canarione. Bar = 2 mm.

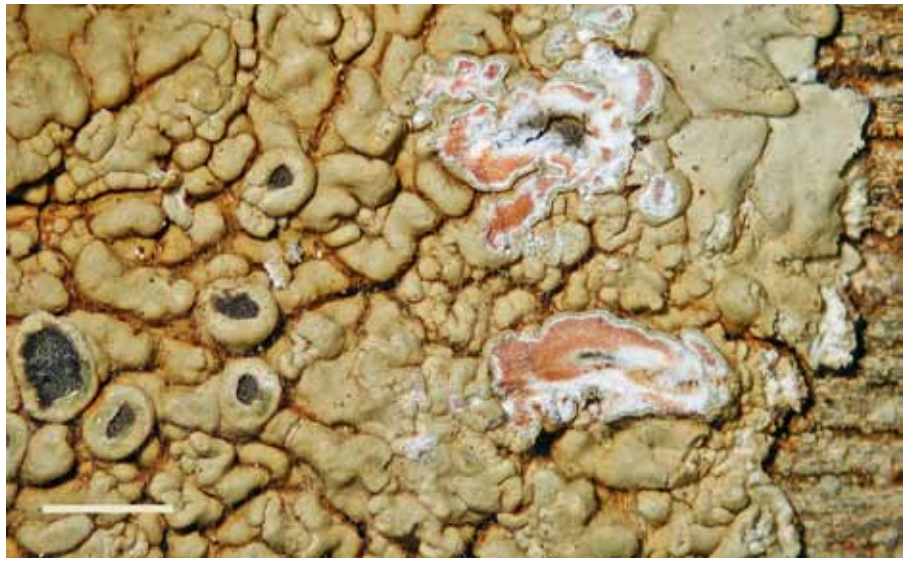

Figure 8. *Dirinaria rhodocladonica* (*Kalb 42542* – herb. K.Kalb). Upper part of the red-purple medulla caused by rhodocladonic acid and seen when the cortex is removed. Bar = 1 mm.

Six new species, a new variety, a new report and two new records in the Australian Pertusariaceae (Pertusariales, lichenized Ascomycota)

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Abstract
Three species of *Lepra* (*L. elatinica* A.W.Archer & Elix and *L. perlacericans* A.W.Archer & Elix from New South Wales and *L. arida* A.W.Archer & Elix from Victoria) and four taxa of *Pertusaria* (*P. alloisidiosa* A.W.Archer & Elix from the Northern Territory and Queensland, *P. copiocarpa* A.W.Archer & Elix from Victoria, *P. macroides* from New South Wales and Tasmania and *P. microstoma* var. *deficiens* from Queensland) are described as new to science. The new combination *Lepra leeuwenii* (Zahlbr.) A.W.Archer & Elix is proposed for *Pertusaria leeuwenii* Zahlbr. *Pertusaria expolita* R.C.Harris is reported as an earlier name for *P. balekensis* A.W.Archer & Elix, originally described from Papua New Guinea. *Lepra dactylina* (Ach.) Hafellner and *Pertusaria simoneana* A.W.Archer & Elix are reported for the first time from Australia.

Introduction
This paper continues our work on the Australian Pertusariceae (Archer & Elix 2009a, 2010, 2014, 2016, 2017a, 2017b, 2019). Three new species of *Lepra* Scop. and four new taxa of *Pertusaria sens. nov*. are described. The specimens were collected by W.H. Ewers, M. Mayrhofer, H. Streimann and D. Verdon from the Northern Territory, Queensland, New South Wales and Victoria between 1981 and 1999.

The specimens were examined microscopically, and their chemistry studied by thin-layer chromatography (Elix 2014) and comparison with authentic samples. The specimens were photographed with a Canon EOS 450D fitted with a Canon Macro Photo lens (MP-E65mm f 2.8 1–5x).

New taxa

1. *Lepra arida* A.W.Archer & Elix, sp. nov. Figs 1–3
MycoBank No. **MB 832123**

Similar to *Lepra thamnolica* (A.W.Archer) A.W.Archer & Elix, but differs in having larger ascospores, 44–62 × 20–30 µm, and in containing 5-*O*-methylhiascic acid.

Type: Australia. Victoria, Lowan Mallee Region, Little Desert National Park, S of Kaniva, 36°33'S, 141°38'E, on *Hakea* sp., *M. Mayrhofer 2827*, 18.viii.1981 (holotype – CANB).

Thallus corticolous, off-white, conspicuously rimose; surface smooth and subtuberculate, lacking isidia and soralia. *Apothecia* disciform, numerous, conspicuous, sessile, 0.4–0.75 mm diam.; disc white-pruinose. *Ascospores* 4–6 per ascus, 1–2-seriate, hyaline, ellipsoid, with a single wall, (44–)54–62 µm long and 20–30 µm wide.
Chemistry: 5-*O*-Methylhiascic acid (major) and gyrophoric acid (minor).

Etymology: From the Latin *aridus*, dry, a reference to the type locality in the Little Desert National Park.

Remarks
Lepra arida is characterized by its conspicuous disciform apothecia and chemistry. It is distinguished from similar eight-spored *Lepra* species found in Australia, *viz*. *L. thamnolica* and *L. truncata* (Kremp.) A.W.Archer & Elix, by its chemistry and the size of its ascospores. *Lepra thamnolica* contains thamnolic acid and *L. truncata* contains picrolichenic acid; furthermore, the ascospores of the two species are 22–32 µm and 19–27 µm long, respectively, compared to those of *L. arida*, which are 44–62 µm long.

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

2. *Lepra elatinica* A.W.Archer & Elix, sp. nov. Fig. 4
MycoBank no. **MB 832124**

Similar to *Lepra subventosa* (Malme) I.Schmitt & Lumbsch, but differs in growing on bark and in containing elatinic acid rather than lichexanthone, picrolichenic and thamnolic acids.

Type: Australia. New South Wales, Moppy Lookout, Barrington Tops State Forest, 40 km WNW of Gloucester, 31°53' S, 151°32' E, 1200 m alt., on *Nothofagus* stem in *Nothofagus*-dominated forest on gentle slope, *H. Streimann 44439*, 26.iv.1990 (holotype–CANB).

Thallus corticolous, very pale olive-green; surface smooth, somewhat cracked, sorediate, lacking isidia. *Soralia* conspicuous, numerous, crowded, off-white, sessile, becoming substipitate, 0.2–0.35 mm diam. Apothecia and ascospores not seen.
Chemistry: Elatinic acid (minor), lichesterinic acid (major) and protolichesterinic acid (major).

Etymology: the epithet *elatinica* refers to the elatinic acid present in the species.

Remarks
Lepra elatinica is characterized by the sorediate thallus and the presence of elatinic acid. It is distinguished from other Australian sterile, sorediate species by its chemistry, in particular by the presence of elatinic acid. *Lepra subventosa* is the most common sorediate species of *Lepra* in eastern Australia, but always occurs on rocks and differs in containing lichexanthone, picrolichenic acid and thamnolic acid. Elatinic acid has been observed as a minor substance in a chemical race of *Lepra tropica* Vain. (Elix *et al.* 2002), but *L. tropica* differs from *L. elatinica* in having an esorediate thallus and in containing lichexanthone and hypothamnolic acid as major substances.

3. *Lepra perlacericans* A.W.Archer & Elix, sp. nov. Figs 5, 6
MycoBank no. **MB 832125**

Similar to *Lepra lacericans* (A.W.Archer) A.W.Archer & Elix, but differs in having larger ascospores, 220–328 × 60–88 µm, and in containing additional caperatic acid.

Type: Australia. New South Wales, Mt Gibraltar, Marsh State Forest, 24 km NNW of Taree, 31°38'S, 152°25'E, 850 m alt., on semi-exposed shrub branches in *Melaleuca* and *Eucalyptus* scrub on side of hill, *H. Streimann 60510*, 17.iv.1998 (holotype – CANB).

Thallus corticolous, pale olive-green; surface smooth, conspicuously rimose, with numerous immature, white, disciform apothecia, lacking soredia and isidia. *Apothecia* rarely mature, disciform, white, 0.7–1.1 mm diam., margins lacerate, disc white. *Ascospores* 1 per ascus, elongate-ellipsoid, with single smooth walls, 220–328 µm long and 60–88 µm wide, filled with fine, pale brown granules.
Chemistry: Protocetraric acid (major) and caperatic acid (major)

Etymology: From the Latin, *per*, very, and *lacericans*, from the species *Lepra lacericans*, which the new species resembles but from which it differs in having larger ascospores.

Remarks

Lepra perlacericans is characterized by the numerous immature apothecia, rarely mature, disciform apothecia with large ascospores and the presence of protocetraric and caperatic acids. It is distinguished from the somewhat similar *Lepra lacericans* (Archer 1997; Archer & Elix 2018) by the larger ascospores, 220–328 µm long in *L. perlacericans* compared to 170–180 µm long in *L. lacericans*, and the presence of additional caperatic acid, which is absent from *L. lacericans*.

At present the new species is known from only two collections from northern New South Wales. Two other *Lepra* species are known to have disciform apothecia and large ascospores and to contain protocetraric acid, namely *Lepra sejilaensis* (Q.Ren) I.Schmitt, B.P.Hodk. & Lumbsch from China, with ascospores (190–)210–240(–250) × 60–90 µm (Ren 2014), and *Lepra leeuwenii* (Zahlbr.) A.W.Archer & Elix (Zahlbruckner 1928, as *Pertusaria leeuwenii*) from Indonesia, with ascospores 220–225 × 40–45 µm. The ascospores in both species are smaller than those in *L. perlacericans*, and neither species contains caperatic acid.

SPECIMEN EXAMINED

New South Wales: ● North Coast, Muldiva, 10 km NW of Dorrigo, 30°18'S, 152°37'E, 750 m alt., on upper trunk of fallen tree in poor disturbed, shrubby forest with dense privet (*Ligustrum*) infestation, *H. Streimann 63659*, 14.vi.1999 (B, CANB, NY).

4. *Pertusaria alloisidiosa* A.W.Archer & Elix, sp. nov. Figs 7–9
MycoBank no. **MB 832126**

Similar to *Pertusaria isidosa* A.W.Archer, but differs in having 8-spored asci, smaller ascospores, 50–64 × 20–26 µm, and in containing 5-*O*-methylhiascic and gyrophoric acids.

Type: Australia. Northern Territory, Mt Brockman complex, 15 km SSE of Jabiru airfield, 12°48"S, 132°56"E, 230 m alt., on dead tree trunk in *Allosyncarpia*-dominated vegetation among deeply dissected sandstone outcrops, *H. Streimann 42299*, 20.iv.1989 (holotype – CANB).

Thallus corticolous, off-white to pale yellow-white or pale fawn, thin, forming patches on the substratum, isidiate. *Isidia* numerous, short, simple, up to 0.2 mm tall. *Apothecia* flattened-hemispherical, constricted at the base, scattered, isidiate, rarely confluent, 0.5–0.75 mm diam. *Ostioles* 2–8 per apothecium, inconspicuous, pale orange to almost colourless. *Ascospores* 8 per ascus, imbricate, 1-seriate, narrowly ellipsoid, hyaline, inner spore wall smooth, 50–64 µm long and 20–26 µm wide.
Chemistry: 5-*O*-Methylhiasic acid (major), gyrophoric acid (minor).

Etymology: from the Latin *allo*, another, and *isidiosa*, a previously used epithet.

Remarks

This species is characterized by the thin, off-white to pale yellow-white or fawn thallus with scattered isidia, flattened-hemispherical apothecia with pale orange ostioles, 8-spored asci, smooth-walled ascospores and the presence of 5-*O*-methylhiascic and gyrophoric acids. Morphologically, it resembles the isidiate Australian *P. isidiosa* A.W.Archer and *P. subisidiosa* A.W.Archer (Archer 1991). *Pertusaria isidiosa* differs in having 2-spored asci, larger ascospores, 100–112 × 30–35 µm, and in containing lichexanthone, stictic and 2'-*O*-methylperlatolic acid, whereas *P. subisidiosa* has 4-spored asci, larger, rough-walled ascospores 80–95 × 30–35 µm, and contains stictic acid and 2,4,5-trichlorolichexanthone, 2,4-dichlorolichexanthone, 2,5-dichlorolichexanthone and 2-chlorolichexanthone. 5-*O*-Methylhiasic acid is also found as a major lichen acid in two non-isidiate species, *Pertusaria flavoexpansa* Kantvilas & Elix from Tasmania (Kantvilas & Elix 2008) [1 spore/ascus, spores 130–220 × 40–110 µm] and *P. mccroryae* C.R.Björk, Goward & T.Sprib. [with additional stictic acid, 8 spores/ascus, spores 32–54 × 15–20 µm] from Alaska (Spribille *et al.* 2010).

At present, the new species is known from two localities in the Northern Territory and Queensland.

SPECIMEN EXAMINED

Queensland: ● Charleys Creek, 18 km NNE of Proserpine, 19°15'S, 148°39'E, 50 m alt., on tree trunk in scrubby forest on rocky hillside, *H. Streimann 37621 pr.p.*, 30.vi.1986 (CANB - growing with *Pertusaria flavoisidiata* A.W.Archer & Elix).

5. *Pertusaria copiofructa* A.W.Archer & Elix, sp. nov. Figs 10, 11
MycoBank no. **MB 832127**

Similar to *Pertusaria neolecanina* Lumbsch & T.H.Nash, but differs in having crowded apothecia and in lacking thiophaninic acid.

Type: Australia. Victoria, Wyperfeld National Park, collected near main camping ground along bitumen road into main camping area, along 9 mile Square Road, 35°26'S, 141°58'E, on twig, *W.H. Ewers 1115B*, 21.iv.1987 (holotype – CANB).

Thallus corticolous, off-white; surface smooth, rimose, lacking isidia and soralia. *Apothecia* conspicuous, numerous, crowded, verruciform, initially flattened-hemispherical, becoming distorted when crowded, 0.5–0.75 mm wide. *Ostioles* conspicuous, black, 1 per apothecium, 0.25–0.5 mm diam. *Ascospores* 2 per ascus, hyaline, ellipsoid, with a smooth inner wall, 90–125 µm long and 36–45 µm wide.
Chemistry: Norstictic acid (major) and connorstictic acid (trace).

Etymology: From the Latin *copia*, plenty and *fructa*, fruit, a reference to the crowded apothecia.

Remarks

Pertusaria copiofructa is characterized by the crowded apothecia, asci with 2, smooth-walled ascospores and the presence of norstictic acid. It closely resembles *P. neolecanina* from North America and Australia (Lumbsch *et al*. 1999) which also has conspicuous black ostioles and asci with 2 ascospores, similar in size to those of *P. copiofructa*, *viz*. 95–118 × 35–40 µm, but contains norstictic acid and thiophaninic acid. It also resembles *P. luteola* Boqueras from Spain, but the latter has smaller ascospores, 70–95 × 25–35 µm, and contains additional thiophaninic acid.

At present the new species is known from only the type locality in Victoria.

6. *Pertusaria macroides* A.W.Archer & Elix, sp. nov. Figs 12–14
MycoBank no. **MB 832128**

Similar to *Pertusaria macra* Müll.Arg., but differs in lacking lichen substances.

Type: Australia. New South Wales, Cooma–Dry Plains road, 15 km NW of Cooma, 36°09'S, 148°59'E, 800 m alt., on basalt in grazed grassland on flats with small basalt outcrops, *H. Streimann 50506*, 24.xii.1992 (holotype – CANB; isotype – B).

Thallus saxicolous, off-white to pale grey, conspicuously areolate, the areoles irregular in shape, 0.5–1 mm wide, most with an immature or mature apothecium. *Ostioles* conspicuous, gaping, 1 per apothecium, grey to black, 0.3–0.6 mm diam. *Ascospores* 8 per ascus, hyaline, predominantly 2-seriate, ovoid, inner wall smooth, 34–48 µm long and 16–24 µm wide.
Chemistry: No lichen substances detected by TLC.

Etymology: From the Greek, *-oides*, indicating a resemblance, and the specific epithet *macra*, relating to *Pertusaria macra* Müll.Arg.

Remarks

Pertusaria macroides is characterized by the saxicolous, areloate thallus, 8 small, ovoid ascospores per ascus and by the absence of lichen substances. The areolate, saxicolous thallus

and the small ascospores are similar to those in the Australian endemic *Pertusaria macra* Müll.Arg. (Müller 1893), which has ascospores measuring 32–36 × 17–20 µm, but it differs from *P. macroides* in containing stictic acid. The two species also differ in their distribution. *Pertusaria macra* was collected on Thursday Island, in tropical northern Australia, in contrast to the Southern Tablelands of New South Wales and Tasmania.

ADDITIONAL SPECIMEN EXAMINED
Tasmania: ● *c.* 1 km W of Circular Marsh, on eastern side of Pine River, 41°59'S, 146°28'E, 50 m alt., on dolerite boulders, *G. Kantvilas 75/14 pr.p.*, 20.ii.2014 (HO).

7. *Pertusaria microstoma* var. ***deficiens*** A.W.Archer & Elix, var. nov. Figs 15, 16
MycoBank no. **MB 832129**

Morphologically similar to *Pertusaria microstoma* Müll.Arg. var. *microstoma*, but differs in lacking stictic acid and in containing planaic acid.

Type: Australia. Queensland, Port Curtis District, 1 km S of Raglan along Bruce Highway, *c*. 52 km SE of Rockhampton, 23°44'S, 150°49'E, on *Alphitonia excelsa* trunk in broad gully in *Eucalyptus-Acacia* woodland, *D. Verdon 5481B*, 26.i.1983 (holotype – CANB).

Thallus corticolous, off-white, subtuberculate and cracked, lacking soralia and isidia. *Apothecia* verruciform, hemispherical, numerous, scattered, rarely confluent, 0.5–1.0 mm diam. *Ostioles* conspicuous, black, punctiform, 1 per apothecium. *Ascospores* 4 per ascus, ellipsoid, hyaline, inner ascospore wall rough, 80–84 µm long and 28–36 µm wide.
Chemistry: 4,5-dichlorolichexanthone (minor), 2'-*O*-methylperlatolic acid (major), planaic acid (minor).

Etymology: From the Latin *deficiens*, lacking, a reference to the absence of stictic acid.

Remarks
Pertusaria microstoma var. *deficiens* is morphologically identical to *P. microstoma* var. *microstoma* Müll.Arg. with four (but sometimes 2–3) ascospores per ascus with rough walls (Müller 1882). Recent chemical analysis showed that this species contains 4,5-dichlorolichexanthone, 2'-*O*-methylperlatolic and stictic acids (Archer 1997). *Pertusaria microstoma* var. *microstoma* is a tropical species first described from Indonesia, but also occurs in Papua New Guinea, New Caledonia and northern Queensland. *Pertusaria microstoma* var. *deficiens* is the southernmost collection of *P. microstoma sens. lat.* in Australia. *Pertusaria javanica* Müll.Arg. from Indonesia also has 4-spored asci and ascospores with rough inner walls, but its ascospores are considerably larger, 95–125 × 35–45 µm wide, and it contains only stictic acid (Müller 1884).
At present the new species is known only from the type collection.

New combination

Lepra leeuwenii (Zahlbr.) A.W.Archer & Elix, comb. nov.
MycoBank No **MB 832130**

Basionym: *Pertusaria leeuwenii* Zahlbr., *Annales de Cryptogamie Exotique* **1**, 190 (1928)
Type: Indonesia, Java, Mount Gede [Gedeh], corticolous at margin of primary forest, *W. van Leeuwen 248 pr.p.* (holotype – W).

New report

Pertusaria expolita R.C.Harris, *Some Florida Lichens*: 60 (1990) Fig. 17

Type: U.S.A. Florida, Nassau County, just E of Lofton Creek on Florida Highway A1A, 5.5 miles W of Amelia River, hardwood swamp, *R.C.Harris 21180*, 17.xii.1987 (holotype – NY).
= *Pertusaria balekensis* A.W.Archer & Elix, *Mycotaxon* **67**, 158 (1998)
Type: Papua New Guinea, Madang Province, Balek Wild Life Sanctuary, *c*. 15 km S of Madang, *A. Aptroot 36802*, 3.xi.1995 (holotype – CANB; isotype – herb. Aptroot).

Pertusaria expolita is a sterile, corticolous, sorediate species containing 4,5-dichlorolichexanthone and stictic acid, known originally from a single collection from Florida (Harris 1990). *Pertusaria balekensis* from Papua New Guinea is chemically and morphologically identical to *P. expolita*, and is here reduced to synonymy with the latter. This greatly increases the known distribution of *P. expolita*, which now appears to be almost pantropical, being known from Florida, Thailand, Papua New Guinea, Fiji, Norfolk Island, Lord Howe Island and mainland Australia. It is both corticolous and saxicolous (*vide infra*).

SPECIMENS EXAMINED
Australia. New South Wales: ● Lord Howe Island, track to Intermediate Hill via North Hummock, 31°32'45"S, 159°04'55"E, 120 m alt., on basalt in lowland forest, *J.A. Elix 42036*, 5.ii.1995 (CANB); ● Lord Howe Island, track from Smoky Tree Ridge to Rocky Run, 31°33'20"S, 159°05'15"E, 80 m alt., on tree trunk in lowland forest, *J.A. Elix 42446*, 10.ii.1995 (CANB). *Victoria*: ● Errinundra National Park, Errinundra Saddle Rainforest Walk, 24 km SE of Bonang, 37°19'03"S, 148°50'19"E, 910 m alt., on dead *Acacia* in cool temperate rainforest *J.A. Elix 39048*. 16.iv.2008 (CANB).
Fiji. ● Viti Levu, Nausori Highlands, Nandi–Sigatoka road, 4 km E of Venturu Dam turnoff, on tree in regrowth area along roadside, *J.A. Elix 15148*, 26.viii.1983 (CANB). *Norfolk Island*: ● Track E of Mt Bates, Mount Bates National Park, 29°00'40"S, 167°56'20"E, 280 m alt., on guava twigs, *J.A. Elix 29006*, 15.vi.1992 (CANB).
Papua New Guinea. ● Central Province, Varirata National Park, *c*. 22 km E of Port Moresby, 9°26'S, 147°21'E, 800 m alt., *A. Aptroot 39605*, 23.x.1995 (herb. Aptroot).
Thailand. ● Trat Province, Ban-Dan Kao Island, 12°21'N, 102°55'E, 5 m alt., on bark in mangrove forest, *F. Schumm 17543*, 15.i.2012 (herb. Schumm).

New records

1. *Lepra dactylina* (Ach.) Hafellner, *in* Hafellner & Türk, *Stapfia* **104**, 171 (2016)

This terricolous or muscicolous, arctic-alpine species is circumpolar in the Northern Hemisphere, but also occurs in New Zealand (Galloway 2007) and Macquarie Island (McCarthy 2018). It is characterized by a white to off-white, isidiate thallus with mainly simple, crowded, cylindrical isidia, 1–2.5 mm tall, 0.4–1 mm diam. It contains fumarprotocetraric acid. A detailed description is given in Chambers *et al.* (2009 – as *Pertusaria dactylina*).

SPECIMEN EXAMINED
Tasmania: ● Near Liffey Bluff, 15 km N of Breona, 41°43'S, 146°43'E, 1150 m alt., on base of pencil pine in pencil pine bog, *J.A. Elix 27278*, 30.iv.1992 (CANB).

2. *Pertusaria simoneana* A.W.Archer & Elix, *Nova Hedwigia* **88**, 4 (2009)

This corticolous species was previously known from New Caledonia (Archer & Elix 2009b). It is characterized by a pale olive-green, isidiate thallus with short, stubby, simple, crowded, cylindrical isidia, which sometimes become slightly swollen at the apices, 0.15–0.2 mm tall, 0.05–0.1 mm diam. It contains arthothelin (major), 6-*O*-methylarthothelin (minor), 4,5-dichloronorlichexanthone (minor), 2,4-dichloronorlichexanthone (minor) and 4,5-dichloro-6-*O*-methylnorlichexanthone (minor). A description and illustration are given in Archer & Elix (2009b).

SPECIMENS EXAMINED

Queensland: ● Corner of Dalrymple and Black Roads, 6 km NE of Eungella, 21°06'S, 148°32'E, 910 m alt., on semi-exposed treelet stem in grasslands with scattered *Acacia* and *Alphitonia*, *H. Streimann 64205 & T. Pocs*, 19.viii.1999 (CANB). *New South Wales*: ● Lord Howe Island, Rocky Run, 31°33'20"S, 159°06'E, 50 m alt., on bark, *D.J. Ramm 30A*, xi.1986 (CANB).

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Figure 1. *Lepra arida* (holotype CANB), *M. Mayrhofer 2827*, habit of thallus. Bar = 1 mm.

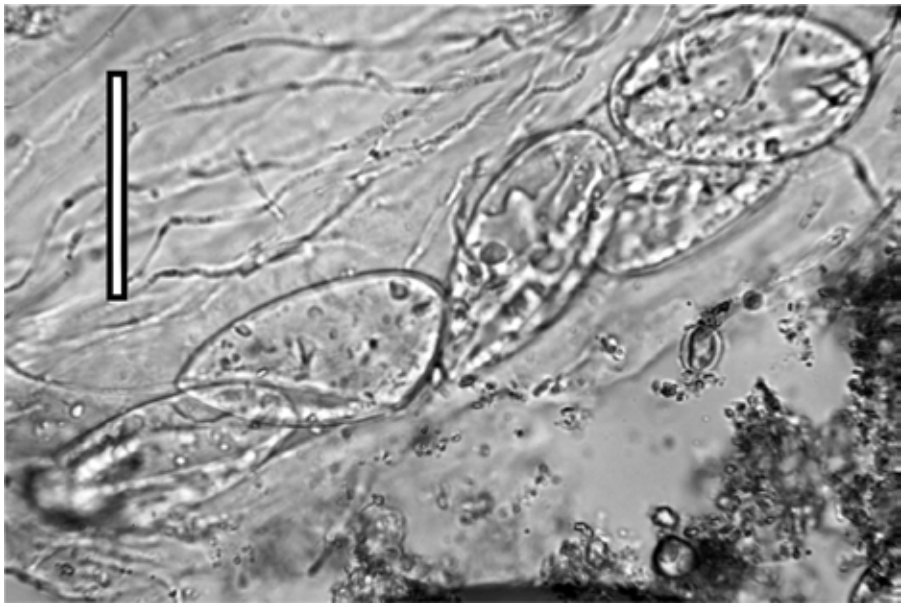

Figure 2. *Lepra arida* (holotype CANB), ascospores in ascus. Bar = 50 µm.

Figure 3. *Lepra arida* (holotype CANB), ascospore. Bar = 50 µm.

Figure 4. *Lepra elatinica* (holotype CANB). *H. Streimann 44439*, habit of thallus. Bar = 1 mm.

Figure 5. *Lepra perlacericans* (holotype CANB), *H. Streimann 60510*, habit. Bar = 1 mm.

Figure 6. *Lepra perlacericans* (holotype CANB), ascospore. Bar = 100 µm.

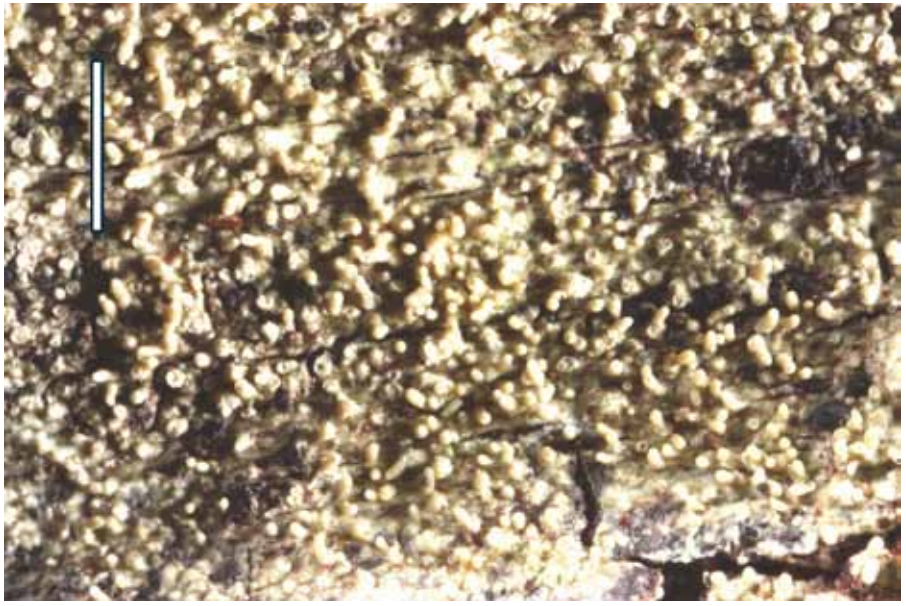

Figure 7. *Pertusaria alloisidiosa* holotype CANB), *H. Streimann 42299*, habit. Bar = 1 mm.

Figure 8. *Pertusaria alloisidiosa* (holotype CANB), apothecia. Bar = 1 mm.

Figure 9. *Pertusaria alloisidiosa* (holotype CANB), ascospores. Bar = 50 µm.

Figure 10. *Pertusaria copiofructa* (holotype CANB), *W. Ewers 1115B*, habit. Bar = 1 mm.

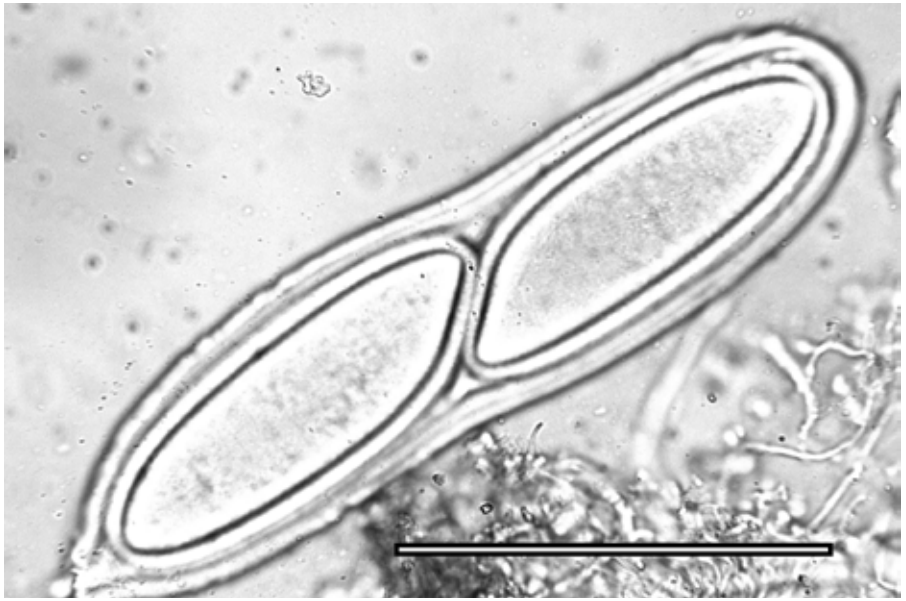

Figure 11. *Pertusaria copiofructa* (holotype CANB), ascospores. Bar = 100 µm.

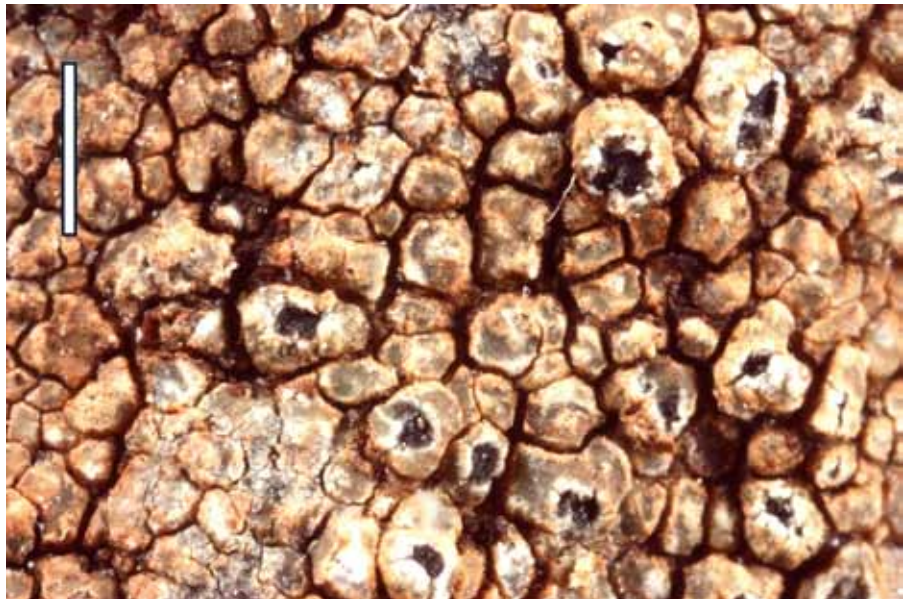

Figure 12. *Pertusaria macroides* (holotype CANB) *H. Streimann 50506*, habit. Bar = 1 mm.

Figure 13. *Pertusaria macroides* (holotype CANB), ascospores in ascus. Bar = 50 µm.

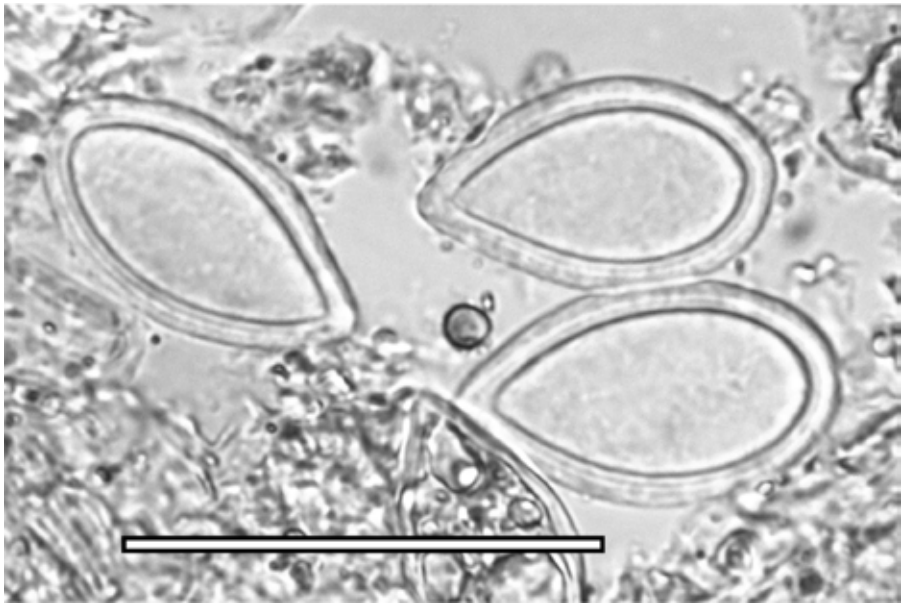

Figure 14. *Pertusaria macroides* (holotype CANB), individual ascospores. Bar = 50 µm.

Figure 15. *Pertusaria microstoma* var. *deficiens* A.W.Archer & Elix (holotype CANB) *D. Verdon 5481B*, habit. Bar = 1 mm.

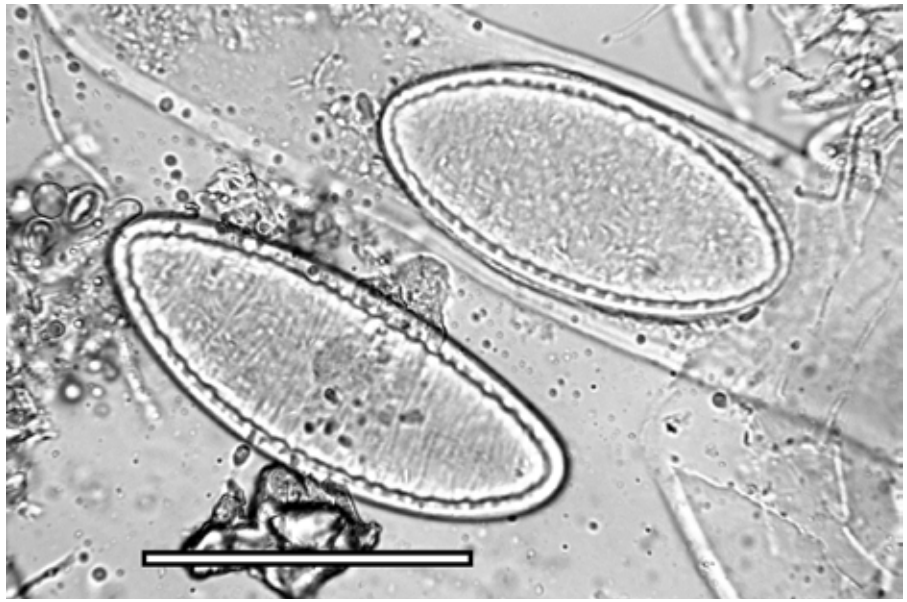

Figure 16. *Pertusaria microstoma* var. *deficiens* A.W.Archer & Elix (holotype CANB), ascospores. Bar = 50 µm.

Figure 17. *Pertusaria expolita* R.C.Harris, *H. Streimann 38285* (CANB). Bar = 1 mm.

Three new species of buellioid lichens (Caliciaceae, Ascomycota) from south-eastern Australia

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Abstract
Amandinea bittangabeensis Elix & P.M.McCarthy, *A. hypohyalina* Elix & P.M.McCarthy and *Buellia quarryana* Elix & P.M.McCarthy are described as new to science.

Introduction
This paper continues our investigation of *Buellia*-like lichens in Australia. For the more recent additions, see Elix *et al.* (2017) and Elix & McCarthy (2018) and references cited therein. In this paper, we describe two new saxicolous species of *Amandinea* and one of *Buellia* in the broad sense. Methods are as described in the previous papers cited above.

1. *Amandinea bittangabeensis* Elix & P.M.McCarthy, sp. nov. Fig. 1
Mycobank No. **MB 832303**

Similar to *Amandinea litoralis* (Zahlbr.) H.Mayrhofer & Elix, but differs in having a subhymenium that is densely inspersed with oil droplets, smaller apothecia, 0.1–0.4 mm wide, a cupular excipulum and a shallow hypothecium, 40–65 µm high.

Type: Australia, New South Wales, Ben Boyd National Park, Bittangabee Bay, 37°13'00"S, 150°01'04"E, 1–3 m alt., on coastal sandstone rocks in the spray zone, *J.A. Elix 46573*, 21.iii.2018 (holotype – CANB).

Thallus crustose, continuous, areolate to subsquamulose, to 30 mm wide and 1 mm thick; individual areoles rounded to irregular, 0.1–0.4 mm wide, sometimes becoming aggregated and imbricate to form a secondary warted or subsquamulose crust; upper surface grey-green to grey-brown or olive-brown, matt; prothallus not apparent; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 5–14 µm diam. *Apothecia* 0.1–0.4 mm wide, lecideine, immersed then broadly adnate, more rarely sessile and constricted at the base, isolated or crowded, rounded, rarely becoming distorted by mutual pressure; disc black, epruinose, weakly concave then plane; proper excipulum thin, tumid at first, persistent, cupular in section, the outer zone brown-black, K–, N–, 25–35 µm thick; inner zone pale brown to colourless. *Epihymenium* 10–15 µm thick, brown to dark brown, K–, N–. *Hypothecium* brown-black, 40–65 µm thick, K–. *Hymenium* 60–80 µm thick, colourless, not inspersed; subhymenium 25–35 µm thick, colourless to pale brown, densely inspersed with oil droplets; paraphyses 1.2–1.5(–2) µm wide, sparsely branched, with apices 3–4 µm wide and brown caps. *Asci* of the *Bacidia*-type, with 8 spores. *Ascospores Physconia*-type when immature, *Buellia*-type when mature, brown, ellipsoid, 12–[*13.8*]–17 × 6–[*6.5*]–9 µm, ± curved; older spores constricted at the septum; outer spore-wall weakly ornamented. *Pycnidia* immersed; ostiole black. *Conidia* filiform, curved, 20–30 × 0.7–1 µm.
Chemistry: Thallus K–, P–, C–, UV–; no lichen substances detected by TLC.

Etymology: The species is named after the type locality.

Remarks
The species is characterized by the crustose, areolate to subsquamulose, grey-green to grey-brown or olive-brown thallus, the immersed then broadly adnate apothecia, the non-amyloid medulla, an inspersed subhymenium, the 1-septate, *Physconia*- then *Buellia*-type ascospores, 12–17 × 6–9 µm, curved, filiform conidia, 20–30 µm long, and the absence of lichen substances. Morphologically, it can resemble specimens of *A. litoralis*, but that species lacks an inspersed subhymenium and has an annular excipulum with a deep hypothecium, 120–200 µm high, which forms a stipe (Blaha *et al.* 2016). Subsquamulose specimens of *A. bittangabeensis* can resemble free-living forms of *Monerolechia badia* (Fr.) Kalb, but that species has shorter ascospores, 10–[*11.8*]–15 × 6–[*6.5*]–8 µm, bacilliform conidia, 3.0–5.0 × 1.0–1.5 µm, and it has a non-inspersed subhymenium (Elix 2011).

Amandinea bittangabeensis is known from siliceous rocks in coastal regions of eastern Australia (Queensland, New South Wales, Tasmania). Associated species include *Buellia halonia* (Ach.) Tuck., *B. spuria* var. *amblyogona* (Müll.Arg.) Elix, *B. stellulata* (Taylor) Mudd var. *stellulata*, *B. stellulata* var. *tasmanica* Elix & Kantvilas, *Caloplaca eos* S.Y.Kondr. & Kärnefelt, *C. gallowayi* S.Y.Kondr. *et al.*, *Halecania subsquamosa* (Müll.Arg.) van den Boom & H.Mayrhofer, *Pertusaria xanthoplaca* Müll.Arg., *Rinodina oxydata* (A.Massal.) A.Massal. and *Jackelixia ligulata* (Körb.) S.Y.Kondr. & Kärnefelt.

SPECIMENS EXAMINED
Queensland: ● North Stradbroke Island, Point Lookout, 27°26'S, 153º33'E, 30 m alt., on cliff faces on seashore, *J. Hafellner 15623*, 10.viii.1986 (GZU). *New South Wales*: ● Type locality, 1–3 m alt., on coastal sandstone rocks in the spray zone, *J.A. Elix 46586*, 21.iii.2018 (CANB); ● Ben Boyd National Park, Green Cape, adjacent to lighthouse, 37°13'00"S, 150°01'04"E, 10–15 m alt., on coastal sandstone rocks in the spray zone, *J.A. Elix 46574*, 21.iii.2018 (GZU). *Tasmania*: ● Crocodile Rock, Mt Wellington, 42°53'S, 147º15'E, 650 m alt., in an underhang on a sandstone bluff in open *Eucalyptus* forest, *G. Kantvilas 4/18*, 1.i.2018 (HO).

2. *Amandinea hypohyalina* Elix & P.M.McCarthy, sp. nov. Fig. 2
MycoBank No. **MB 832304**

Similar to *Amandinea nebulosa* (Elix & Kantvilas) Elix & Kantvilas, but differs in having a colourless hypothecium, a subhymenium inspersed with granules, and somewhat smaller ascospores.

Type: Australia, Australian Capital Territory, Aranda, trail to Aranda Bushland, 4 km W of Canberra, 35°15'32"S, 149°04'53"E, 672 m alt., on sandstone rocks in dry *Eucalyptus* woodland, *J.A. Elix 46770*, 8.vii.2019 (holotype – CANB).

Thallus to 15 mm wide, endolithic and not apparent or epilithic, areolate, discontinuous; areoles irregular, angular to fleck-like, 0.1–0.4 mm wide, upper surface off-white, matt; prothallus effuse, dark grey or not apparent; photobiont cells 8–18 µm wide; medulla lacking calcium oxalate (H_2SO_4–), I–. *Apothecia* 0.05–0.4 mm wide, lecideine, roundish, scattered, broadly adnate then sessile; disc black, epruinose, plane to markedly convex; proper excipulum thin, excluded in older, convex apothecia, in section 15–20 µm thick; outer part brown to dark brown, K–, N–; inner part colourless. *Epihymenium* 10–12 µm thick, brown, N–. *Hypothecium* 40–50 µm thick, colourless. *Hymenium* 50–75 µm thick, colourless, not inspersed; subhymenium 10–12 µm thick, colourless, inspersed with granules; paraphyses 1–2 µm wide, sparingly branched, with apices 4–6 µm wide and brown caps. *Asci* 8-spored, *Bacidia*-type. *Ascospores Physconia*- then *Buellia*-type, 1-septate, pale brown then dark brown, ellipsoid, 9–[*11.1*]–13 × 5–[*5.9*]–8 µm, becoming constricted at the septum; outer wall smooth to finely ornamented. *Pycnidia* rare, punctiform, immersed; ostiole black. *Conidia* curved, filiform, 16–24 × 0.7–1 µm.
Chemistry: Thallus K–, P–, C–, UV–; no lichen substances detected by TLC.

Etymology: The species is named after its colourless hypothecium.

Remarks
The endolithic or poorly developed, very thin, discontinuous thallus resembles the endemic *A. nebulosa*, as both species are dominated by very small, broadly adnate to sessile apothecia. However, *A. nebulosa* has a dark brown hypothecium, a subhymenium that lacks granules and somewhat larger ascospores, 10–[*11.6*]–14 × 5–[*6.4*]–9 µm (Elix & Kantvilas 2013, as *Buellia nebulosa*). *Amandinea hypohyalina* could also be confused with the Australasian *Buellia suttonensis* Elix & A.Knight, but the latter differs in having a brown to dark brown hypothecium as well as bacilliform conidia (Elix & Knight 2017).

The new species is known from southern New South Wales and the Australian Capital Territory. Commonly associated lichens include *Buellia spuria* var. *amblyogona* (Müll.Arg.) Elix, *B. amandineaiformis* Elix & Kantvilas, *B. suttonensis*, *Lecidea sarcogynoides* Körb., *L. terrena* Nyl., *Trapelia concentrica* Elix & P.M.McCarthy and *Xanthoparmelia* sp.

SPECIMENS EXAMINED
Australian Capital Territory: ● Woodstock Nature Reserve, Shepherds Lookout Walk, 20 km WNW of Canberra, 35°14'34"S, 148°58'38"E, 555 m alt., on porphyry pebbles in open *Eucalyptus-Callitris* woodland, *J.A. Elix 46678*, 17.viii.2018 (CANB); ● Kowen Rd, Kowen Forest, 11.7 km E of Canberra, 35°19'02"S, 149°15'07"E, 700 m alt., on sandstone rocks in open *Eucalyptus* woodland, *J.A. Elix 46780*, 9.i.2019 (CANB). *New South Wales*: ● Collector-Gundaroo road, 3 km WSW of Collector, 34°55'12"S, 149°24'19"E, 630 m alt., on roadside rocks in dry *Eucalyptus* woodland, *P.M. McCarthy 4862*, 22.v.2019 (CANB); ● Gooloogong-Grenfell road, 5 km N of Grenfell, 33°51'16"S, 148°10'37"E, 385 m alt., on consolidated clay in *Eucalyptus-Callitris* woodland, *J.A. Elix 46831*, 2.x.2019 (CANB, HO, NSW).

3. *Buellia quarryana* Elix & P.M.McCarthy, sp. nov. Fig. 3
MycoBank No. **MB 832305**

Similar to *Buellia ferax* Müll.Arg., but differs in having smaller apothecia, 0.1–0.5 mm wide, and smaller ascospores, 9–12 × 5–7 µm.

Type: Australia, Victoria, East Gippsland, Quarry Beach, 6 km SW of Mallacoota, near airfield, 37°36'03"S, 149°43'41"E, 1–3 m alt., on siliceous rocks along the seashore, *J.A. Elix 46271 & P.M. McCarthy*, 30.x.2016 (holotype – CANB).

Thallus crustose, forming extended patches to 30 mm wide, endolithic and not apparent or epilithic, very thin and membranaceous, forming a thin grey-white film over the substratum; prothallus absent; medulla white, very thin, containing calcium oxalate (H_2SO_4+), I–, K+ red-orange in patches; photobiont cells 10–19 µm wide. *Apothecia* 0.1–0.5 mm wide, lecideine, broadly adnate to sessile, scattered or crowded, rounded or often irregularly shaped; disc black, epruinose, weakly concave to plane or weakly convex; proper excipulum distinct, thick, persistent, in section 25–40 µm thick, with an outer zone brown-black to green-black, K+ yellow soon forming red, needle-like crystals or K–, paler red-brown within. *Epihymenium* 10–12 µm thick, dark brown to greenish black, N– or N+ dark brown. *Hypothecium* 75–100 µm thick, dark brown to brown-black. *Hymenium* 50–60 µm thick, colourless, not inspersed with oil droplets or granules; subhymenium 20–30 µm thick, pale brown to brown, not inspersed; paraphyses 1.2–1.5 µm wide, simple to moderately branched, capitate; apices 4–6 µm wide, with dark brown caps. *Asci* of the *Bacidia*-type, 8-spored. *Ascospores* of the *Buellia*-type, 1-septate, pale olive-green to brown, ellipsoid, 9–[*10.5*]–12 × 5–[*5.7*]–7 µm, becoming constricted at the septum; outer spore wall microrugulate. *Pycnidia* immersed; ostiole black. *Conidia* bacilliform to ellipsoid, 4–6 × 1–2 µm.
Chemistry: Excipulum K+ yellow then red, C–, PD+ orange, UV–; containing norstictic acid (major), connorstictic acid (trace) by TLC.

Etymology: The species is named after the type locality.

Remarks
The new species is characterized by the numerous minute, black, broadly adnate to sessile apothecia, by the endolithic thallus, the *Buellia*-type ascospores, 9–12 × 5–7 µm, the non-inspersed hymenium and subhymenium, the bacilliform to ellipsoid conidia, 4–6 × 1–2 µm, and by the presence of norstictic acid. In many respects, it closely resembles *Buellia ferax*, in that both contain norstictic acid, have rudimentary or endolithic thalli and *Buellia*-type ascospores. However, the latter has larger ascospores, 10–[*12.6*]–15 × 5–[*6.2*]–8 µm, and larger apothecia, to 1.2 mm wide (Elix & McCarthy 2018). Morphologically, *B. quarryana* resembles poorly developed specimens of *B. austroabstracta* Elix & Kantvilas, but the latter lacks lichen substances (Elix *et al.* 2017).

Buellia quarryana is a coastal species known from southern New South Wales and Victoria where it is associated with typical littoral species including *Buellia aeruginosa* A.Nordin, Owe-Larsson & Elix, *B. stellulata* (Taylor) Mudd var. *stellulata*, *Catillaria austrolittoralis* Kantvilas & van den Boom, *Jackelixia ligulata* (Körb.) S.Y.Kondr., Fedorenko, S.Stenroos, Kärnefelt & A.Thell, *Pertusaria melanospora* var. *soredíata* Elix & A.W.Archer, *Rinodina blastidiata* Matzer & H.Mayrhofer, *Rinodinella fertilis* (Körb.) Elix, *Tylothallia verrucosa* (Müll.Arg.) Kantvilas and *Xanthoparmelia australasica* D.J.Galloway.

SPECIMENS EXAMINED
New South Wales: ● South Coast, Gerringong, Warrai Beach near Penguin Head, Culburra, 34°55'59"S, 150°46'46"E, 1–3 m alt., on S-facing sandstone rocks along the foreshore, *J.A. Elix 46380*, 18.iv.2017 (CANB); ● 1 km S of Plantation Point, Vincentia, Jervis Bay, 35°04'22"S, 150°41'41"E, 1–3 m alt., on sandstone rocks along the foreshore, *J.A. Elix 46409*, 23.v.2017 (CANB).

Acknowledgements
We thank Helmut Mayrhofer and Walter Obermayer (GZU), Gintaras Kantvilas (HO), and the curators of CANB for their kind cooperation in providing loans of key collections.

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Elix, JA; Kantvilas, G (2013): New taxa and new records of *Buellia sensu lato* (Physciaceae, Ascomycota) in Australia. *Australasian Lichenology* **73**, 24–44.
Elix, JA; Kantvilas, G; McCarthy, PM (2017): Thirteen new species and a key to buellioid lichens (Caliciaceae, Ascomycota) in Australia. *Australasian Lichenology* **81**, 26–67.
Elix, JA; Knight, A (2017): Three new species of buellioid lichens (Caliciaceae, Ascomycota) from Otago, South Island, New Zealand. *Australasian Lichenology* **81**, 86–92.
Elix, JA; McCarthy, PM (2018): Three new species and four new records of buellioid lichens (Caliciaceae, Ascomycota) from south-eastern Australia. *Herzogia* **31**, 444–452.

Figure 1. *Amandinea bittangabeensis* (holotype in CANB). Scale = 1 mm.

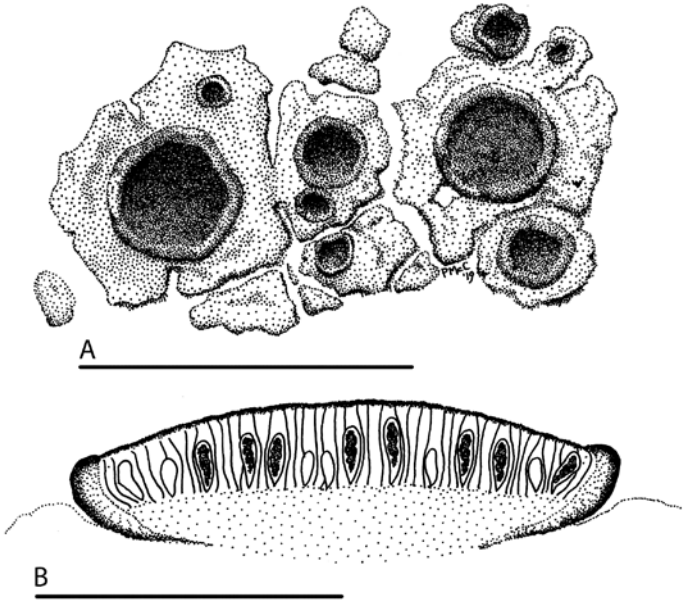

Figure 2. *Amandinea hypohyalina* (A = *McCarthy 4862* in CANB; B = *Elix 46678* in CANB). Scales: A = 0.5 mm, B = 0.2 mm.

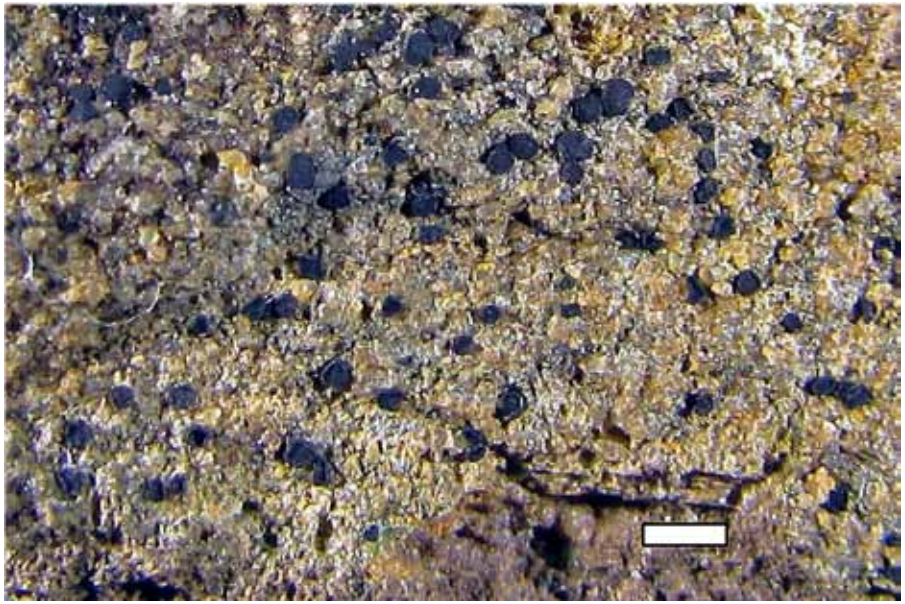

Figure 3. *Buellia quarryana* (holotype in CANB). Scale = 1 mm.

New species and new records of the lichen genus *Rhizocarpon* from Tasmania, with a key to the Australian taxa

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Abstract
Rhizocarpon austroalpinum P.M.McCarthy, Elix & Kantvilas, *R. exiguum* P.M.McCarthy, Elix & Kantvilas and *R. torquatum* P.M.McCarthy, Elix & Kantvilas are described as new to science from Tasmania; the first species also occurs in alpine New South Wales. *Rhizocarpon exiguum* is most similar to *R. intersitum* Arnold; it differs by having a sparse, minutely areolate thallus lacking lichen substances, very small apothecia with an exceptionally thin excipulum, a thin hymenium and significantly smaller and more sparingly septate, dark brown submuriform ascospores. The other new taxa are related to the common, pantemperate *R. reductum* Th.Fr., but they have substantially larger apothecia, and they are distinguishable from each other by a suite of differences in thalline and apothecial anatomy and morphology as well as thallus chemistry and apothecial pigmentation. Detailed descriptions are provided for the Tasmanian collections of *R. intersitum* and *R. reductum* for comparative purposes. Four other species of *Rhizocarpon* are reported for the first time from Tasmania, including *R. aff. lusitanicum* (Nyl.) Arnold, a parasite of the lichen *Lepra* sp. An updated key is provided to the 22 species currently accepted from Australia.

Introduction

Rhizocarpon Ramond ex DC. (Rhizocarpaceae) is a genus of *c.* 200 crustose, free-living or lichenicolous species which is most diverse on montane, siliceous rocks and at temperate to higher latitudes, particularly in the Northern Hemisphere. Free-living taxa have a rimose to areolate thallus, a usually distinct prothallus, an often diverse thallus chemistry, innate to superficial, lecideine apothecia, mostly anastomosing and conglutinate paraphysoids, distinctive 1–8-spored asci and hyaline to greenish black, halonate, ellipsoid ascospores that can be transversely septate or submuriform to eumuriform (Runemark 1956; Clauzade & Roux 1985; Timdal & Holtan-Hartwig 1988; Feuerer 1991; Ihlen 2004; Fletcher *et al.* 2009; Galloway 2007; McCarthy & Elix 2014). The asci have a dark amyloid cap in the upper part of the tholus, a non-amyloid ascus wall, and they lack an ocular chamber (Hafellner 1984; Ihlen 2004; Fletcher *et al.* 2009).

Recent studies of Australian *Rhizocarpon* have seen the description of *R. austroamphibium* Fryday & Kantvilas from Tasmania (Fryday & Kantvilas 2012), while an assessment of the genus in mainland Australia recognized 16 species including the newly described *R. flavomedullosum* Elix & P.M.McCarthy and *R. vigilans* P.M.McCarthy & Elix (McCarthy & Elix 2014). Subsequently, *R. ridescens* (Nyl.) Zahlbr., a Northern Hemisphere species, was reported from New South Wales (Elix *et al.* 2019), and another endemic taxon, *R. bicolor* Elix & P.M.McCarthy, was described from the Australian Capital Territory, New South Wales and Victoria (Elix & McCarthy 2019).

In this paper, *R. exiguum* is described as new from siliceous rock on the west coast of Tasmania; it is most closely related to *R. intersitum* Arnold, which has a scattered distribution in the Northern Hemisphere and in temperate mainland Australia, as well as in Tasmania. *Rhizocarpon austroalpinum* and *R. torulosum*, both broadly similar to the pantemperate *R. reductum* Th.Fr., are also described as new, from alpine, siliceous rocks (in Tasmania and New South Wales) and from a seasonally inundated, lowland river bed, respectively. Morphological and chemical variation is documented for Tasmanian *R. intersitum* and *R. reductum*, four other *Rhizocarpon* taxa are reported for the first time from Tasmania, including the lichenicolous *R. aff. lusitanicum* (Nyl.) Arnold, and an updated key is provided to the 22 species currently known from Australia.

Methods

Observations and measurements of photobiont cells, thalline and apothecial anatomy, asci and ascospores were made on hand-cut sections mounted in water. Sectioned apothecia were treated with 10% potassium hydroxide (K), 50% nitric acid (N) and 10% hydrochloric acid (H). Asci were 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.

The species

1. *Rhizocarpon austroalpinum* P.M.McCarthy, Elix & Kantvilas, sp. nov. Figs 1, 2, 3A, 4A
MycoBank No.: **MB 832447**

Characterized by the whitish to pale grey areolate thallus that lacks lichen substances and all visible traces of a prothallus, large, often adnate to subsessile apothecia [(0.43–)0.88(–1.38) mm diam.] with a thin to moderately thick proper exciple (80–140 µm) producing a deep red leachate in K, an epihymenium that is N+ pale brown and then decolorized, a thick, dark hypothecium [(80–)160–350(–450) µm], and hyaline and mostly submuriform ascospores, (18–)26(–37) × (9–)13(–17) µm, with (6–)7–15(–17) cells in optical section.

Type: Australia. Tasmania, Cradle Mountain Lake St Clair Natl Park, Mt Pillinger, 41°49'S, 146°07'E, 1270 m alt., on alpine dolerite boulders, *G. Kantvilas 30/15*, 6.i.2015 (holotype – HO 576724).

Thallus crustose, epilithic, rather effuse to determinate and forming colonies to *c.* 5 cm wide, off-white, very pale grey or pale to medium greenish grey, 80–250(–400) µm thick, areolate. *Areoles* contiguous or somewhat scattered, dull, smooth, plane to moderately convex or, occasionally, strongly convex, 0.15–0.8(–1.5) mm wide, rimulose or not, angular (when contiguous) to somewhat rounded (when scattered); surface dull, smooth to minutely and irregularly uneven, epruinose. *Cortex* clearly delimited in thin section, 7–12(–15) µm thick, paraplectenchymatous, comprising 1 or 2 layers of cells, subtending an amorphous, hyaline necral layer (8–)15–30(–60) µm thick; cortical cells rounded, 4–6(–8) µm wide, thick-walled, with a dark greenish brown distal wall, the internal wall hyaline. *Algal layer* continuous, (30–)50–100(–120) µm thick, with an uneven lower edge; cells green, chlorococcoid, globose to ellipsoid, rather thick-walled, 6–13(–18) µm diam.; interstitial mycobiont cells vertically elongate above, thin-walled, 7–11 × 5–7 µm; lower interstitial cells ± parenchymatous, thin-walled, 2–4(–5) µm wide. *Medulla* white, (30–)60–100(–250) µm thick or not apparent when the lower thallus is heavily impregnated with minute rock fragments and crystals, non-amyloid (I–), not containing calcium oxalate (H_2SO_4–); hyphae short-celled, 2–4(–6) µm wide. *Prothallus* not apparent at the thallus margin or internally between or beneath areoles. *Apothecia* numerous, uniformly dull black, lecideine, round or broadly ellipsoid in outline, or rather angular to irregular due to mutual pressure, usually solitary, occasionally paired or in proliferating or merging clusters of up to 8; single apothecia (0.43–)0.88(–1.38) mm diam. [*n* = 105], innate to adnate or subsessile; margin concolorous with the disc, dull black, (50–)80–120(–160) µm thick, smooth, entire, prominent, usually persistent, becoming thinner at maturity and often irregularly cracked and/or flexuose; disc plane to slightly or moderately convex, occasionally strongly convex or undulate, smooth to minutely uneven, epruinose, the colour unchanged when wetted. *Proper excipulum* annular, frequently uniformly brown-black

to carbonized in thin section and 80–140 µm thick; submature and occasional mature excipula with the outermost *c.* 70 µm brown-black and the inner *c.* 30 µm medium brown, of radiating elongate hyphae; other excipular sections internally pale to medium greenish brown, of variously orientated hyphae that radiate and darken towards the surface, the outermost 15–30 µm comprised of rounded, thick-walled, brown-black cells 4–7 µm diam.; hyphae closest to the hypothecium and hymenium long-celled, parallel, thin-walled and periclinal, 12–20 µm long; excipular section, K+ with deep red leachate, N+ deep red-brown or dark orange-brown, H–. *Epihymenium* medium greenish brown to dark brown, occasionally with concolorous vertical streaks penetrating the hymenium, (10–)15–25(–30) µm thick, non-amyloid, with or without a hyaline, amorphous, supraepihymenial layer 7–12 µm thick, K+ pale brown or more intensely greenish, N+ pale brown and then decolorized, H+ rapidly decolorized or greyish green to violet-green. *Hypothecium* dark brown to brown-black, (80–)160–350(–450) µm thick (the uppermost *c.* 30 µm slightly paler), not inspersed with granules or oil droplets, K+ with deep red leachate, N+ deep red-brown, no change in H, not or only sparingly subtended by algae; cells vertically elongate above, ± parenchymatous and ellipsoid below, thick-walled, 4–6 µm wide. *Hymenium* (90–)100–140(–160) µm thick, hyaline to pale blue-green (above), not inspersed, I+ blue, KI+ blue, K+ blue-green or K–, N+ pale brown-pink or N–, H–; subhymenium not distinguishable at maturity. *Paraphysoids* tightly conglutinate in water, loosening in K, sparingly to abundantly anastomosing, short-celled and constricted at the septa above, longer-celled below, 1–2(–2.5) µm thick; apical cells not or scarcely swollen, 2–3(–3.5) µm wide, medium to dark brown. *Asci* narrowly to broadly clavate or clavate-cylindrical, (4–)8-spored, (70–)85–125 × 22–35 µm [*n* = 25]; ascoplasm non-amyloid. *Ascospores* hyaline, submuriform or, less commonly, eumuriform at maturity, with 3–5(–7) transverse divisions, each transverse loculus with 0–1(–2) vertical or diagonal divisions [with (6–)7–15(–17) cells in optical section], narrowly ellipsoid to almost oblong or obovoid, straight or slightly bent, irregularly biseriate or more massed in the ascus, or overlapping-uniseriate below, usually slightly to markedly constricted at the septa, (18–)26(–37) × (9–)13(–17) µm [*n* = 158]; spore wall 1.5–2 µm thick at maturity; perispore 3–5(–6) µm thick; apices rounded (especially the distal end) to subacute; contents clear. *Pycnidia* not seen.
Chemistry: No substances detected by TLC.

Etymology: The epithet *austroalpinum* refers to the Australian (and southern) distribution and alpine habitats of the new species.

Remarks
A robust and highly distinctive species, *R. austroalpinum* is characterized by the whitish and often large thallus areoles, the absence of a prothallus and lichen substances, large, prominent, uniformly black apothecia, (0.43–)0.88(–1.38) mm diam., with an epihymenium that is N+ pale brown and then decolorized, a carbonized excipulum and an exceptionally thick, brown-black hypothecium. By contrast, the pantemperate *R. reductum*, which is common in southern Australia, including Tasmania, has apothecia that rarely exceed 0.7 mm in diameter, an epihymenium that is N+ reddish brown or purple-brown, a thinner excipulum and a much thinner hypothecium (Fryday 2000; Ihlen 2004; Fletcher *et al.* 2009; and see below).

Rhizocarpon lavatum (Fr.) Haszl., another species with a thallus that lacks lichen substances and with rather large apothecia, is known from the British Isles, continental Europe, Scandinavia, Svalbard, North America, North Africa, East Asia, New Zealand and Macquarie Island (Timdal & Holtan-Hartwig 1988; Feuerer 1991; Galloway 2007; Ihlen 2004; Fletcher *et al.* 2009). It can be distinguished from *R. austroalpinum* by its usually brownish thallus with an obvious prothallus, apothecia with a much thicker proper margin, an exciple that is paler in section and not carbonized and a thicker hymenium. Moreover, the ascospores are considerably larger, 30–50 × 12–25 µm, and fully muriform, having (9–)12–21(–28) locules in optical section.

The new species is currently known from siliceous rocks at two localities in alpine Tasmania, as well as Mt Kosciuszko in New South Wales. The mainland specimen was misidentified as *R. lavatum* by McCarthy & Elix (2014), as was the second Tasmanian collection cited by McCarthy *et al.* (2017).

ADDITIONAL SPECIMENS EXAMINED
Tasmania: ● Central Highlands, Skullbone Plains, 42°02'S, 146°19'E, 1000 m alt., on siliceous boulders in open heathland, *G. Kantvilas 136/12*, 29.ii.2012 (HO 564811). *New South Wales*: ● Mount Kosciuszko Natl Park, 2 km NE of the summit, 36°20'S, 148°16'E, 2150 m alt., on [siliceous] rock outcrop in herbfield on ridge, *H. Streimann 7632 (part)*, 14.iii.1979 [CANB, H (*n.v.*)].

2. *Rhizocarpon exiguum* P.M.McCarthy, Elix & Kantvilas, sp. nov. Figs 5, 6A, B
MycoBank No.: **MB 832448**

Characterized by the very pale effuse thallus with a nondescript prothallus and small, plane, scattered areoles that lack lichen substances and have a non-amyloid medulla, exceptionally small apothecia [(0.19–)0.29(–0.44) mm diam.] with a very thin proper exciple [35–45(–50) µm], an epihymenium that is K+ deep purple, comparatively small, mostly 8-spored asci, 62–85 × 24–30 µm, and dark brown, sparingly septate, submuriform ascospores, (17–)20(–24) × (9–)11(–14) µm, with only (3–)4–7(–8) cells in optical section.

Type: Australia. Tasmania, Trial Harbour, 41°56'S, 145°10'E, 2 m alt., in sheltered crevices of coastal serpentinite rock outcrops, *G. Kantvilas 422/14*, 19.ix.2014 (holotype – HO 574852).

Thallus crustose, epilithic, effuse, forming colonies to *c.* 10–15 mm wide, off-white to pale creamy grey to medium grey, 50–70(–90) µm thick, areolate. *Areoles* scattered, rounded, elongate or irregular in shape, plane, 0.1–0.3(–0.4) mm wide, not rimulose; surface dull, smooth, epruinose. *Cortex* clearly delimited in thin section, 20–30 µm thick, paraplectenchymatous, subtending a hyaline necral layer 8–15 µm thick which is either uniformly amorphous or composed of rounded to angular, thin-walled hyaline cells 3–6 µm wide; cortical cells rounded, 5–7 µm wide, thick-walled, uniformly hyaline or with a greenish brown distal wall, the inner walls hyaline. *Algal layer* continuous, 20–30 µm thick, with an uneven lower edge; cells green, chlorococcoid, globose to ellipsoid, rather thick-walled, 5–12(–14) µm diam.; interstitial hyphae short-celled, thin-walled, 3–5 µm wide. *Medullary layer* poorly delimited, *c.* 25–30 µm thick, heavily impregnated with minute rock fragments and crystals, non-amyloid (I–), not containing calcium oxalate (H_2SO_4–); hyphae short-celled, 3–5 µm wide. *Prothallus* not very conspicuous, black, visible at the thallus margin and between areoles. *Apothecia* moderately numerous, uniformly dull black, lecideine, round or broadly ellipsoid in outline, or rather angular and irregular due to pressure from adjacent areoles, usually solitary, occasionally paired or in proliferating clusters of 3 or 4, (0.19–)0.29(–0.44) mm diam. [*n* = 40], innate between areoles to adnate; margin concolorous with the disc, dull black, 30–50 µm thick, inconspicuous, smooth, entire, persistent but never very prominent, occasionally becoming excluded at maturity; disc plane to slightly convex, smooth to minutely uneven, epruinose, the colour unchanged when wetted. *Proper excipulum* annular, 35–45(–50) µm thick and brown-black laterally in thin section, with the outermost 1 or 2 layers of cells rounded, thick-walled, dark brown, slightly to markedly paler within and consisting of loose, radiating hyphae 2–3 µm thick, K–, N+ deep purple-brown, H–. *Epihymenium* dark brown to brown-black, 15–25 µm thick, non-amyloid, K+ deep purple, N+ purple-brown, H+ deep maroon-brown. *Hypothecium* dark brown to brown-black, 80–110 µm thick (the upper *c.* 20 µm slightly paler), not inspersed with granules or oil droplets, K–, N+ pale red-brown, H+ mid-brown, not subtended by algae; cells vertically elongate above, ± parenchymatous and ellipsoid below, thick-walled, 3–5 µm wide. *Hymenium* 85–110 µm thick, hyaline or with pale greenish vertical streaks, not inspersed, I+ blue, KI+ blue, K–, N–, H–; subhymenium not distinguishable at maturity. *Paraphysoids* sparingly to abundantly anastomosing, 1–1.5(–2) µm thick, short-celled and constricted at the septa, or longer-celled below; apical cells not or only moderately swollen, 2–3.5(–4.5) µm wide, medium to dark brown, tightly conglutinate in water, loosening slightly in K. *Asci* narrowly to broadly clavate, (4–)8-spored, 62–85 × 24–30 µm [*n* = 12]; ascoplasm non-amyloid. *Ascospores* medium to dark greenish grey or dark brown at maturity, initially trans-septate, becoming submuriform [with (3–)4–7(–8) cells in

optical section], broadly ellipsoid to almost oblong or obovoid or rather irregular in shape, occasionally soleiform, straight or, commonly, slightly bent, irregularly biseriate or more massed in the ascus, (17–)20(–24) × (9–)11(–14) µm [*n* = 100], N+ purple-brown; post-mature ascospores often almost black and collapsing, the septa completely obscured; spore wall 0.8–1.2 µm thick at maturity; perispore not apparent or to 4–6(–7) µm thick; apices rounded (especially the distal end) to subacute; contents clear. *Pycnidia* not seen.
Chemistry: No substances detected by TLC.

Etymology: The epithet *exiguum* (L.: little, small, poor, meagre) refers to the scant thallus of the new species and its very small and inconspicuous apothecia.

Remarks
Rhizocarpon exiguum can be recognized by its pale, sparsely areolate thallus, very small apothecia with a thin excipulum, small asci and small, brown, few-celled ascospores. While further collections might be expected to expand its known range of thallus chemistry and even apothecial pigmentation, as indicated by several other Australian taxa such as *R. geographicum* (L.) DC., *R. intersitum*, *R. lecanorinum* Anders, *R. polycarpum* (Hepp) Th.Fr. and *R. reductum* (McCarthy & Elix 2014), it is the morphology and anatomy of the new species that are likely to be most reliable distinguishing characters when compared with other greyish *Rhizocarpon* species with dark brown submuriform to eumuriform ascospores. Thus, *R. disporum* (Hepp) Müll.Arg. has asci that produce a single eumuriform ascospore 50–75 × 20–30 µm (Fletcher *et al.* 2009; McCarthy & Elix 2014), while *R. geminatum* Körb. has mostly bisporous asci, and the montane-aquatic Tasmanian endemic, *R. austroamphibium* Fryday & Kantvilas, contains gyrophoric acid, has a smooth thallus, innate white-margined apothecia, mainly 2–4-spored asci and anomalous simple paraphyses (Fryday & Kantvilas 2012). It is the highly variable *R. intersitum* that most closely resembles the new Tasmanian species (see below). However, that lichen almost invariably has a robust, areolate thallus, an often dominant prothallus, larger apothecia and larger and more septate ascospores (Figs 2, 3). In contrast, the distinctive thallus and diminutive apothecia and ascospores of *R. exiguum* provide an unambiguous circumscription.

Rhizocarpon exiguum is known only from sheltered serpentine rock at the type locality on the west coast of Tasmania. Ultramafic (serpentine) rocks are widely known to support highly localised endemic vascular plants (van der Endt *et al.* 2015), not least in Tasmania where many such species are known and continue to be discovered and described (for example, *Viola serpentinicola*; de Salas 2018). However, these rocks are generally poorly colonised by lichens, and the species encountered hitherto are almost invariably widespread and ubiquitous saxicolous species. A possible exception is *Cladonia praetermissa* var. *modesta* (Ahti & Krog) Kantvilas & A.W.Archer which, in Tasmania at least, is mostly (but not exclusively) associated with serpentine-derived soils (Kantvilas 1991). Thus, *Rhizocarpon exiguum* is significant in being the first locally endemic, serpenticolous lichen to be discovered in Tasmania.

3. *Rhizocarpon intersitum* Arnold, *Verhandl. Zool.-Bot. Ges. Wien* **27**, 554 (1877) Figs 6C, 7

[*Tasmanian specimens*] *Thallus* epilithic, pale to medium or dark grey or brownish grey, occasionally greenish or pink-tinged, epruinose, (80–)150–300(–500) µm thick, areolate, determinate, forming colonies to *c.* 5–10 cm wide. *Areoles* scattered or contiguous, rounded, elongate or irregular in shape (when scattered) or angular to irregular (when contiguous), plane to moderately or strongly convex, sometimes hemispherical to almost subglobose, (0.1–)0.3–0.8(–1.0) mm wide. *Cortex* paraplectenchymatous, 15–25(–35) µm thick, subtending an amorphous, hyaline, necral layer (5–)8–15(–25) µm thick. *Algal layer* continuous, 40–70(–100) µm thick; cells green, chlorococcoid, globose to ellipsoid, rather thick-walled, 5–12(–14) µm diam. *Medullary layer* (50–)100–250(–300) µm thick, I–, not containing calcium oxalate (H_2SO_4–). *Prothallus* inconspicuous to, usually, dominant at the thallus margin and between areoles, dull black, either thin and fimbriate or commonly rimose to areolate internally and up to 0.3 mm thick. *Apothecia* dull black, lecideine, round or broadly ellipsoid in outline, or rather angular and irregular due to pressure from adjacent areoles or apothecia, (0.27–)0.66(–1.08) mm diam. [*n* = 376], usually solitary, occasionally paired or in small proliferating clusters, innate between areoles to adnate; disc slightly concave to plane or slightly to moderately convex, epruinose; margin concolorous with the disc, dull black, 70–120 µm thick, smooth, entire, persistent but never very prominent, occasionally becoming excluded. *Proper excipulum* annular, 60–110(–140) µm thick in section, the outermost 25–40 µm brown-black, slightly paler within and consisting of loose, radiating hyphae 3–5(–7) µm thick, K+ orange-red, red, purple or deep red-brown, N+ purple, purple-brown or deep orange, H– or H+ deep red-brown. *Epihymenium* dark brown to brown-black, 10–20(–25) µm thick, K– or becoming decolourized or K+ weak purple or K+ deep purple, N+ deep red or purple, H– or H+ deep purple-brown. *Hypothecium* dark brown to brown-black, (80–)150–200(–250) µm thick, not inspersed with granules or oil globules, K– or K+ deep red-brown with red-brown solution, N+ deep red to red-brown, H– or H+ deep red-brown, not subtended by algae. *Hymenium* (85–)100–140(–160) µm thick, hyaline or with pale greenish or brown streaks, not inspersed, I+ blue, KI+ blue, K–, N+ pale red (streaks only), H– or H+ brown. *Paraphysoids* sparingly to abundantly anastomosing, 1–1.5(–2) µm thick; apical cells not or moderately swollen, 2–3.5(–4.5) µm wide, medium to dark brown or blackish. *Asci* narrowly to broadly clavate, (4–)8-spored, 85–140 × 27–40 µm [*n* = 35]. *Ascospores* medium to dark greenish grey or dark brown at maturity, submuriform to eumuriform [with (7–)9–15(–17) cells in optical section], narrowly to broadly ellipsoid to almost oblong or rather irregular in shape, straight or slightly bent, irregularly biseriate or more massed in the ascus, (22–)29(–38) × (10–)15(–19) µm [*n* = 162], N+ red-brown, purple-brown or purple-red; post-mature ascospores often almost black and collapsing; perispore not apparent or to 4–6(–7) µm thick. *Pycnidia* not seen.
Chemistry: *Rhizocarpon intersitum* exhibits diverse thallus chemistry, producing stictic acid or lacking lichen substances in the Northern Hemisphere (Timdal & Holtan-Hartwig 1988; Fryday 2010), while the numerous collections from mainland Australia invariably contain gyrophoric acid (McCarthy & Elix 2014). Tasmanian material includes five chemotypes by TLC, as follows: gyrophoric acid chemotype; barbatic acid chemotype [without or with 4-*O*-demethylbarbatic acid (minor)]; psoromic acid chemotype [with barbatic acid (minor)]; norstictic acid chemotype; and populations without lichen substances. The norstictic acid chemotype of *R. intersitum* in Tasmania is rather similar to *R. purpurascens* Fryday from the Kerguelen Islands, Campbell Island and southern New Zealand (Fryday 2004), although that species is somewhat variable in morphology, secondary chemistry and apothecial pigmentation.

Remarks
Superficially, *R. intersitum* is rather similar to the northern-temperate to boreal *R. grande* (Flörke ex Flotow) Arnold, but the latter usually has an I+ blue medulla, and somewhat larger ascospores. Indeed, while the reliability of thallus chemistry in *Rhizocarpon* is limited due to its often almost unparalleled variability, and apothecial pigments are not always informative, the amyloid reaction of the thallus medulla remains a very useful species level determinant. Feuerer (1991) included *R. intersitum* and *R. grande* in the synonymy of *R. eupetraeum* (Nyl.) Arnold, another species with an amyloid medulla.

Rhizocarpon intersitum occurs on exposed, montane siliceous rocks in the Australian Capital Territory, southern New South Wales, Victoria and Western Australia (McCarthy & Elix 2014); it was subsequently confirmed from Tasmania by McCarthy *et al.* (2017). Whereas many crustose, saxicolous lichens in Tasmania show a preference for either the highly siliceous, pre-Carboniferous rock types of the western half of the island, or the more recent and more fertile rocks, such as Jurassic dolerite, of central and eastern parts, the many collections of *R. intersitum* suggest that it occurs equally on all major rock types. Nor is any correlation evident between rock type and chemical composition. Elsewhere in the world, this species is known from south-western and north-eastern U.S.A., Scotland, Scandinavia and Central Europe (Clauzade & Roux 1985; Timdal & Holtan-Hartwig 1988; Feuerer 1991 [in synonymy with *R. eupetraeum*]; Fryday 2010).

TASMANIAN SPECIMENS EXAMINED
Tasmania: ● Mt Arrowsmith, Franklin-Gordon Wild Rivers Natl Park, 42°13'S, 146°04'E, 960 m alt., on [siliceous] rock, *G.C. Bratt 1779 & J.A. Cashin*, 14.xi.1964 (HO) [barbatic acid (major)]; ● Flat Bluff, 42°10'S, 145°48'E, 1100 m alt., on [siliceous] rock outcrops in alpine heathland, *G. Kantvilas 99/94*, 26.i.1994 (HO) [psoromic acid (major), barbatic acid (minor)]; ● track to Clear Hill, 42°41'S, 146°16'E, 1030 m alt., on horizontal surfaces of conglomerate boulders in a dry, sheltered overhang in buttongrass moorland, *G. Kantvilas 28/00*, 12.i.2000 (HO) [no lichen substances detected]; ● Loyetea Peak, 41°19'S, 145°57'E, 650 m alt., on conglomerate boulders, *G. Kantvilas 1135/01*, 19.xi.2001 (HO) [gyrophoric acid (major)]; ● Crater Peak, Cradle Mountain Lake Saint Clair Natl Park, 41°40'S, 145°56'E, 1270 m alt., on Precambrian metamorphosed alpine rocks, *G. Kantvilas 570/02* (*part*), 12.x.2002 (HO) [norstictic acid (major), connorstictic acid (trace)]; ● Tanina Bluff, 42°39'S, 147°02'E, 890 m alt., on dolerite boulders in open eucalypt forest, *G. Kantvilas 206/05*, 24.vii.2005 (HO) [gyrophoric acid (major)]; ● Meredith Range, *c.* 3.5 km SE of Mt Meredith, 41°35'S, 145°17'E, 750 m alt., on granite outcrops in buttongrass moorland, *G. Kantvilas 56/11*, 2.ii.2011 (HO) [no lichen substances detected]; ● NE slopes of Mt Bowes, Southwest Natl Park, 42°51'S, 146°25'E, 700 m alt., on quartzite boulders in buttongrass moorland, *G. Kantvilas 26/13*, 7.iv.2013 (HO) [barbatic acid (major)]; ● Gowan Brae, E side of Nive River, 42°02'S, 146°25'E, 810 m alt., on low basalt outcrop in heathland, *G. Kantvilas 128/14*, 19.ii.2014 (HO) [norstictic acid (major)]; ● Crocodile Rock, Mt Wellington, 42°53'S, 147°15'E, 725 m alt., on sandstone bluff in open eucalypt forest, *G. Kantvilas 322/14*, 17.viii.2014 (HO) [barbatic acid (major)]; ● North East Ridge, Mt Anne, Southwest Natl Park, 42°55'57.3"S, 146°26'25.6"E, 1090 m alt., on quartzitic rock outcrops in alpine heathland, *G. Kantvilas 90/16*, 5.ii.2016 (HO) [barbatic acid (major), 4-*O*-demethylbarbatic acid (minor)]; ● Mt Hobbs summit, 42°30'S, 147°35'E, 820 m alt., on sheltered dry dolerite boulders, *G. Kantvilas 58/18*, 10.v.2018 (HO) [gyrophoric acid (major)].

4. *Rhizocarpon reductum* Th.Fr., *Lichenogr. Scand.* **2**, 633 (1874) Figs 3C, 8, Table 1

[*Tasmanian specimens*] *Thallus* pale grey or pale greenish grey to medium or darker grey or greyish brown, epruinose, sparingly areolate on a fimbriate prothallus to contiguous-areolate, or areolate near the thallus margin and rather robustly bullate-areolate internally, (50–)100–200(–300) µm thick; areoles usually plane to moderately convex, 0.1–0.4 mm diam**.** *Cortex* usually clearly delimited in thin section, 8–15 µm thick, medium to dark greenish brown, subtending a hyaline, amorphous layer (5–)10–25(–40) µm thick. *Algal layer* usually continuous, 50–100(–150) µm thick; cells mostly globose, chlorococcoid, 6–15 µm diam. *Medulla* white, (50–)80–150(–200) µm thick, non-amyloid (I–). *Prothallus* greyish black to black, broad and marginal or inconspicuous to dominant between scattered areoles, or not apparent. *Apothecia* dull greenish or brownish black to jet-black, lecideine, round or broadly ellipsoid in outline, or rather angular to irregular due to mutual pressure, (0.19–)0.45(–0.77) mm diam. [*n* = 923], solitary, or occasionally paired or in proliferating clusters of up to 5, innate between areoles or subadnate to adnate; margin entire, persistent, concolorous with or slightly paler than the disc, often with a very thin but distinct whitish inner edge to the margin; disc at first shallowly concave to plane, remaining plane or becoming moderately convex or undulate, epruinose. *Proper excipulum* annular, uniformly medium to dark brown, or dark olive-brown to blackish at the outer edge and composed of ± globose cells, internally pale to medium brown and composed of rather loose to contiguous, radiating hyphae, 30–65(–100) µm thick, K+ blue-green or greenish brown, N+ purple-brown to deep red or purple. *Epihymenium* medium to dark brown or dark olive-green, 10–15(–20) µm thick, K+ blue-green to olive-green, N+ reddish brown or purple-brown. *Hypothecium* dark brown to brownish black, (30–)70–100(–150) µm thick, K+ deep red-brown, N+ dark red or deep red-brown. *Hymenium* 80–120(–160) µm thick, hyaline, amyloid, not inspersed. *Paraphysoids* tightly conglutinate, anastomosing, 1–2(–3) µm thick; apical cells not or slightly swollen, 2–4(–4.5) µm wide, hyaline to dark brown. *Asci* narrowly to broadly clavate or clavate-cylindrical, (4–)8-spored, 65–110 × 17–27 µm. *Ascospores* hyaline, submuriform at maturity, with 5–14(–17) cells in optical section, (16–)25(–35) × (8–)13(–16) µm [*n* = 182]; perispore 2–5 µm thick. *Pycnidia* not seen.
Chemistry: This species has been reported to contain stictic acid or, very rarely, lacking lichen substances (Timdal & Holtan-Hartwig 1988; Fryday 2000; Feuerer & Timdal 2004; Galloway 2007; Fletcher *et al.* 2009; Wang *et al.* 2015), or containing stictic and norstictic acids (Fryday 2000; Feuerer & Timdal 2004; Fletcher *et al.* 2009). The most common chemotype in mainland Australia contains both hypostictic and stictic acids as major substances along with associated constictic, cryptostictic, menegazziaic and/or peristictic acids (McCarthy & Elix 2014). Additional chemotypes with gyrophoric and bourgeanic acids, or bourgeanic acid alone, were also seen. The stictic acid chemotype is dominant in Tasmania, while others produce bourgeanic acid, gyrophoric acid, psoromic acid, barbatic acid in addition to stictic acid, or lack lichen substances. In contrast to mainland populations of *R. reductum*, hypostictic acid is very rare among Tasmanian collections and is never seen in major quantities (Table 1).

Remarks
Rhizocarpon reductum is the most common species in a rather discrete group of 14 morphologically similar taxa worldwide, all having a greyish, greyish green or brownish, usually areolate thallus with a non-amyloid medulla and containing a broad suite of lichen compounds. Asci are predominantly 8-spored, and the ascospores are colourless, submuriform to eumuriform and mostly in the range 20–50 µm long (Feuerer 1991; Fryday 2000, 2019; Ihlen & Fryday 2002, 2004; Ihlen 2004; Galloway 2007; Fletcher *et al*. 2009; Matwiejuk 2012; Wang *et al*. 2015). A common, pantemperate species on siliceous rocks in both hemispheres, it is known from Western Australia, South Australia, Queensland, New South Wales, the Australian Capital Territory, Victoria and Tasmania (McCarthy & Elix 2014). It also occurs in the British Isles, continental Europe, Arctic Eurasia, Morocco, Tunisia, Turkey, the Ukraine, Central Asia, China, South Africa, North America, Venezuela, Bolivia, Chile, Argentina, the Falkland Islands, Antarctica and New Zealand (Feuerer 1991 [as *R. obscuratum*]; Timdal & Holtan-Hartwig 1988 [as *R. obscuratum*]; Fryday 2000, 2019; Øvstedal & Lewis Smith 2001 [as *R. obscuratum*]; Calvelo & Liberatore 2002; Feuerer & Timdal 2004 [as *R. obscuratum*]; Galloway 2007; Fletcher *et al*. 2009; Wang *et al*. 2015). In Tasmania, *R. reductum* displays a very broad ecological amplitude, ranging from littoral to alpine elevations, and from seasonally inundated rocks in rivers to semi-shaded habitats in open, dry sclerophyll woodlands or at the margins of closed, wet forest, to highly exposed sites in heathland and moorland. Furthermore, it has been recorded from all major Tasmanian rock-types with the exception of limestone.

TASMANIAN SPECIMENS EXAMINED
Tasmania: ● behind Bedlam Walls, 42°50'S, 147°20'E, on siliceous rock, *M.L. Westbrook*, 17.vii.1971 (HO); ● quarry W of Gunns Plains, 41°17'S, 146°03'E, on siliceous rock, *G.C. Bratt 75/387 & J.A. Cashin*, 27.i.1975 (HO); ● Cramps Road, Upper Scamander area, 41°24'S, 148°13'E, on mudstone in the open, *G.C. Bratt 75/490 & K.M. Mackay*, 24.iii.1975 (HO); ● Huon River at Scotts Peak Road, 42°52'S, 146°22'E, 400 m alt., on serpentine rocks on river bank, *G. Kantvilas 593/81 & P.W. James*, 11.viii.1981 (HO); ● Prosser River, Orford, 42°34'S, 147°52'E, 20 m alt., on dolerite rocks in *Eucalyptus globulus* forest, *G. Kantvilas 944/81A*, 12.ix.1981 (HO); ● Cassiterite Creek, 2.5 km NW of Balfour, 41°14'S, 144°52'E, 190 m alt., on low sill outcrop, *A. Moscal 5123*, 21.xii.1983 (HO); ● Adams River, 42°43'S, 146°18'E, *c.* 350 m alt., on siliceous rocks in river bed subject to seasonal inundation, *G. Kantvilas 1/00*, 12.i.2000 (HO); ● track to Clear Hill, 42°41'S, 146°17'E, *c.* 750 m alt., on sheltered faces and crevices of conglomerate boulders in buttongrass moorland, *G. Kantvilas 16/00*, 12.i.2000 (HO); ● Lady Bay, 43°24'S, 147°01'E, *c.* 3 m alt., on seashore dolerite in moist sheltered crevices, *G. Kantvilas 313/00*, 14.vi.2000 (HO); ● Channel Highway, *c.* 2 km NE of Ninepin Point, 43°17'S, 147°11'E, 3 m alt., on coastal sandstone, *G. Kantvilas 790/01*, 1.ix.2001 (HO); ● Mt Clark, 43°06'S, 147°47'E, 460 m alt., on dolerite outcrops, *G. Kantvilas 1358/01*, 27.xii.2001 (HO); ● plateau above Lake Skinner, 42°56'S, 146°41'E, 1130 m alt., on alpine dolerite, *G. Kantvilas 170/02*, 7.iv.2002 (HO); ● Crater Peak, Cradle Mountain Lake St Clair Natl Park, 41°40'S, 145°56'E, 1270 m alt., on Precambrian metamorphosed alpine rock, *G.*

Kantvilas 570/02, 12.x.2002 (HO); ● junction of Holly Road and Gordon River Road, 42°48'S, 146°05'E, 320 m alt., on quartz pebbles along roadside in wet scrub, *G. Kantvilas 605/02*, 11.xii.2002 (HO); ● near Blythe River, 41°14'S, 145°56'E, 250 m alt., on weathered basalt along roadside in pasture, *G. Kantvilas 519/03*, 12.x.2003 (HO); ● Western Explorer Road, *c.* 42 km S of Rebecca Road turnoff, 41°25'S, 145°03'E, 400 m alt., on quartzite outcrop in buttongrass moorland, *G. Kantvilas 610/03*, 14.x.2003 (HO); ● near summit, South Sister, 41°32'S, 148°10'E, 800 m alt., on exposed dolerite boulders, *G. Kantvilas 416/04*, 10.xi.2004 (HO); ● Daley property, 'High Country', *c.* 2 km W of Long Point, 42°20'S, 147°48'E, 305 m alt., on dolerite boulders in open *Eucalyptus pulchella* woodland, *G. Kantvilas 8/06*, 1.i.2006 (HO); ● Lake Highway, near Projection Bluff, 41°44'S, 146°43'E, 1100 m alt., on dolerite boulder along roadside at edge of rainforest, *G. Kantvilas 318/12*, 5.vii.2012 (HO); ● Cherry Tree Hill, along O-Road, 41°58'S, 148°08'E, 180 m alt., on dolerite boulders in dry sclerophyll forest, *G. Kantvilas 325/12*, 25.vii.2012 (HO); ● Espies Craig, 42°34'S, 147°01'E, 600 m alt., on vertical dolerite tor in open eucalypt forest, *G. Kantvilas 363/12*, 14.viii.2012 (HO); ● N summit of Mt Rogoona, Walls of Jerusalem Natl Park, 41°53'S, 146°12'E, 1330 m alt., on alpine dolerite, *G. Kantvilas 669/12*, 27.xi.2012 (HO); ● Skullbone Plains, *c.* 200 m from road intersection to Nive River, 42°02'S, 146°21'E, 970 m alt., on alpine dolerite, *G. Kantvilas 726/12*, 12.xii.2012 (HO); ● Windy Moor, track to Mt Field East, Mount Field Natl Park, 42°40'S, 146°38'E, 1170 m alt., on dolerite at interface of alpine heathland and woodland, *G. Kantvilas 16/13*, 17.iii.2013 (HO); ● NW of settlement, Granville Harbour, 41°48'S, 145°02'E, 3 m alt., on coastal basalt, *G. Kantvilas 87/13*, 16.v.2013 (HO); ● Interview River, just upstream from mouth, Arthur-Pieman Conservation Area, 41°35'S, 144°53'E, 3 m alt., on granite boulders semi-submerged in fresh running water, *G. Kantvilas 150/15*, 31.i.2015 (HO); ● summit of knoll *c.* 0.5 km NE of Wielangta Hill, 42°40'S, 147°51'E, 550 m alt., on dolerite boulders in open eucalypt forest, *G. Kantvilas 147/16*, 2.vii.2016 (HO); ● Crest Range, Southwest Natl Park, 43°17'31"S, 146°30'26"E, 960 m alt., on alpine, metamorphosed mudstone outcrops, *G. Kantvilas 202/16*, 4.ii.2016 (HO); ● NE summit, Mt Anne, at the W rim of the Annakananda Sinkhole, Southwest Natl Park, 42°55'57"S, 146°26'29"E, 1050 m alt., on sheltered, alpine, siliceous outcrops, *G. Kantvilas 93/16*, 4.ii.2016 (HO); ● summit, Three Thumbs, 42°36'S, 147°52'E, 545 m alt., on dolerite, *G. Kantvilas 234/16*, 25.ix.2016 (HO); ● Lime Bay Nature Reserve, *c.* 1 km N of Plunkett Point, 42°59'S, 147°43'E, 2 m alt., on littoral sandstone boulders, *G. Kantvilas 251/16*, 15.x.2016 (HO); ● Rapid River, near bridge on the Tarkine Drive, 41°09'S, 145°06'E, 70 m alt., on siliceous rocks along river bank in rainforest, *G. Kantvilas 376/16*, 26.x.2016 (HO); ● Tasman Bay, 42°51'S, 147°55'E, 2 m alt., on sheltered side of seashore dolerite boulder, *G. Kantvilas 406/16*, 27.xii.2016 (HO); ● Russell River, at bridge on the Russell Road, 42°57'S, 146°47'E, 130 m alt., on siliceous rocks along river bank (probably occasionally inundated), *G. Kantvilas 30/17*, 3.i.2017 (HO); ● summit of Mt Ponsonby, 42°27'S, 147°32'E, 810 m alt., in sheltered overhang among dolerite boulders, *G. Kantvilas 117/17*, 17.vi.2017 (HO); ● Windsong property, NW corner adjacent to Swanston Road, 42°21'S, 147°54'E, 60 m alt., on dolerite boulders and exposed bedrock in a paddock, *G. Kantvilas 173/17*, 26.x.2017 (HO); ● Saw Back Range Track, *c.* 0.5 km SE of Welcome Rock, 42°47'S, 146°21'E, 600 m alt., on siliceous pebbles in an abandoned road through buttongrass moorland, *G. Kantvilas 92/18*, 2.ix.2018 (HO).

5. *Rhizocarpon torquatum* P.M.McCarthy, Elix & Kantvilas, sp. nov. Figs 3B, 4B, 9
MycoBank No.: **MB 832449**

Characterized by the pale and rather thick, smooth, areolate thallus with hypostictic acid (major) and a distinct marginal prothallus, large, adnate to subsessile apothecia [(0.52–)0.86 (–1.30) mm diam.] with a thick margin [80–160(–200) µm thick] that can be concolorous with the blackish disc, or moderately to considerably paler, then often retaining a whitish inner collar, not releasing a deep red leachate in K, a pale epihymenium that is K+ pale pink and N+ pale red-brown, a thick hypothecium [170–300(–380) µm] and mostly submuriform ascospores, (22–)28(–35) × (10–)13(–17) µm, with (5–)7–15(–18) cells in optical section.

Type: Australia. Tasmania, Frankland River, at bridge on Blackwater Road, 41°11'S, 144°52'E, 80 m alt., on seasonally inundated, siliceous rocks in river bed, *G. Kantvilas 464/15*, 10.xi.2015 (holotype –HO 581537).

Thallus crustose, epilithic, determinate, forming colonies *c.* 1–4 cm wide, greyish white, or pale grey with a greenish tint, or patchily medium grey, (60–)100–200(–300) µm thick, rimose to areolate. *Areoles* contiguous, dull, smooth to minutely or coarsely rugulose, epruinose, mostly plane to very slightly convex, 0.2–1(–1.2) mm wide, angular, irregular. *Cortex* absent, the thallus with an uppermost, hyaline, amorphous, necral layer 4–7(–10) µm thick, this subtended directly by massed algal cells or by an alga-free, paraplectenchymatous layer, 20–25 µm thick, of thin-walled, hyaline cells 5–8 µm wide. *Algal layer* discontinuous or continuous, 70–150(–200) µm thick, with an even upper edge and an uneven lower edge; cells green, chlorococcoid, globose to ellipsoid, rather thick-walled, 6–12(–16) µm diam.; interstitial mycobiont cells vertically elongate above, thin-walled, 4–8 µm wide; lower interstitial cells ± parenchymatous, thin-walled, 3–5 µm wide. *Medulla* white, 30–60(–80) µm thick or thinner and poorly defined when the lower thallus is heavily impregnated with minute rock fragments and crystals, non-amyloid (I–), not containing calcium oxalate (H_2SO_4–); hyphae short-celled, 2–5 µm wide. *Prothallus* well-defined, dark grey to black, marginal, less commonly internal between areoles. *Apothecia* numerous, dull greenish black to black, lecideine, mostly round, occasionally broadly ellipsoid in outline or rather irregular due to mutual pressure, usually solitary, occasionally paired or in proliferating or merging clusters of up to 4, (0.52–)0.86 (–1.30) mm diam. [*n* = 80], initially innate, later adnate to subsessile; margin to 200 µm thick when immature, entire, the inner half whitish in surface view, the outer half greenish black, at maturity dull black and concolorous with the disc or somewhat to considerably paler, or retaining a whitish inner collar, 80–160(–200) µm thick, smooth, entire, scarcely prominent above the surface of the disc, but usually persistent; disc plane to slightly or moderately convex, occasionally strongly convex, minutely to coarsely uneven, epruinose, the blackish colour scarcely changing when wetted. *Proper excipulum* annular, often becoming uniformly brown-black (thin section) and 100–140(–160) µm thick; immature, submature and many mature excipula with the outermost *c.* 15–40 µm pigmented dark brown to brown-black, of rounded, thick-walled cells, internally pale brown and composed of loose, elongate, radiating hyphae with cells 5–8(–10) × 3–5 µm; the excipular tissue closest to the hymenium ± hyaline, of hyphae 2–3 µm wide in a loose reticulum; excipular section K+ mid-brown, N+ deep red-brown, H+ mid-brown. *Epihymenium* scarcely delimited from the hymenium, or pale to dark brown and 10–20 µm thick, occasionally with concolorous, vertical or diagonal streaks to 15 µm wide penetrating the hymenium or forming a distinctive reticulum down to the hypothecium, non-amyloid, K+ pale pink, N+ pale red-brown, H–. *Hypothecium* dark brown to brown-black, 170–300(–380) µm thick (the upper *c.* 20–30 µm slightly paler), not inspersed with granules or oil droplets, K+ with yellowish leachate, N+ deep red-brown, H+ mid-brown, not subtended by algae; cells rather elongate above, ± parenchymatous and ellipsoid below, thick-walled, 2–3(–4) µm wide. *Hymenium* 110–190 µm thick, hyaline to pale brown or pale greenish brown, not inspersed, I+ blue, KI+ blue, K+ faint pink, N–, H–; subhymenium not distinguishable at maturity. *Paraphysoids* tightly conglutinate in water, loosening in K, sparingly to abundantly anastomosing, short-celled, not or scarcely constricted at the septa, 1.5–2(–2.5) µm thick; apical cells not or scarcely swollen (to 3 µm wide), hyaline to pale brown. *Asci* narrowly to broadly clavate or clavate-cylindrical, (4–)8-spored, 105–140 × 21–32 µm [*n* = 15]; ascoplasm non-amyloid. *Ascospores* hyaline, mostly submuriform, occasionally eumuriform at maturity, with 3–5(–7) transverse divisions, each transverse loculus with 0–1(–2) vertical or diagonal divisions [with (5–)7–15(–18) cells in optical section], narrowly ellipsoid to oblong-ellipsoid, obclavate or oblong, occasionally almost soleiform, straight or slightly bent, irregularly biseriate or more massed in the ascus, usually slightly constricted at the septa (particularly the primary septum), (22–)28(–35) × (10–)13(–17) µm [*n* = 85]; spore wall 1–1.5(–2) µm thick at maturity; perispore 4–5(–6) µm thick; apices mostly rounded (especially the distal end); contents clear. *Pycnidia* not seen.
Chemistry: Hypostictic acid (major) and hyposalazinic acid (trace) by TLC.

Etymology: From the Latin *torquatus* (adorned with a collar), in reference to the immature and many mature apothecia having a distinct, whitish ring at the inner edge of the margin.

Remarks

Rhizocarpon torquatum is characterized and distinguished from similar species by attributes of thallus morphology and chemistry as well as apothecial anatomy and pigmentation. Thus, while the newly described *R. austroalpinum* (above) has similarly large apothecia and shares moderately large ascospores, its thallus lacks lichen substances, nor is it bounded by a visible prothallus, the thinner proper exciple is considerably darker inside and out, and it leaches a red solution in K. The apothecia of *R. torquatum* are comparable in size to those of *R. lavatum*, but the latter has fully muriform ascospores, 30–50 × 12–25 µm, and with (9–)12–21(–28) cells in optical section. Finally, the common *R. reductum* is most readily separated by its unequivocally smaller apothecia, which are (0.19–)0.28–0.62(–0.77) mm diam. in Tasmania.

A seemingly reliable diagnostic character in the type specimen of *R. torquatum* is the absence of the parenchymatous cortex that is almost invariably seen in species of *Rhizocarpon*. Instead, the thallus has only a thin, uppermost necral layer. By contrast, most Tasmanian specimens of *R. reductum* (and indeed both collections of *R. austroalpinum*) have a clearly delimited parenchymatous cortex of rounded, brownish, thick-walled cells. The single exception among the specimens of the former taxon examined (*G. Kantvilas 1/00*) occurred on siliceous rocks in river bed subject to seasonal inundation, suggesting the development of a cortex might be heavily influenced by environment and, specifically, its moisture regime.

The new species is known only from the type locality, *viz.* seasonally inundated, siliceous rocks in the Frankland River in north-western Tasmania, where the river runs through extensive cool temperate rainforest. Here, it is relatively wide and its bed consists of exposed shelves of bedrock. Other lichens present include characteristic saxicolous taxa such as *Paraporpidia leptocarpa* (C.Bab. & Mitt.) Rambold & Hertel, species typical of habitats subject to periodic disturbance, for example *Baeomyces heteromorphus* Nyl. ex C.Bab. & Mitt., *Trapelia coarctata* (Sm.) M.Choisy and *Stereocaulon ramulosum* (Sw.) Räusch., and a small suite of aquatic species, including *Hymenelia lacustris* (With.) M.Choisy and an undescribed but well-known species of *Trapelia*. This site is the type and only known locality of *Porina australis* P.M.McCarthy & Kantvilas, which also inhabits seasonally inundated, siliceous rock in the river bed (McCarthy & Kantvilas 2017).

New records

1. *Rhizocarpon bicolor* Elix & P.M.McCarthy, *Australas. Lichenol*. **85**, 51 (2019)
R. badioatrum (Flörke) Th.Fr.: Australian collections (see McCarthy & Elix 2014)
R. eupetraeoides (Nyl.) Blomb. & Forsell: Australian collections (see McCarthy & Elix 2014)

This species was described recently from siliceous rocks in eastern New South Wales, the Australian Capital Territory and Victoria (Elix & McCarthy 2019).

SPECIMENS EXAMINED
Tasmania: ● summit, Mt Murchison, 41°49'S, 145°37'E, 1275 m alt., on quartzite, *F.N. Lakin* [*G.C. Bratt76/1141*], xi.1976 (HO) [psoromic acid (major), rhizocarpic acid (minor) by TLC]; ● Gingerbread Track, Mt Rufus, Cradle Mountain Lake St Clair Natl Park, 42°08'S, 146°06'E, 1140 m alt., on coarse sandstone outcrops in alpine heathland, *G. Kantvilas 253/12*, 18.iii.2012 (HO) [bourgeanic acid (major) by TLC].

2. *Rhizocarpon geminatum* Körb., *Syst. Lich. German*. 259 (1855)
Reported from alpine, siliceous rocks in the Australian Capital Territory, the south and central-west of New South Wales and Victoria by McCarthy & Elix (2014), it is also known from Europe, Arctic Eurasia, Greenland, Turkey, Central Asia, North America, Bolivia, Argentina, islands in the South Atlantic Ocean, Antarctica and New Zealand.

SPECIMEN EXAMINED
Tasmania: ● Lake Kaye, 41°54'S, 146°31'E, 1140 m alt., on large basalt boulder in alpine meadow subject to seasonal inundation, *G. Kantvilas 80/00*, 8.iii.2000 (HO) [bourgeanic acid (major), or bourgeanic acid (major) and gyrophoric acid (major) by TLC].

3. *Rhizocarpon* aff. ***lusitanicum*** (Nyl.) Arnold, *Flora* **53**, 478 (1870) Fig. 10
Lecidea lusitanica Nyl., *Flora* **48**, 605 (1865)

Thallus nondescript, indistinguishable from the host. *Prothallus* not apparent. *Apothecia* moderately numerous, dull black, lecideine, round or broadly ellipsoid in outline, (0.27–)0.43(–0.62) mm diam. [*n* = 37], solitary, innate between the host areoles to adnate; margin entire, usually becoming excluded, concolorous with the disc; disc moderately to strongly convex or almost subglobose, epruinose. *Proper excipulum* annular, uniformly to dark brown, 60–85 µm thick. *Epihymenium* blackish, *c.* 20 µm thick, K+ purple, N+ deep purple-brown. *Hypothecium* brownish black, 150–200 µm thick. *Hymenium* 100–160 µm thick, hyaline, amyloid. *Paraphysoids* tightly conglutinate, anastomosing, 1–2(–3) µm thick; apical cells 2–4(–4.5) µm wide, medium to dark brown. *Asci* narrowly to broadly clavate, (4–)8-spored, 75–100 × 22–35 µm. *Ascospores* dark greenish brown to brown-black, mostly narrowly to broadly ellipsoid, submuriform at maturity and with 5–8 cells in optical section, 18–27(–30) × 9–14 µm [*n* = 27]; perispore 2–4 µm thick. *Pycnidia* not seen.
Chemistry: no substances detected by TLC.

Apothecial morphology and anatomy in the Tasmanian specimen are a very close match for *R. lusitanicum* as documented by Poelt & Hafellner (1982). That species, initially a parasite of *Pertusaria sens. lat.*, is known from southern and south-eastern Europe and Macaronesia. It can become a partly yellowish (with rhizocarpic acid) and independent lichen, or it can remain a greyish and nondescript parasymbiont (without rhizocarpic acid; Poelt & Hafellner 1982; Breuss 1988). Given the sparse Tasmanian material and its novel host, additional collections are required to confirm the status of this species.

SPECIMEN EXAMINED
Tasmania: ● *c.* 1 km W of Circular Marsh, on E side of Pine River, 41°59'S, 146°28'E, 860 m alt., lichenicolous on *Lepra* sp., in turn growing on dolerite boulders, *G. Kantvilas 74/14*, 20.ii.2014 (HO).

4. *Rhizocarpon polycarpum* (Hepp) Th.Fr., *Lichenogr. Scand*. **2**, 617 (1874)
Previously recorded from Western Australia, New South Wales, the Australian Capital Territory and Victoria (McCarthy & Elix 2014); also in Europe, Arctic Eurasia, North Africa, Turkey, China, the Bering Strait, North America, southern South America, islands in the South Atlantic Ocean, Antarctica and New Zealand.

SPECIMENS EXAMINED
Tasmania: ● Lake Kaye, 41°54'S, 146°31'E, 1140 m alt., on basalt boulders in alpine heathland, *G. Kantvilas 95/00*, 8.iii.2000 (HO) [norstictic acid (major), connorstictic acid (trace)]; ● Bisdee Tier [near Spring Hill], 42°26'S, 147°17'E, 640 m alt., on plates of dolerite bedrock in rocky grassland, *G. Kantvilas 134/09*, 11.iii.2009 (HO) [stictic acid (major), bourgeanic acid (major) and satellite compounds by TLC].

Key to the species of *Rhizocarpon* in Australia

1 Thallus yellow-green; cortex containing rhizocarpic acid.....2
1: Thallus whitish, brown, green or grey; cortex lacking rhizocarpic acid.....8

2 Thallus with punctiform to capitate soralia; soredia yellow-green, granular.....**R. ridescens**
2: Thallus lacking soralia.....3

3 Ascospores 1-septate.....4
3: Ascospores submuriform to muriform 6

4 Ascospores 20–35 × 11–18 µm.....**R. bicolor**
4: Ascospores 12–23 × 6–10 µm.....5

5 Medulla yellow; containing only rhizocarpic acid.....**R. adarense**
5: Medulla white; containing rhizocarpic and stictic or perlatolic acids.....**R. superficiale**

6 Thallus forming a pseudolecanorine margin around apothecia.....**R. lecanorinum**
6: Thallus not forming a pseudolecanorine margin around apothecia.....7

7 Thallus initially parasitic on the lichen *Aspicilia sens. lat.*; upper surface usually pale green; containing rhizocarpic and ± norstictic acids..... **R. viridiatrum**
7: Thallus not parasitic on other lichens; upper surface predominantly yellow; containing rhizocarpic and psoromic, barbatic or 2'-*O*-methylperlatolic acids .....**R. geographicum**

8 Initially lichenicolous on *Lepra* sp. .....**R.** aff. **lusitanicum**
8: Never lichenicolous 9

9 Ascospores 1-septate..... 10
9: Ascospores 3-septate to submuriform or muriform..... 13

10 Mature ascospores hyaline, 17–22 × 8–11 µm; medulla I+ blue.....**R. polycarpum**
10: Mature ascospores dark grey-green to dark brown; medulla I+ blue or I– 11

11 Medulla white, I+ blue ..... **R. vigilans**
11: Medulla yellow or white, I–..... 12

12 Medulla yellow above; ascospores 12–22 × 6–10 µm..... **R. flavomedullosum**
12: Medulla uniformly white; ascospores 20–35 × 11–18 µm ..... **R. bicolor**

13 Mature ascospores predominantly 3-septate, rarely 1-septate, occasionally with 1 or 2 longitudinal or diagonal septa, colourless (collapsed post-mature ascospores can be dark brown); medulla I+ blue ..... **R. distinctum**
13: Mature ascospores submuriform to muriform, with 8–50 cells in optical section, colourless to dark brown; medulla I–..... 14

14 Mature ascospores colourless 15
14: Mature ascospores dark grey-green to dark brown 19

15 Ascospores mostly submuriform, 16–37 µm long..... 16
15: Ascospores eumuriform, 30–50 µm long 18

16 Apothecia (0.19–)0.45(–0.77) mm diam.....**R. reductum**
16: Apothecia (0.43–)0.86(–1.38) mm diam. 17

17 Thallus without a prothallus, lacking lichen substances; apothecial margin black; proper excipulum and hypothecium producing a deep red leachate in K ..... **R. austroalpinum**
17: Thallus with a distinct marginal prothallus, containing hypostictic acid (major); apothecial margin concolorous with the black disc or somewhat to considerably paler, often retaining a whitish inner collar; proper excipulum and hypothecium not producing a deep red leachate in K..... **R. torquatum**

18 Upper surface pale brown; proper margin thick, swollen; thallus lacking lichen substances; on siliceous rocks [Macquarie Island] ..... **R. lavatum**
18: Upper surface white to grey; proper margin not swollen; thallus with stictic acid; usually on calcareous rocks..... **R. petraeum**

19 Asci 1-spored; ascospores 50–75 × 20–30 µm ..... **R. disporum**
19: Asci (1–)2–8-spored; ascospores smaller 20

20 Ascospores 17–38 × 9–19 µm, (4–)8 per ascus 21
20: Ascospores 30–55 × 17–25 µm, (1–)2–6 per ascus..... 22

21 Apothecia 0.19–0.44 mm diam.; proper exciple 35–45(–50) µm thick; ascospores 17–24 × 9–14 µm, with (3–)4–7(–8) cells in optical section..... **R. exiguum**
21: Apothecia 0.27–1.08 mm diam.; proper exciple 60–110(–140) µm thick; ascospores 22–38 × 10–19 µm, with (7–)9–15(–17) cells in optical section..... **R. intersitum**

22 Paraphyses anastomosing; ascospores (1–)2(–4) per ascus; apothecia ± elevated, uniformly black; on comparatively dry montane rocks, not associated with water bodies ..... **R. geminatum**
22: Paraphyses ± simple; ascospores 2–4(–6) per ascus; apothecia immersed, with a white rim; on rocks in and around Tasmanian alpine lakes..... **R. austroamphibium**

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	bourgeanic acid	gyrophoric acid	psoromic acid	barbatic acid	cryptostictic acid	hypostictic acid	constictic acid	stictic acid	nil
GK 202/16	●	-	-	-	-	-	-	-	-
GK 234/16	●	-	-	-	-	-	-	-	-
GK 376/16	●	-	-	-	-	-	-	-	-
GK 313/00	●	-	-	-	-	-	-	-	-
MLW 1971	●	-	-	-	-	-	-	-	-
GK 416/04	-	●	-	-	-	-	-	-	-
AM 5123	-	●	-	-	-	-	-	-	-
GK 570/02	-	-	●	-	-	-	-	-	-
GK 16/00	-	-	-	-	-	-	-	●	-
GK 790/01	-	-	-	-	-	-	-	●	-
GK 150/15	-	-	-	-	-	-	-	●	-
GK 147/16	-	-	-	-	-	-	-	●	-
GK 251/16	-	-	-	-	-	-	-	●	-
GK 605/02	-	-	-	-	-	-	-	●	-
GCB 75/490	-	-	-	-	-	-	-	●	-
GK 170/02	-	-	-	-	-	-	○	●	-
GK 8/06	-	-	-	-	-	-	○	●	-
GK 16/13	-	-	-	-	-	-	○	●	-
GK 93/16	-	-	-	-	-	-	○	●	-
GK 318/12	-	-	-	-	-	-	○	●	-
GK 593/81	-	-	-	-	-	-	○	●	-
GK 325/12	-	-	-	-	-	-	○	●	-
GK 944/81A	-	-	-	-	-	-	○	●	-
GK 363/12	-	-	-	-	-	-	○	●	-
GK 669/12	-	-	-	-	-	-	○	●	-
GK 406/16	-	-	-	-	○	-	○	●	-
GK 30/17	-	-	-	-	○	-	○	●	-
GK 1/00	-	-	-	-	○	-	○	●	-
GCB 75/387	-	-	-	-	○	-	○	●	-
GK 87/13	-	-	-	-	-	-	○	●	-
GK 726/12	-	-	-	-	-	-	○	●	-
GK 173/17	-	-	-	-	-	○	○	●	-
GK 610/03	-	-	-	●	-	-	-	●	-
GK 519/03	-	-	-	-	-	-	-	-	●
GK 92/18	-	-	-	-	-	-	-	-	●
GK 1358/01	-	-	-	-	-	-	-	-	●
GK 117/17	-	-	-	-	-	-	-	-	●

Table 1. Secondary metabolites of *Rhizocarpon reductum* in Tasmania. The satellite substances constictic, cryptostictic, menegazziaic and peristictic acids, as well as hypostictic acid, are not included when present in only trace quantities with stictic acid.
● = major quantity, ○ = minor quantity.

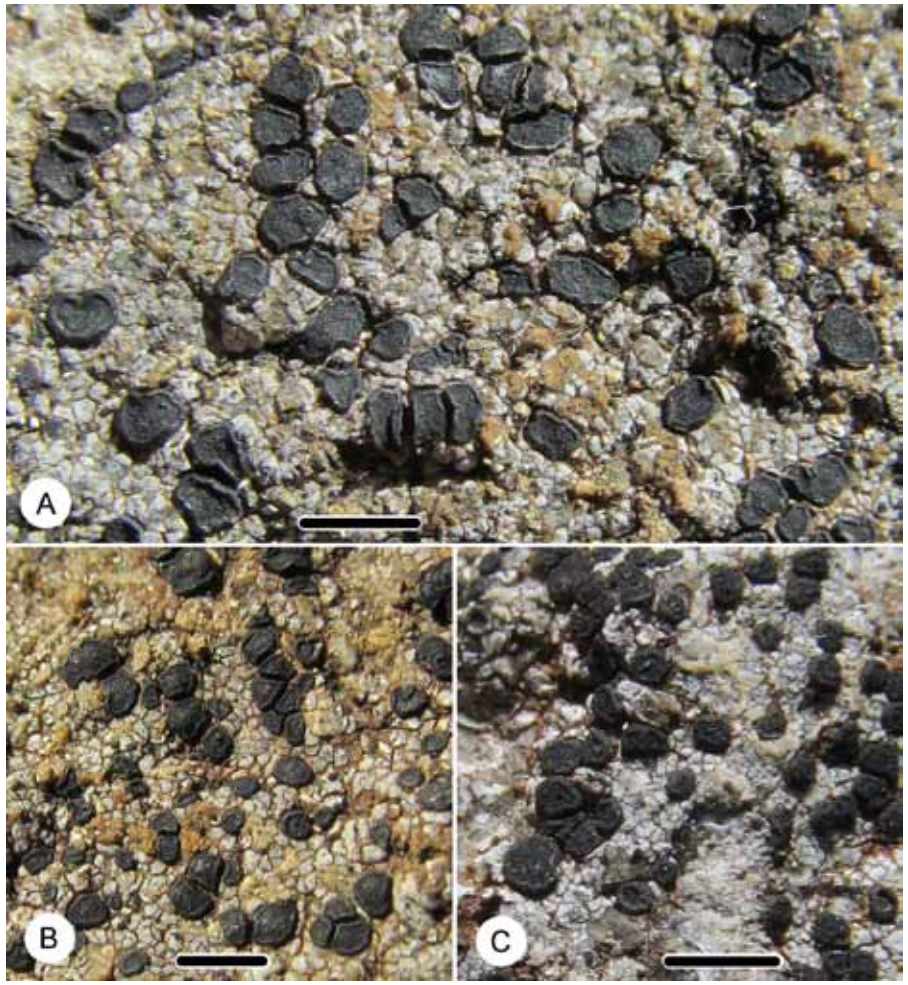

Figure 1. *Rhizocarpon austroalpinum*. A, B, holotype; C, *G. Kantvilas 136/12*. Scales: 2 mm.

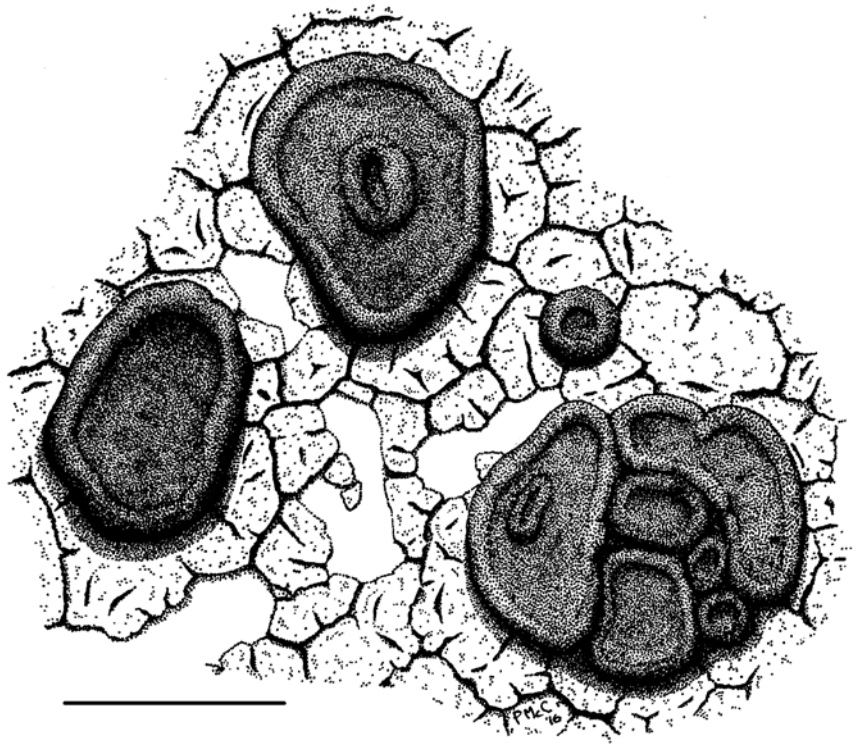

Figure 2. *Rhizocarpon austroalpinum* (*G. Kantvilas 136/12*). Habit of thallus and apothecia. Scale: 0.5 mm.

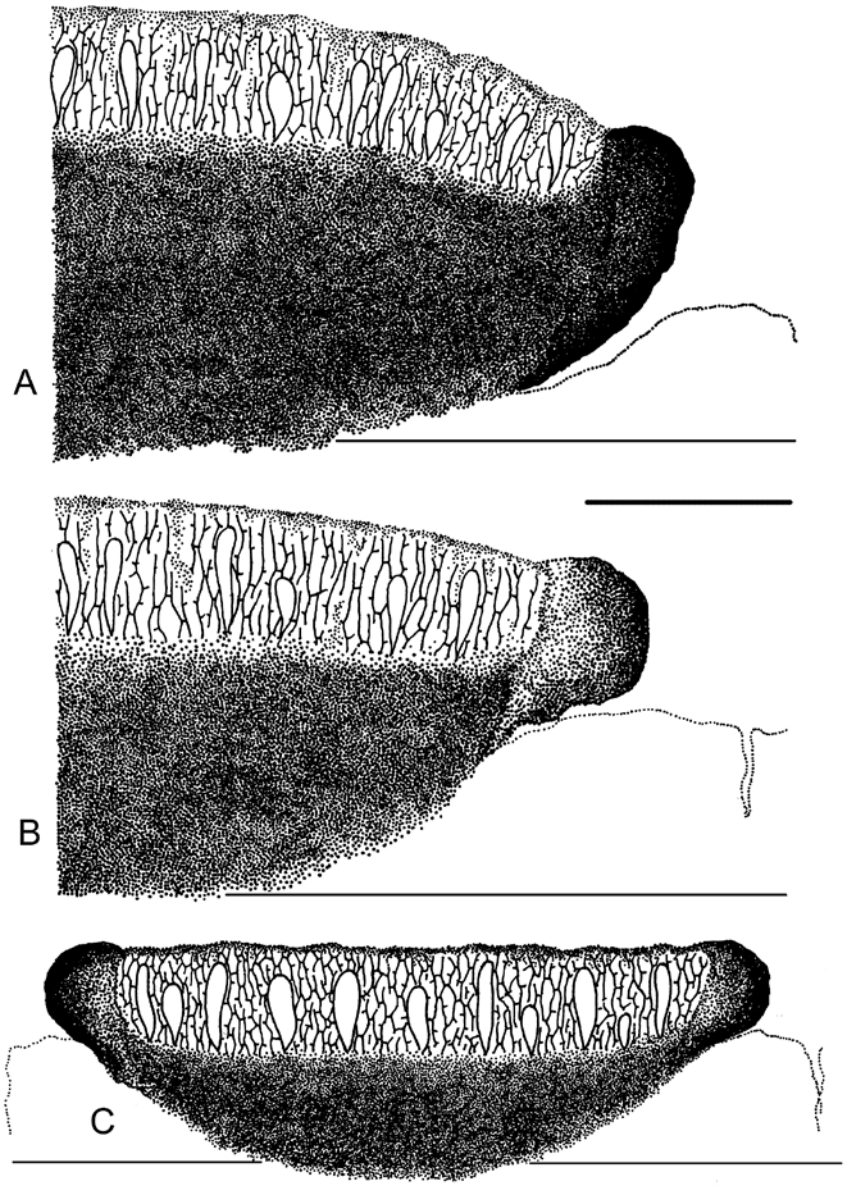

Figure 3. Apothecial sections (semi-schematic). A, *Rhizocarpon austroalpinum* (holotype). B, *R. torquatum* (holotype). C, *R. reductum* (*G. Kantvilas 363/12*). Scale: 0.2 mm.

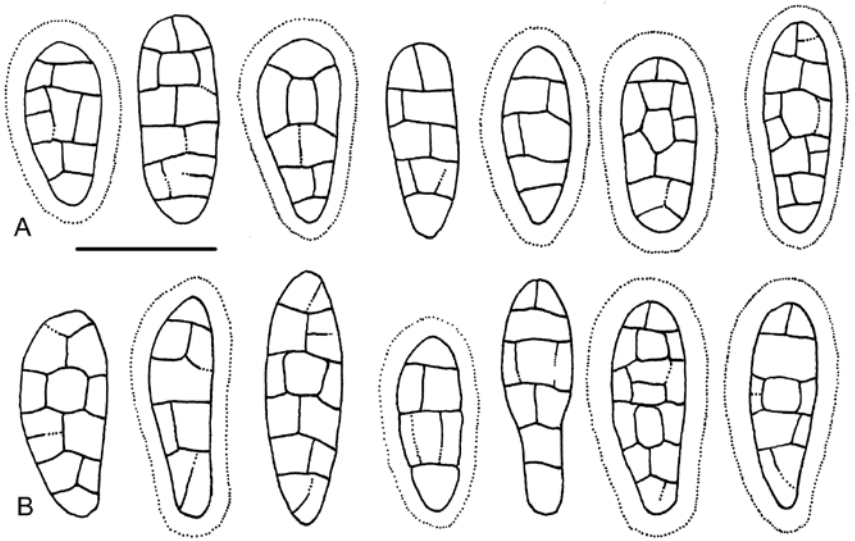

Figure 4. Ascospores. A, *Rhizocarpon austroalpinum* (holotype). B, *R. torquatum* (holotype). Scale: 20 µm.

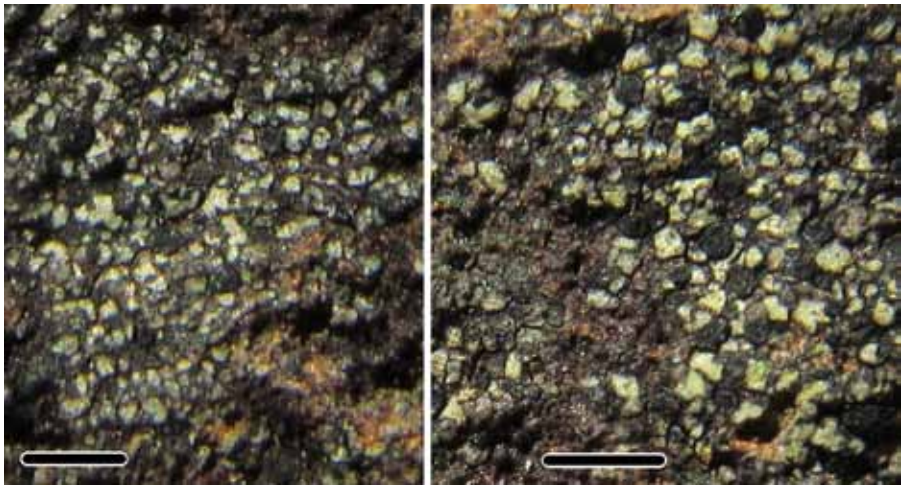

Figure 5. *Rhizocarpon exiguum* (holotype). Scales: 1 mm.

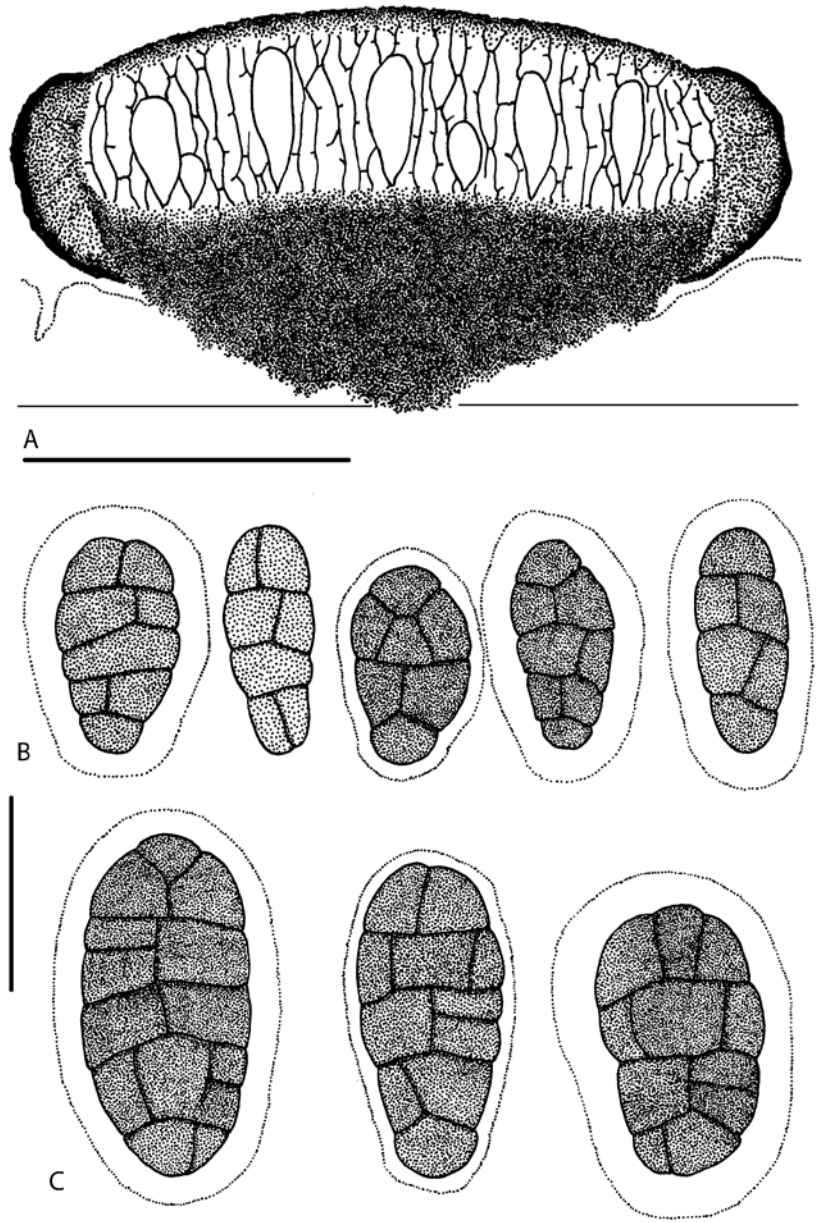

Figure 6. *Rhizocarpon exiguum* (holotype). A, Vertical section of an apothecium (semi-schematic); B, Ascospores; C, Ascospores of *Rhizocarpon intersitum* (*G. Kantvilas 99/94*). Scales: A = 0.2 mm; B, C = 20 µm.

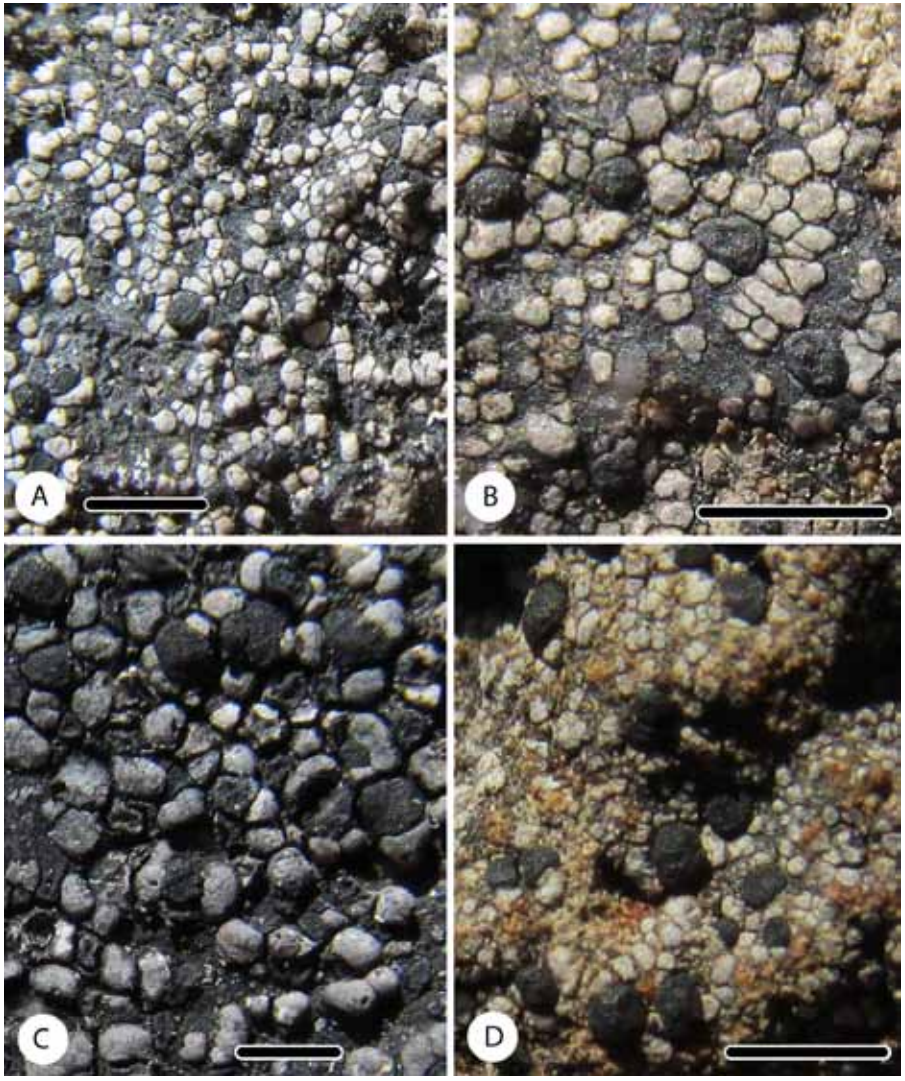

Figure 7. *Rhizocarpon intersitum*: morphological variation in Tasmania. A, *G. Kantvilas 206/05*; B, *G. Kantvilas 1135/01*; C, *G. Kantvilas 99/94*; D, *G. Kantvilas 128/14*. Scales: 2 mm.

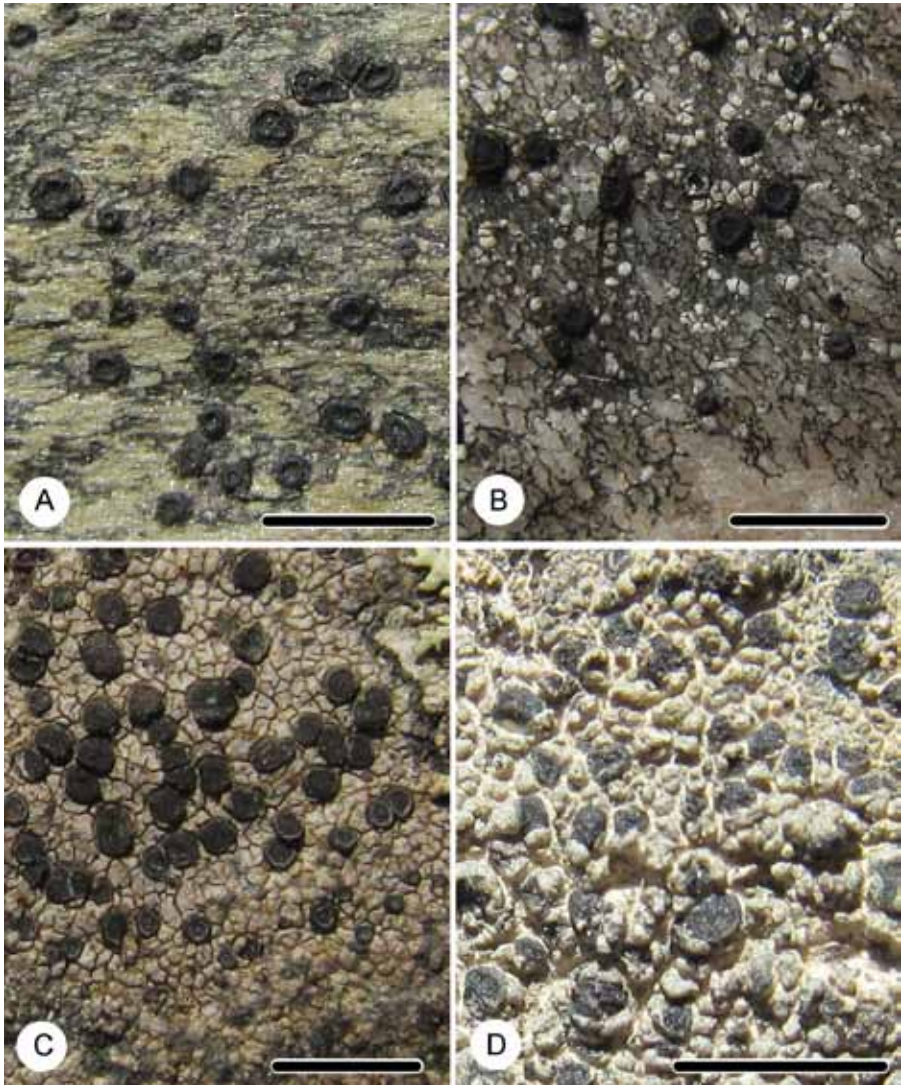

Figure 8. *Rhizocarpon reductum*, morphological variation in Australia. A, *G. Kantvilas 202/16*; B, *G. Kantvilas 16/00*; C, *G. Kantvilas 363/12* (A–C, Tasmania); D, *P.M. McCarthy 4666* (Southern Tablelands, New South Wales). Scales: 2 mm.

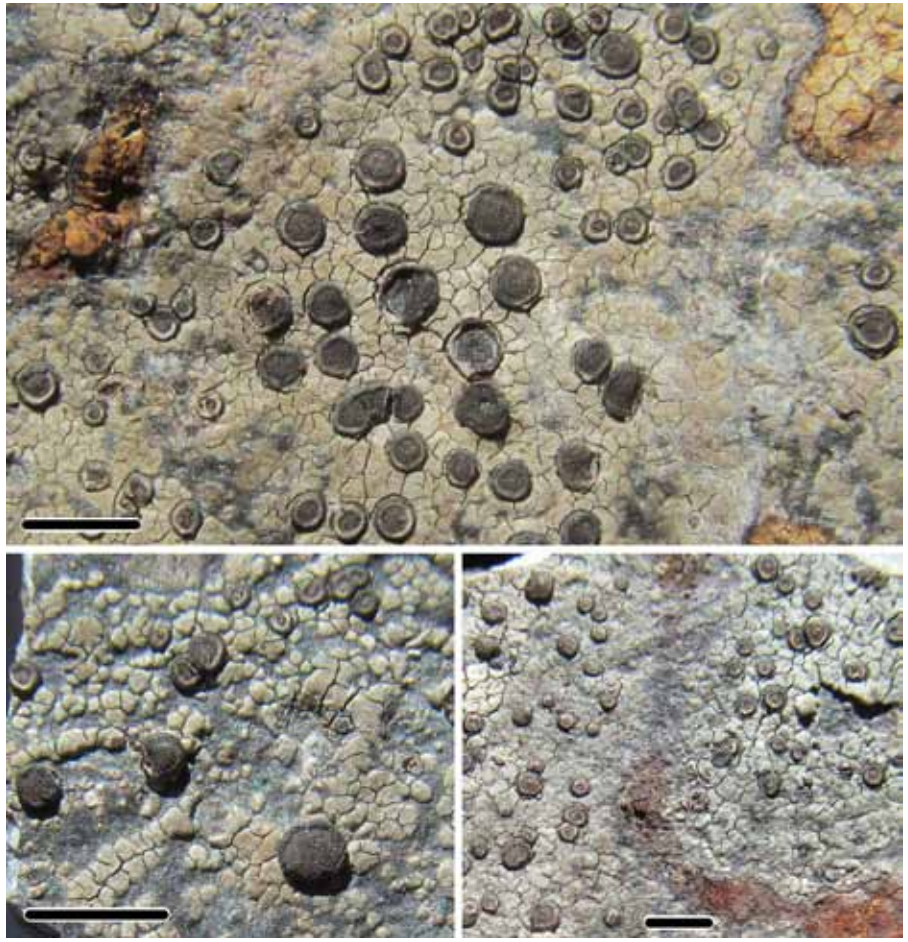

Figure 9. *Rhizocarpon torquatum* (holotype). Scales: 2 mm.

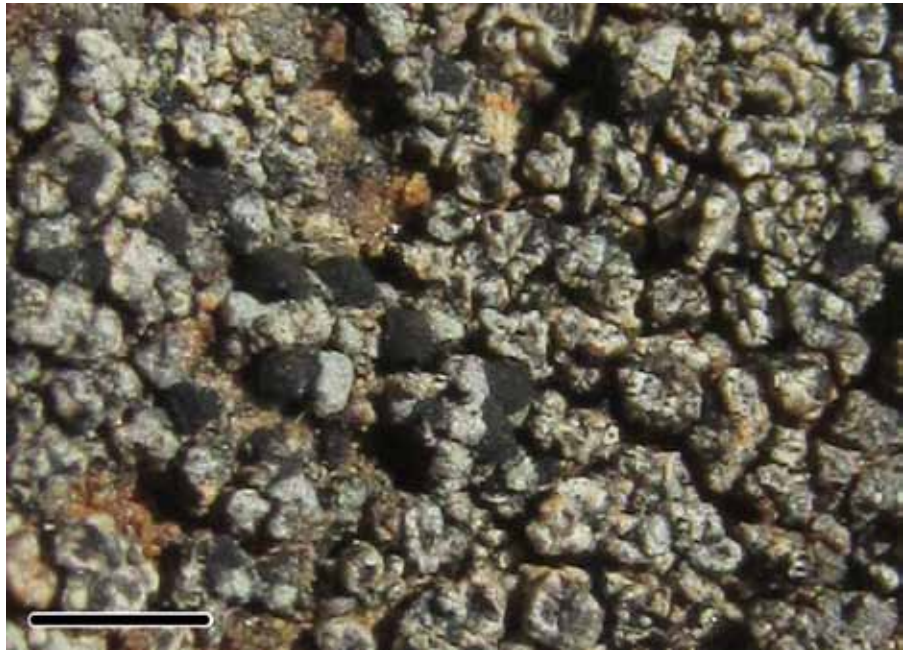

Figure 10. *Rhizocarpon* aff. *lusitanicum* (*G. Kantvilas 75/14*). Scale: 2 mm.

Four new species and a new record of buellioid lichens (Caliciaceae, Ascomycota) from Australia

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Abstract
Amandinea mountmeensis Elix & H.Mayrhofer, *Buellia bularmialensis* Elix & H.Mayrhofer, *B. dayboroana* Elix & H.Mayrhofer and *B. neohalonia* Elix & H.Mayrhofer are described as new to science. In addition, *Buellia haywardii* Elix, A.Knight & H.Mayrhofer is reported from Australia for the first time.

Introduction
This paper continues our investigation of *Buellia*-like lichens in Australia. For the more recent additions, see Elix *et al.* (2017a, b) and Elix & McCarthy (2018) and references cited therein. In this paper, we describe a new saxicolous species of *Amandinea* and three species of *Buellia* in the broad sense. Methods are as described in the previous papers cited above.

The new species

1. *Amandinea mountmeensis* Elix & H.Mayrhofer, sp. nov. Figs 1, 2
Mycobank No. **MB 833069**

Similar to *Amandinea isabellina* (Hue) Søchting & Øvstedal, but differs in having a rimose-areolate to subsquamulose thallus with a granular upper surface and an amyloid medulla that contains calcium oxalate.

Type: Australia, Queensland, road to Mount Mee State Forest, N of Dayboro, on rocks, *H. Mayrhofer & R. Rogers 2667*, 6.x.1981 (holotype – GZU).

Thallus crustose, continuous, rimose-areolate to subsquamulose, to 60 mm wide and 0.5 mm thick; individual areoles irregular, 0.1–0.4 mm wide, sometimes becoming aggregated and imbricate to form a secondary subsquamulose crust; upper surface off-white to pale brown, granular, matt; prothallus not apparent; medulla white, containing calcium oxalate (H_2SO_4+), I+ purple-blue; photobiont cells 8–20 µm diam. *Apothecia* 0.3–0.7 mm wide, lecideine, broadly adnate to sessile and constricted at the base, dispersed; disc black, epruinose, plane to convex; proper exciple thin, persistent or excluded in older convex apothecia, in section the outer zone brown-black, K–, N–, 25–38 µm thick; inner zone pale brown. *Epihymenium* 10–15 µm thick, brown to dark brown, K–, N–. *Hypothecium* brown-black, 130–250 µm thick, K–. *Hymenium* 100–125 µm thick, colourless, not inspersed; subhymenium 25–35 µm thick, colourless to pale brown, not inspersed; paraphyses 1.2–1.5(–2) µm wide, sparsely branched, with apices 4.5–5.5 µm wide and brown caps; asci of the *Bacidia*-type, with 8 spores. *Ascospores Buellia*-type, brown, ellipsoid, 15–[*18.1*]–20 × 7–[*8.7*]–10 µm, ± curved, often with acute apices, older spores constricted at septum; outer spore-wall rugulate. *Pycnidia* immersed; ostiole dark brown to black. *Conidia* filiform, curved, 16–23 × 0.7–1 µm.
Chemistry: Thallus K–, P–, C–, UV–; no lichen substances detected.

Etymology: The species is named after the type locality.

Remarks
This species is characterized by the crustose, rimose-areolate or subsquamulose thallus with a granular, off-white to pale brown upper surface, the broadly adnate to sessile apothecia, the amyloid medulla that contains calcium oxalate, a non-inspersed hymenium, the 1-septate, *Buellia*-type ascospores, 15–20 × 7–10 µm, curved, filiform conidia, 16–23 µm long, and the absence of lichen substances. Morphologically, it can resemble some specimens of *A. isabellina* because they have similar-sized ascospores, but *A. isabellina* has a thallus composed of congested verruculae and a non-amyloid medulla that lacks calcium oxalate (Lamb 1968; Elix & Kantvilas 2013). The two species also have very different ecological requirements. *Amandinea isabellina* grows on rocks in cool-temperate forests and alpine areas of southern Australia, Tasmania and New Zealand as well as in Antarctica, in contrast to the subtropical habitat of *A. mountmeensis.* The subsquamulose thallus of *A. mountmeensis* can resemble some free-living forms of *Monerolechia badia* (Fr.) Kalb, but that species has smaller ascospores, 10–15 × 6–8 µm, and bacilliform conidia, 3–5 µm long.

At present *A. mountmeensis* is known from only the type collection. Known associated species are *Buellia stellulata* (Taylor) Mudd var. *stellulata* and *Heterodermia japonica* (M.Satô) Swinscow & Krog.

2. *Buellia bularmialensis* Elix & H.Mayrhofer, sp. nov. Fig. 3
Mycobank No. **MB 833072**

Similar to *Buellia epiaeruginosa* Elix, but differs in having a much thinner hymenium, 45–55 µm thick, and significantly smaller ascospores, 9–13 × 5–7 µm.

Type: Australia. Western Australia, Albany Region, Stirling Ranges National Park, Bluff Knoll, [34°22′32″S, 118°15′22″E], *c.* 900–1000 m alt., on schist rock, *H. Mayrhofer 8457*, 24.viii.1988 (holotype – GZU).

Thallus crustose, to 35 mm wide and 0.1 mm thick, continuous, rimose, ± plane; upper surface pale grey-brown, matt, epruinose; prothallus black, prominent at the periphery; photobiont cells 7–17 µm wide; medulla white, lacking calcium oxalate (H_2SO_4–), I–. *Apothecia* 0.1–0.3 mm wide, abundant, aspicilioid then lecideine, roundish, scattered, immersed or very rarely adnate; disc black, epruinose, weakly concave to plane; proper exciple thick, black, persistent, in section 30–60 µm thick; outer part dark olive-brown to deep aeruginose, K–, N+ purple-brown; inner part brown. *Epihymenium* 10–12 µm thick, olive-brown to aeruginose, N+ purple-brown. *Hypothecium* 50–70 µm thick, dark brown, K–, N+ orange-brown. *Hymenium* 45–55 µm thick, colourless, not inspersed, I+ blue; subhymenium 10–15 µm thick, pale brown; paraphyses 1.8–2 µm wide, shortly septate, sparsely branched, with apices 3–4 µm wide and olive-brown caps; asci of the *Bacidia*-type, 8-spored. *Ascospores Buellia*-type, 1-septate, pale then dark brown, ellipsoid, 9–[*10.7*]–13 × 5–[*6.1*]–7 µm, becoming constricted at the septum; outer wall finely ornamented. *Pycnidia* punctiform, immersed; ostiole brown. *Conidia* bacilliform, straight, 5–6 × 1 µm.
Chemistry: Medulla K–, C–, P–, UV–; no lichen substances detected.

Etymology: The specific epithet refers to the type locality, Bluff Knoll, known by the indigenous Nyoongar people as Bular Mial (meaning "many eyes" — they believe that the rocks on the mountain are shaped like the eyes of an ancestral master spirit).

Remarks
The new species resembles *B. epiaeruginosa*, in that both have immersed apothecia (at least initially), an aeruginose, N+ purple-brown epihymenium and proper exciple and bacilliform conidia, and lack lichen substances. However, *B. epiaeruginosa* differs in having a much thicker hymenium, 100–130 µm thick, larger ascospores, 12–20 × 7–11 µm, and longer conidia, 6.5–10 µm long (Elix 2016). In several respects it also resembles the common and widely distributed *B. aethalea* (Ach.) Th.Fr. in that both have initially immersed apothecia and

aeruginose epihymenia. However, in *B. aethalea* the medulla reacts K+ yellow then red due to the presence of norstictic acid, and the ascospores are much larger, 12–20 × 7–12 µm (Bungartz *et al.* 2007; Elix 2011).

At present the new species is known only from the type locality. Associated species include *Circinaria caesiocinerea* (Nyl. ex Malbr.) A.Nordin, S.Savic & Tibell, *Buellia aethalea* (Ach.) Th.Fr., *B. homophylia* (C.Knight) Zahlbr., *Lecanora mayrhoferi* Lumbsch, *Ramboldia petraeoides* (Bab. & Mitt.) Kantvilas & Elix, *Rhizocarpon geographicum* (L.) DC., *Xanthoparmelia mougeotina* (Nyl.) D.J.Galloway and several other *Xanthoparmelia* species.

3. *Buellia dayboroana* Elix & H.Mayrhofer, sp. nov. Fig. 4
Mycobank No. **MB 833070**

Similar to *Buellia straminea* Tuck., but differs in having an areolate thallus that lacks lobate margins, and apothecia with a colourless hypothecium.

Type: Australia, Queensland, Woodford Road, N of Dayboro, Terrors Creek, 27°09'S, 152°50'E, *c.* 300 m alt., on greenstone boulders, *J. Hafellner 15646 & N. Stevens*, 13.viii.1986 (holotype – GZU).

Thallus crustose, discontinuous, to 15 mm wide, areolate; areoles crowded or dispersed, 0.05–0.15 mm wide; upper surface pale yellow, dull; prothallus absent; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 6–14 µm wide. *Apothecia c.* 0.1 mm wide, lecideine, immersed to just adnate, 1 per areole, round; disc black, epruinose, plane to convex; proper exciple thin, excluded in convex apothecia, in section 15–20 µm thick; outer zone dark brown, K–, N–; inner zone pale brown. *Epihymenium* 10–12 µm thick, brown to dark olive-brown, K–, N–. *Hypothecium* colourless, 35–50 µm thick, K–. *Hymenium* 35–45 µm thick, colourless, not inspersed; paraphyses 1.5–2 µm wide, sparsely branched, with apices 3–4 µm wide and brown caps; asci of the *Bacidia*-type, with 8 spores. *Ascospores Buellia*-type, brown, ellipsoid, 10–[*11.5*]–13 × 5–[*5.4*]–7 µm, the older spores rarely constricted at the septum; outer spore-wall weakly ornamented. *Pycnidia* not seen.
Chemistry: Thallus K–, P–, C+ orange, UV+ orange; containing arthothelin.

Etymology: The specific epithet refers to the type locality of Dayboro.

Remarks
The species is characterized by the crustose thallus consisting of minute, pale yellow areoles, the immersed to adnate, lecideine apothecia, the non-amyloid medulla, a non-inspersed hymenium, the ellipsoid, 1-septate, *Buellia*-type ascospores, 10–13 × 5–7 µm, and the presence of arthothelin. Chemically, it is identical to *B. straminea*, but the latter has a brown to dark brown hypothecium and an areolate thallus that is usually lobate at the margins (Bungartz 2019).

Buellia dayboroana is known only from the type collection. Associated species are *Lecidella buelliastrum* (Müll.Arg.) Knoph & Rambold and *Rinodina oxydata* (A.Massal.) A.Massal.

4. *Buellia neohalonia* Elix & H.Mayrhofer, sp. nov. Fig. 5
MycoBank number: **MB 833071**

Similar to *Buellia halonia* (Ach.) Tuck., but differs in having *Buellia*-type ascospores and an amyloid medulla that contains calcium oxalate.

Type: Australia, Victoria, Gippsland, Agnes Falls Reserve, NW of Welshpool, 38°38'S, 146°22'E, *c.* 150 m alt., on sandstone, *H. Mayrhofer 11532 & E. Hierzer*, 29.vii.1992 (GZU – holotype).

Thallus crustose, continuous, rimose-areolate, to 30 mm wide and 0.6 mm thick; individual areoles 0.3–1 mm wide; upper surface off-white to pale yellow, dull, appearing granular, crystalline or maculate, esorediate; prothallus not apparent; photobiont cells 9–14 µm wide; medulla white, containing calcium oxalate (H_2SO_4+), I+ purple-blue. *Apothecia* 0.3–1.4 mm wide, cryptolecanorine then lecideine, initially erumpent, separate or commonly crowded, ± round or distorted by mutual pressure, immersed to broadly adnate or sessile; disc black, epruinose or grey-white-pruinose, plane to weakly convex; proper exciple thick, persistent, in section 50–70 µm thick, the outer zone brown, K–, paler within. *Hypothecium* 120−150 µm thick, brown to dark brown, K−, N−. *Epihymenium* 15–20 µm thick, brown, K–, N−. *Hymenium* 110–140 µm thick, colourless, not inspersed with oil droplets; subhymenium 15−20 µm thick, pale brown; paraphyses 1.5–2.0 µm wide, simple to sparsely branched, with apices 3−5 µm wide and pale brown caps; asci of the *Bacidia*-type, with 8 spores. *Ascospores* of the *Buellia*-type, 1-septate, brown, ellipsoid, 12–[*15.0*]–18 × 7–[*8.2*]–10 µm, becoming constricted at the septum; outer spore-wall microrugulate. *Pycnidia* punctiform, immersed; ostiole brown-black. *Conidia* bacilliform, 5–6 × 1 µm.
Chemistry: Cortex K+ pale yellow, C+ yellow-orange, KC+ orange, P–, UV+ dull orange; containing arthothelin (major), 4,5-dichloronorlichexanthone (trace).

Etymology: The epithet is derived from the similarity of the species to *Buellia halonia*.

Remarks
Morphologically, *B. neohalonia* closely resembles *B. halonia*, a widespread saxicolous species known from Australia, North America, South America and South Africa (Bungartz *et al.* 2007; Elix 2011). Both are characterized by the presence of arthothelin or isoarthothelin, and they have similar-sized ascospores. However, *B. neohalonia* differs in having an amyloid medulla, a granular, crystalline or maculate upper surface (smooth and waxy in *B. halonia*) and *Buellia*-type ascospores that become constricted at maturity (*Physconia*-type and non-constricted in *B. halonia*). The two species also differ chemically. Whereas *B. halonia* contains isoarthothelin and roccellic acid as major substances and lacks medullary calcium oxalate, *B. neohalonia* contains arthothelin as a major substance and has high concentrations of calcium oxalate. The new species also resembles *Buellia halonioides* Elix, in that both have a granular upper surface and similar-sized *Buellia*-type ascospores, and contain medullary calcium oxalate and arthothelin. However, *B. halonioides* has a partially aeruginose epihymenium and excipulum (N+ red-violet) and a non-amyloid medulla (Elix *et al.* 2017b).

At present, the new species is known from Victoria and the South Island of New Zealand, where it occurs on siliceous rocks in coastal and hinterland regions. Associated species include *Amandinea isabellina* (Hue) Søchting & Øvstedal, *Buellia stellulata* (Taylor) Mudd var. *stellulata*, *Paraporpidia leptocarpa* (C.Bab. & Mitt.) Rambold & Hertel, *Rhizocarpon geographicum* (L.) DC., *Tephromela atra* (Huds.) Hafellner and *Xanthoparmelia australasica* D.J.Galloway.

SPECIMEN EXAMINED
New Zealand: ● South Island, Nelson, Boulder Bank, near oxidation ponds, NZMS 260 O27:370003, 41°12.3'S, 173°19.3'E, 2 m alt., on exposed rounded cobbles on lee side of bank, *W. Malcolm 3318*, 10.x.2015 (CANB) [growing together with *Buellia stellulata*].

New record for Australia

Buellia haywardii Elix, A.Knight & H.Mayrhofer, *Telopea* **20**, 77 (2017)
This species was previously known from northern New Zealand (Elix & Mayrhofer 2017). It is characterized by the crustose, rimose-areolate, white to grey-brown thallus, the immersed to adnate apothecia that are initially lecanorine, then biatorine and ultimately lecideine, the 1-septate, *Buellia*-type ascospores, 10–16 × 5–9 µm, which become constricted at the septum, the bacilliform or weakly fusiform conidia, 6–10 × 1–1.5 µm, and the presence of norstictic acid. A detailed description and illustration are given in Elix & Mayrhofer (2017).

SPECIMEN EXAMINED
Victoria: ● Brisbane Ranges, Little River Gorge, *c.* 25 km S of Bacchus Marsh, 37°51'S, 144°22'E, on rock, *R. Filson & H. Mayrhofer 3021*, 18.x.1981 (GZU).

Acknowledgements
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Figure 1. *Amandinea mountmeensis* (holotype in GZU). Bar = 1 mm.

Figure 2. Ascospore ontogeny of *A. mountmeensis*. Bar = 10 µm.

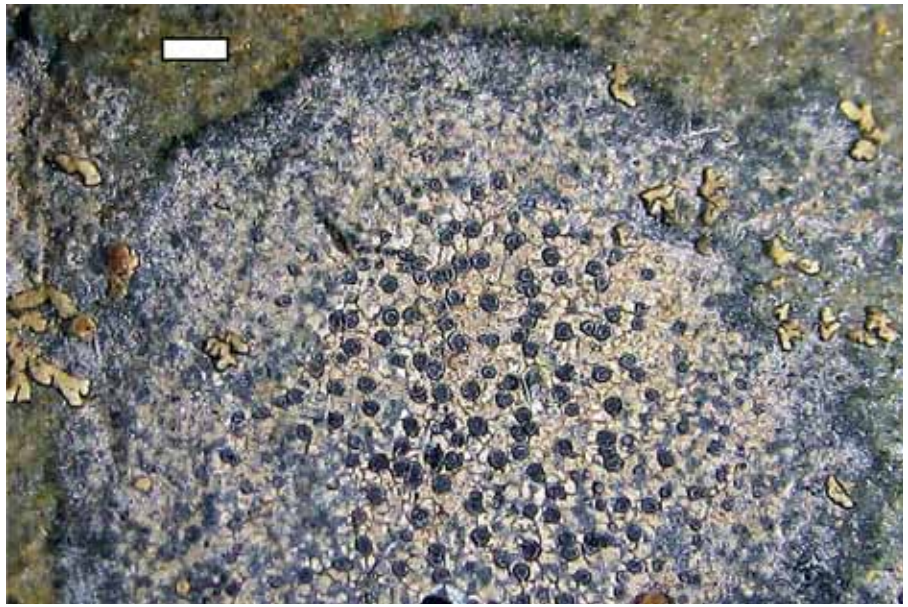

Figure 3. *Buellia bularmialensis* (holotype in GZU). Bar = 1 mm.

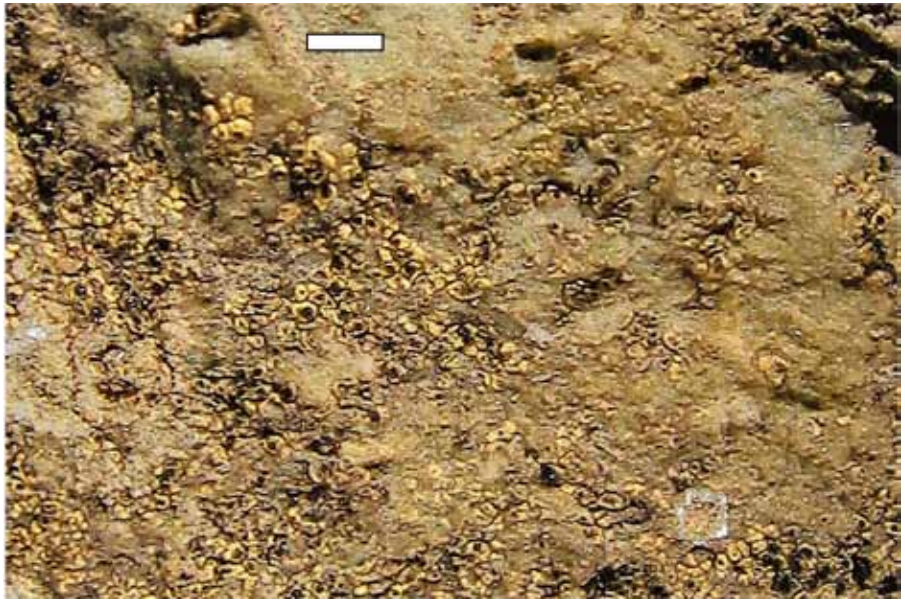

Figure 4. *Buellia dayborana* (holotype in GZU). Bar = 1 mm.

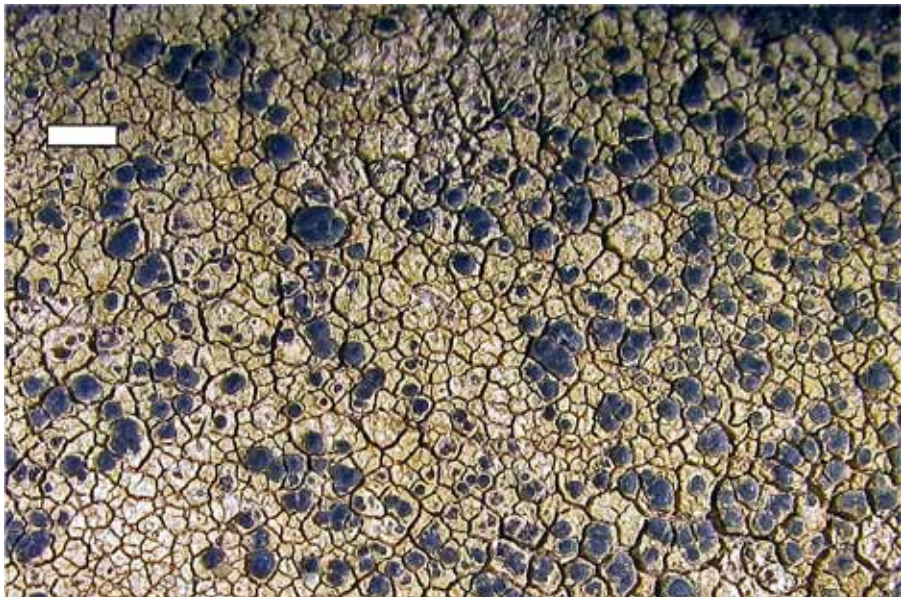

Figure 5. *Buellia neohalonia* (holotype in GZU). Bar = 2 mm.

A new sorediate species of *Amandinea* (Caliciaceae, Ascomycota) from Antarctica

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Abstract
The new species *Amandinea clearyi* Elix & Øvstedal, is described from Marie Byrd Land and MacRobertson Land, Antarctica.

Introduction

In the austral summer 1987–88, a combined geological and biological expedition was made to Edward VII Peninsula (77°00'–78°30'S, 152°–156°W), Marie Byrd Land, Antarctica. A general survey was made of algae, mosses, lichens and microfauna (Broady 1989) and of bird life (Broady *et al.* 1989). 376 samples of lichens were collected on 23 nunataks in the Rockefeller and Alexandra Mountains. Amongst them was a unique species with a placodioid thallus with effigurate marginal areoles, curved filiform conidia and medullary usnic acid. The species was also discovered in several collections made in 1986 by Rex Filson at Mount Henderson in MacRobertson Land.

Material and methods

Material from the expedition described above (deposited at CHR) as well as several collections from MEL were studied. The specimens were examined using a Zeiss Stemi 2000C microscope and a Zeiss Axiolab compound microscope. Microscopical details were obtained by examining hand-cut sections. The sections were mounted in dilute lactophenol cotton blue or water. Measurements were made on sections mounted in water or 10% KOH. Chemical constituents were identified by thin-layer chromatography (Elix 2014).

Amandinea clearyi Elix & Øvstedal, sp. nov. Fig. 1
Mycobank No. **MB 830225**

Similar to *Amandinea latemarginata*, but differs in having a sorediate upper surface and in containing usnic acid. No apothecia seen.

Type: Antarctica, Marie Byrd Land, Edward VII Peninsula, Alexandra Mountains, Clark Peak, [77°30'52"S, 154°11'45"W], on siliceous rock. *P. Broady s.n.*, xii.1987–i.1988, (holotype – CHR 647811).

Thallus crustose to placodioid, forming orbicular or confluent patches, to 12 mm wide and 0.12 mm thick, lobate-effigurate at the periphery, the inner part unevenly verrucose or rimose-areolate, often eroding and the areoles dispersed with age; areoles of irregular form, 2–3 mm wide, marginal areoles radially elongate; apices blackened, 0.1–0.2 mm wide. *Upper surface* pale yellow to whitish or darkening with age, mealy, sorediate; soralia 0.1–0.3 mm diam., sessile, subglobose, deep yellow then darkening with age, laminal or rarely marginal; soredia deep yellow, dark brown to blackish with age, 18.9 ± 1.8 µm wide (n = 20), without protruding hyphae. *Upper cortex* pseudoparenchymatous, often disrupted, the individual cells 1.5–2 µm diam., with some brown spots. *Medulla* white, composed of intertwined hyphae, lacking calcium oxalate (H_2SO_4–), I–. *Photobiont* green, trebouxioid, concentrated just above the lower surface; cells 7–16 µm diam. *Lower cortex* pseudoparenchymatous, 15–25 µm thick, dark brown, individual cells 1.5–2 µm wide; hapters and rhizines absent. *Apothecia* not seen. *Pycnidia* immersed in thallus areoles, indicated by small, slightly prominent dark spots; conidia curved, filiform, 16–23 × 0.7 µm.
Chemistry: Thallus K–, C–, KC+ yellow, P–, UV–; containing usnic acid by TLC.

Etymology: the species is named in honour of Peter J. Cleary who, as field leader of the expedition to Edward VII Peninsula, was critical to its success.

Remarks

The generic placement of the new species is problematic, because we have yet to encounter fertile material. Several genera with placodioid thalli were considered but discounted. For example, *Dimelaena* Norman has similar thalli but short bacilliform conidia, while *Placopsis* (Nyl.) Linds. has curved, filiform conidia, but invariably has cephalodia on the upper surface, which the present species lacks. On the other hand, four buellioid species in Antarctica have similar placodioid thalli and effigurate or subeffigurate margins [*Amandinea babingtonii* (Hook.f. & Taylor) Søchting & Øvstedal, *A. latemarginata* (Darb.) Søchting & Øvstedal, *A. petermannii* (Hue) Matzer, H.Mayrhofer & Scheid. and *Buellia frigida* Darb.] The buellioid genus *Amandinea* M.Choisy ex Scheid. & H.Mayrhofer has been defined as having brown, 1-septate ascospores and curved, filiform conidia (Scheidegger 1993). Although several published phylogenies contain species with both filiform and bacilliform conidia (Wedin *et al.* 2002; Prieto & Wedin 2016), indicating that species with filiform conidia are not a monophyletic group, *Amandinea* is retained here until its status has been clarified further.

Nine saxicolous species of *Amandinea* have been recorded for Antarctica (Lamb 1968; Øvstedal & Lewis Smith 2001; Søchting *et al.* 2004; Elix 2019), seven of which are restricted to continental Antarctica or to Antarctica plus the subantarctic islands. Three of the Antarctic-subantarctic species are characterized by effigurate or subeffigurate marginal lobes (elongated areoles) as mentioned above. Given the morphological attributes of the new species, we are confident in assigning it to *Amandinea*.

Morphologically, the new species closely resembles a diminutive thallus of *Amandinea latemarginata*, with effigurate margins and areoles within. However, the latter has an esorediate upper surface and contains medullary norstictic acid (Lamb 1968). *Buellia soredians* Filson has areoles with a sorediate upper surface and contains usnic acid, but it differs in having minute areoles up to 1 mm wide dispersed on a prominent, black prothallus that never becomes contiguous or agglomerated. Moreover, it produces short, bacilliform conidia, 3–4 × 0.5 µm (Filson 1974). A similar species, *A. puertomonttensis* Elix, H.Mayrhofer & J.M.Rodr. from southern Chile, has a thallus with subeffigurate margins and a sorediate upper surface, but it lacks lichen substances (Elix *et al.* 2018).

At present, the new species is known only from continental Antarctica (MacRobertson Land in east Antarctica and Marie Byrd Land in west Antarctica). Associated species include *Buellia frigida* Darb., *Pseudephebe minuscula* (Nyl. ex Arnold) Brodo & D.Hawksw., *Umbilicaria decussata* (Vill.) Zahlbr., *Tetramelas lokenensis* Elix and *Usnea antarctica* DuRietz.

SPECIMENS EXAMINED

Antarctica. ● MacRobertson Land, Mt Henderson, N end of Goldsworthy Ridge, *R.B. Filson 4186 pr.p.*, *4191 pr.p.*, 1.viii.1962 (MEL); ● Marie Byrd Land, Edward VII Peninsula, Rockefeller Mountains, Mount Franklin, on siliceous rock, *P. Broady s.n.*, xii.1987–i.1988, (CHR 647571); ● Marie Byrd Land, Edward VII Peninsula, Rockefeller Mountains, Breckinridge Peak, on siliceous rock, *P. Broady s.n.*, xii.1987–i.1988 (CHR 647643).

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Figure 1. *Amandinea clearyi* (holotype in CHR). Scale = 10 mm.

Three new species of *Sarcogyne* (Acarosporaceae) from the Australian Capital Territory

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Abstract
Sarcogyne molongloensis P.M.McCarthy & Elix sp. nov. (Acarosporaceae) is described from sandstone outcrops, while *S. porphyricola* P.M.McCarthy & Elix sp. nov. and *S. terrulenta* P.M.McCarthy & Elix sp. nov. are reported from consolidated, siliceous soil in the Australian Capital Territory. Some recent collections of *S. canberrensis* P.M.McCarthy & Elix, *S. iridana* P.M.McCarthy & Kantvilas and *S. tholifera* P.M.McCarthy & Elix are reported from the A.C.T. and the Northern Territory, and an updated key is provided to the 12 Australian species of *Sarcogyne*.

Introduction
Species of *Sarcogyne* Flot. (Acarosporaceae) have a crustose, often immersed and usually inconspicuous thallus, reddish brown to black apothecia with a lecideine exciple, a non-carbonized epihymenium, simple to sparingly branched paraphyses and asci that usually produce 50–200 or more, simple ascospores (Magnusson 1935a; Poelt 1969; Clauzade & Roux 1985; Knudsen & Standley 2008; Fletcher & Hawksworth 2009; Westberg *et al.* 2015; Knudsen & Kocourková 2018). Approximately 50 species inhabit calcareous and siliceous rocks and soil mainly in temperate and semi-arid areas, especially in Europe, North Africa and North America, less commonly in subtropical, wet-tropical and subpolar regions. Nine species have been reported from Australia, most of which are saxicolous and found only in southern latitudes (McCarthy & Kantvilas 2013; McCarthy & Elix 2014, 2017a, b). In this paper, three new species of *Sarcogyne* are described from sandstone and consolidated, siliceous soil in the Australian Capital Territory, new records are reported for the endemic *S. canberrensis* P.M. McCarthy & Elix, *S. iridana* P.M.McCarthy & Kantvilas and *S. tholifera* P.M.McCarthy & Elix, and a key is provided to the 12 species currently known from Australia.

Methods
Observations and measurements of thallus and apothecium anatomy, asci and ascospores were made on hand-cut sections mounted in water and treated with 10% potassium hydroxide (K) and 50% nitric acid (N). Asci were also observed in Lugol's Iodine (I), with and without pre-treatment in K.

New species

1. *Sarcogyne molongloensis* P.M.McCarthy & Elix, sp. nov. Figs 1, 2
MycoBank No. **MB 832308**

Distinguished from the endemic, coastal, silicolous *S. maritima* P.M.McCarthy & Elix by having larger apothecia [(0.28–)0.65(–1.1) diam. *vs* (0.23–)0.40(–0.55) mm diam.]; a thinner apothecial margin (*c.* 30–50 µm thick *vs* 50–70(–80) µm thick) that is concolorous with the disc, and a cupulate proper excipulum (apothecial margin markedly paler in *S. maritima* and the excipulum annular); and a thicker hymenium and longer asci (100–140 µm thick and 65–105 µm long *vs* 80–100 µm thick and 55–80 µm long).

Type: Australia. Australian Capital Territory. W bank of Molonglo River at Coppins Crossing, *c.* 8 km W of Canberra, 35°17'17"S, 149°02'04"E, *c.* 500 m alt., on flat, exposed sandstone outcrop, *P.M. McCarthy 4846*, 30.i.2019 (holotype – CANB).

Thallus crustose, endolithic to subepilithic or epilithic, effuse-granular to ± determinate, continuous to areolate, pale cream-grey to medium or rather dark greenish grey, 0.06–0.15(–0.2) mm thick, forming colonies to *c.* 30(–50) mm wide, heavily impregnated with rock fragments and crystals. *Areoles* contiguous or scattered, usually plane, occasionally somewhat convex or slightly concave and with faintly raised margins, 0.3–1(–1.5) mm wide, rounded, angular or irregular; surface smooth to minutely and irregular uneven, dull to slightly glossy. *Cortex* poorly delimited, *c.* 8–15 µm thick, hyaline, of rounded, thick-walled cells 4–6(–8) µm wide, or an indistinct and almost amorphous layer *c.* 5–10 µm thick, or the cortex not apparent. *Algal layer* ± continuous, 40–80(–110) µm thick, with an uneven lower edge; cells green, chlorococcoid, globose, 6–13(–15) µm wide; interstitial mycobiont cells in short hyphae, 2–4 µm wide. *Medulla* usually poorly defined and almost obscured by rock fragments and crystals, or distinct and 60–120 µm thick, non-amyloid (I–), not containing calcium oxalate (H_2SO_4–); hyphae short- to long-celled, 2–3 µm wide. *Prothallus* not apparent. *Apothecia* very numerous, lecideine, initially innate in areoles, many becoming adnate, solitary, paired or in proliferating clusters of 3–5, rounded or broadly ellipsoid or irregular in outline, the shape commonly distorted due to mutual pressure, (0.28–)0.65(–1.1) mm diam. [*n* = 120], subtended by a continuous layer of algae; disc slightly concave to plane or slightly convex, smooth, epruinose, dull greenish black to black, occasionally slightly glossy, the colour unchanged when wetted; margin *c.* 30–50 µm thick, entire, flush with the disc or slightly prominent, smooth, persistent at maturity or almost excluded, concolorous with the disc, epruinose. *Proper excipulum* cupular, non-carbonized, 30–55(–70) µm thick laterally in section, radiating-prosoplectenchymatous, the outer 10–15(–20) µm medium to dark orange-brown to reddish brown (K–, N+ deep red-brown), the hyphae tightly conglutinate, elongate, thick-walled, with cells 2–3(–4) µm wide, the outermost cells subglobose to globose, 3–5 µm; inner marginal zone hyaline to pale brown, 20–30 µm thick, with longer, thinner-walled, paler hyphae; excipulum base colourless, 10–15(–20) µm thick, composed of long-celled and moderately thick-walled periclinal hyphae with cells 7–15 × 2–3 µm, 15–20(–25) µm thick in the centre of the apothecial base, with variously orientated hyphae and cells 3–5 µm wide, these merging with the hypothecium above and the thallus below. *Hypothecium* hyaline to pale red-brown, 30–75(–90) µm thick, inspersed with minute crystals and oil droplets or not, I–, KI+ lilac blue, K–, N+ intensifying, of loose, short-celled, variously orientated hyphae 1.5–2 µm wide. *Hymenium* 100–140 µm thick, not inspersed with granules or oil droplets; hymenial gel I+ red-brown, KI+ deep blue, K–, N–. *Epihymenium* pale brown to medium orange-brown or dark reddish brown, 8–15 µm thick, K–, N+ intensifying. *Paraphyses* rather tightly conglutinate in water, loosening a little in K, unbranched throughout, long-celled, 1–2(–2.5) µm wide; apical cells thicker-walled, dark brown, broadening gradually to 3(–3.5) µm wide. *Asci* narrowly ellipsoid, narrowly to broadly clavate or clavate-cylindrical, containing *c.* 150–200 ascospores, 65–105 × 16–32 µm [*n* = 15], with a short abrupt stalk; apex rounded, with a thin, uniformly lightly amyloid tholus; ocular chamber not apparent. *Ascospores* colourless, simple, narrowly to broadly ellipsoid or subglobose, obovoid or fusiform to bacilliform, with rounded or, occasionally, somewhat pointed ends, lacking a perispore, usually uni- or biguttulate, the contents usually clear, (2.5–)4(–6) × (1.5–)2(–2.5) µm [*n* = 50]. *Pycnidia* not seen.
Chemistry: Thallus K–, C–, KC–, PD–, UV–; no substances detected by TLC.

Etymology: The specific epithet refers to the type locality adjacent to the Molonglo River.

Remarks
Sarcogyne molongloensis is characterized by its preference for siliceous rock substrata, combined with an endolithic to epilithic, continuous to areolate thallus that lacks lichen substances, moderately large, innate to adnate apothecia with a thin, persistently dark margin and a cupulate excipulum, a thick hymenium and large asci with very numerous

ascospores. Thalline and apothecial attributes distinguish it from two endemic Australian silicoles, *S. maritima* and *S. iridana* (see key, below). The widespread *S. hypophaea* (Nyl.) Arnold occurs on siliceous and calcareous rocks, has a very thin and inconspicuous thallus, and its apothecia have carbonized and jointed margins (Knudsen & Standley 2008; Fletcher & Hawksworth 2009; Knudsen *et al.* 2013b), while the usually silicolous *S. similis* H.Magn. (North America, the Mediterranean and southern Africa) has a predominantly endolithic thallus and apothecia 0.5–1(–2.1) mm wide, each with a thick, black margin (Knudsen & Standley 2007).

Sarcogyne arenosa (Herre) K.Knudsen & Standley, known from California, Colorado, Texas and Kansas, U.S.A. (Knudsen & Standley 2008; Lendemer *et al.* 2009), occurs on calcareous and siliceous rocks and is broadly similar to *S. molongloensis* in many thalline and apothecial characters. However, in the former species the hymenium is thinner, the asci are shorter and, most significantly, the ascospores are only 1–1.5 µm wide (Knudsen & Standley 2008).

The new species has been collected from siliceous rocks at two localities in the west and east of the Australian Capital Territory.

ADDITIONAL SPECIMENS EXAMINED
Australian Capital Territory: ● type locality, on flat sandstone rock outcrops, *P.M. McCarthy 4845*, *4848*, 30.i.2019 (CANB); ● Kowen Road, Kowen Forest, 11.7 km E of Canberra, 35°19'02"S, 149°15'07"E, 700 m alt., on sandstone beside an old road bank bordering dry *Eucalyptus* woodland, *P.M. McCarthy 4868*, 31.vii.2019 (CANB).

2. *Sarcogyne porphyricola* P.M.McCarthy & Elix, sp. nov. Figs 3, 4
MycoBank No. **MB 832309**

Characterized by the mainly off-white to pale greenish grey, granulose to quasi-areolate thallus lacking lichen substances and with a ± prosoplectenchymatous, but poorly defined, hyaline cortex, immersed apothecia, 0.13–0.46 mm diam., with a rather smooth, slightly concave to plane, blackish and lightly pruinose disc, with a thin and mainly colourless (thin section), cupulate, proper exciple (pale to medium brown distally), a deep, hyaline hymenium, 180–250 µm thick, a colourless and almost vestigial hypothecium, thin and largely unbranched paraphyses, and clavate-cylindrical asci 150–210 × 16–32 µm, each with *c.* 150–200(–250) ascospores measuring (3–)5(–7.5) × (1.5–)2.2(–2.5) µm.

Type: Australia. Australian Capital Territory. NE slope of Mt Mugga Mugga, Canberra Nature Park, Woden Valley, Canberra, 35°20'43"S, 149°07'10"E, 660 m alt., on consolidated, porphyritic soil in an area of dry land salinity in open *Eucalyptus-Allocasuarina* woodland, *P.M. McCarthy 4777*, 22.ix.2017 (holotype – CANB).

Thallus crustose, predominantly immersed in the substratum to partially superficial, effuse to ± determinate, continuous to granulose and quasi-areolate, off-white, greenish white or pale to medium greenish grey, (0.05–)0.1–0.25(–0.4) mm thick, visible as numerous, small, inconspicuous colonies to *c.* 5 mm wide, scattered on bare soil or among the thalli of other crustose lichen species, occasionally forming larger colonies to *c.* 20 mm wide; 'areoles' rounded to angular-irregular, 0.15–0.4(–0.5) mm wide, their size and shape largely determined by cracks in the soil substratum. *Cortex* poorly defined, hyaline, 15–27 µm thick, ± prosoplectenchymatous, of thick-walled, periclinal hyphae 2–3 µm wide, or indistinct. *Algal layer* dense, continuous, 40–70 µm thick; cells green, chlorococcoid, globose, 7–12(–15) µm wide; interstitial hyphae 2–3 µm wide. *Medulla* poorly delimited, dominated by soil material, non-amyloid (I–), not containing calcium oxalate (H_2SO_4–); hyphae loose, long-celled, (1.5–)2–2.5(–3) µm wide. *Prothallus* not apparent. *Apothecia* numerous, lecideine, immersed in the thallus and substratum, solitary, paired or in small clusters, rounded or broadly ellipsoid in outline, although commonly distorted due to mutual pressure, (0.13–)0.33(–0.46) mm diam. [*n* = 100], subtended by a continuous layer of algae *c.* 50 µm thick; disc dull black, slightly concave to plane, mostly smooth or, sometimes, minutely uneven, with a sparse, whitish pruina or epruinose; margin concolorous with the thallus or dull black, entire, scarcely raised above the disc, 50–80 µm thick. Many immature and submature apothecia with a pale grey, pseudothalline margin that is, anatomically, mostly amorphous, necral material with soil fragments and incorporating very few or no algal cells. *Proper excipulum* deeply cupulate, 50–70 µm thick distally and uniformly pale to medium brown (the colour intensifying a little in K and N), paraplectenchymatous in thin section; cells thick-walled, 2–3.5 µm diam.; occasionally the upper excipular edge with an outer, hyaline amorphous zone to 10(–15) µm thick; excipulum sides hyaline to pale brown, 22–30 µm thick; excipulum base hyaline to pale brown, 13–25 µm thick, the sides and base composed of long-celled, thin-walled, periclinal hyphae, with cells 4–8(–10) × 1–1.5(–2.5) µm. *Hypothecium* hyaline, (10–)12–18(–20) µm thick, not inspersed with granules or oil droplets, K–, N–, I– (with or without pretreatment in K). *Hymenium* 180–250 µm thick, hyaline, not inspersed, K–, N–, KI+ deep blue. *Epihymenium* uniformly greenish brown or pale purple-brown in water, granular, 5–10(–15) µm thick, colour intensifying a little in K, N+ pale olive-brown. *Paraphyses* strongly conglutinate in water and K, especially the apices, unbranched below and mainly unbranched above, with sparse anastomoses, long-celled, 1–1.5(–2.5) µm thick; cell contents clear or minutely granulose or with small oil globules; apices strongly conglutinate, not swollen. *Asci* narrowly to broadly clavate or clavate-cylindrical (immature asci often narrowly cylindrical), with *c.* 150–200 (–250) ascospores, 150–210 × 16–32 µm [*n* = 20], with an abrupt or tapering stalk; apex rounded, with an amyloid tholus 3–5 µm deep, lacking a distinct ocular chamber. *Ascospores* colourless, simple, narrowly to broadly ellipsoid, oblong or short-bacilliform, occasionally subglobose, straight or slightly curved, with rounded or, occasionally, somewhat pointed ends, lacking a perispore, usually (1–)2-guttulate, the contents also commonly granular, (3–)5(–7.5) × (1.5–)2.2(–2.5) µm [*n* = 50]. *Pycnidia* not seen.
Chemistry: Thallus K–, C–, KC–, PD–, UV–; no substances detected by TLC.

Etymology: The specific epithet refers to the occurrence of the type specimen on porphyry-derived soil.

Remarks
The new species, while inconspicuous in the field, possesses a distinctive suite of thalline and apothecial characters. The thallus is comparatively pale and well-developed (cf. *S. terrulenta*, below), and the apothecia exhibit a discrete and largely unvarying morphology and anatomy, being almost completely immersed, with a rather smooth, usually concave and lightly pruinose disc, a deep hymenium on a rudimentary hypothecium and the thin, cupulate and basally hyaline proper excipulum subtended by a dense and unbroken layer of algal cells. In contrast, the thallus of *S. terrulenta* is thinner, rather nondescript and almost indistinguishable from the substratum, the apothecial discs are rougher and epruinose, the excipulum sides and base are usually medium to dark brown or brown-black, and the ascospores are shorter [(2–)3(–4) µm long *vs* (3–)5(–7.5) µm long].

Very few *Sarcogyne* species are known to occur exclusively on soil. Thus, for example, the thallus of *S. terrena* H.Magn., from sandy soil in coastal, southern Brazil, is completely immersed in the substratum, being anchored by anastomosing rhizohyphae, and the minute apothecia, to 0.3 mm wide, have a punctiform disc to 0.1 mm wide and an elevated margin (Magnusson 1935b; Knudsen *et al.* 2012). *Sarcogyne crustacea* K.Knudsen & Kocourk., from western North America, has sessile apothecia 0.4–1.5 mm wide with a margin that becomes crenulate to flexuose. The asci are only 60–80 × 20 µm, and they contain *c.* 100 ascospores (Knudsen & Kocourková 2010). *Sarcogyne mitziae* K.Knudsen, Kocourk. & McCune (Knudsen *et al.* 2013a), also from western North America, has a brown corticate thallus, ± sessile apothecia with an inspersed hymenium *c.* 80–100 µm tall and asci that are 50–65 × 15–20 µm, while *S. brunnea* K.Knudsen & Flakus, known from montane soil in Bolivia and Ecuador, has a pruinose, white to brown thallus and a dark reddish brown upper cortex (Knudsen *et al.* 2012). In Australia, the recently described *S. tholicola* P.M.McCarthy & Elix occurs on consolidated, acidic soil in southern Queensland and central-western New South Wales (McCarthy

& Elix 2017a). This highly distinctive species has a minutely squamulose, predominantly yellowish thallus and a secondary chemistry dominated by rhizocarpic acid. Moreover, the apothecia are semi-immersed to almost superficial and moderately to strongly convex or ± hemispherical, 0.32–0.62 mm diam., with a dull greenish black, bilayered, cupulate excipulum, and ascospores 2–3.5 µm long (McCarthy & Elix 2017a).

Sarcogyne porphyricola is known only from a low, porphyritic soil-bank, several metres in extent, in open *Eucalyptus-Allocasuarina* woodland in the Australian Capital Territory. It is part of a rich, terricolous cryptogam community that includes *Buellia suttonensis* Élix & A.Knight, *Caloplaca arandensis* Elix, S.Y.Kondr. & Kärnefelt, *Diploschistes thunbergianus* Lumbsch & Vězda, *Endocarpon pallidum* Ach., *E. pusillum* Hedw., *Heterodea muelleri* (Hampe) Nyl., *Lecanora pseudistera* Nyl., *Lecidea terrena* Nyl., *Micarea humilis* P.M. McCarthy & Elix, *Trapelia* sp., as well as sterile pottiaceous mosses and cyanobacterial crusts.

ADDITIONAL SPECIMEN EXAMINED
Australian Capital Territory: ● type locality, *P.M. McCarthy 4806*, 15.ix.2017 (CANB).

3. *Sarcogyne terrulenta* P.M.McCarthy & Elix, sp. nov. Fig. 5
MycoBank No. **MB 832310**

Similar to *S. porphyricola* P.M.McCarthy & Elix, but differs in having an inconspicuous, pale greyish brown or pale to medium sandy brown thallus (not off-white to pale greenish grey), with a thinner necral layer, apothecia that are subtended by a broken algal layer (not continuous as in *S. porphyricola*) with an uneven, epruinose disc (not smooth and lightly pruinose), a pale brown or, more commonly, medium to dark brown or brown-black proper excipulum (in thin section, not hyaline to very pale brown), and smaller ascospores [(2–)3(–4) µm long *vs* (3–)5 (–7.5) µm long].

Type: Australia. Australian Capital Territory. Kowen Road, Kowen Forest, 11.7 km E of Canberra, 35°19’02”S, 149°15’07”E, 700 m alt., on consolidated, siliceous soil on an old road bank bordering dry *Eucalyptus* woodland, *P.M. McCarthy 4827*, 9.i.2019 (holotype – CANB).

Thallus crustose, very inconspicuous, largely immersed in to partly superficial on the substratum, effuse to ± determinate, continuous to rimose or quasi-areolate, pale greyish brown or pale to medium sandy brown (and ± concolorous with the substratum), 0.08–0.2(–0.3) mm thick, forming poorly delimited colonies to *c.* 20(–30) mm wide dominated by soil material; ‘areoles’ rounded to angular-irregular, 0.2–0.5(–0.7) mm wide, slightly concave and with a somewhat raised margin, or immarginate and plane to moderately convex, areolar size and shape largely determined by the soil substratum, ecorticate, but often with an uppermost, hyaline, amorphous layer *c.* 10 µm thick. *Algal layer* dense, continuous, 40–60 µm thick; cells green, chlorococcoid, globose, 7–13(–15) µm wide; interstitial hyphae, 2–3 µm wide. *Medulla* poorly defined, dominated and largely obscured by soil material, non-amyloid (I–), not containing calcium oxalate (H_2SO_4–); hyphae loose, long-celled, 2.5–4 µm wide. *Prothallus* not apparent. *Apothecia* numerous, lecideine, 2/3-immersed to almost completely immersed in the substratum (sometimes more prominent following the erosion of the adjacent substratum by wind or rain), solitary, paired or in small clusters, mostly rounded or broadly ellipsoid in outline, occasionally the shape distorted due to mutual pressure, (0.27–)0.41(–0.58) mm diam. [*n* = 100], subtended by a discontinuous layer of algae, the cells in clusters *c.* 50 µm deep; disc dull black, slightly concave to plane, smooth or minutely to coarsely uneven, epruinose; margin often incorporating soil material, pseudolecanorine and dark grey to lecideine and dull black, entire, thin and inconspicuous to rather tumid, ± flush with the disc or raised and prominent, 60–100(–120) µm thick. *Proper excipulum* cupulate, 45–70(–90) µm thick distally, with a dark brown to brown-black outer zone (K+ deep red-brown or chestnut-brown and N+ red-brown), this often subtending an outermost, hyaline to pale brown, amorphous zone 5–10(–15) µm thick; internally the excipular apex is slightly to considerably paler (and almost hyaline), paraplectenchymatous in thin section, the dark brown cells thick-walled, 3–5 µm diam.;

excipulum sides and base pale brown or, more commonly, medium to dark brown to brown-black, 15–25(–30) µm thick, composed of long-celled, thin-walled, periclinal hyphae, the cells 5–10 × 1–2 µm. *Hypothecium* hyaline, 20–30(–40) µm thick, not inspersed with granules or oil droplets, K–, N– or N+ pale brown, I– (with or without pretreatment in K). *Hymenium* 150–250(–330) µm thick, hyaline to pale brown, not inspersed, K–, N–, I+ blue, fugitive to red-brown, KI+ pale blue. *Epihymenium* pale brown or pale red-brown in water, 15–25(–35) µm thick, the colour intensifying in K, intensifying or fading in N. *Paraphyses* strongly conglutinate in water and K, unbranched below and above, with very sparse branches and anastomoses (anastomoses most numerous adjacent to the excipulum, other branching mainly in and below the epihymenium), long-celled, not or scarcely constricted at the septa, (1–)1.5–2.5(–3.5) µm thick; cell contents clear or minutely granulose or with minute oil globules; apices strongly conglutinate, pale brown, not or only slightly swollen. *Asci* narrowly ellipsoid or narrowly to broadly clavate or clavate-cylindrical, containing *c.* 200–250 ascospores, 120–170 × 20–35(–40) µm [*n* = 20], with an abrupt or more tapering stalk; apex rounded, with an amyloid tholus 2–4 µm deep, lacking a distinct ocular chamber. *Ascospores* colourless, simple, narrowly to broadly ellipsoid or subglobose, occasionally ovoid or short-bacilliform, straight and with rounded ends, lacking a perispore, with or without 1 or 2 guttules, other cell contents clear or minutely granular, (2–)3(–4) × (1.5–)2.2(–2.5) µm [*n* = 60]. *Pycnidia* not seen; however, numerous conidia observed adjacent to an apothecial section, 1–2 × 0.5–0.7 µm. *Chemistry*: Thallus K–, C–, KC–, PD–, UV–; no substances detected by TLC.

Etymology: The specific epithet *terrulenta* (Latin, of the soil) refers to the preferred substratum of this species.

Remarks
The diagnostic attributes of *S. terrulenta* are outlined in the comparison with *S. porphyricola* and the species diagnosis above, and in the key to Australian taxa below.

Elsewhere in the Australian lichen flora, *S. terrulenta* exhibits a marked, superficial similarity to the terricolous Tasmanian endemic *Acarospora tasmaniensis* K.Knudsen & Kocourk. (syn: *Polysporina terricola* Kantvilas; Kantvilas 1998; Knudsen & Kocourková 2015) in its rather nondescript, greyish thallus, apothecial morphology and anatomy. However, the epihymenium of the Tasmanian lichen has melanized accretions, and the paraphyses develop abundant anastomoses, their hyphal cells containing oil-filled vacuoles that can give them a moniliform appearance (Kantvilas 1998).

Sarcogyne terrulenta is known from consolidated siliceous soils, mainly in *Eucalyptus*-dominated woodland, at several localities in the Australian Capital Territory. Associated lichens include *Caloplaca arandensis* Elix, S.Y.Kondr. & Kärnefelt, *Catapyrenium* spp., *Cladonia* spp., *Diploschistes* spp., *Endocarpon pusillum* Hedw., *Heterodea muelleri* (Hampe) Nyl., *Lecanora pseudistera* Nyl., *Lecidea terrena* Nyl., *Micarea humilis* P.M.McCarthy & Elix, *Trapelia* spp. and *Verrucaria kowenensis* P.M.McCarthy.

ADDITIONAL SPECIMENS EXAMINED
Australian Capital Territory: ● type locality, *P.M. McCarthy 4864*, 31.vii.2019 (CANB); ● Woodstock Nature Reserve, Shepherds Lookout Walk, 20 km WNW of Canberra, 35°14’34”S, 148°58’38”E, 555 m alt., on consolidated, siliceous soil bank in open *Eucalyptus-Callitris* woodland, *P.M. McCarthy 4805*, 17.vii.2018 (CANB); ● Canberra Nature Park, Aranda Bushland, Powerline Track, *c.* 4 km W of Canberra, 35°16’00”S, 149°04’54”E, 690 m alt., on siliceous soil bank in open *Eucalyptus* woodland, *J.A. Elix 46806*, 10.viii.2019 (CANB); ● *loc. id.*, *J.A. Elix 46810*, 14.viii.2019 (CANB); ● *loc. id.*, *P.M. McCarthy 4881*, 14.viii.2019 (CANB).

New records

1. *Sarcogyne canberrensis* P.M.McCarthy & Elix, *Australas. Lichenol.* **80**, 17 (2017)
Initially described and known only from Cotter Caves in the A.C.T. (McCarthy & Elix 2017a), this species was recently collected on calcareous substrata at two other localities in the Territory.

SPECIMENS EXAMINED
Australian Capital Territory: ● Woodstock Nature Reserve, Shepherds Lookout Walk, 20 km WNW of Canberra, 35°14'34"S, 148°58'38"E, 555 m alt., on concrete in remnants of paved track through *Eucalyptus-Callitris* woodland, *P.M. McCarthy 4798*, *4790*, *4793*, *4794*, 5.xii.2018 (CANB); ● Namadgi National Park, former Honeysuckle Creek Tracking Station, 32 km SSW of Canberra, 35°35'03"S, 148°58'35"E, 1020 m alt., on vertical edge of concrete slab in open *Eucalyptus* woodland, *P.M. McCarthy 4852*, 27.ii.2019 (CANB).

2. *Sarcogyne iridana* P.M.McCarthy & Kantvilas, *J. Adelaide Bot. Gard.* **26**, 15 (2013)
This species was previously known only from sandstone outcrops in dry scrub at Rainbow Valley, *c.* 75 km south of Alice Springs, Northern Territory (McCarthy & Kantvilas 2013).

SPECIMEN EXAMINED
Northern Territory: ● near Rockhole Bore, Henbury Station, Chandler Range, 24°30'55"S, 133°27'12"E, 434 m alt., on sandstone boulder near base of a steep rocky slope, in open shrubland dominated by *Acacia*, *V. Stajsic 6635*, 22.v.2013 [MEL, NT (*n.v.*)].

3. *Sarcogyne tholifera* P.M.McCarthy & Elix, *Australas. Lichenol.* **80**, 18 (2017)
This lichen is known from consolidated, acidic soils at two woodland localities in southern Queensland and central-western New South Wales (McCarthy & Elix 2017a).

SPECIMEN EXAMINED
Australian Capital Territory: ● track to Aranda Bushland, 4 km W of Canberra, 35°15'32"S, 149°04'53"E, 655 m alt., on soil at base of *Eucalyptus* in dry *Eucalyptus* woodland, *J.A. Elix 46828*, 7.ix.2019 (CANB).

Key to the Australian species of *Sarcogyne*

1 Thallus growing on soil.....2
1: Thallus growing on rock.....4

2 Thallus squamulose-areolate, yellow-green, containing rhizocarpic acid.....***S. tholifera***
2: Thallus crustose, rimose to quasi-areolate, shades of grey, green or brown, not yellowish, lacking lichen substances.....3

3. Thallus off-white to pale greenish grey; apothecia subtended by a continuous algal layer, and with a lightly pruinose disc; proper excipulum colourless at the sides and base; ascospores (3–)5(–7.5) µm long.....***S. porphyricola***
3: Thallus pale greyish brown or pale to medium sandy brown; apothecia subtended by a discontinuous algal layer, and with an epruinose disc; proper excipulum mostly medium to dark brown or brown-black at the sides and base; ascospores (2–)3(–4) µm long.....
.....***S. terrulenta***

4 Excipulum carbonized.....5
4: Excipulum not carbonized.....6

5 Apothecia 0.4–1 mm diam.; margin entire; hypothecium colourless to pale brown .....
.....***S. hypophaea***
5: Apothecia 1–3(–6) mm diam.; margin crenulate; hypothecium medium to dark brown.
.....***S. clavus***

6 Thallus on calcareous rocks.....7
6: Thallus on siliceous rocks.....9

7 Apothecia 0.4–1.2 mm diam.; disc usually white- to blue-grey-pruinose, plane to convex.....***S. regularis***
7: Apothecia 0.15–0.5 mm diam.; disc epruinose, deeply concave to plane.....8

8 Apothecia immersed, often leaving pits in the substratum; ascospores 3–6 × 1.5–2.5 µm, *c.* 150–200 per ascus; hypothecium 30–80 µm thick.....***S. meridionalis***
8: Apothecia mostly adnate; ascospores 4–8.5 × 2.5–5 µm, *c.* 80–150 per ascus; hypothecium 10–35 µm thick.....***S. canberrensis***

9 Ascospores 6–9.5 µm long, *c.* 40–60(–80) per ascus; thallus containing sekikaic acid; apothecia usually white-pruinose.....***S. sekikaica***
9: Ascospores 2.5–5.5(–7) µm long, *c.* (100–)150–180(–250) per ascus; thallus lacking secondary substances; apothecia epruinose.....10

10 Thallus whitish, diffuse, 15–25 µm thick; apothecia usually moderately to markedly convex or subglobose and then strongly constricted at the base.....***S. iridana***
10: Thallus pale greenish or pale brown to medium or dark greenish grey, forming substantial colonies that are rimose to areolate and 60–200(–250) µm thick; apothecia innate to adnate, slightly concave to plane or slightly convex, never constricted at the base.....11

11 Apothecia (0.23–)0.40(–0.55) mm diam.; margin 50–70(–80) µm thick, slightly or markedly paler than the disc; proper excipulum annular; hymenium 80–100 µm thick; asci with *c.* 100–150 ascospores, 55–80 µm long.....***S. maritima***
11: Apothecia (0.28–)0.65(–1.1) mm diam.; margin *c.* 30–50 µm thick, concolorous with the disc; proper excipulum cupulate; hymenium 100–140 µm thick; asci with *c.* 150–200 ascospores, 65–105 µm long.....***S. molongloensis***

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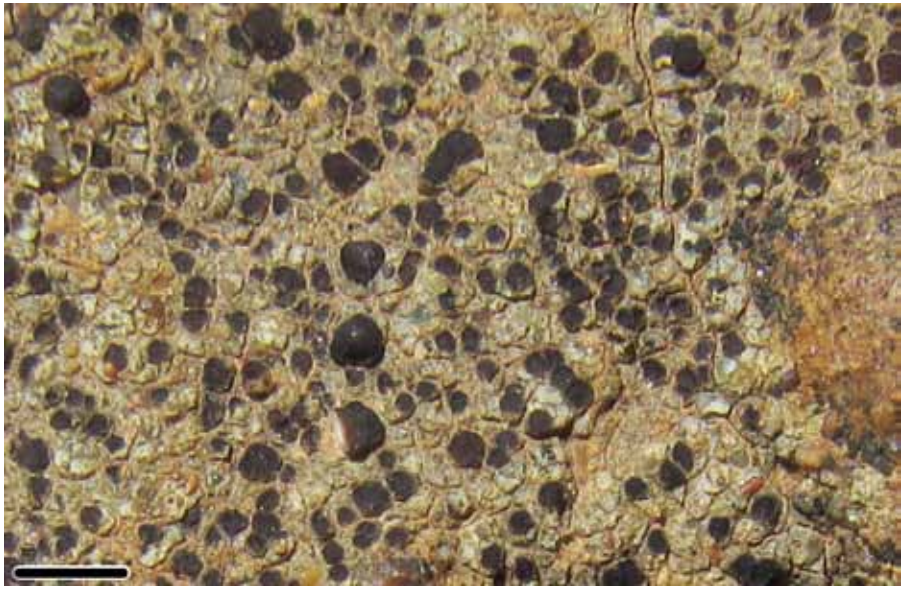

Figure 1. *Sarcogyne molongloensis* (holotype). Scale: 2 mm.

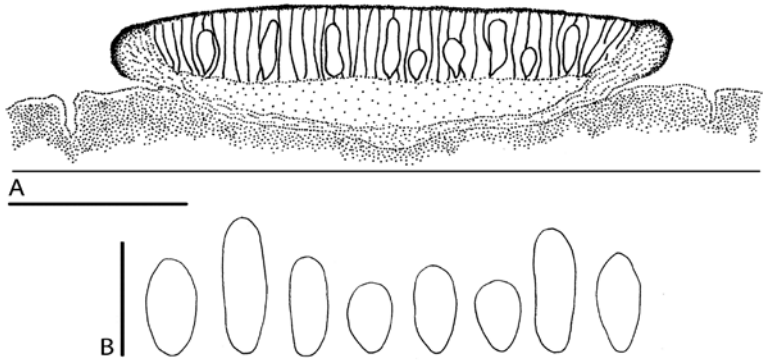

Figure 2. *Sarcogyne molongloensis* (holotype). A, Section of apothecium (semi-schematic); B, Ascospores. Scales: A = 0.2 mm; B = 5 µm.

Figure 3. *Sarcogyne porphyricola* (holotype). Scales: 1 mm.

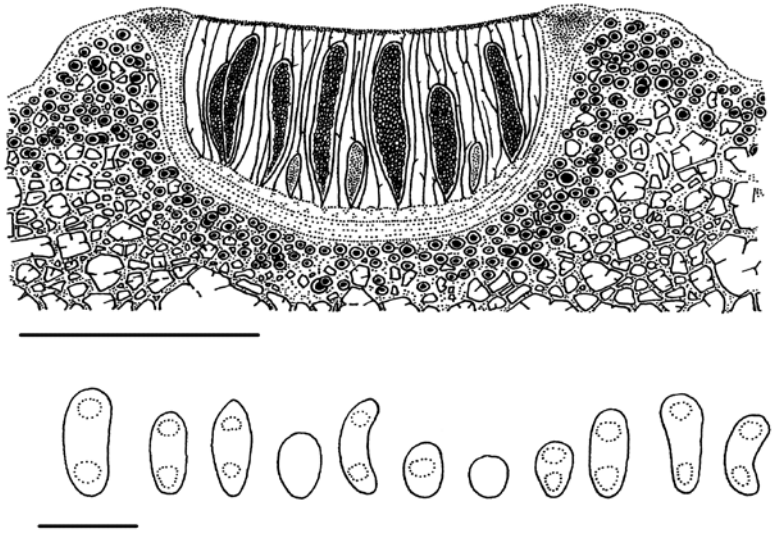

Figure 4. *Sarcogyne porphyricola* (holotype). A, Section of apothecium (semi-schematic); B, Ascospores. Scales: A = 0.2 mm; B = 5 µm.

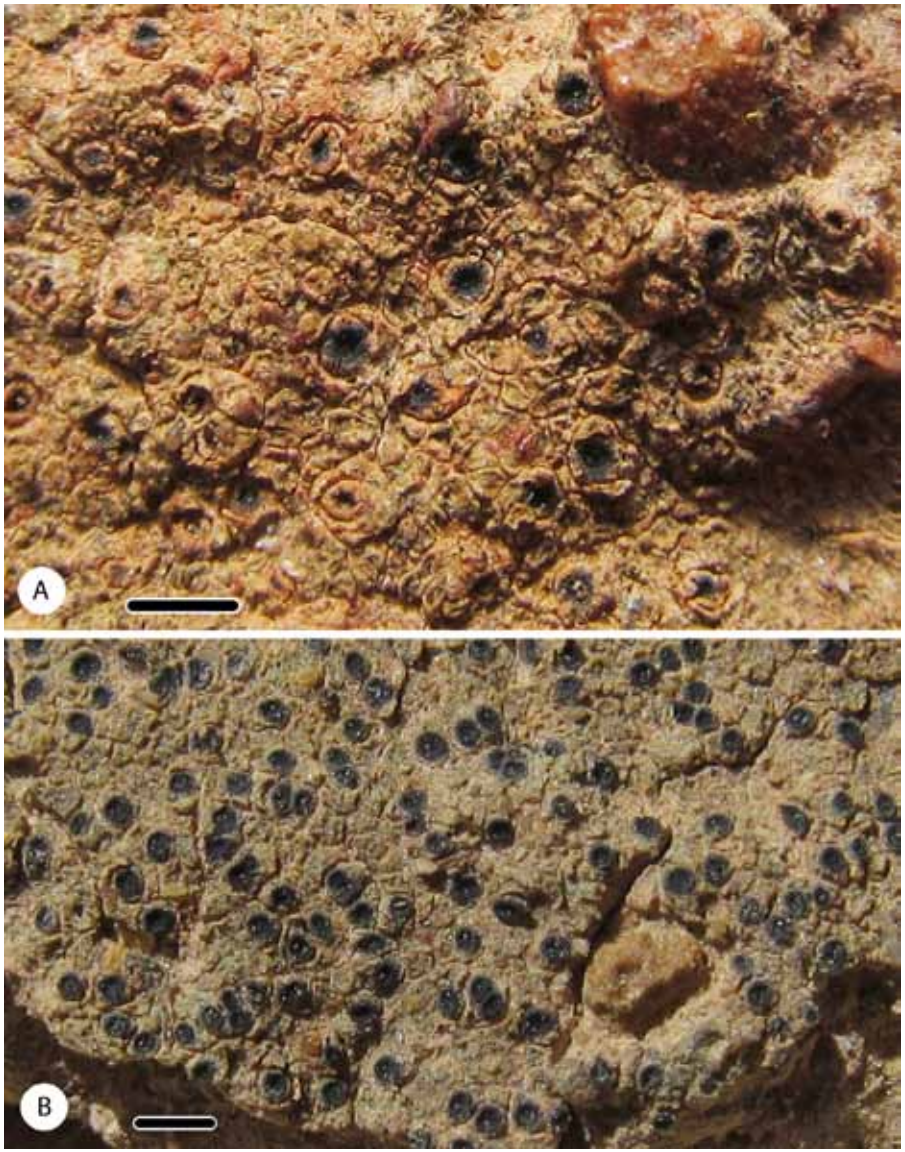

Figure 5. *Sarcogyne terrulenta*. A, holotype; B, *J.A. Elix 46806*. Scales: 1 mm.

A new species of *Cratiria* (Caliciaceae, Ascomycota) from Ascension Island, South Atlantic Ocean

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Abstract
Cratiria jamesiana Elix & H.Mayrhofer, a saxicolous species with *Physconia*- then *Buellia*-type ascospores and bacilliform conidia, and containing thuringione and arthothelin, is described as new to science.

Introduction
This paper is a continuation of our investigations into *Buellia*-like lichens in the Southern Hemisphere (Elix 2018; Elix & McCarthy 2018; Elix *et al.* 2018; Elix 2019a, b and references therein). The genus *Cratiria* Marbach includes species that are characterized by relatively large, submuriform or 1-septate ascospores, 15–28 × 7–13 µm, with apical wall-thickenings, short, bacilliform conidia 4–6 µm long, a hymenium that can be inspersed with oil droplets or not and an excipulum containing lichen substances (Marbach 2000; Elix 2014). In this paper we describe a new saxicolous species of *Cratiria* from Ascension Island in the South Atlantic Ocean. Methods are as described in previous papers cited above.

Cratiria jamesiana Elix & H.Mayrhofer, sp. nov. Figs 1, 2
MycoBank number: **MB 832570**

Similar to *Cratiria chloraceus* Marbach, but differs in being saxicolous and in having a K– excipulum and hypothecium.

Type: Ascension Island, Green Mountain, Monkey Rock, [07.9500°S, 14.3500°W], 460 m alt., on volcanic rock, *P.W. James s.n.*, 3.xi.1976 (BM – holotype).

Thallus crustose, continuous, to 55 mm wide and up to 1 mm thick; upper surface pale grey to pale yellow-grey, verruculose, matt; warts 0.1–1 mm wide; prothallus black, marginal when abutting other lichens; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 8–14 µm diam. *Apothecia* 0.4–1.5 mm wide, lecideine, scattered, sessile; disc black, pale grey-pruinose, concave to ± plane; proper exciple thick, concolorous with the disc, entire, persistent, cupuliform, in section 75–100 µm thick; outer zone opaque brown-black with crystals, K–, N–; inner zone brown. *Hypothecium* 190–240 µm thick, dark brown to brown-black, K–. *Epihymenium* 10–15 µm thick, pale brown to grey-brown, with crystals soluble in K, K–, N–. *Hymenium* 90–110 µm thick, colourless, inspersed with oil droplets; subhymenium 25–35 µm thick, pale brown; paraphyses 1.7–2.0 µm wide, simple to branched, capitate, with apices dark brown, 3–3.5 µm wide; asci approximating the *Bacidia*- type, with 8 or fewer spores. *Ascospores* at first of the *Physconia*-type, then of the *Buellia*-type, 1-septate, olive-brown to brown, ellipsoid, 15–[*16.6*]–20 × 8–[*8.9*]–10 µm, rarely constricted at the septum, with apical wall-thickenings; outer spore-wall rugulate. *Pycnidia* immersed; conidia bacilliform, straight, 4–5 × 0.7–1 µm.
Chemistry: Thallus K–, C–, P–, UV+ orange; containing thuringione (major), arthothelin (major), 3-*O*-methylthiophanic acid (minor).

Etymology: the species is named after the collector of the type specimen, the late British lichenologist Peter James.

Remarks

This new species is characterized by the verrucose-areolate, pale grey to pale yellow-grey crustose thallus, with a non-amyloid medulla lacking calcium oxalate, the sessile, lecideine apothecia with pruinose discs, an inspersed hymenium, *Physconia*- then *Buellia*-type ascospores, 15–20 × 8–10 µm, the bacilliform conidia, 4–5 µm long, and the presence of thuringione and arthothelin. Its chemistry and anatomy closely resemble those of *C. chloraceus*, a corticolous species known from Australia, Papua New Guinea and New Caledonia (Elix *et al.* 2017). However, the thallus of *C. chloraceus* differs in being corticolous and significantly thinner, and the hypothecium reacts K+ intense crimson-purple. *Cratiria jamesiana* could be confused with *Buellia halonia* (Ach.) Tuck., which has been reported from Ascension Island (Aptroot 2008). Both species have similar-sized *Physconia*- then *Buellia*-type ascospores, and both contain xanthones. However, *B. halonia* has a non-inspersed hymenium, an epihymenium that is often aeruginose in part, and ascospores lacking apical wall-thickenings. In addition, it contains isoarthothelin (major), roccellic acid (major) and minor quantities of atranorin. *Cratiria jamesiana* is the first saxicolous species of *Cratiria* known to contain xanthones.

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

Acknowledgement

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Figure 1. *Cratiria jamesiana* (holotype in BM). Bar = 2 mm.

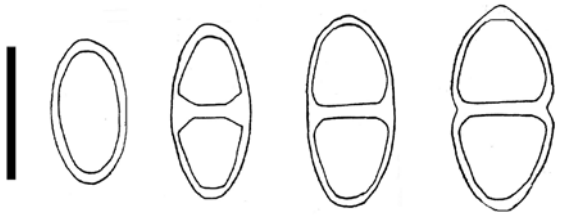

Figure 2. Ascospore ontogeny of *C. jamesiana*. Bar = 10 µm.

A new species of *Circinaria* (Megasporaceae) from New South Wales, Australia

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Abstract
Circinaria deminuta P.M.McCarthy & Elix sp. nov. (lichenized Ascomycota, Megasporaceae) is described from sandstone in central-western New South Wales, Australia. The new species has a dark greyish brown, areolate thallus containing aspicilin, small, aspicilioid apothecia with a dark brown to blackish disc, cylindrical, *Aspicilia*-type asci with (4–)8, minute, globose ascospores in uniseriate arrangement, and bacilliform conidia 3.5–5(–6) × 0.5 µm.

Introduction

Until recently, species of *Circinaria* Link (Megasporaceae) formed part of the much larger, predominantly saxicolous and pantemperate to arid zone genus *Aspicilia* A.Massal. (Magnusson 1939; Clauzade & Roux 1984, 1985; Owe-Larsson *et al.* 2008; Fletcher *et al.* 2009). However, following phylogenetic analyses, Nordin *et al.* (2010) reintroduced *Circinaria* for species with broadly ellipsoid to globose ascospores that are often fewer than 8 per ascus, as well as comparatively small conidia and, uniquely, the exclusive, although not obligate occurrence of the very uncommon, aliphatic compound aspicilin. The subsequent description of new taxa and the transfer of additional species from *Aspicilia* (Owe-Larsson *et al.* 2011; Sohrabi *et al.* 2013; Roux *et al.* 2016; Chesnokov *et al.* 2018; Ren & Zhang 2018; Ismayil *et al.* 2019) brought the known diversity of *Circinaria* to more than 40 crustose, foliose and subfruticose species.

Four taxa known from Australia include the mainly temperate, silicolous *Circinaria caesiocinerea* (Nyl. ex Malbr.) A.Nordin, S.Savić & Tibell, as well as the limestone-inhabiting *C. calcarea* (L.) A.Nordin, S.Savić & Tibell, *C. contorta* (Hoffm.) A.Nordin, S.Savić & Tibell and *C. hoffmanniana* (S.Ekman & Froberg ex R.Sant.) A.Nordin (the last including the synonymous "*Aspicilia*" *calcarea* var. *caesioalba* (Le Prévost) Hazsl.) (McCarthy 2018). A fifth species, *C. deminuta*, is described here from siliceous rock near Grenfell in central-western New South Wales.

Circinaria deminuta P.M.McCarthy & Elix, sp. nov. Figs 1, 2
MycoBank No. **MB 833005**
Thallus crustose, on sandstone, dark greyish brown, areolate, containing aspicilin; areoles adnate, 0.15–0.6(–1) mm wide, 100–180(–250) µm thick; cortex bilayered, paraplectenchymatous; algae chlorococcoid, 8–17(–20) µm wide. Apothecia aspicilioid, dominating the thallus, (0.12–)0.27(–0.45) mm diam., usually not subtended by algae; disc shallow-concave, dull dark brown to brown-black; proper excipulum thin, cupulate; hypothecium and subhymenium hyaline, together (20–)30–40(–50) µm thick; epihymenium medium to dark brown; paraphyses long-celled below, shorter-celled to moniliform towards the swollen, dark-pigmented apices; asci *Aspicilia*-type, cylindrical, with (4–)8, uniseriate ascospores that are globose and (6–)8(–11) µm diam. Pycnidia immersed in the thallus, *c.* 80–120 µm wide; conidia bacilliform, 3.5–5(–6) × 0.5 µm.

Type: Australia. New South Wales, Central West, Warraderry Range, beside the Gooloogong–Grenfell road, *c.* 38 km N of Grenfell, 33°38'42"S, 148°22'15"E, 330 m alt., on shaded, roadside sandstone boulders, *P.M. McCarthy 4892*, 2.x.2019 (holotype – CANB).

Thallus crustose, epilithic, determinate, uniformly dark greyish brown, to 100–180(–250) µm thick, areolate, forming scattered or contiguous colonies to 30(–50) mm wide; thallus margin effuse or faintly radiate-effigurate. *Areoles* rounded to ellipsoid or oblong to angular and irregular, 0.15–0.6(–1) mm in maximum extent, plane to slightly or moderately convex, smooth to minutely and irregularly uneven, epruinose, uniformly adnate to the substratum or (in older parts of the thallus) with slightly raised margins, commonly somewhat radially elongate towards the thallus margin, but not forming distinct lobes; cracks separating dark areoles showing the pale substratum, 60–100(–150) µm wide. *Cortex* rather thick, bilayered, paraplectenchymatous, subtending or not a hyaline, amorphous necral layer to 5–10 µm thick; upper cortical layer dark brown, (5–)10–15 µm thick, the cells rounded, thick-walled, 2.5–4(–5) µm wide; lower cortical layer hyaline, 15–20 µm thick, the cells rounded to angular, thick-walled, 3–4(–5) µm wide. *Algal layer* 50–80(–150) µm thick; cells green, globose, chlorococcoid, 8–17(–20) µm wide towards the thallus surface, mostly smaller (to 10 µm diam.) below; interstitial hyphae short-celled, thin-walled, 2–2.5(–3) µm wide. *Medulla* to 100–120 µm thick, dominated by whitish crystals and minute rock fragments, not containing calcium oxalate (H_2SO_4–), I–; hyphae short-celled, 2–3 µm wide. *Prothallus and hypothallus* not apparent. *Apothecia* very numerous, aspicilioid, innate, rounded, narrowly to broadly ellipsoid or more irregular in outline, (0–)1–2(–4) on each areole in older parts of the thallus, (0.12–)0.27(–0.45) mm diam. [*n* = 80], usually not subtended by algae at maturity; disc mostly shallow-concave, less commonly deeply concave or plane, dull dark brown to brown-black, smooth, epruinose; thalline margin prominent or not, entire, 60–80(–100) µm thick. *Proper excipulum* thin, cupulate, 20–35 µm thick laterally towards the surface, dark olivaceous and apparently continuous with the epihymenium; hyaline to paler brown below, 10–15(–20) µm thick at the base and pale to medium brown, K–, N–; cells periclinal 4–8 × 3–4 µm. *Hypothecium* hyaline to very pale yellowish, indistinguishable from the subhymenium, together (20–)30–40(–50) µm thick, inspersed with minute granules, KI–, K–, N–. *Hymenium* hyaline, 80–120 µm thick, not inspersed with granules or oil droplets, K–, N–; hymenial gel I–, KI–. *Epihymenium* medium to dark brown, 10–15 µm thick, K– (paler brown), N+ paler orange-brown, not inspersed with granules. *Paraphyses* rather conglutinate in water, loosening in K (but remaining contiguous near their apices), simple or with sparse furcate branches and anastomoses below, more richly branched in and below the epihymenium; longer-celled and not or only slightly constricted at the septa below, (1–)1.5–2(–2.5) µm wide, shorter-celled to moniliform distally and more markedly constricted at the septa (the distalmost 3–5 cells); apical cells swollen, rounded, ellipsoid or somewhat irregular, the uppermost walls usually dark olivaceous to almost black, 3–5(–6) µm wide. *Asci Aspicilia*-type, narrowly or more broadly cylindrical, (4–)8-spored (only *c.* 1–2% of asci with fewer than 8 ascospores), 66–88 × 10–13 µm [*n* = 20]; apex rounded, lacking a tholus and apical apparatus; ocular chamber usually lacking, when apparent rather broad and possibly only an artefact; wall I+ dark blue-grey, KI+ medium blue; ascoplasm KI+ orange-brown or olive-brown. *Ascospores* colourless, simple, globose, uniseriate in the ascus, thin-walled, lacking a perispore, (6–)8(–11) µm diam. [*n* = 100], mostly 9–11 µm diam. in 4-spored asci, usually containing a large, ± central vacuole and granules. *Pycnidia* very sparse, completely immersed in the thallus and extremely inconspicuous (sectioned only fortuitously), ± globose, blackish above, hyaline at middle and lower levels, *c.* 80–120 µm wide; pycnidial wall 8–10 µm thick laterally and at the base; conidiogenous layer simple; conidiophores unbranched, 10–15 × 0.5 µm. *Conidia* bacilliform, straight, 3.5–5(–6) × 0.5 µm.
Chemistry: Aspicilin (major) by TLC (Elix 2014).

Etymology: The epithet *deminuta* (Latin: diminished, reduced, small) refers to the comparatively small apothecia and exceptionally minute, globose ascospores of this species.

Remarks

As noted by Nordin *et al.* (2010), the occurrence of aspicilin is unique to *Circinaria* and, critically, while it is not found in every *Circinaria* species, the compound is not known *at all* from *Aspicilia* or its other segregates, such as *Lobothallia* (Clauzade & Cl.Roux) Hafellner.

The latter genus, sharing with *C. deminuta* a sometimes obscurely lobate thallus margin and comparatively small ascospores (although ellipsoid rather than globose) and conidia, is represented in the Australian lichen flora by the almost cosmopolitan, calcicolous *L. radiosa* (Hoffm.) Hafellner. While the recognition of the new species as a *Circinaria* is supported by aspicilin and globose ascospores, it is the exceptionally small ascospores themselves that distinguish it from all known representatives of the genus. Thus, the ascospores of *C. deminuta*, being only (6–)8(–11) µm diam. in 8-spored asci and mostly 9–11 µm diam. in the very uncommon 4-spored asci, are in stark contrast to those of other species which are all or mostly in the range 18–36 × 12–26 µm (Magnusson 1939; Clauzade & Roux 1984, 1985; Owe-Larsson *et al.* 2008, 2011; Fletcher *et al.* 2009; Nordin *et al.* 2010; Sohrabi *et al.* 2013; Roux *et al.* 2016; Chesnokov *et al.* 2018; Ren & Zhang 2018; Ismayil *et al.* 2019).

The new species is known only from the type locality beside the Gooloogong–Grenfell road north of Grenfell in the Central-West of New South Wales. There it is abundant on sandstone rubble and larger boulders in a well-established community dominated by *Caloplaca* spp., *Lecidea* spp. and Parmeliaceae. Other associated crustose lichens include *Acarospora citrina* (Taylor) Zahlbr. ex Rech., *Buellia homophylia* (C.Knight) Zahlbr., *B. suttonensis* Elix & A. Knight, *Lecanora pseudistera* Nyl., *Myriospora smaragdula* (Wahlenb.) Nägeli ex Uloth and *Trapelia pruinosa* Elix & P.M.McCarthy.

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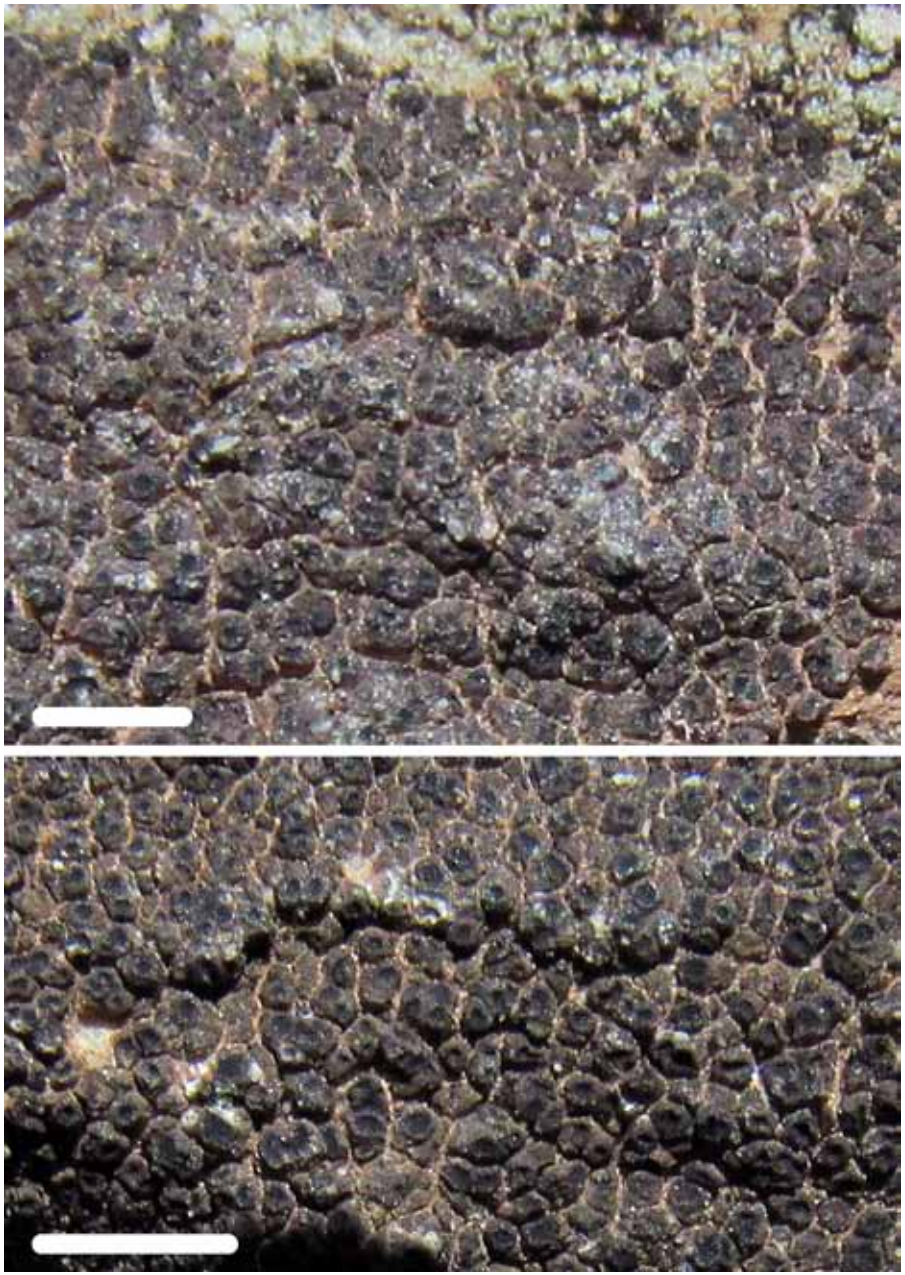

Figure 1. *Circinaria deminuta* (holotype). Scales: 2 mm.

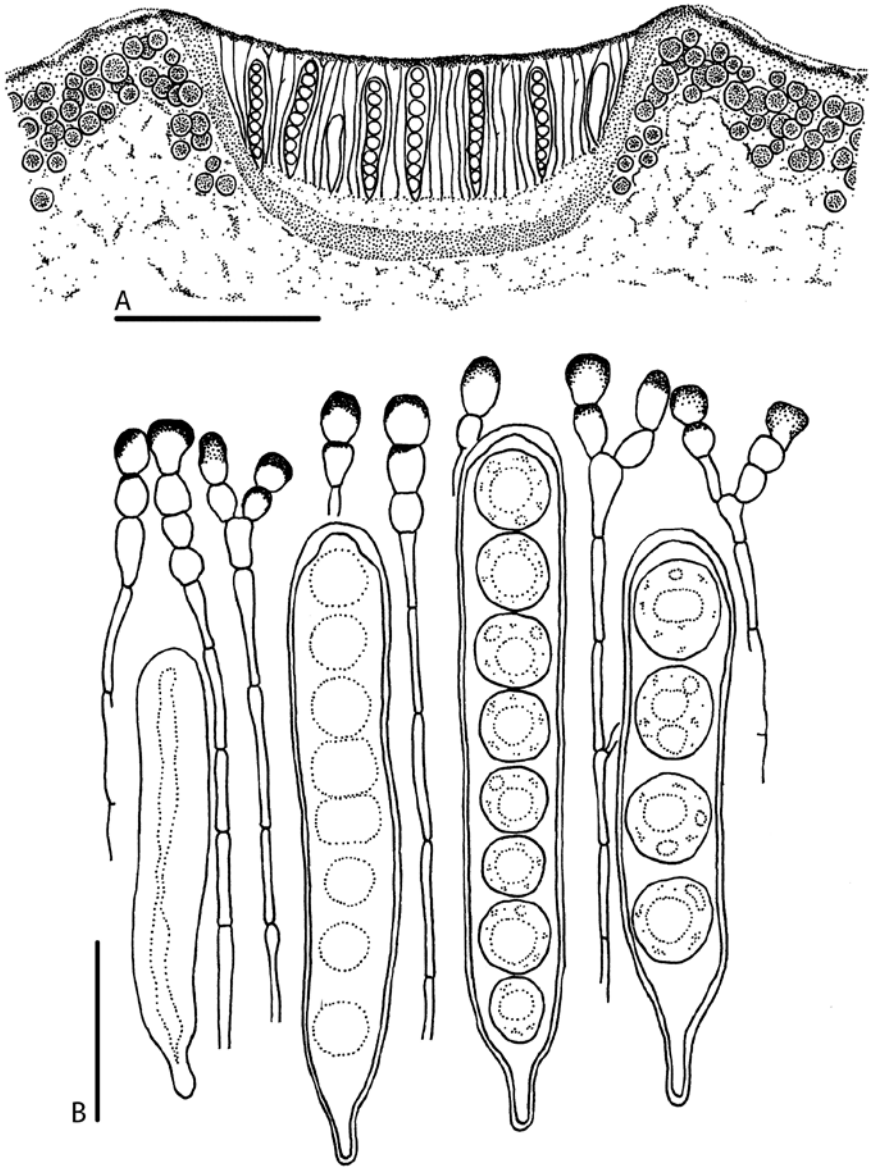

Figure 2. *Circinaria deminuta* (holotype). A, Section of apothecium and adjacent thallus (semi-schematic); B, Immature and mature asci, with ascospores and paraphyses. Scales: A = 0.1 mm; B = 20 µm.

Two new corticolous species of *Rinodina* (Physciaceae, Ascomycota) from New Zealand

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Abstract
The corticolous *Rinodina fineranii* Elix, Ch.Edler & H.Mayrhofer and *R. malcolmii* Elix, Ch.Edler & H.Mayrhofer, both characterized by the presence of *Mischoblastia*-type ascospores, are described as new to science. In addition, *Rinodina australiensis* Müll.Arg. is reported for the first time from New Zealand

Introduction

The corticolous and lignicolous species of *Rinodina* (Ach.) S.F.Gray in New Zealand are not well known. In the revised second edition of the *Flora of New Zealand Lichens*, *Lichen-forming and Lichenicolous Fungi*, eight species were recorded from bark or wood (Mayrhofer *et al.* 2007). These included the widespread *R. capensis* Hampe, *R. conradii* Körb., *R. ficta* (Stizenb.) Zahlbr. (as *R. boleana* Giralt & H.Mayrhofer), *R. inflata* Kalb, *R. oleae* Bagl., *R. pyrina* (Ach.) Arnold and *R. septentrionalis* Malme, as well as *R. exigua* (Ach.) S.F.Gray, but the latter record remains doubtful because the specimens cited were unavailable (Mayrhofer *et al.* 2007). Corticolous or lignicolous species of *Rinodina* with *Mischoblastia*-type ascospores are rare worldwide. The North American endemic, *R. wetmorei* Sheard, is one such species where the *Mischoblastia*-type spores become inflated at maturity and more *Pachysporaria*-type (Sheard 2010). *Rinodina australiensis* Müll.Arg. from the Southern Hemisphere exhibits a similar transition of the spore lumina with age (Mayrhofer *et al.* 1999, 2014), whereas the European *R. euskadiensis* A.Crespo & M.B.Aguirre has persistently *Mischoblastia*-type spores (Giralt 2001). *Rinodina colobina* (Ach.) Th.Fr., widespread in the Northern Hemisphere and characterized by its blue-grey K+ purplish red epihymenium, also has *Mischoblastia*-type spores at maturity after transitioning from a *Physcia*-type stage during development (Ropin & Mayrhofer 1995). In this paper, we describe two new corticolous species of *Rinodina* from New Zealand with *Mischoblastia*-type spores, and report the occurrence of *Rinodina australiensis* from the South Island.

Methods

Observations and measurements of photobiont cells, thallus and apothecium anatomy, asci and ascospores were made on hand-cut sections mounted in water and 10% KOH (K). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K. Medullary sections were treated with 10% sulfuric acid (H_2SO_4) and apothecial sections with 50% nitric acid (N). Chemical constituents were investigated by thin-layer chromatography (Elix 2014).

The new species

Rinodina fineranii Elix, Ch.Edler & H.Mayrhofer, sp. nov. Figs 1, 2
MycoBank number: **MB 832607**

Similar to *Rinodina australiensis*, but differs in having smaller *Physcia*- to *Mischoblastia*-type ascospores, 17–25 × 7–10 µm.

Type: New Zealand, Bird Island, Foveaux Strait, [41°45'52"S, 168°25'06"E], on twig of

Myrsine chatamica, *B.A. Fineran 1304*, ii-iii.1965 (CANU – holotype).

Thallus to 15 mm wide, crustose, membranaceous to verruculose, areolate or coarsely granular; individual areoles 0.05–0.2 mm wide, to 0.05 mm thick; upper surface matt, smooth or granular, esorediate, off-white to pale grey; prothallus not apparent; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 8–14 µm diam. *Apothecia* 0.1–0.7 mm wide, scattered or crowded, lecanorine, broadly adnate to sessile and basally constricted; disc pale brown to black, epruinose, weakly concave to plane; thalline exciple thick and raised above the disc at first, becoming thinner and excluded in older apothecia, concolorous with the thallus; proper excipulum brown to pale yellow-brown, persistent, thick, in section 35–50 µm thick; outer zone brown, K–, N–; inner zone colourless. *Epihymenium* 10–15 µm thick, pale brown, K–, N–. *Hypothecium* 20–30 µm thick, colourless, K–, N–. *Hymenium* 90–110 µm thick, colourless, not inspersed; paraphyses 1.5–2.5 µm wide, simple to branched, capitate, with apices 3–5 µm wide and brown caps, with scattered oil paraphyses 4–6 µm wide; asci of the *Lecanora*-type, 8-spored. *Ascospores* with internal wall thickenings transitioning from *Physcia*- to *Mischoblastia*-types at different stages of development, 1-septate, brown, broadly ellipsoid, 17–[*20.5*]–25 × 7–[*8.5*]–10 µm, neither constricted nor dilated at the septum; ontogeny of type-A; outer spore-wall finely ornamented. *Pycnidia* not seen.
Chemistry: Thallus K–, C–, P–, UV–; no lichen substances detected by TLC

Etymology: The species is named after the collector of the type material, the New Zealand botanist Dr Brian A. Fineran.

Remarks
In many respects this new species closely resembles the well-known *R. australiensis*, which is widespread in Australia and southern Africa (Mayrhofer *et al.* 1999, 2014; Mayrhofer & Wirth 2011). Both have broadly adnate to sessile, lecanorine apothecia and *Mischoblastia*-type ascospores at different stages of development. However, the spore lumina of *R. australiensis* and *R. fineranii* differ subtly, those of *R. fineranii* transitioning from *Physcia*- to mainly *Mischoblastia*-type, whereas those of *R. australiensis* transition from *Mischoblastia*- to mainly *Pachysporaria*-types. In addition, the ascospores of *R. australiensis* are consistently larger, 18–[*25.5*]–33 × 9–[*12.3*]–16 µm.

At present, the new species is known from Bird Island in Foveaux Strait, *c*. 3 km west of West Point, Ruapuke Island. Associated lichens include *Caloplaca flavorubescens* (Huds.) J.R.Laundon and *C. subpyracea* (Nyl.) Zahlbr.

ADDITIONAL SPECIMEN EXAMINED
New Zealand. ● Type locality, on dead twig of *Myrsine chatamica*, *B.A. Fineran 1276*, ii-iii.1965 (CANU).

Rinodina malcolmii Elix, Ch.Edler & H.Mayrhofer, sp. nov. Figs 3, 4
MycoBank number: **MB 832608**

Similar to *Rinodina euskadiensis*, but differs in having lecanorine apothecia, smaller ascospores and in lacking lichen substances.

Type: New Zealand, South Island, Nelson, Wairoa Gorge Road, 6 km from Lee Valley junction, 41°29’54”S, 173°05’24”E, 135 m alt., on twigs of *Podocarpus totara*, *W. Malcolm 2024*, 25.ix.1994 (GZU – holotype).

Thallus to 12 mm wide, crustose, membranaceous to verruculose, areolate or granular; individual areoles 0.05–0.1 mm wide, to 0.05 mm thick; upper surface matt, smooth to granular, esorediate, off-white to pale grey; prothallus not apparent; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 8–16 µm diam. *Apothecia* 0.1–0.8 mm wide, scattered or crowded, lecanorine, broadly adnate, disc brown to dark brown, epruinose, plane

to convex; thalline exciple thick and raised above the disc at first, becoming thinner and excluded in older apothecia, concolorous with the thallus; proper excipulum brown, persistent, in section 20–25 µm thick; outer zone brown, K–, N; inner zone colourless. *Epihymenium* 10–12 µm thick, pale brown to pale red-brown, K–, N–. *Hypothecium* 30–50 µm thick, colourless, K–, N–. *Hymenium* 60–90 µm thick, colourless, not inspersed; paraphyses 1.5–2.5 µm wide, simple to branched, capitate, with apices 3.5–4.5 µm wide and brown caps, with scattered oil paraphyses 5–7 µm wide; asci of the *Lecanora*-type, 8-spored. *Ascospores* with internal wall thickenings transitioning from *Pachysporaria*-type when young to *Mischoblastia*-type at maturity, 1-septate, brown, broadly ellipsoid, 14–[*16.6*]–21 × 7–[*8.6*]–10 µm, not constricted but often dilated at the septum; ontogeny of type-A; outer spore-wall finely ornamented. *Pycnidia* not seen.
Chemistry: Thallus K–, C–, P–, UV–; no lichen substances detected by TLC.

Etymology: The species is named after the New Zealand cryptogamist, botanical photographer and collector of the type specimen, Dr W.M. (Bill) Malcolm.

Remarks
This new species is characterized by the thin, off-white to pale grey membranaceous to areolate or granular thallus, the lecanorine apothecia, the relatively small, *Mischoblastia*-type ascospores, 14–21 × 7–10 µm and the absence of lichen substances. The European *R. euskadiensis* has pseudolecanorine apothecia with persistently *Mischoblastia*-type ascospores, but its spores are larger, 19–26 × 10–13 µm, and do not become inflated at the septum. It also differs in containing atranorin (Giralt 2001).

At present, the new species is known from twigs of trees in both North and South Islands of New Zealand. Associated lichens include *Bactrospora metabola* (Nyl.) Egea & Torrente, *Bacidia* sp., *Lecanora* sp., *Megalaria grossa* (Pers. ex Nyl.) Hafellner and *Podotara pilophoriformis* Malcolm & Vězda.

ADDITIONAL SPECIMENS EXAMINED
New Zealand. North Island. ● Bay of Plenty, Opatiki, Waioeko Rivers, 145 m alt., on *Salix* sp., *Ch. Edler s.n.*, 19.iv.2001 (GZU); ● Wellington, Botanical Gardens, 41°17’29”S, 174°46’15”E, 31 m alt., on *Tilia* sp., *Ch. Edler s.n.*, 14.iv.2001 (GZU). South Island. ● Nelson, Golden Bay, Kaihoka Lakes, 40°33’S, 172°36’18”E, on twig and leaves of *Podocarpus totara*, *W. Malcolm 1132*, 24.ix.1993 (GZU); ● NE of Nelson, Okiwi Bay, camping ground, 7 m alt., on *Sophora* sp., *Ch. Edler*, 8.iv.2001 (GZU). ● Westland. Route 6, 16 km N of Franz Josef, on twigs of *Podocarpus totara*, *W. Malcolm 1353*, 17.xi.1993 (GZU).

New record

Rinodina australiensis Müll.Arg., *Hedwigia* **32**, 123 (1893)

Type: Australia, Victoria, by seaside on *Banksia serrata*, *F.R.M. Wilson 368*, 1892 (lectotype - G! *fide* H.Mayrhofer, G.Kantvilas & K.Ropin, *Muelleria* **12**, 177 (1999)).

This species was previously known from Australia (Mayrhofer *et al.* 1999) and southern Africa (Mayrhofer & Wirth 2011; Mayrhofer *et al.* 2014). It is characterized by a thick, well-developed areolate-crustose to subsquamulose thallus and comparatively large ascospores, 18–[*25.5*]–33 × 9–[*12.3*]–16 µm, where the spore lumina transition from *Mischoblastia*- to mainly *Pachysporaria*-types. A detailed description is provided in Mayrhofer *et al.* (1999).

SPECIMEN EXAMINED
New Zealand. ● South Island, Southland, Cosy Nook Bay, E of Riverton, 46°19’54”S, 167°42’46”E, 5 m alt., on wooden paling, *Ch. Edler s.n.*, 25.iii.2001 (GZU).

A nomenclatural change

Rinodina freyi H.Magn., *Acta Horti Gothob*. **17**, 236 (1947)
Mayrhofer *et al*. (2007) recorded *R. septentrionalis* Malme from twigs of *Malus domestica* in the South Island of New Zealand. The specimen was originally identified as *R. glauca* Ropin (Ropin & Mayrhofer 1993), but that species was subsequently synonymized with *R. septentrionalis*, as was *R. freyi* (Giralt & Mayrhofer 1995). In 2010 Sheard resurrected *Rinodina freyi* with *Rinodina glauca* as a new synonym. He distinguished two morphotypes, one with more distinctly grey thalli corresponding to the type of *R. glauca*. The species is a characteristic pioneer of the twigs of a wide range of shrubs and trees in Europe and North America (Ropin & Mayrhofer 1993; Sheard 2010), Japan and north-eastern Asia (Sheard *et al.* 2017). It has been confused with *R. septentrionalis*, which has very similar ascospores, but the apothecia of the latter are more scattered and narrowly attached. According to Sheard (2010), *R. septentrionalis* is widespread in the Arctic and northern Scandinavia, and more rarely in the boreal zone in North America, but it has often been confused with *R. freyi* in central and southern Europe. A detailed description of it is given in Mayrhofer *et. al.* (2007, as *R. septentrionalis*) and Sheard (2010).

Key to the corticolous and lignicolous species of *Rinodina* in New Zealand

1 Ascospores 3-septate at maturity; lignicolous or rarely corticolous ..... **R. conradii**
1: Ascospores persistently 1-septate 2

2 Thallus K+ yellow; atranorin present 3
2: Thallus K–; atranorin absent 5

3 Thallus sorediate ..... **R. inflata**
3: Thallus esorediate 4

4 Apothecial cortex distinct; I + pale-blue ..... **R. capensis**
4: Apothecial cortex indisdinct; I – ..... **R. exigua**

5 Ascospores *Physconia*-type; lacking apical thickenings when mature ..... **R. pyrina**
5: Ascospores *Physcia*-, *Dirinaria*-, *Mischoblastia*- or *Pachysporaria*-type; with apical thickenings when mature 6

6 Ascospores *Physcia*-type ..... **R. freyi**
6: Ascospores *Dirinaria*-, *Mischoblastia*- or *Pachysporaria*-type 7

7 Ascospores *Dirinaria*-type, lignicolous and more rarely corticolous ..... **R. oleae**
7: Ascospores *Mischoblastia*- or *Pachysporaria*-type 8

8 Mature ascospores *Pachysporaria*-type 9
8: Mature ascospores *Mischoblastia*-type 10

9 Ascospores 12–18 µm long ..... **R. ficta**
9: Ascospores 18–25 µm long ..... **R. australiensis**

10 Ascospores 17–[*20.5*]–25 µm long, transitioning from *Physcia*- to *Mischoblastia*-type, not dilated at the septum ..... **R. fineranii**
10: Ascospores 14–[*16.6*]–21 µm long, transitioning from *Pachysporaria*-type to *Mischoblastia*-type, often dilated at septum ..... **R. malcolmii**

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We thank Dr Bill Malcolm (Nelson) for generously donating his collections of *Rinodina* to GZU, and to the curators of CANU (University of Canterbury Herbarium, Christchurch) for the loan of specimens collected by Dr Brian Fineran. H.M. acknowledges financial support from the Austrian Science Fund (FWF-projects, P8500-BIO, P10514-BIO and P25237-B16). Ch.E. acknowledges financial support from the Austrian Government and assistance in the field from Colin Meurk, Allan Fife, Nancy and Bill Malcolm, Patricia and David Galloway, Hugh Wilson, Barbara Polly, Philippa Scott, and Wendy Nelson.

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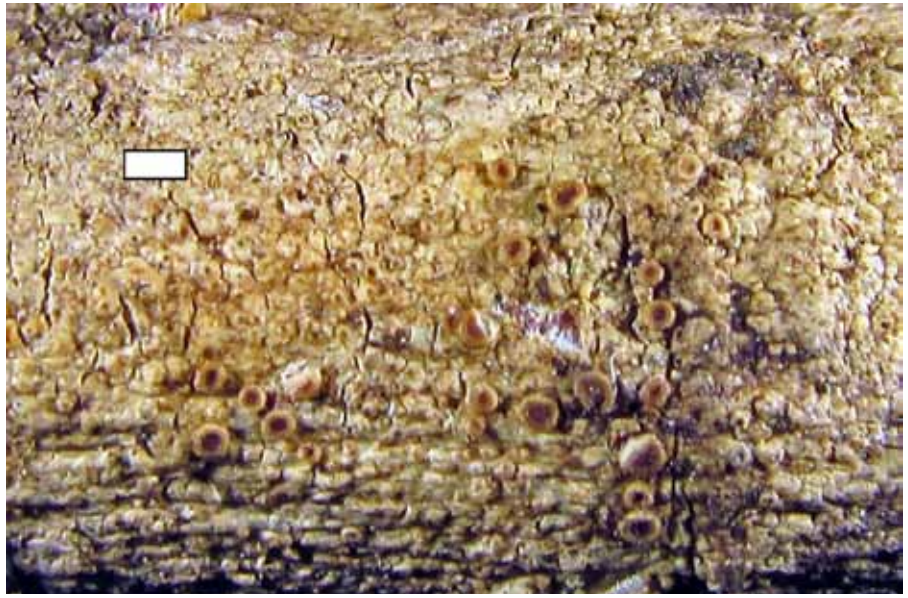

Figure 1. *Rinodina fineranii* (holotype in CANU). Scale = 1 mm.

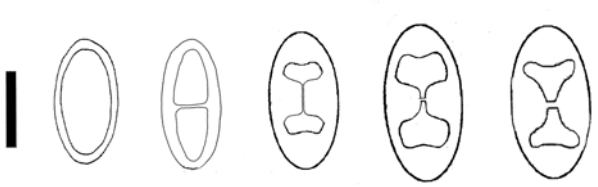

Figure 2. Ascospore ontogeny of *R. fineranii*. Scale = 10 µm.

Figure 3. *Rinodina malcolmii* (holotype in GZU). Scale = 2 mm.

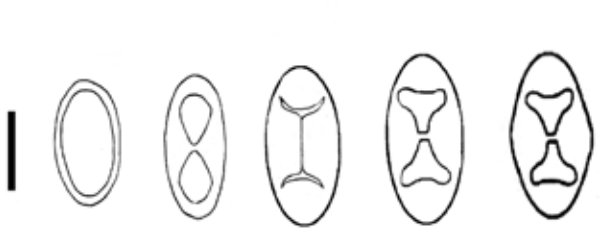

Figure 4. Ascospore ontogeny of *R. malcolmii*. Scale = 10 µm.

Three new species of *Trapelia* (lichenized Ascomycota, Trapeliaceae) from eastern Australia

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Abstract
Trapelia atrocarpa Elix & P.M.McCarthy, *T. kosciuszkoensis* Elix and *T. pruinosa* Elix & P.M.McCarthy (Trapeliaceae) are described as new from siliceous rocks and soil in eastern Australia.

Introduction

The genus *Trapelia* M.Choisy (1929), based on *Lecidea coarctata* Sm., includes lichens with a *Chlorella*-type photobiont, hemiangiocarpic apothecia that burst through the upper surface of the thallus, a reduced, cupulate excipulum composed of prosoplectenchymatous hyphae, eight-spored, hemiamyloid asci (Baral 1987) in which the tholus typically lacks internal amyloid structures, simple ascospores, richly branched paraphyses and bacilliform to filiform conidia (Lumbsch & Kainz 2004; Kantvilas & Elix 2007; Purvis *et al*. 2009; Kantvilas *et al.* 2015; Orange 2018). All species contain gyrophoric acid, 5-*O*-methylhiascic acid or related substances.

Eight species of *Trapelia* have been reported from Australia (McCarthy 2018; Elix & McCarthy 2019), including the widespread, probably cosmopolitan *T. coarctata* (Sm.) M. Choisy and *T. involuta* (Taylor) Hertel, as well as the Australasian *T. macrospora* Fryday and five Australian endemics, *T. calvariana* Kantvilas & Lumbsch, *T. concentrica* Elix & P.M.McCarthy, *T. crystallifera* Kantvilas & Elix, *T. lilacea* Kantvilas & Elix and *T. thieleana* Kantvilas, Lumbsch & Elix. In this paper, three new species are described and illustrated, *viz. T. atrocarpa* from consolidated soil in the Australian Capital Territory and New South Wales, *T. kosciuszkoensis* from siliceous rocks in alpine New South Wales, and *T. pruinosa* from siliceous rocks and soil in Queensland, the Australian Capital Territory, New South Wales and Victoria.

The species

Trapelia atrocarpa Elix & P.M.McCarthy, sp. nov. Fig. 1
MycoBank No. **MB 833122**

Similar to *Trapelia concentrica* Elix & P.M.McCarthy, but differs in having larger ascospores, 14–27 × 7–16 µm, and longer conidia, 20–25 µm long.

Type: Australia, Australian Capital Territory, Woodstock Nature Reserve, Shepherds Lookout Walk, 20 km WNW of Canberra, 35°14’34”S, 148°58’38”E, 555 m alt., on consolidated soil in open *Eucalyptus*-*Callitris* woodland, *P.M. McCarthy 4799*, 17.vii.2018 (CANB – holotype).

Thallus areolate, whitish grey to glaucous grey or dark grey, smooth at first, not sorediate; areoles dispersed or contiguous, 0.05–0.2 mm wide, roundish, plane to convex; medulla white, containing calcium oxalate (H_2SO_4+), I–. *Photobiont* green, of the *Chlorella*-type, with individual cells irregularly roundish or rhomboid, 6–10 × 5–8 µm, solitary or in pairs, triads or tetrads. *Apothecia* scattered, 0.1–0.4 mm wide, irregularly roundish, adnate to sessile, at first appearing as a pale pruinose disc, then often splitting at the apex, soon becoming superficial and often with white, slightly roughened or pruinose margins and black or rarely brown-black, epruinose discs; proper margin thick, brownish, usually with a well-developed, white thalline rim. *Excipulum* in section cupular, brown at the sides, pale brown to colourless within, unchanged in K, 50–60 µm thick at the sides, 100–120 µm thick at the base. *Hypothecium* 70–80 µm thick, pale brown, poorly differentiated from the hymenium. *Hymenium* 100–140 µm thick, colourless, I+ blue, not inspersed with granules or oil droplets. *Paraphyses* richly branched, particularly at the base and near the apices, slender, 1–2.5(–3) µm thick, flexuose, tangled, separating readily in K; apices not markedly expanded. *Asci* 8-spored, of the *Trapelia*-type, with an amyloid wall and a prominent, non-amyloid tholus, elongate-clavate, often with a long tapering stalk, 80–100 × 18–25 µm. *Ascospores* simple, non-halonate, thin-walled, often vacuolate, ellipsoid to ovate, 14–[*19.5*]–27 × 7–[*10.5*]–16 µm. *Pycnidia* punctiform, brown-black, immersed in areoles; conidia filiform, curved, 20–25 × 0.7 µm.
Chemistry: Thallus K–, C+ red, KC+ red, P–, UV–; containing gyrophoric acid (major), 5-*O*-methylhiascic acid (trace or absent).

Etymology: The specific epithet refers to the black apothecial discs.

Remarks

The new species is characterized by small but conspicuous apothecia with black or rarely brown-black epruinose discs with a well-developed white thalline rim, the nondescript, areolate thallus with a smooth surface, the relatively large, ovate to ellipsoid ascospores and the presence of gyrophoric acid. *Trapelia atrocarpa* appears to be most closely related to the Australian endemic *T. concentrica*, with both species having a poorly developed, areolate thallus containing gyrophoric acid and calcium oxalate. There are, however, clear and consistent differences between the two taxa. In *T. concentrica* the apothecia often become surrounded by 1–3 more-or-less concentric fissures with a white-pruinose surface so that the apothecium appears almost gyrose, the ascospores are smaller, 11–[*13.3*]–17 × 6–[*7.7*]–10 µm, and the conidia are shorter, 11–17 µm long (Elix & McCarthy 2019). *Trapelia atrocarpa* is sometimes superficially similar to the European *T. elacista* (Ach.) Orange, but that species has a much better developed, cracked, crustose thallus, larger apothecia (to 0.7 mm wide) and a preference for moist rock surfaces (Orange 2018).

At present, the species is known from consolidated soil and siliceous rocks in dry *Eucalyptus* woodland in the Australian Capital Territory and New South Wales. Commonly associated lichens on soil include various *Caloplaca* species, *Cladia aggregata* (Sw.) Nyl. *sens. lat.*, *Buellia suttonensis* Elix & A.Knight, *Diploschistes thunbergianus* (A.Massal.) Lumbsch & Vězda, *Lecidea terrena* Nyl., *Rhizocarpon reductum* Th.Fr., *Trapelia pruinosa* and *T. involuta* (Taylor) Hertel.

ADDITIONAL SPECIMENS EXAMINED
New South Wales: ● Mount Canobolas State Conservation Area, N slopes of Mt Canobolas, 12 km SW of Orange, 33°19’58”S, 148°58’52”E, 1100 m alt., on roadside trachytic rhyolite in *Eucalyptus* woodland, *J.A. Elix 46879*, 30.ix.2019 (CANB); ● Tuena–Bathurst road, *c.* 10 km N of Tuena, 33°55’38”S, 149°21’09”E, 650 m alt., on pebble in open *Eucalyptus* woodland, *J.A. Elix 46884*, 30.ix.2019 (CANB). *Australian Capital Territory*: ● Type locality, on consolidated soil in open *Eucalyptus*-*Callitris* woodland, *P.M. McCarthy 4784*, *4791*, *4793*, 5.xii.2018 (CANB).

Trapelia kosciuszkoensis Elix, sp. nov. Fig. 2
MycoBank No. **MB 833123**

Similar to *Trapelia macrospora* Fryday, but differs in having shorter ascospores, 17–[*23.2*]–30 µm long, a thinner hypothecium, 70–100 µm thick, and in containing 5-*O*-methylhiascic acid as the major lichen substance.

Type: Australia. New South Wales, Mount Kosciuszko National Park, Etheridge Range, Seamans Hut, 2 km ENE of Mt Kosciuszko, 36°21S, 148°17E, 2100 m alt., on granite rocks in alpine heath, *D. Verdon 4422C*, 14.iii.1979 (CANB – holotype).

Thallus to 50 mm wide and 0.1 mm thick, whitish to glaucous grey or cream-grey, sometimes with a pale fawn tinge, rimose-areolate, smooth at first, soon becoming rather scabrid, at length irregularly cracked, not sorediate, areoles contiguous, 0.2–0.5 mm wide, roundish to irregular, plane to weakly convex; medulla white, lacking calcium oxalate (H_2SO_4–), I–. *Photobiont* green, of the *Chlorella*-type, with individual cells irregularly roundish or rhomboid, 6–10 × 5–8 µm, solitary or in pairs, triads or tetrads. *Apothecia* scattered, 0.5–1.3 mm wide, irregularly roundish, immersed to just emergent, at first appearing as a pale pruinose disc, then often spitting at the apex, soon becoming superficial and often with white, slightly roughened or pruinose margins; proper margin very thin, brownish, usually with a well-developed, rather ragged, white thalline rim; disc concave to weakly convex, pale to dark brown, epruinose, subgyrose. *Excipulum* in section cupular, dark brown at the sides, pale grey-brown to colourless within, unchanged in K, 50–70 µm thick at the sides, 15–25 µm thick at the base. *Hypothecium* 70–100 µm thick, red-brown, poorly differentiated from the hymenium. *Epihymenium* 30–45 µm thick, pale grey-brown to brown. *Hymenium* 140–160 µm thick, colourless, I+ blue, not inspersed with granules or oil droplets. *Paraphyses* richly branched, particularly at the base and near the apices, slender, 1.5–2 µm thick, flexuose, tangled, separating readily in K; apices not markedly expanded. *Asci* 8-spored, of the *Trapelia*-type, with an amyloid wall and a prominent, non-amyloid tholus, elongate-clavate, 100–120 × 25–35 µm. *Ascospores* simple, non-halonate, thin-walled, often vacuolate, broadly-ellipsoid, 17–[*23.2*]–30 × 12–[*14.0*]–18 µm. *Pycnidia* punctiform, brown, immersed in areoles; conidia filiform, curved, 20–30 × 0.7 µm.
Chemistry: Thallus K–, C+ red, KC+ red, P–, UV–; containing 5-*O*-methylhiascic acid (major) and gyrophoric acid (trace).

Etymology: The species is named after the type locality.

Remarks
This species is characterized by the crustose, non-effiguate thallus containing 5-*O*-methylhiascic acid, the immersed apothecia and the large ascospores, 17–[*23.2*]–30 × 12–[*14.0*]–18 µm. *Trapelia kosciuszkoensis* had previously been confused with *T. macrospora*, known from Campbell Island and Tasmania (Fryday 2004; Kantvilas & Elix 2007), with both species having relatively large ascospores, rimose-areolate thalli and immersed apothecia. However, *T. macrospora* has longer ascospores, 25–[*29.3*]–34 µm long, a much thicker hypothecium, 150–180 µm thick, and contains gyrophoric acid.

At present, the species is known only from granite rocks in Mount Kosciuszko National Park, southern New South Wales. Commonly associated lichens on rock include *Candelariella vitellina* (Hoffm.) Müll.Arg., *Diploschistes scruposus* (Schreb.) Norman, *Lecanora polytropa* (Ehrh.) Rabenh., *Notoparmelia signifera* (Nyl.) A.Crespo, Ferencova & Divakar, *Pertusaria lophocarpa* Körb., *Rhizocarpon geographicum* (L.) DC., *Umbilicaria cylindrica* (L.) Delise ex Duby and *U. decussata* (Vill.) Zahlbr.

ADDITIONAL SPECIMENS EXAMINED
New South Wales: ● Mount Kosciuszko National Park, just S of Rawsons Pass, 36°27'S, 148°15'E, 2130 m alt., on granite rocks in alpine heath, *J.A. Elix 4265*, 6.ii.1978 (CANB); ● Mount Kosciuszko National Park, 1 km N of Mt Kosciuszko, along the Lakes Trail, 36°27'S, 148°16'E, 2120 m alt., on granite rocks in alpine grassland, *J.A. Elix 4265*, 6.ii.1978 (CANB); ● Mount Kosciuszko National Park, N slopes of Mt Stillwell, 36°26'S, 148°19'E, 1950 m alt., on exposed granite rocks in alpine herbfield, *J.A. Elix 11670 & P.W. James*, 23.i.1984 (CANB).

Trapelia pruinosa Elix & P.M. McCarthy, sp. nov. Fig. 3
MycoBank No. **MB 833124**

Similar to *Trapelia crystallifera* Elix & Kantvilas, but differs in having a pruinose upper surface, longer ascospores, 13–[*16.6*]–20 µm long, and in containing 5-*O*-methylhiascic acid as the major lichen substance.

Type: Australia. Australian Capital Territory, trail to Aranda Bushland, 35°15'32"S, 149°04'53"E, 672 m alt., on soil bank in dry *Eucalyptus* woodland, *J.A. Elix 46785*, 14.vii.2019 (CANB – holotype).

Thallus to 50 mm wide and 1 mm thick, whitish to cream-grey, glaucous grey or dark grey, squamulose; upper surface sparsely to usually densely white-pruinose, the pruina often concentrated in a shallow depression in the centre of squamules, not sorediate; squamules 0.2–3 mm wide, roundish to irregular, weakly concave to plane, becoming unevenly crenulate to lobate, plane to undulate, discrete and dispersed or contiguous, overlapping and imbricate or fused, margins entire, not thickened, adnate to the substratum or upturned, squamules becoming irregularly cracked with age; medulla white, containing calcium oxalate (H_2SO_4+), I–. *Photobiont* green, of the *Chlorella*-type, with individual cells irregularly roundish or rhomboid, 5–10 × 5–8 µm, solitary or in pairs, triads or tetrads. *Apothecia* scattered, 0.5–1.3 mm wide, irregularly roundish, immersed to just emergent, at first often appearing as a pale pruinose disc, soon becoming superficial and often with white, slightly roughened or pruinose margins; proper margin very thin, brownish, usually with a well-developed, rather ragged, white thalline rim; disc plane to convex, pale to dark brown, white-pruinose or not. *Excipulum* in section cupular, dark brown at the sides, pale grey-brown to colourless within, K+ yellow-brown solution, 70–100 µm thick at the sides, 25–50 µm thick at the base. *Hypothecium* 100–120 µm thick, pale brown, poorly differentiated from the hymenium. *Epihymenium* 15–30 µm thick, brown. *Hymenium* 150–170 µm thick, colourless, I+ blue, not inspersed with granules or oil droplets. *Paraphyses* richly branched, particularly at the base and near the apices, slender, 1.5–2 µm thick, flexuose, tangled, separating readily in K; apices not markedly expanded. *Asci* 8-spored, of the *Trapelia*-type, with an amyloid wall and a prominent, non-amyloid tholus, elongate-clavate, 70–100 × 20–25 µm. *Ascospores* simple, non-halonate, thin-walled, often vacuolate, broadly-ellipsoid, 13–[*16.6*]–20 × 7–[*9.1*]–12 µm. *Pycnidia* punctiform, brown, immersed in the upper surface; conidia filiform, straight to weakly curved, 11–16 × 0.7 µm.
Chemistry: Thallus K–, C+ red, KC+ red, P–, UV–; containing 5-*O*-methylhiascic acid (major) and gyrophoric acid (minor or trace).

Etymology: The species is named after the pruinose upper surface of its thallus.

Remarks
Trapelia pruinosa appears to be most closely related to the widespread Australian endemic *T. crystallifera*, with both species having an esorediate, areolate to squamulose thallus, with the squamules usually well-developed, often separate, relatively large and crenulate-lobate. However, *T. crystallifera* differs in having a crystalline, cracked, mealy upper surface, epruinose discs, smaller ascospores, 9–[*12.3*]–15 × 4–[*6.4*]–8 µm, which are often pointed at one end, and it contains gyrophoric acid as the major lichen substance (Kantvilas & Elix 2007). *Trapelia involuta* is chemically identical to *T. pruinosa*, but the areoles are smaller, 0.2–0.6 mm wide, they lack surface pruina and calcium oxalate and the ascospores are significantly longer, 19–[*21.3*]–24.5 × 9–[*10.4*]–12.5 µm (Orange 2018).

At present, the species is known from siliceous rocks and clay soil in dry *Eucalyptus* woodland, and is common in the Australian Capital Territory and central-western New South Wales. It also occurs occasionally in Victoria and Queensland. Commonly associated lichens on rock include various *Caloplaca* and *Xanthoparmelia* species, *Acarospora citrina* (Taylor) Zahlbr. ex Rech., *Buellia amandineiformis* Elix & Kantvilas, *B. suttonensis* Elix & A.Knight,

Candelariella vitellina (Hoffm.) Müll.Arg., *Diploschistes eugeneus* (A.Massal.) J.Steiner, *D. sticticus* (Körb.) Müll.Arg., *Lecanora pseudistera* Nyl., *Lecidea terrena* Nyl., *Lepra erubescens* (Hook.f. & Taylor) A.W.Archer & Elix, *Pertusaria lophocarpa* Körb., *Rhizocarpon geographicum* (L.) DC. and *R. reductum* Th.Fr.

ADDITIONAL SPECIMENS EXAMINED

Queensland: ● Box Creek, Leichhardt Hwy, 51 km SW of Theodore, 25°22'S, 149°52'E, 230 m alt., on semi-shaded boulder in *Eucalyptus-Callitris* woodland, *H. Streimann 52560*, 30.viii.1993 (CANB). *New South Wales*: ● Newell Hwy, 29 km N of Dubbo, 31°54'S, 148°32'E, on soil in *Callitris* woodland, *J.A. Elix 2677*, *2683*, 3.ix.1976 (CANB); ● Weddin State Forest, 25 km WSW of Grenfell, 34°01'S, 148°01'E, 300 m alt., on soil in *Callitris* forest, *J.A. Elix 4745*, 14.vii.1978 (CANB); ● Weddin Mountains National Park, 15 km SW of Grenfell, 33°54'S, 148°00'E, 340 m alt., on rocks in dry sclerophyll forest, *J.A. Elix 25117*, 31.v.1990 (CANB); ● Jimberoo State Forest, Mountain Creek, 14 km NNE of Rankin Springs, 33°43'S, 146°20'E, 280 m alt., on consolidated soil in *Eucalyptus-Callitris* woodland, *J.A. Elix 25311*, 13.vi.1990 (CANB); ● Conapaira State Forest, 13 km SSW of Rankin Springs, 33°58'S, 146°13'E, 420 m alt., on metamorphic rocks in *Eucalyptus-Callitris* woodland, *J.A. Elix 25381*, 13.vi.1990 (CANB); ● Shingle Ridge, 5 km N of Molong along road to Yeoval, 33°04'22"S, 148°49'45"E, 595 m alt., on sandstone rock in remnant *Eucalyptus* woodland, *J.A. Elix 38562*, 13.x.2005 (CANB); ● Goonoo State Forest, Goondy Creek, Mogriguy Forest Road, 11 km E of Mogriguy, 25 km NE of Dubbo, 32°03'07"S, 148°46'34"E, 350 m alt., on soil in *Eucalyptus-Allocasuarina* woodland, *J.A. Elix 37153*, 11.x.2005 (CANB); ● Goobang National Park, Ten Mile Creek, 1.5 km SSW of Gingham Gap, 32°49'56"S, 148°20'11"E, 430 m alt., on old termite mound in *Eucalyptus-Callitris* woodland, *J.A. Elix 39349*, 4.viii.2008 (CANB); ● Ingalba Nature Reserve, 9 km W of Temora, S of highway, 34°26'11"S, 147°26'01"E, 315 m alt., on soil in open *Eucalyptus-Callitris* woodland, *J.A. Elix 39735*, 16.iv.2009 (CANB); ● Ingalba Nature Reserve,7 km W of Temora, N of highway, 34°26'10"S, 147°26'23"E, 270 m alt., on soil and pebbles in *Eucalyptus-Callitris* woodland, *J.A. Elix 45155*, 14.v.2010 (CANB); ● Ingalba Nature Reserve, 7 km W of Temora, N of highway, 34°26'10"S, 147°26'23"E, 270 m alt., on soil and pebbles in *Eucalyptus-Callitris* woodland, *J.A. Elix 45155*, 14.v.2010 (CANB); ● Tuena–Bathurst road, *c.* 10 km N of Tuena, 33°55'38"S, 149°21'09"E, 650 m alt., on soil bank in open *Eucalyptus* woodland, *J.A. Elix 46871*, 30.ix.2019 (CANB); ● Gooloogong–Grenfell road, 5 km N of Grenfell, 33°51'16"S, 148°10'37"E, 385 m alt., on consolidated soil in *Eucalyptus-Callitris* woodland, *J.A. Elix 46835*, 2.x.2019 (CANB); ● Warraderry Range, Gooloogong–Grenfell road, 38 km N of Grenfell, 33°38'42"S, 148°22'15"E, 330 m alt., on sandstone in *Eucalyptus-Callitris* woodland, *J.A. Elix 46843*, *46844*, 2.x.2019 (CANB); *loc. id.*, *P.M. McCarthy 4896*, 2.x.2019 (CANB). *Australian Capital Territory*: ● Woodstock Nature Reserve, Shepherds Lookout Walk, 20 km WNW of Canberra, 35°14'34"S, 148°58'38"E, 555 m alt., on consolidated soil in open *Eucalyptus-Callitris* woodland, *P.M. McCarthy 4782*, 4.xii.2018 (CANB); ● type locality, on soil bank in dry *Eucalyptus* woodland, *J.A. Elix 46804*, 9.viii.2019 (CANB). *Victoria*: ● Tallarook State Forest, Horan Track, 17 km S of Seymour, 37°11'S, 145°10'E, 600 m alt., on exposed rock outcrop in dry sclerophyll forest, *H. Streimann 36058*, 25.xii.1985 (CANB).

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Figure 1. *Trapelia atrocarpa* (holotype in CANB), Scale = 2 mm.

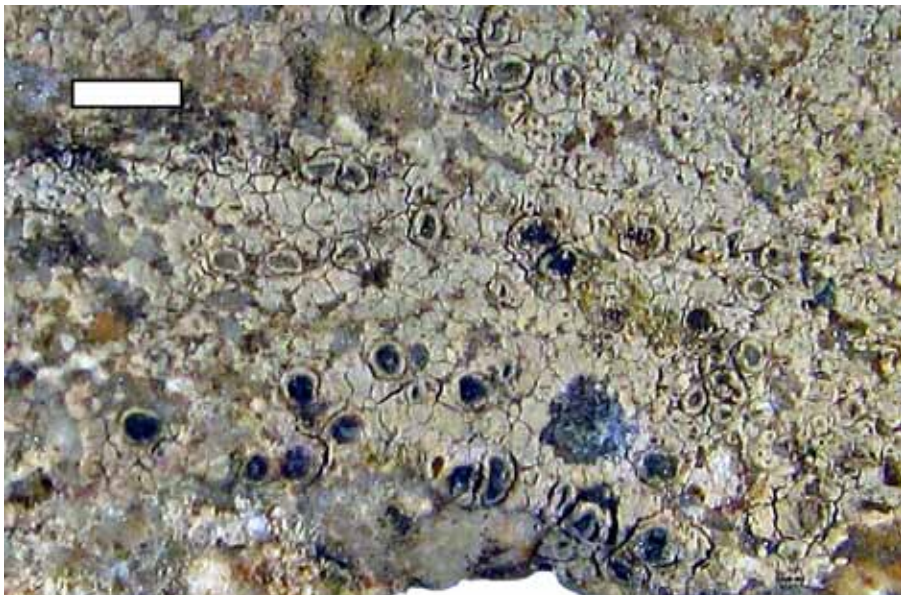

Figure 2. *Trapelia kosciuszkoensis* (holotype in CANB). Scale = 2 mm.

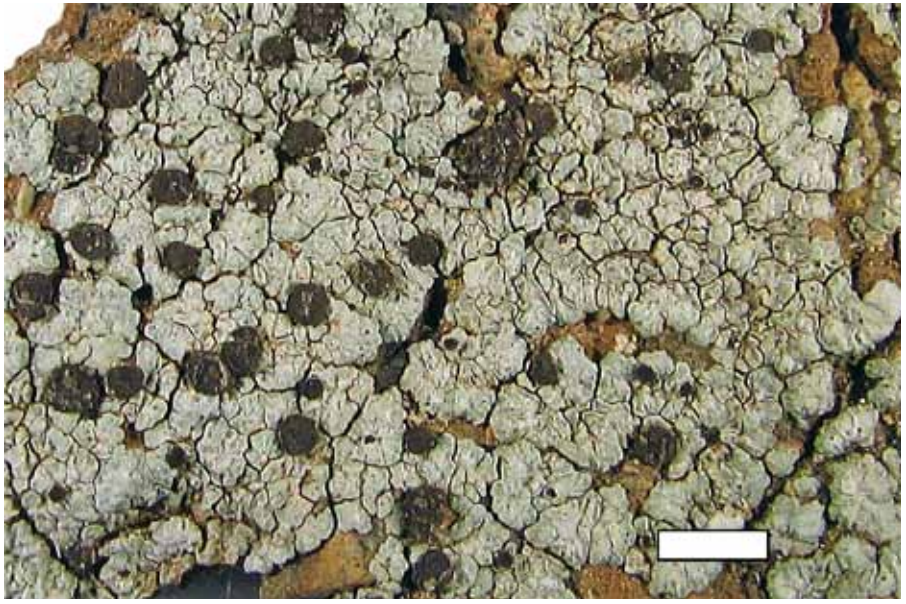

Figure 3. *Trapelia pruinosa* (holotype in CANB). Scale = 2 mm.

Thelidium carbonaceum (Verrucariaceae), a new saxicolous lichen from Tasmania

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Abstract
The lichen *Thelidium carbonaceum* P.M.McCarthy & Kantvilas (Verrucariaceae) is described from siliceous rock in south-western Tasmania. It has very small, thin thalli that are jet-black and rimose-areolate along with diminutive, semi-immersed perithecia, 0.08–0.17 mm diam., with an excavate apex and a well-developed, carbonized involucrellum, a brown-black excipulum, and 1-septate ascospores, 11–18 × 4.5–6 µm.

Introduction

Thelidium A.Massal. (Verrucariaceae, Verrucariales), a genus of approximately 100 species, grows almost exclusively on calcareous or siliceous rocks in aquatic, semi-aquatic and terrestrial habitats, especially in northern-temperate to boreal latitudes (Zschacke 1933; Servít 1954; Kopachevskaya *et al.* 1977; Clauzade & Roux 1985; McCarthy 2001; Galloway 2007; Thüs & Nascimbene 2008; Orange 2009, 2013; Thüs & Schultz 2009; Harada 2013). The thallus is crustose, usually ecorticate and immersed in the substratum to partially superficial and diffuse, continuous or rimose to areolate. Ascomata are perithecioid, immersed in the thallus or directly in the substratum, or semi-immersed to superficial, with or without a dark to black involucrellum, and the asci are fissitunicate, each producing 8 colourless, thin-walled ascospores with 1–3(–7) transverse septa and, occasionally, with 1–3 longitudinal or oblique divisions. Traditionally, ascospore septation has distinguished *Thelidium* from the simple-spored *Verrucaria* Schrad., while it remains poorly differentiated from *Polyblastia sens. lat.* in which ascospores are submuriform to fully muriform and range from colourless to dark brown.

Thelidium is currently represented in Australia by five species, four of which are exclusively calcicolous, with two others reported from Australian island territories in the Subantarctic (McCarthy 2018). In this paper, we describe as new a highly distinctive species on quartz in south-western Tasmania.

Methods

Observations and measurements of thallus and ascomatal anatomy, asci and ascospores were made on hand-cut sections mounted in water and dilute KOH (K). Asci were also ob-served in Lugol's Iodine (I), with and without pretreatment in K.

Thelidium carbonaceum P.M.McCarthy & Kantvilas, sp. nov. Figs 1, 2
MycoBank No. **MB 832113**

Characterized by its very small, thin, black, rimose-areolate thalli with minute, semi-immersed perithecia, 0.08–0.17 mm diam., each with an excavate apex, a well-developed, carbonized involucrellum, 35–60 µm thick, a brown-black excipulum, 10–13 µm thick, sparse periphyses, mostly obclavate asci, 42–55(–60) × 13–23 µm, and 1-septate ascospores, 11–18 × 4.5–6 µm.

Type: Australia. Tasmania, Southwest Natl Park, Mount Sprent Track, 42°47'S, 145°58'E, 720 m alt., on quartzite pebbles in a gravelly gap in buttongrass moorland, *G. Kantvilas 142/18*, 13.x.2018 (holotype – HO 594769).

Thallus crustose, epilithic, greenish black to jet-black, growing on quartz pebbles and providing a striking contrast to the whitish substratum, diffuse and with scattered microthalli mostly 1–2 mm wide, which are best-developed and thickest in minute fissures and pits in the

rock, not forming substantial colonies, rimose to minutely areolate, 50–80(–100) µm thick, dull to slightly glossy, ± smooth; areoles somewhat rounded to angular and irregular, (80–) 100–200(–250) µm wide when fertile, 40–80(–120) µm wide when lacking a perithecium, separated by very narrow fissures (to *c.* 20 µm wide), ecorticate. *Photobiont cells* green, unicellular, round or broadly ellipsoid, rather thick-walled, chlorococcoid, (5–)6–11(–13) µm wide, not forming a distinct layer within the thallus or occupying the upper *c.* 50 µm. *Medulla* nondescript, in thin section the thallus dominated by a compact paraplectenchyma of rounded, thick-walled, brown-black cells 3–5(–6) µm wide. *Prothallus* absent; hypothallus not apparent. *Ascomata* perithecia, numerous, solitary, (0.08–)0.12(–0.17) mm diam. [*n* = 50], usually 1 per areole, outwardly dull black, semi-immersed in the thallus; perithecial apex shallow-concave to deeply excavate, 50–80 µm wide; ostiole central, inconspicuous, *c.* 20 µm diam. *Involucrellum* well-developed, 35–50(–60) µm thick, not overgrown by the thallus, uniformly brown-black in thin section, contiguous with the excipulum and extending almost to excipulum-base level, K–. *Excipulum* dark brown to brown-black, 10–13 µm thick at the apex, sides and base, K–. *Subhymenium* hyaline to pale brown, 10–15 µm thick, K–, I+ red-brown; hyphae 2–2.5 µm wide. *Paraphyses* absent. *Periphyses* sparse, apparently unbranched although very difficult to observe in thin section or squash preparations, *c.* 10–15 × 1.5–2 µm. *Centrum* obpyriform, *c.* 60–100 µm wide, non-amyloid, KI+ patchily red-brown. *Asci* fissitunicate, 8-spored, broadly clavate to mostly obclavate, 42–55(–60) × 13–23 µm [*n* = 10]; when immature the wall markedly thickened at the apex and with a narrow ocular chamber, at maturity the tholus thin (*c.* 2 µm) and the ocular chamber absent. *Ascospores* irregularly arranged in the ascus, or concentrated in the proximal half of obclavate asci, colourless, 1-septate, narrowly ellipsoid to oblong-fusiform, straight, with a median septum and rounded or subacute ends, not or, more commonly, slightly constricted at the septum, (11–)15(–18) × (4.5–)5(–6) µm [*n* = 62]; wall very thin, smooth; epispore usually not apparent, occasionally seen in immature and mature spores, 1–2.5 µm thick; spore contents clear to minutely granulose, most locules with a single large vacuole. *Pycnidia* absent.

Etymology: The epithet *carbonaceum* refers to the jet-black thallus of the new species.

Remarks

Thelidium carbonaceum is characterized by its siliceous substratum, the thin, black, minutely areolate thallus with diminutive, compound perithecia, each with a distinctively concave to excavate apex, a perithecial centrum bounded by a brown-black excipulum, containing small, mostly obclavate asci and 1-septate ascospores 11–18 × 4.5–6 µm. This combination of attributes readily separates *T. carbonaceum* from other known Australian species, all but one of which are exclusively calcicolous, the exception being the bipolar *T. pluvium* Orange, a species of aquatic, siliceous rock in Tasmania with a greenish brown thallus that overgrows perithecia 0.25–0.4 mm wide, while the excipulum base is hyaline and the 1-septate spores measure 21–31 × 12–16 µm (McCarthy 2001; McCarthy & Kantvilas 2016).

Black, carbonaceous thalli are very uncommon in *Thelidium*, most species having nondescript, endolithic thalli or semi-immersed to superficial crusts in shades or combinations of white, grey, green or brown. An exception is *T. heardense* C.W.Dodge, which was reported from siliceous rock in subantarctic Heard Island in the southern Indian Ocean (Dodge 1948). That species has a thicker thallus than the Tasmanian lichen, perithecia to 0.5 mm wide with an involucrellum to 100 µm thick, a considerably thicker excipulum, and 1-septate ascospores 14–16 × 7–8 µm (Dodge 1948). Another similar species, *T. sinense* Harada & Li.S.Wang, is known from aquatic, siliceous rock in Yunnan, China and from shaded, non-aquatic rock in Honshu, Japan. It has a dark granulose thallus, very small, prominent, compound perithecia 0.15–0.25 mm wide, and 1-septate ascospores 13–17 × 5–8 µm. However, the thallus is brown rather than black, it lacks the brown-black paraplectenchyma of *T. carbonaceum*, the perithecia are more prominent and have a persistently rounded rather than excavate apex, and the excipulum base is colourless (Harada & Wang 2006; Harada 2013).

The new species is known only from quartzite pebbles on the ground at the type locality in buttongrass (*Gymnoschoenus sphaerocephalus*, Cyperaceae) moorland in south-western Tasmania. This vegetation type dominates much of the south-western and western parts of Tasmania, extending from sea-level to as much as 1000 m in elevation. It typically occurs on highly acidic peaty soil over infertile rock types, usually Precambrian metamorphosed rocks such as quartzite. Within the expanse of moorland, areas where the peat has been eroded, leaving only exposed bedrock, pebbles, gravel or sand are not uncommon. Such sites are usually seemingly devoid of lichens, in part due to intermittent inundation or abrasion from strong winds that can even flip the pebbles over. However, careful searching will usually reveal several highly inconspicuous lichens that are characteristic of this habitat, all with highly reduced or absent thalli and tiny black ascomata. In addition to the new species, these include *Leimonis erratica* (Körb.) R.C.Harris & Lendemer, *Lithographa graphidioides* (Cromb.) Imshaug ex Coppins & Fryday, *Micarea micromelaena* Kantvilas & Coppins and *Stephanocyclos henssenianus* Hertel.

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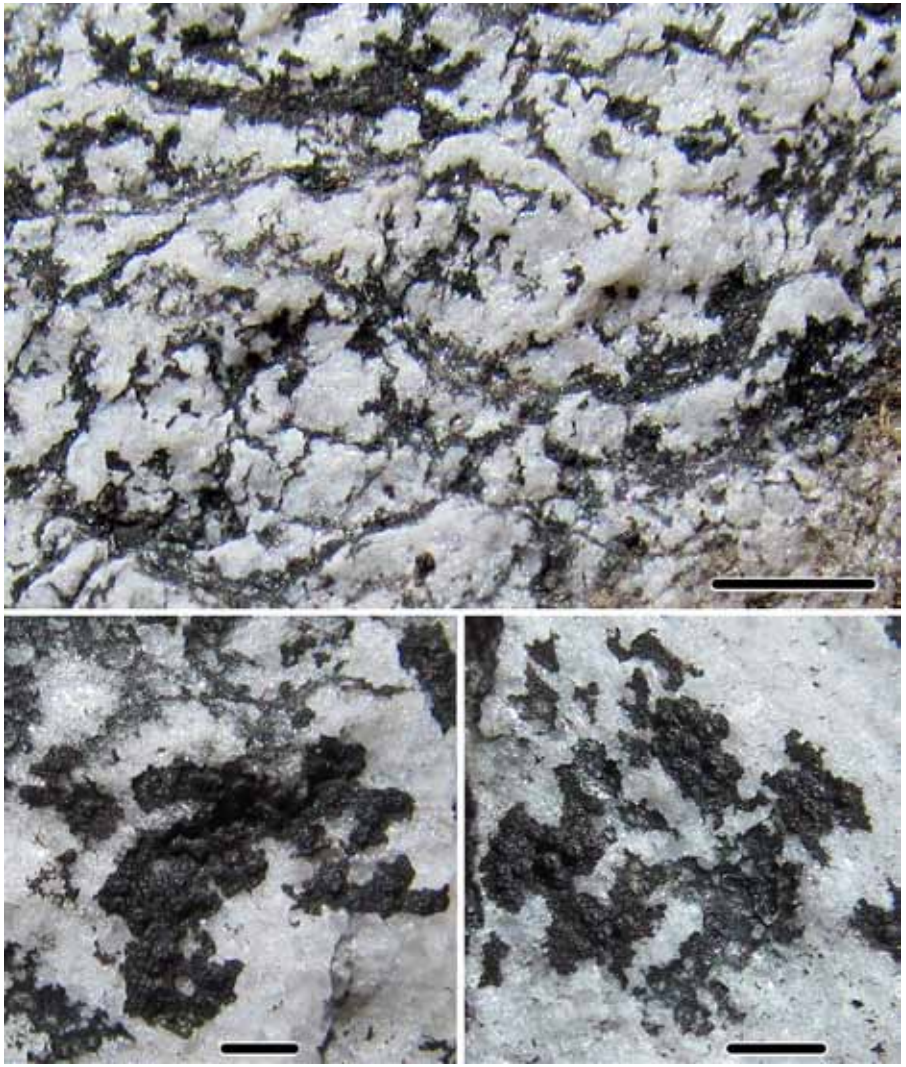

Figure 1. *Thelidium carbonaceum* (holotype). Scales: 5 mm (above) and 1 mm (below).

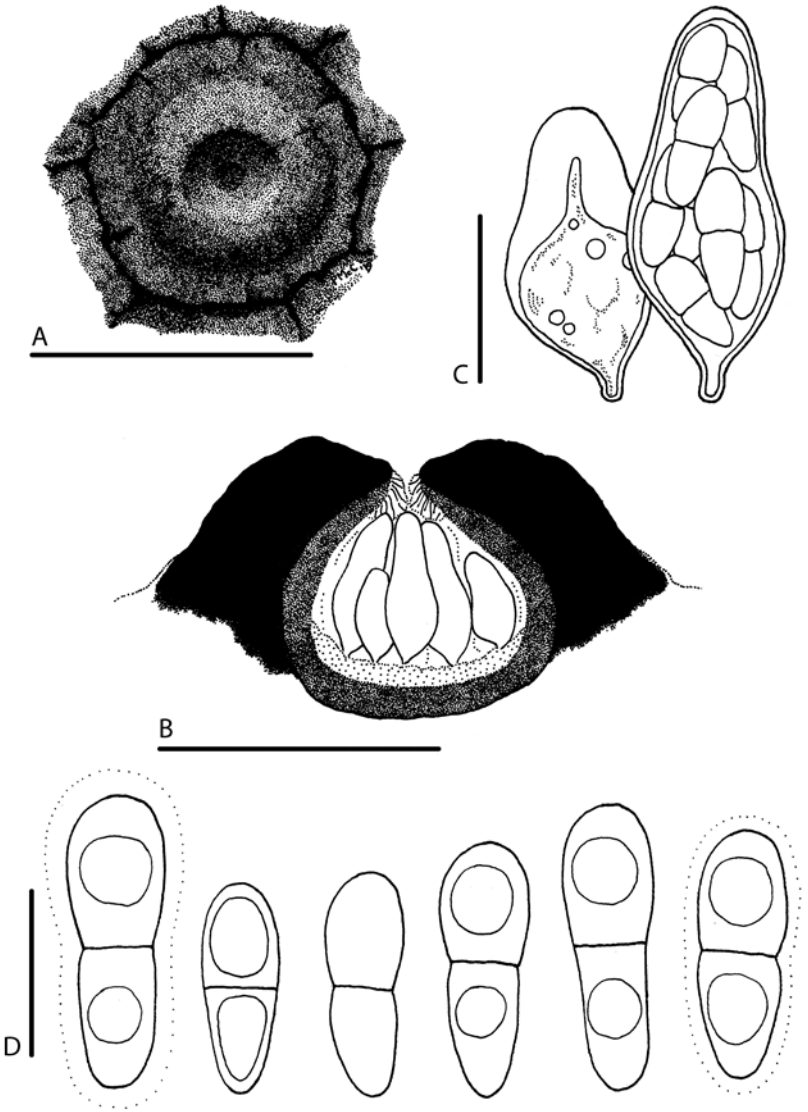

Figure 2. *Thelidium carbonaceum* (holotype). A, Habit of a fertile areole with a semi-immersed perithecium; B, Vertical section of an ascoma (semi-schematic); C, Immature (left) and mature asci; D, Ascospores. Scales: A = 0.2 mm; B = 0.1 mm; C = 20 µm; D = 10 µm.

Additional lichen records from New Zealand 51.
***Usnea dasaea* Stirt.**

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Abstract
Usnea dasaea is reported for the first time from New Zealand.

Introduction
Corticolous specimens of *Usnea* collected in Northland and Tasman in 2004 could not be identified at the time using the key and descriptions in the first edition of the New Zealand lichen *Flora* (Galloway 1985). Thin-layer chromatography revealed the presence of salazinic, norstictic and galbinic acids, which did not match species then recognized in New Zealand. Reading the description of Australian *Usnea* species in Stevens (1999), it seemed possible that the specimens were *U. undulata* Stirt. although *U. undulata* was not recorded in New Zealand until the second edition of the *Flora* for saxicolous material (Galloway 2007), and Clerc & Herrera-Campos (1997) considered *U. undulata* to be a synonym of *U. dasaea* Stirt. Clerc (2004) later identified a specimen of *U. dasaea* from Australia, which suggested the species could also be present in New Zealand. Morphological and chemical examination of a wider range of specimens from the North Island and comparison with descriptions of *U. dasaea* confirm the presence of the species in New Zealand.

Materials and methods
Whole specimens were photographed using an Olympus Stylus TG4 camera. A Leica M 125 C microscope was used to examine the specimens in detail, and photographs were taken using LAS V4.12 software. Transverse sections of branches were used to measure CMA values (the relative thickness of the cortex (C), medulla (M), and axis (A) in the cross-section of a longitudinal branch, Clerc 1984, 1987). A modified Lactophenol cotton blue stain was used to stain the spinulose fibrils before mounting in GAW (glycerol : alcohol : water 1:1:1) and photographing with a Leica DM 1000 microscope using the same software. Thin-layer chromatography was carried out using the methods of Culberson (1972) and White & James (1985), using solvents C and G.

New record for New Zealand

Usnea dasaea Stirt., *Scott. Naturalist* **6**, 104 (1881) Figs 1, 2

Type: MADEIRA. Funchal, *Payne s.n.* (BM – holotype!). CMA: C = 9.5%, M = 26.5%, A = 28%.
Chemistry: usnic, norstictic, galbinic and salazinic acids, all in major concentrations.
Syn: *Usnea undulata* Stirt. *Scott. Naturalist* **6**, 104 (1881).

Thallus grey-green to yellow-green, shrubby to subpendent, to 10–15 cm long; branching mixed isotomic/anisotomic; lower branches not constricted at the origin; smaller branches appearing slightly constricted at the origin, but articular cracks can mimic constrictions; trunk short, not pigmented; lower branches slightly inflated, terete to slightly ridged, foveoles present or absent, cylindrical, tapering, tips of branches tapering, articular cracks on branches few but typical at smaller branch origins; papillae seen on some specimens; spinulose fibrils present and often dense on at least some branches; fibrils easily break off and leave a slightly raised scar or fibercle on which soralia can develop; soralia punctiform and slightly raised on branches, eroding to form larger soralia in places, also developing on fibercles; isidiomorphs present in soralia. *Apothecia* sometimes present, terminal, subterminal, or lateral, variable in size, up to 4 mm in diam.; ray fibrils in a single row, variable in number and length; disc yellowish and pruinose; cortical thickness variable, 7–12% of the branch width; medulla dense, occasionally dense/lax, 24–31% of the branch width; axis narrow, 22–32% of the branch width, A/M 0.7–1.2, pigment absent in both the medulla and axis.
Chemistry: Usnic, salazinic, norstictic and galbinic acids, usually all in major quantities (TLC).

Diagnostic features
The presence of dense spinulose fibrils that can detach easily, leaving a slightly raised scar or fibercle on which soralia can develop, and the presence of salazinic, norstictic and galbinic acids.

Remarks
Until 2004, *U. dasaea* was known from North America, South America, Europe and Asia, but not from Australasia (Clerc & Herrera-Campos 1997). Clerc (2004) identified an *Usnea* specimen collected in Queensland, Australia (*H. Mayrhofer 2586*) as *U. dasaea*, and he realized that specimens of *U. dasaea* from Australia had been included with specimens of *U. cornuta* Körb (synonym *U. confusa* Asahina) by Stevens in 1999 (Clerc 2004). Fos & Clerc (2000) and Clerc (2004) considered that *U. dasaea* was closely related to *U. cornuta*, differing in having dense spinulose fibrils and in its chemistry (usnic, salazinic, norstictic and galbinic acids). Specimens of *U. dasaea* from New Zealand might have been confused with *U. cornuta* (*U. arida* in Galloway 1985), and also with *U. rubicunda* Stirt., but those species can be distinguished by the presence of dense spinulose fibrils (Figs 1 & 2) which detach easily and leave a slightly raised scar or fibercle on which soralia can develop, also by the presence of salazinic, norstictic and galbinic acids and by the lack of red cortical pigmentation. Specimens of *U. undulata*, now a synonym of *U. dasaea* (Clerc & Herrera-Campos 1997) in New Zealand herbaria could also prove to be *U. dasaea*.

The species has been collected from sea level to 807 m elev. from several sites in Northland, Auckland, Waikato, Whanganui-Manawatu, Tasman and Otago. As noted above, it often is confused with *U. rubicunda* and *U. cornuta*, so an examination of material from New Zealand herbaria is likely to show that it is widespread. So far, it is known from coastal pohutukawa (*Metrosideros excelsa*) forest, inland mixed broadleaf native forest and a range of native and introduced trees and shrubs in suburban settings. It commonly occurs with *Usnea rubicunda*.

SELECTED SPECIMENS EXAMINED
North Island: • Waitaraire Stream, near Takahue, Northland, 35°10′57″S, 173°21′02″E, 50 m alt., corticolous, *P. & J. Bannister s.n.*, xii.2004 (OTA59241); • Governor's Bay, Moturoa Island, Bay of Islands, Northland, 35°12′25″S, 174°04′38″E, 0 m alt., fallen branch of pohutukawa, *E. Asquith s.n.*, 06.iv.2012 (UNITEC5423); • Taraire Valley, Motu Kaikoura, Hauraki Gulf, Auckland, 36°10′58″S, 175°19′11″E, 104 m alt., on dead shrub, *D. J. Blanchon & I.L. Ennis s.n.*, 11.vi.2008 (UNITEC4383); • Hillcrest Rd, Orewa,

Hibiscus Coast, Auckland, 36°34′17″S, 174°41′26″E, 40 m alt., on plum tree in residential garden, *B. Davidson s.n.*, 16.ix.2010 (UNITEC4235); • Maywood Crescent, Glen Eden, Auckland, 36°55′03″S, 174°37′46″E, 58 m alt., growing on branch of silver birch in residential garden, *K. Crabbe s.n.*, 17.ix.2009 (UNITEC3901); • Hamilton Domain, Hamilton, Waikato, 37°47′46″S, 175°16′23″E, 38 m alt., on trees, *W.Martin A567*, 21.x.1964 (OTA59235).
South Island: • Takaka Walkway, Tasman, 41°01′56″S, 172°51′55″E, 5 m alt., corticolous, *P. & J. Bannister s.n.*, vi.2004 (OTA59293); • Eve's Bush, Brightwater, Tasman, 41°20′02″S, 173°03′14″E, 80 m alt., corticolous, *J. Bannister s.n.*, v.2004 (OTA68061); • Trotters Gorge, Otago, 45°24′10″S, 170°46′37″E, 180 m alt., on dead branch in mixed broadleaf forest, *J. Steel s.n.*, 8.ix.2018 (OTA71217).

Acknowledgement
We thank Philippe Clerc for confirming our identification of *U. dasaea*.

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Figure 1. *Usnea dasaea* (OTA71235). Scale bar = 1 cm.

Figure 2. *Usnea dasaea* (OTA71235), part of branch showing spinulose fibrils (stained with lactophenol cotton blue). Scale bar = 1 mm.

Additional lichen records from Australia 86. *Hymenelia ceracea* (Arnold) M.Choisy and *Thelenella fernandeziana* (Zahlbr.) H.Mayrhofer

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Abstract

Hymenelia ceracea (Arnold) M.Choisy (Hymeneliaceae) and *Thelenella fernandeziana* (Zahlbr.) H.Mayrhofer (Thelenellaceae) are reported for the first time from Australia. The former occurs on granite in the Southern Tablelands, New South Wales, while the latter was collected from sandstone in woodland in the Australian Capital Territory.

Introduction

Field work and the re-assessment of older herbarium collections continue to improve our understanding of the diversity and distribution of the Australian lichen flora. In this contribution, *Hymenelia ceracea* (Arnold) M.Choisy and *Thelenella fernandeziana* (Zahlbr.) H.Mayrhofer, are reported for the first time from Australia, the former from the Southern Tablelands, New South Wales, and the latter from the Australian Capital Territory.

Hymenelia ceracea (Arnold) M.Choisy, *Bulletin Mensuel de la Société Linnéenne de Lyon* **18**, 145 (1949) Figs 1 & 2

Thallus epilithic, effuse to ± determinate, pale to medium yellowish brown, smooth, continuous and almost membranous to rimose or areolate, thin, to 50–80(–100) µm thick, forming scattered colonies to 5(–10) mm wide, often in a mosaic with other crustose lichen species. *Areoles* solitary and rounded to contiguous and angular, 0.2–0.5 mm wide. *Cortex* lacking, but the thallus with an uppermost, amorphous, alga-free layer, 6–15 µm thick. *Algal layer* 25–70 µm thick, thinner and continuous beneath apothecia; cells green, globose, chlorococcoid, 7–13 µm wide; interstitial hyphae 1.5–2.5(–3) µm wide. *Medulla* thin and poorly delimited, heavily impregnated with minute rock fragments and crystals, not containing calcium oxalate (H_2SO_4–), I–; hyphae short-celled, 2–3 µm wide. *Prothallus and hypothallus* not apparent. *Apothecia* moderately numerous, usually solitary, occasionally in pairs or 3s, innate to subadnate, rounded, broadly ellipsoid or more irregular in outline, (0.13–)0.22(–0.30) mm diam. [*n* = 55]; disc plane to slightly or deeply concave, smooth, epruinose, initially flesh-coloured to yellowish brown, becoming orange-brown to medium or darker rust-brown or brown-black; margin slightly paler than or concolorous with the disc, 30–50 µm thick, entire, moderately prominent, persistent; apothecia hyaline in section, apart from the dark, granular and refractive epipsamma that dominates the epihymenium and covers the outer excipular surface. *Proper excipulum* with a comparatively thick, outer, annular collar and a thin, cupulate, inner zone; excipular collar 35–50 µm thick, almost completely hyaline, of radiating thin-walled hyphae with cells 4–6 × 2–2.5 µm, K–, N–, the outermost 5–8 µm of rounded cells, 2–3 µm wide, appearing dark greenish brown to brown-black in section due to being heavily coated and interspersed with the same K-insoluble granules as in the epihymenium (see below); inner excipular zone hyaline, 20–30 µm thick laterally towards the surface, 10–15 µm thick below and at the base, extending from a point adjacent to the epihymenium downwards beside the hymenium, beneath the hypothecium and up the opposite side of the apothecial section, consisting of thin-walled, elongate periclinal hyphae, KI+ dark blue, K–, N–. *Hypothecium* hyaline, 10(–15) µm thick, inspersed with minute granules, KI–, K–, N–, of variously orientated hyphae 1.5–2 µm wide. *Hymenium* hyaline, 65–85 µm thick, not inspersed with granules or oil droplets; hymenial gel I+ red-brown, KI+ blue; hymenium, hypothecium and inner excipulum patchily H_2SO_4+ blue. *Epihymenium* hyaline, 7–10 µm thick, K–, N–, dominated by a dense concentration of epipsammic granules on and between the apices of paraphyses; granules *c.* 0.5–0.8 µm wide, not dissolving in K. *Paraphyses* rather loosely arranged to tightly conglutinate in water, loosening a little in K (except near the apices), simple or with some anastomoses below, more richly branching in and below the epihymenium, longer-celled below, shorter-celled to slightly moniliform distally and more markedly constricted at the septa, 2–3(–3.5) µm wide, containing minute granules and vacuoles; apical cells hyaline, not or slightly swollen or moderately swollen and rounded to ellipsoid, 3–5(–6) µm wide. *Asci* narrowly to broadly clavate or clavate-cylindrical, (4–)8-spored, 55–75 × 12–17 µm [*n* = 20], KI–, with an abrupt stalk; apex rounded, with a thick tholus when immature, the tholus much thinner at maturity; ocular chamber lacking. *Ascospores* colourless, simple, narrowly to broadly ellipsoid or oblong-ellipsoid, with rounded or subacute ends, thin-walled, lacking a perispore, overlapping-uniseriate in the ascus or irregularly biseriate or uniseriate below and biseriate distally, (11–)14(–17) × (6–)7.5(–9) µm [*n* = 70], commonly containing a large vacuole and granules. *Pycnidia* not seen.
Chemistry: No substances detected by TLC.

Previously known from Europe, Macaronesia, Korea and eastern Canada (Poelt & Vězda 1981; Clauzade & Roux 1985; Berger & Priemetzhofer 2008; Aptroot & Moon 2014; Fryday & McCarthy 2018), *H. ceracea* is the third species of the genus known from Australia, along with the common and mainly pantemperate *H. lacustris* (With.) M.Choisy and the endemic Tasmanian species *H. gyalectoidea* Kantvilas (Kantvilas 2014). *Hymenelia lacustris* is most similar to *H. ceracea*, but it is semi-aquatic to almost fully aquatic in fresh water, with paler and often larger apothecia that are sunken in the more robust thallus and have a hypothecium that is thicker and non-inspersed (e.g. Fletcher *et al.* 2009, as *Ionaspis*; Kantvilas 2014).

SPECIMENS EXAMINED
New South Wales: ● Southern Tablelands, Twomeys Creek, 3 km N of Jerangle, on road to Captains Flat, 35°51’14”S, 149°23’59”E, 985 m alt., on weathered roadside granite in pasture, *J.A. Elix 46493*, 5.xi.2017 (CANB); ● *loc. id.*, *P.M. McCarthy 4684*, 5.xi.2017 (CANB).

Thelenella fernandeziana (Zahlbr.) H.Mayrhofer, *Bibliotheca Lichenologica* **26**, 33 (1987) Figs 3 & 4

Thallus epilithic on siliceous rocks, areolate, medium to dark grey-green, to 0.3(–0.5) mm thick. *Areoles* moderately to strongly convex, 0.3–1(–1.5) mm wide, smooth, matt, corticate. *Cortex* hyaline, amorphous or obscurely prosoplectenchymatous, (30–)40–70 µm thick, subtended by a paraplectenchymatous subcortex to 12 µm thick, of rounded, hyaline to grey-brown cells 4–7 µm wide. *Algal layer* 80–150 µm thick. *Photobiont* cells green, globose, chlorococcoid, 10–18(–20) µm diam. *Medulla* 70–150(–200) µm thick, I–. *Prothallus* not apparent. *Ascomata* perithecia, numerous, solitary, almost completely immersed in the thallus, 0.18–0.45 mm diam.; perithecial apex rounded, black; ostiole punctiform, in a shallow depression. *Involucrellum* absent. *Excipulum* (in section) 40–70 µm thick at the apex, with an outer brown-black zone, internally pale brown; sides and base hyaline, 25–35 µm thick and consisting of thin-walled, periclinally elongate hyphae with cells 5–8 × 1–1.5 µm. *Subhymenium* hyaline to pale brown, 15–20 µm thick. *Paraphyses* with abundant anastomoses, 1–1.5 (–2.5) µm thick, long-celled, containing minute oil(?) globules, tightly conglutinate in water, loosening a little in K. *Hymenium* non-amyloid. *Asci* (6–)8-spored, elongate-cylindrical or clavate-cylindrical; apex thick-walled, lacking an ocular chamber. *Ascospores* biseriate or overlapping-uniseriate in the ascus, medium to dark brown from early in their development, narrowly ellipsoid to oblong-ellipsoid or short-fusiform, muriform, with 6–9(–10) transverse septa, each transverse locule with (1–)2(–3) longitudinal or diagonal septa, (28–)37(–47) × (13–)17(–22) µm [*n* = 25]; wall thin, smooth, lacking a perispore (except when very immature). *Pycnidia* not seen.

First described from basalt in the Juan Fernández Islands, a Chilean territory in the south-eastern Pacific Ocean (Zahlbruckner 1924, as *Microglaena*), this lichen is distinguished from all other *Thelenella* species by the combination of a comparatively thick greyish thallus, simple, immersed, non-involucrellate perithecia and ascospores that become brown early in their ontogeny (Mayrhofer 1987; Morse 2016). The type collection was made by C. and I. Skottsberg on Santa Clara Island in 1917 (Zahlbruckner 1924; Mayrhofer 1987), and the species was recollected there and on nearby Mas a Tierra by H.A. Imshaug in 1965 (Fryday & Coppins 2004). Although there are no further published records of this species, the Museum of New Zealand Te Papa Tongarewa contains material of *T. fernandeziana* from New Zealand (4 km NW of Pourerere, E of Waipukurau) collected by H. Mayrhofer in 1992. https://collections.tepapa.govt.nz/object/224955

SPECIMEN EXAMINED

Australian Capital Territory: ● NE slopes of Mt Mugga Mugga, Canberra Nature Park, beside Hindmarsh Drive, Woden Valley, Canberra, 35°20'43"S, 149°07'10"E, 660 m alt., on sandstone pebbles embedded in porphyritic soil in area of dry land salinity in open *Eucalyptus-Allocasuarina* woodland, *P.M. McCarthy 4811*, 27.xii.2018 (CANB).

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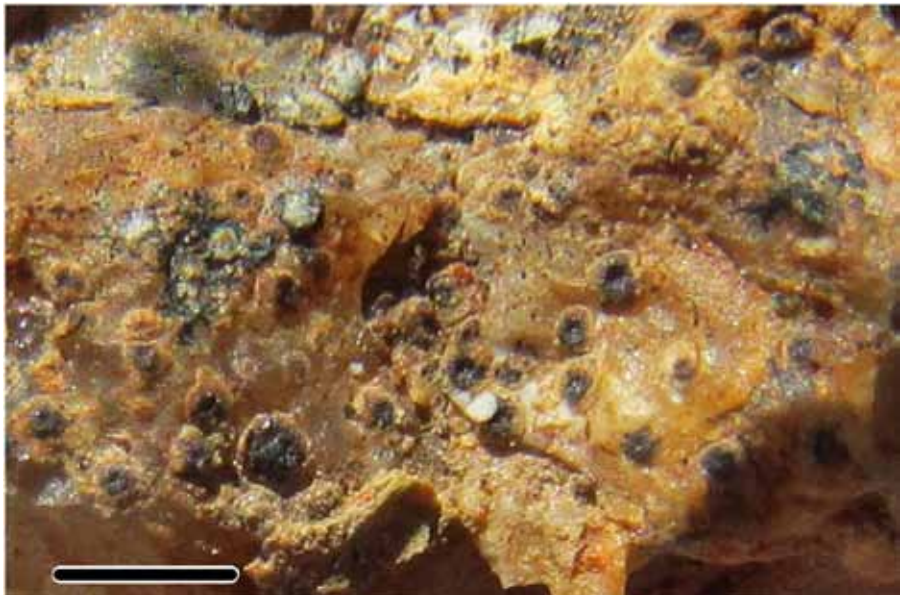

Figure 1. *Hymenelia ceracea* (*J.A. Elix 46493*, CANB). Scale: 1 mm.

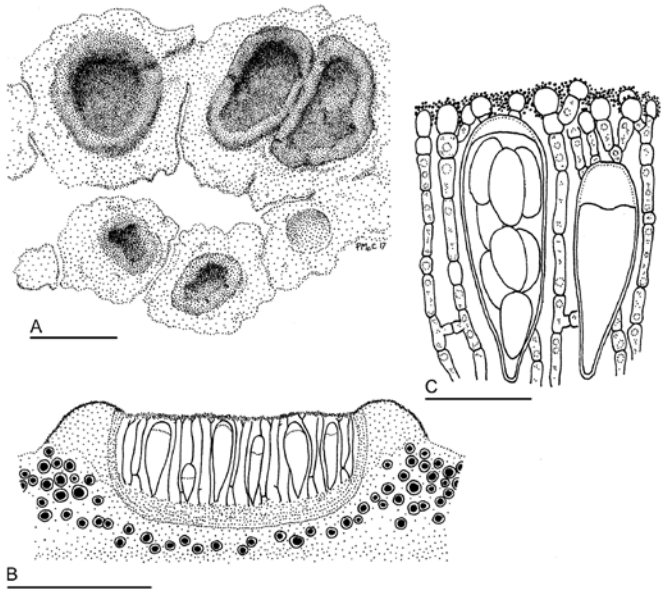

Figure 2. *Hymenelia ceracea* (*J.A. Elix 46493*, CANB). A, Habit of thallus and apothecia; B, Sectioned apothecium and adjacent thallus (semi-schematic); C, Mature and immature asci, paraphyses and epipsammic granules. Scales: A = 0.2 mm; B = 0.1 mm; C = 20 µm.

Figure 3. *Thelenella fernandeziana* (*P.M. McCarthy 4811*, CANB). Scale: 2 mm.

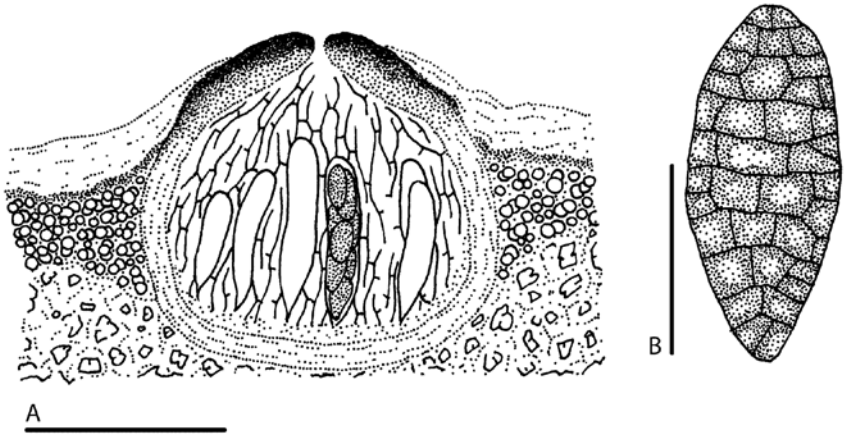

Figure 4. *Thelenella fernandeziana* (*P.M. McCarthy 4811*, CANB). A, Sectioned perithecium and adjacent thallus (semi-schematic); B, Mature ascospore. Scales: A = 0.2 mm; B = 20 µm.

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