



# Australasian Lichenology

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At first known from only Mount Kosciuszko National Park in N.S.W., *Buellia australpina* has since been reported from New Zealand. It typically colonizes occasionally inundated siliceous boulders in fast-flowing streams. It often forms extensive colonies, but they can be heavily eroded by waterborne silt during freshes, and even scoured away altogether in prolonged flooding. The species has a smooth beige-white thallus, persistently immersed apothecia, a red-brown epihymenium (N-), a dark red-brown hypothecium, and *Buellia*-type ascospores measuring  $14\text{--}20 \times 6\text{--}8 \mu\text{m}$ . It produces two lichen substances—atranorin (major) and norstictic acid (minor or absent).

1 mm 

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**A new species of *Phlyctis* (lichenized  
Ascomycota, Phlyctidaceae) from Australia**

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**Abstract**

*Phlyctis tolgensis* P.M.McCarthy & Elix, sp. nov., is described from bark in a rainforest remnant in north-eastern Queensland, Australia. A key is provided to the five species of *Phlyctis* now known from Australia.

The genus *Phlyctis* (Wallr.) Flot. (Ostropales, Phlyctidaceae) includes at least 20 species that are most diverse on bark in the subtropics and at southern-temperate latitudes. The thallus is thin, leprose-byssoid to crustose and usually whitish, with or without a cortex and soredia and in containing unicellular green algae. Apothecia are immersed in thalline verrucae to emergent, with a pruinose disc, a poorly developed to distinct proper excipulum (in section), a thin, hyaline hypothecium, a hymenium of sparingly branched paraphyses that are strongly conglutinate in water, and asci with a thin, non-amyloid to weakly amyloid apex and 1–8, hyaline, transversely septate to muriform ascospores (Galloway & Guzmán 1988; Tønsberg 2004; Galloway 2007; Joshi *et al.* 2010, 2012; Lumbsch *et al.* 2011).

Four species are already known from Australia, *viz.* *Phlyctis psoromica* Elix & Kantvilas and *P. sordida* C.Knight in the Northern and Central Tablelands of New South Wales, respectively (Lumbsch *et al.* 2011), *P. subuncinata* Stirt. in New South Wales, Victoria and Tasmania (Kantvilas 1990; Kantvilas & James 1991) and *P. uncinata* Stirt. in the Northern Tablelands, New South Wales (Elix 2010). Here, *P. tolgensis* is described and documented from rainforest in the Atherton Tableland, north-eastern Queensland.

**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). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K. Chemical constituents were identified by thin-layer chromatography (TLC, Elix 2014) and comparison with authentic samples.

***Phlyctis tolgensis*** P.M.McCarthy & Elix, sp. nov. Figs 1, 2  
Mycobank Number: **MB 819996**

Differs from *P. subagelaea* S.Joshi & Upreti in having a thinly corticate, K+ pale brown, KC– thallus (ecorticate, K+ yellow and KC+ red in *P. subagelaea*) and broader ascospores (25–55  $\mu\text{m}$  vs 12–30  $\mu\text{m}$  wide).

*Type:* Australia, Queensland, Atherton Tableland, 2.5 km S of Tolga, grounds of Rainforest Motel, 17°14'05"S, 145°20'44"E, alt. 765 m, on canopy branch in remnant rainforest, *J.A. Elix 44645*, 6.viii.2006 (holotype – CANB).

*Thallus* corticolous, crustose, epiphloeodal, forming a colony 5.5 cm wide, 40–80  $\mu\text{m}$  thick, greenish white, smooth to minutely and irregularly uneven, dull but somewhat

glossy towards the margin, continuous to richly but faintly rimose, not areolate, lacking calcium oxalate ( $\text{H}_2\text{SO}_4$ -), 1-. *Cortex* 6–9  $\mu\text{m}$  thick, hyaline, of long-celled, periclinal, prosoplectenchymatous hyphae 1–2  $\mu\text{m}$  wide. *Algae* occupying most of the thallus; cells chlorococcoid,  $\pm$  globose, 6–10(–12)  $\mu\text{m}$  wide; interstitial hyphae short-celled, 1.5–2.5  $\mu\text{m}$  wide. *Medulla* indistinct. *Prothallus* silvery white, diffuse and firm-ribrate when overgrowing bare bark, to 2.5 mm wide. *Apothecia* moderately numerous, mostly scattered, immersed in thalline verrucae to emergent, rounded, oblong or irregular in outline, (0.45–)0.84(–1.4) mm in maximum extent [ $n = 50$ ]; disc plane to slightly convex, concolorous with the thallus due to its thick pruina, this dissolving in K (or sometimes eroding) to reveal the dark greyish brown surface; thalline margin rather prominent, 80–150(–200)  $\mu\text{m}$  thick, entire to irregularly broken or crenulate, anatomically identical with the thallus. *Proper excipulum* cupulate, dark brown, 20–30  $\mu\text{m}$  thick laterally, 25–50  $\mu\text{m}$  thick above the apothecial base, paraplectenchymatous, with minute, thick-walled cells. *Hypothecium* hyaline, 25–40(–50)  $\mu\text{m}$  thick, non-amyloid. *Hymenium* 100–160(–190)  $\mu\text{m}$  thick, not interspersed with granules or oil globules. *Epithymenium* dominated by a layer of pruina 25–50  $\mu\text{m}$  thick which dissolves in K, subtended by a medium brown-pigmented zone 20–30  $\mu\text{m}$  thick. *Paraphyses* strongly conglutinate in water, embedded in hymenial gel, loosening in K, mostly simple below, or with sparse to abundant distal branches (with rare anastomoses), long-celled, 1–1.5  $\mu\text{m}$  thick; apical cells not or scarcely swollen, hyaline, to 2  $\mu\text{m}$  thick. *Asci* narrowly to broadly clavate, 1-spored, 95–160  $\times$  28–50(–60  $\mu\text{m}$ ) [ $n = 20$ ], with a short, gradually tapering stalk; apex broadly rounded, without a distinct apical apparatus, 4–8  $\mu\text{m}$  thick; wall non-amyloid; ascoplasma of immature asci IKI+ pale to medium reddish; most submature and mature ascospores IKI+ dark blue to blue-black, a minority remaining IKI+ reddish. *Ascospores* colourless, narrowly ellipsoid to oblong-ellipsoid, muriform, with 23–30(–33) transverse divisions, each transverse locule with 5–7(–8) longitudinal divisions, lacking a perispore, with rounded ends, frequently a little broader towards the proximal end and tapering distally, (82–)115(–152)  $\times$  (25–)35(–55)  $\mu\text{m}$  [ $n = 40$ ]; spore wall c. 2–3  $\mu\text{m}$  thick; cells mostly cuboid, their contents clear. *Pycnidia* not seen.

*Chemistry:* Thallus K+ pale brown, C–, KC–, PD+ orange-red, UV–; protocetraric acid (major), physodalic acid (minor) by TLC.

*Etymology:* The specific epithet refers to the type locality, Tolga.

**Remarks**

*Phlyctis tolgensis* is characterized by the thin and thinly corticate, greenish white thallus containing protocetraric and physodalic acids, moderately large, immersed to emergent apothecia with a greenish white-pruinose, dark greyish brown disc, a thick, dark brown proper excipulum, monosporous asci and amyloid, muriform ascospores 87–152  $\times$  25–55  $\mu\text{m}$ . The corticolous, southern Indian species *P. subagelaea* is most similar, having monosporous asci and amyloid, muriform ascospores (Joshi *et al.* 2010). However, the latter has narrower ascospores (12–30  $\mu\text{m}$  wide) and an ecorticate thallus said to contain fumarprotocetraric acid. However, the spot test reactions cited for *P. subagelaea*, K+ yellow, KC+ red, PD+ orange (Joshi *et al.* 2010), suggest that additional or alternative compounds are most likely present (Elix 2014). Efforts to obtain the type specimen of *P. subagelaea* from LWG on loan were not successful.

Three other species of *Phlyctis* have an esorediate thallus, monosporous asci and muriform ascospores. *Phlyctis nepalensis* Räsänen has a K– thallus containing an unidentified compound as well as comparatively small ascospores (45–53  $\times$  12–16  $\mu\text{m}$ ; Joshi *et al.* 2012). Both the North American *P. speirea* G.Merr. and *P. chilensis* D.J.Galloway & Guzmán, from southern Chile, contain norstictic acid (K+ red), the former having apothecia to 0.6(–0.8) mm wide (Tønsberg 2004), while the latter has an arachnoid-byssoid thallus and considerably larger ascospores (190–285  $\times$  55–70  $\mu\text{m}$ ; Galloway & Guzmán 1988).

The new species is known from bark in the canopy of a rainforest remnant at the type locality, near Tolga on the Atherton Tableland, north-eastern Queensland, Australia.

#### Key to the species of *Phlyctis* in Australia

1 Ascospores muriform, 1 per ascus..... ***P. tolgensis***  
 1: Ascospores with transverse septa only, mostly 8 per ascus.....2

2 Thallus containing psoromic acid; asci (4–)8-spored..... ***P. psoromica***  
 2: Thallus not containing psoromic acid; asci 8-spored.....3

3 Ascospores 45–100 × 5–10 μm; thallus containing norstictic acid..... ***P. uncinata***  
 3: Ascospores 35–72 × 5–7 μm; thallus not containing norstictic acid.....4

4 Thallus granular-leprose, containing stictic, constictic and cryptostictic acids; apothecial disc red to red-brown under the white pruina..... ***P. subuncinata***  
 4: Thallus areolate, containing stictic and hypostictic acids; apothecial disc dark grey to black under the white pruina..... ***P. sordida***

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Figure 1. *Phlyctis tolgensis* (holotype). Scale bar: 2 mm.

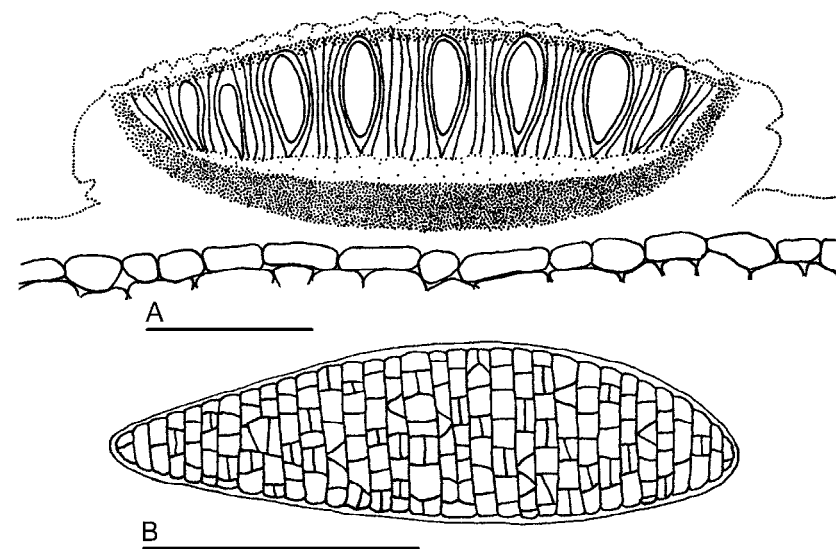


Figure 2. *Phlyctis tolgensis* (holotype). A, Sectioned apothecium; B, Ascospore. Scale bars: A = 0.2 mm; B = 50 μm.

Two new species and new records of buellioid lichens  
(Caliciaceae, Ascomycota) from Macquarie Island

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Abstract

*Amandinea hnatiukii* Elix and *Buellia seppeltii* Elix, from subantarctic Macquarie Island, are described as new to science. The new combinations *Amandinea subcervina* (Nyl.) Elix and *Tetramelas austropapillatus* (Øvstedal) Elix are proposed, and *Amandinea austroconiops* Elix & Kantvilas, *A. subcervina*, *Tetramelas austropapillatus* and *T. concinnus* (Th.Fr.) Giralt are new records for Macquarie Island. *Tetramelas concinnus* is also reported from mainland Australia for the first time. *Buellia dunedina* Zahlbr. is shown to be a later synonym of *T. concinnus*. *Buellia seppeltii* also occurs in the South Island of New Zealand and on Campbell Island.

Macquarie Island is a subantarctic island located in the Southern Ocean, about half-way between Australia and Antarctica at 54°30'S, 158°57'E, with a total land area of 128 square kilometres. Nearby are two small groups of minor islands, the Judge and Clerk Islets (54°21'S, 159°01'E) 14 km to the north (0.2 km<sup>2</sup> in area), and the Bishop and Clerk Islets (55°03'S, 158°46'E) 34 km to the south (0.6 km<sup>2</sup> in area). An introduction to the geology, landforms, vegetation, climate and lichenological history of the island has been provided by Kantvilas & Seppelt (1992). Three species of buellioid lichens have previously been reported from Macquarie Island, namely *Amandinea petermannii* (Hue) Matzer, H.Mayrhofer & Scheid., *A. subbadioatra* (C.Knight) Elix & Kantvilas and *Buellia mawsonii* C.W.Dodge (Kantvilas & Seppelt 1992; McCarthy 2017). A fourth species, *Buellia atroflavella* (Nyl.) Müll.Arg., is a later synonym of *Rhizocarpon superficiale* (Schaer.) Vain.

In this contribution, a new species of *Buellia* de Not. is described from coastal rocks on Macquarie Island; it also occurs on the South Island of New Zealand and on Campbell Island. A new species of *Amandinea* from similar habitats is so far known only from Macquarie Island. Five new records of buellioid lichens are also reported.

Methods

Observations and measurements of thallus and apothecium anatomy, asci, ascospores and conidia 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 pretreatment in K. Chemical constituents were identified by thin-layer chromatography (TLC) (Elix 2014) and comparison with authentic samples.

New species

1. *Amandinea hnatiukii* Elix, sp. nov.  
MycoBank Number: MB 819948

Figs 1, 2

Similar to *Amandinea coniops* (Wahlenb.) M.Choisy ex Scheid. & H.Mayrhofer, but differs in having larger ascospores that are dilated at the septum during ontogeny, white-pruinose discs, an inspersed subhymenium and in containing 4,5-dichlorolichexanthone.

Type: Australia, Macquarie Island, The Brothers, 54°34'S, 158°55'E, alt. 5 m, on coastal rock, *R. Hnatiuk* 11693, 8.i.1972 (holotype – MEL).

*Thallus* crustose, to 30 mm wide and 1 mm thick, epilithic, rimose to rimose-areolate; upper surface off-white to pale grey or grey, matt, cracked, chinky; prothallus not apparent; photobiont cells 10–17 µm wide; medulla lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-. *Apothecia* 0.2–0.8 mm wide, abundant, lecideine, roundish, scattered, immersed at first but ultimately broadly adnate; disc black, epruinose or often white- to pale grey-pruinose, plane to markedly convex; proper exciple thin and distinct at first, excluded with age, in section 35–45 µm thick, outer part dark brown to brown-black, K-, N-, inner part brown. *Epithymenium* 10–14 µm thick, brown to dark brown, K-, N-. *Hypothecium* 125–175 µm thick, dark brown to brown-black, K-. *Hymenium* 70–80 µm thick, colourless, with a few scattered oil droplets but not inspersed; subhymenium 30–40 µm thick, pale brown, inspersed; paraphyses 1–2.5 µm wide, sparingly branched, with apices 4–5 µm wide and brown caps. *Asci* (4–)6–8-spored, *Bacidia*-type. *Ascospores* *Physconia*- then *Buellia*-type, 1-septate, pale then dark brown, ellipsoid, 15–[18.4]–25 × 8–[9.5]–12 µm, dilated at the septum in early ontogeny but becoming constricted with age, not curved, outer wall microrugulate. *Pycnidia* common, punctiform, immersed; ostiole black. *Conidia* curved, filiform, 17–25 × 0.7–1 µm.

*Chemistry*: Thallus K-, P-, C-, UV-; no lichen substances detected.

*Etymology*: The species is named in honour of the Australian biologist and collector of the type, Dr Roger Hnatiuk.

Remarks

*Amandinea hnatiukii* is characterized by the crustose, rimose to rimose-areolate, off-white to pale grey thallus, the inspersed subhymenium, ± white- to pale grey-pruinose discs, the *Physconia*- then *Buellia*-type ascospores that are dilated at the septum in early ontogeny but become constricted at the septum with age and have a microrugulate outer wall, and by the lack of lichen substances. *Amandinea hnatiukii* is superficially similar to *A. coniops*, a common saxicolous species in New Zealand and Antarctica (Elix & Kantvilas 2016). However, *A. coniops* has epruinose discs, a non-inspersed subhymenium and smaller, constricted ascospores (12–[16.5]–20 7–[8.5]–11 µm). *Amandinea nitrophila* (Zahlbr.) Elix has mainly immersed apothecia and an inspersed subhymenium, but differs in having smaller ascospores, 12–[16.3]–20 × 7–[8.7]–12 µm and epruinose discs (Blaha *et al.* 2016).

At present the new species is known from only Macquarie Island. Associated lichens include *Amandinea austroconiops* Elix & Kantvilas, *A. subcervina*, *Carbonea phaeostoma* (Nyl.) Hertel, several *Caloplaca* species, *Lecanora subcoarctata* (C.Knight) Hertel, *Rhizocarpon reductum* Th.Fr. and *Tetramelas concinnus*.

ADDITIONAL SPECIMENS EXAMINED

Australia: Macquarie Island: • type locality, alt. 5 m, on coastal rock, *R. Hnatiuk* 11689A, 8.i.1972 (MEL); • unspecified locality, *R.B. Filson* 4729 *pr.p.min.*, 29.iii.1963 (MEL).

2. *Buellia seppeltii* Elix, sp. nov.  
MycoBank Number: MB 819949

Figs 3, 4

Similar to *Buellia procellarum* A.Massal., but differs in having smaller, often curved ascospores, 18–30 × 8–14 µm, yellow-grey- to pale grey-pruinose discs and in lacking diploicin.

Type: Australia, Macquarie Island, west side of The Isthmus, 54°30'S, 158°57'E, alt. 2 m, on SE side of rock stack, *R.D. Seppelt* 19418, 26.i.1995 (holotype – HO).

*Thallus* crustose, to 45 mm wide and 0.3 mm thick, epilithic, rimose to rimose-areolate, forming small rosettes or spreading, ± subeffigurate at the margins; upper surface off-white to pale yellow-grey, matt, cracked, sometimes becoming verruculose; prothallus not apparent or rarely black, marginal; photobiont cells 11–23 µm wide; medulla lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-. *Apothecia* 0.3–1 mm wide, abundant, lecideine,

roundish, scattered, immersed at first but ultimately broadly adnate or rarely sessile; disc black, epruinose or often yellow-grey- to pale grey-pruinose, plane to markedly convex; proper exciple thin and distinct at first, excluded with age, in section 25–40  $\mu\text{m}$  thick, outer part dark brown to brown-black, K–, N–, inner part brown. *Epihymenium* 8–12  $\mu\text{m}$  thick, olive-brown to dark brown, K–, N–. *Hypothecium* 60–120  $\mu\text{m}$  thick, dark brown to brown-black, K–. *Hymenium* 95–105  $\mu\text{m}$  thick, colourless, with a few scattered oil droplets but not inspersed; subhymenium 40–55  $\mu\text{m}$  thick, pale brown, inspersed; paraphyses 1–2  $\mu\text{m}$  wide, sparingly branched, with brown-capped apices 4–6  $\mu\text{m}$  wide. *Asci* (4–6)–8-spored, *Bacidia*-type. *Ascospores* *Callispora*- then *Buellia*-type, 1-septate, pale then dark brown, ellipsoid, 18–[21.4]–30  $\times$  8–[10.1]–14  $\mu\text{m}$ , becoming constricted at the septum and broadly fusiform with age, often curved, outer wall ornamented (rugulate). *Pycnidia* common, punctiform, immersed; ostiole black. *Conidia* bacilliform, 4.5–7  $\times$  1–1.5  $\mu\text{m}$ .

*Chemistry*: Thallus K+ yellow, P+ pale yellow, C–, UV–; atranorin (major), unknown terpenes (minor),  $\pm$  zeorin (minor).

*Etymology*: The species is named in honour of the Australian biologist and collector of the type, Dr Rod Seppelt.

#### Remarks

*Buellia seppeltii* belongs to *Buellia* in the broad sense (Bungartz *et al.* 2007; Elix 2011). It is characterized by the crustose, rimose to rimose-areolate, off-white to pale yellow-grey thallus, the non-inspersed hymenium,  $\pm$  pale yellow-grey-pruinose discs, the commonly curved, *Callispora*- then *Buellia*-type ascospores which often become broadly fusiform with age and have an ornamented outer wall, and the presence of atranorin. *Buellia seppeltii* is superficially similar to *B. procellarum*, a common saxicolous species in Australia (Elix 2009). However, the latter has epruinose discs, a densely inspersed hymenium and larger, straight ascospores (22–40  $\times$  10–18  $\mu\text{m}$ ), and contains atranorin and diploicin. The ontogeny of the ascospores of *B. seppeltii* is remarkably similar to that observed in *Amandinea subbadioatra* (C.Knight) Elix & Kantvilas, a species that also occurs on Macquarie Island. However, the latter has curved, filiform conidia 18–31  $\mu\text{m}$  long, somewhat larger ascospores, 20–[25]–32  $\times$  10–[13]–16  $\mu\text{m}$ , epruinose discs and a thicker hymenium (115–130  $\mu\text{m}$  thick) and hypothecium (150–350  $\mu\text{m}$  thick) and in lacking medullary terpenes (Elix & Kantvilas 2016).

At present the new species is known from Macquarie Island, Campbell Island and the South Island of New Zealand. On Macquarie Island, associated species include *Amandinea subcervina*, *Carbonea phaeostoma* (Nyl.) Hertel, several *Caloplaca* species, *Lecanora subcoarctata* (C.Knight) Hertel and *Rhizocarpon reductum* Th.Fr. In New Zealand, commonly associated species include *Amandinea decedens* (Nyl.) Blaha, H.Mayrhofer & Elix, *A. pelidna* (Ach.) Fryday & L.Arcadia, *Buellia cranwelliae* Zahlbr., *Caloplaca cribrosa* (Hue) Zahlbr., *C. gallowayi* S.Y.Kondr., Kärnefelt & Filson, *Halecania subsquamosa* (Müll.Arg.) van den Boom & H.Mayrhofer, *Lecanora subcoarctata* (C.Knight) Hertel, *Pertusaria xanthoplaca* Müll.Arg., *Rinodina blastidiata* Matzer & H.Mayrhofer and *Jackelia ligulata* (Körb.) S.Y.Kondr., Fedorenko, S.Stenroos, Kärnefelt & A.Thell.

#### ADDITIONAL SPECIMENS EXAMINED

**Australia**: Macquarie Island: • type locality, 2–3 m alt., on rock stack at water's edge, R.D. Seppelt 19421 *pr.p.*, 19427 *pr.p.*, 26.i.1995 (HO).

**New Zealand**: • Otago: Akatore Creek, 46°06'45"S, 170°11'38"E, 1 m alt., on schistose rocks, 15 m seaward from coastal cliffs, *A. Knight s.n.*, 26.xi.2015 (CANB, OTA); • Campbell Island: N side of Perserverance Harbour across from Shoal Point, 50°32'S, 166°13'E, on seashore rocks, R.C. Harris 4857, 30.xii.1969 (MSC); • E side of Tucker Cove, on marine rocks, R.C. Harris 4514 *pr.p.*, 4515 *pr.p.*, 24.xii.1969 (MSC); • W side of Monument Harbour, on rocks along shore, H.A. Imshaug 46694 *pr.p.*, 8.i.1970 (MSC).

#### New records

##### 1. *Amandinea austroconiops* Elix & Kantvilas, *Australas. Lichenol.* 78, 23 (2016)

This species was previously known from Tasmania and the South Island of New Zealand (Elix & Kantvilas 2016). It is characterized by the crustose, white to grey-white, rimose-areolate thallus, broadly adnate to rarely sessile, lecideine apothecia 0.3–1 mm wide, relatively large, 1-septate *Physconia*- then *Buellia*-type ascospores, 15–[19.6]–25  $\times$  8–[11.2]–14  $\mu\text{m}$ , which become constricted at the septum and have rugulate outer walls, the curved, filiform conidia, (15–)20–27  $\times$  0.7–1  $\mu\text{m}$ , the amyloid medulla, inspersed hymenium and the lack of lichen substances. A detailed description and illustrations are given in Elix & Kantvilas (2016).

#### SPECIMENS EXAMINED

**Australia**: Macquarie Island: • Halfway along S shore of Waterfall Lake, 54°44'S, 158°55'E, 200 m alt., on rock with NW aspect, R.B. Filson 6080 & P. Atkinson, 12.ii.1964 (MEL); • 0.8 km N of Aurora Point, Station 7, 54°36'S, 158°51'E, 8 m alt., on rocky outcrop in featherbed, R.B. Filson 6202 & P. Atkinson, 20.ii.1964 (MEL); • cliffs on W side of island, 0.8 km from South Double Point, 54°29'S, 158°58'E, on rocks with N aspect, J. Phillips 5923 & R.B. Filson, 3.ii.1964 (MEL).

##### 2. *Amandinea subcervina* (Nyl.) Elix, comb. nov.

Figs 5, 6

Mycobank Number: MB 819950

Basionym: *Lecidea subcervina* Nyl., *Lichenes Novae Zelandiae* 147 (1888).

Type: Tierra del Fuego, Cape Horn, collector unknown (isotype – H-NYL 9698a!).

Synonyms: *Buellia subcervina* (Nyl.) Vain., *Résult. Voy. Belgica, Botanique* 26 (1903); *Toninia subcervina* (Nyl.) Zahlbr., *Cat. Lich. Univ.* 4, 276 (1926).

This species was known previously from southernmost South America (Lamb 1968). It is characterized by its continuous, rimose to rimose-areolate, pale grey to grey-brown or tawny brown, crustose thallus that lacks secondary lichen substances and is often delimited by a dark prothallus, its small, often immersed lecideine apothecia, 0.2–0.5 mm wide, with *Physconia*- then *Buellia*-type ascospores, 15–[17.9]–22  $\times$  8–[9.8]–13  $\mu\text{m}$ , which become constricted at maturity and have a rugulate outer spore-wall and curved, filiform conidia, 12–22  $\times$  0.7–1  $\mu\text{m}$ . It resembles some forms of *A. coniops*, but differs in having persistently plane, marginate, often immersed apothecia, broader ascospores with a thicker septum, a thicker hymenium and darker hypothecium. A detailed description is given in Lamb (1968).

#### SPECIMENS EXAMINED

**Argentina**: • Isla de Los Estados, Puerto Cook, 54°46'S, 64°03'W, on rock in littoral zone with *Chliotrichum* and *Berberis* at head of bay, H. Imshaug 52148 & K. Ohlsson, 29.x.1971 (CANB); • Isla de Los Estados, Puerto Parry, 54°47'S, 64°22'W, on rock in littoral zone on E side of inner bay, H. Imshaug 53960 & K. Ohlsson, 10.xi.1971 (CANB); • *loc. id.*, on rock in littoral zone at head of inner bay, H. Imshaug 54043 & K. Ohlsson, 11.xi.1971 (CANB); • Tierra del Fuego, Dept. Ushuaia, Estancia Moat, c. 4 km W of Pampa de los Indios, 0–30 m alt., on coastal rock in *Nothofagus betuloides* forest, J. Poelt *s.n.*, 12.i.1989 (GZU).

**Australia**: Macquarie Island: • Lusitania Bay, 54°35'S, 158°55'E, on rocky outcrop on the beach, R.B. Filson 5978, 10.ii.1964 (MEL); • Gadgets Gully, c. 2.4 km S of ANARE Station, 54°30'S, 158°55'E, 60 m alt., on rock with E aspect, R.B. Filson 6358C & P. Atkinson, 18.iii.1964 (MEL); • Green Gorge Beach, 54°30'S, 158°57'E, 3 m alt., on rock stack at upper edge of beach, R.D. Seppelt 12021, 3.xii.1981 (HO); • W side of The Isthmus, 54°30'S, 158°57'E, alt. 2 m, on SE side of rock stack, R.D. Seppelt 19421 *pr.p.*, 19422, 19426, 19427 *pr.p.*, 26.i.1995 (HO); • E slope of Mt Elder, 54°31'S, 158°57'E, alt.

31 m, on rock in gully near waterfall, *K. Simpson E11B*, 1.x.1965 (MEL).

**Chile:** • Prov. Magallanes, rocky shore, W side of B. San Nicolás, on rock, 53°51'S, 71°07'W, on rock, *H. Imshaug 45600 & K. Ohlsson*, 9.x.1969 (CANB).

**3. *Tetramelas austropapillatus*** (Øvstedal) Elix, comb. nov.  
Mycobank Number: **MB 819951**

Figs 7, 8

Basionym: *Buellia austropapillata* Øvstedal, *Cryptogamie Mycologie* **25**(4), 325 (2004).

Type: Antarctica, Victoria Land, Cape King, *R.I. Lewis Smith 10280*, 23.xii.1995 (holotype – AAS).

This species was known previously from Antarctica (Øvstedal & Lewis Smith 2004). It is characterized by its thick, off-white to pale yellow-grey crustose thallus that contains atranorin, 6-*O*-methylarthothelin and norstictic acid and medullary calcium oxalate, the non-amyloid medulla, a dark olive-brown, N- epihymenium, the often clustered, lecideine apothecia, 0.5–1.1 mm wide, the often curved, *Buellia*-type ascospores, 15–[17.6]–23 × 8–[9.5]–11 μm, which become constricted at maturity and have a microrugulate outer spore-wall. Its spores are usually 1-septate, but sometimes become 2- or 3-septate. It resembles *Tetramelas papillatus* (Sommerf.) Kalb, which differs in having larger ascospores and in containing only atranorin (Nordin 2004). Normally *T. austropapillatus* grows on moribund mosses and soil, but is rarely found on rock and pebbles. A detailed description is given in Øvstedal & Lewis Smith (2004).

#### SPECIMEN EXAMINED

**Australia:** *Macquarie Island:* • Hasselborough Bay, 54°30'S, 158°57'E, 10 m alt., on stones in scree outwash at base of plateau slope, upper raised beach terrace, *R.D. Seppelt 19524 pr.p.*, 5.ii.1995 (HO).

**4. *Tetramelas concinnus*** (Th.Fr.) Giralt, *Nova Hedwigia* **89**, 330 (2009)

*Buellia dunedina* Zahlbr., *Denkschr. Akad. Wiss. Wien math.-naturwiss. Kl.* **104**, 375 (1941)  
Type: New Zealand, Otago, Horse Range, near Dunback, *J.S. Thomson T1426* (CHR – lectotype, OTA – isolectotype!). *vide* D.J. Galloway, *Flora of New Zealand Lichens*: **48** (1985).

This species was known previously from subarctic, subalpine and alpine areas of Europe, North America (Bungartz *et al.* 2007; Giralt *et al.* 2009) and New Zealand (Galloway 2007). It is characterized by its areolate to rimose-areolate, pale yellow-grey to yellow, crustose thallus that contains arthothelin and is rarely dispersed on a thin black prothallus, the amyloid medulla, a dark brown, N- epihymenium, the often clustered, lecideine apothecia, 0.5–1.2 mm wide, the often curved, *Callisporathen Buellia*-type ascospores, 13–[17.1]–22 × 6–[8.5]–11 μm, which become constricted at maturity and have a microrugulate outer spore-wall. Rarely, the ascospores become 2- or 3-septate, developing additional transverse septa at one or both ends (Giralt *et al.* 2009). The species usually contains arthothelin as the major secondary substance present. A detailed description and illustrations are given in Giralt *et al.* (2009). It is also reported for the first time from mainland Australia.

#### SPECIMENS EXAMINED

**Australia:** *Australian Capital Territory:* • Brindabella Range, summit of Mt Aggie, 43 km WSW of Canberra, 35°28'S, 148°46'E, 1490 m alt., on schist rock outcrops in subalpine heath, *P.W. James s.n.*, 21.i.1984 (BM 001176780). *Macquarie Island:* • Gadgets Gully, c. 2.4 km S of ANARE Station, 54°30'S, 158°55'E, 60 m alt., on rock with E aspect, *R.B. Filson 6358B & P. Atkinson*, 18.iii.1964 (MEL); • Hasselborough Bay,

54°30'S, 158°57'E, 10 m alt., on stones in scree outwash at base of plateau slope, upper raised beach terrace, *R.D. Seppelt 19524 pr.p.*, 5.ii.1995 (HO).

#### Acknowledgements

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Figure 1. *Amandinea hnatiukii* (holotype in MEL). Scale = 1 mm.

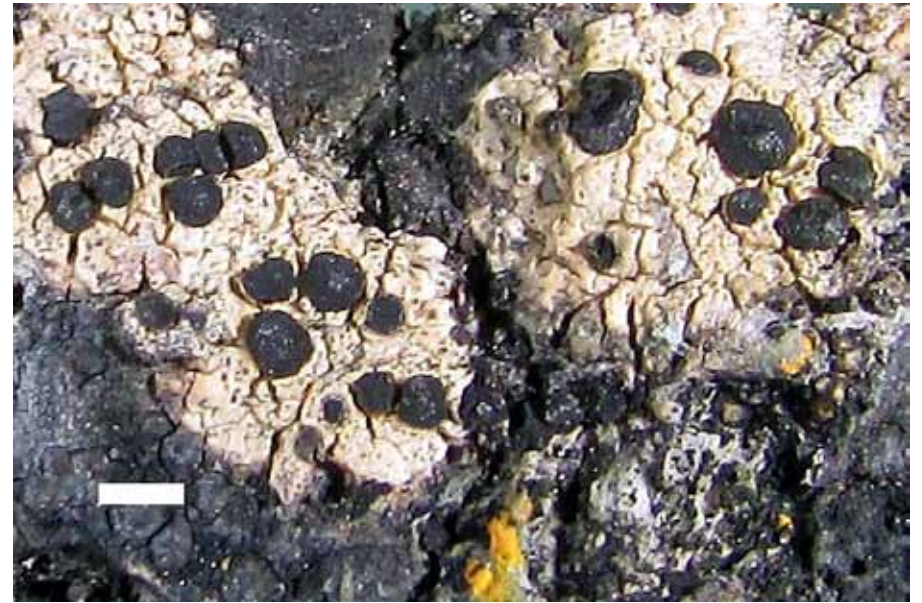


Figure 3. *Buellia seppeltii* (holotype in HO). Scale = 1 mm.

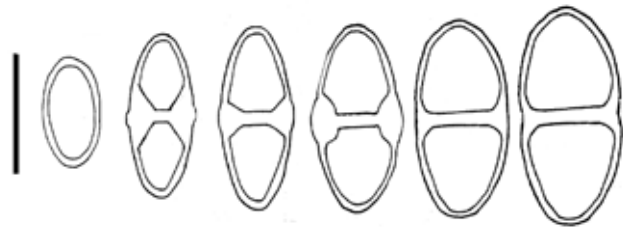


Figure 2. Ascospore ontogeny of *A. hnatiukii*. Scale = 10  $\mu$ m.

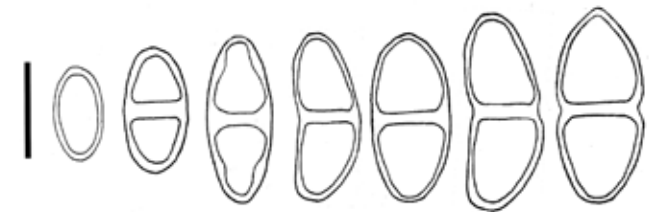


Figure 4. Ascospore ontogeny of *B. seppeltii*. Scale = 10  $\mu$ m.



Figure 5. *Amandinea subcervina* (Poelt s.n. in GZU). Scale = 1 mm.



Figure 7. *Tetramelas austropapillatus* (R. Seppelt in HO). Scale = 1 mm.



Figure 6. Ascospore ontogeny of *A. subcervina*. Scale = 10  $\mu$ m.

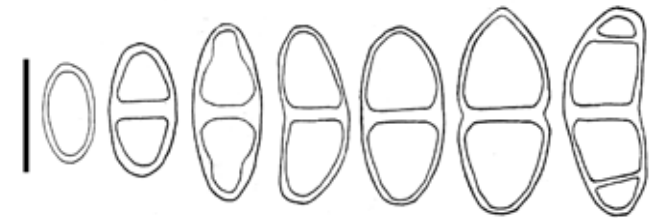


Figure 8. Ascospore ontogeny of *T. austropapillatus*. Scale = 10  $\mu$ m.



**Two new species of *Fellhaneropsis* (lichenized Ascomycota, Pilocarpaceae) from Australia**

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**Abstract**

*Fellhaneropsis macrocarpa* P.M.McCarthy, Elix & Kantvilas (Pilocarpaceae) is described from the base of a palm in moist, subtropical forest on Lord Howe Island, New South Wales. It has a well-developed, pale greyish green to pale or medium olive-green, rimose (but non-areolate) thallus containing 4-*O*-demethylsuperconfluent acid, comparatively large, convex, greyish bronze to dark olive-brown, lecideine apothecia with a prosoplectenchymatous excipulum, exceptionally small 3-septate ascospores and comparatively short, filiform conidia. *Fellhaneropsis tasmanica* P.M.McCarthy, Kantvilas & Elix sp. nov., from *Nothofagus* bark in south-western Tasmania, has an areolate thallus that lacks lichen substances, smaller, mostly plane, brown apothecia, larger 3-septate ascospores and longer, filiform conidia.

*Fellhaneropsis* Sérus. & Coppins, a genus of eight species in the family Pilocarpaceae, was first described for two lichens previously included in the cosmopolitan *Fellhanera* Vězda (Sérusiaux 1996). The segregate differs from *Fellhanera* in having apothecia with a proper excipulum of prosoplectenchymatous rather than paraplectenchymatous hyphae, and filiform rather than pyriform to bacilliform conidia (Sérusiaux 1996; Lücking 2008; Aptroot & Edwards 2009). Both genera have a crustose thallus containing a chlorococcoid photobiont, thinly marginate or immarginate apothecia, *Byssoloma*-type asci, branched and variously anastomosing paraphyses, and hyaline, transversely septate ascospores. The two original species, *F. myrtillicola* (Erichsen) Sérus. & Coppins and *F. vezdae* (Coppins & P.James) Sérus. & Coppins, grow on bark, rock and leaves, mainly at temperate to boreal latitudes in the Northern Hemisphere, the former being especially common. More recent additions to the genus include the foliicolous *F. kurokawana* G.Thor, Lücking & Tat.Matsumoto from Japan (Thor *et al.* 2000), *F. subantarctica* Øvstedal, a sterile lichen on soil and moribund bryophytes on Heard Island in the southern Indian Ocean (Øvstedal & Gremmen 2006), the sterile, foliicolous *F. rhododendri* Aptroot from the Netherlands (Aptroot 2012) and the rock-inhabiting *F. almqvistiorum* S.Ekman from Sweden and Germany (Ekman 2015).

Two apparently endemic species are known from Australia. *Fellhaneropsis australiana* Lücking occurs on the leaves of forest trees in south-eastern New South Wales and southern Victoria (Lücking *et al.* 2001), while *F. pallidonigrans* (Müll.Arg.) Kantvilas & Lücking grows on bark in cool-temperate rainforest in Victoria and in Tasmania where it is rather common (Kantvilas & Lücking 2009). In this contribution, two new species are described. *Fellhaneropsis macrocarpa*, from Lord Howe Island, can be distinguished by its robust, rimose, ecorticate thallus containing a distinctive suite of orcinol depsides, large apothecia with a very dark hypothecium and proper exciple (in section), and exceptionally small, 3-septate ascospores. *Fellhaneropsis tasmanica*, from southwestern Tasmania, has an areolate thallus with a palisade-like cortex, but

it lacks lichen substances and has smaller and mostly plane apothecia, a pale yellowish or brown hypothecium, an even paler exciple (in section), larger ascospores and longer conidia.

**Methods**

Observations and measurements of photobiont cells, thallus and apothecium anatomy, asci, ascospores and conidia were made on hand-cut sections mounted in water and treated with 10% potassium hydroxide (K). Sections of apothecia were also observed in 50% nitric acid (N). Asci were observed in Lugol's Iodine (I), with and without pretreatment in K. Chemical constituents of *F. macrocarpa* were identified by high-performance liquid chromatography (HPLC, Elix 2014) and comparison with authentic samples; thin-layer chromatography (TLC) was employed to test thallus samples of *F. tasmanica*.

***Fellhaneropsis macrocarpa*** P.M.McCarthy, Elix & Kantvilas, sp. nov. Figs 1A, 2, 4A  
MycoBank Number: **MB 820108**

Characterized by the well-developed, richly rimose, non-areolate, pale greyish green to pale or medium olive-green, epiphloeodal thallus containing a suite of orcinol depsides dominated by 4-*O*-demethylsuperconfluent acid, convex and mostly persistently marginate, pale to medium greyish bronze to dark olive-brown apothecia (0.45–)0.95(–1.7) mm wide, with a cupulate, prosoplectenchymatous proper excipulum of radiating, conglutinate hyphae which is externally orange-brown and brown-black within, a thin and slightly paler hypothecium, a very thin, amyloid hymenium, a nondescript epihymenium, sparingly branched and anastomosing paraphyses, *Byssoloma*-type asci, 3-septate ascospores, 8.5–13 × 2.5–4 µm, and filiform conidia 10–20 × 0.5 µm.

*Type:* Australia, New South Wales, Lord Howe Island, track to Goathouse Cave at base of Mt Lidgebird, 31°33'48"S, 159°05'11"E, alt. 380 m, on base of palm in moist, subtropical forest with *Dracophyllum* and *Cyathea*, J.A. Elix 42083, 7.ii.1995 (holotype – CANB 9703563).

*Thallus* crustose, epiphloeodal, diffuse or continuous and forming colonies up to 4 cm wide, pale greyish green to pale or medium olive-green, richly and deeply rimose but not areolate, dull to patchily glossy, smooth to minutely and irregularly rugulose, (50–)80–120(–150) µm thick, ecorticate, but with a discontinuous, 8–15(–20) µm thick, hyaline necral layer. *Algal layer* continuous or not, 50–130 µm deep; cells green, globose, 5–8(–10) µm diam., thin- or rather thick-walled, usually tightly clustered. *Medulla* poorly delimited; hyphae 2–2.5 µm wide, thin-walled. *Prothallus* marginal, dark silvery grey to black and up to 0.4 mm wide, or not apparent. *Apothecia* numerous, adnate to subsessile, lecideine, solitary and rounded or shallowly lobate, paired or in rounded or elongate clusters or imbricated rosettes of 5–8(–10) apothecia, the rosettes derived from the repeated division of a single 'parent' apothecium, (0.45–)0.95(–1.7) mm in maximum extent [*n* = 80 solitary and rosetted apothecia]; apothecial shape commonly distorted by mutual pressure; proper margin initially rather prominent, usually persistent and 40–100 µm thick in surface view, slightly glossy, entire, smooth to flexuose, a little or considerably paler than the disc when dry and pale olive-green to chestnut-brown, concolorous with or noticeably darker than the disc when wetted, persistent or, occasionally, becoming excluded around the largest or most convex apothecia; disc at first slightly concave or plane, becoming moderately to strongly convex at maturity, pale to medium greyish bronze to dark olive-brown, occasionally almost black or with a pinkish tone, dull to slightly glossy, smooth to minutely and irregularly uneven, epruinose. *Thalline excipulum* absent. *Proper excipulum* cupulate, prosoplectenchymatous, 40–80(–100) µm thick laterally, with an outer, orange-brown

zone 10–18  $\mu\text{m}$  thick, the colour intensifying in K and N, internally brownish black, but not carbonized and not impregnated with crystals; hyphae radiating, anastomosing and tightly conglomerate, thin-walled, 1–2  $\mu\text{m}$  wide, the distalmost cells no thicker than those subtending them; basal excipulum 100–220(–300)  $\mu\text{m}$  thick, penetrating the uppermost bark layers as a 100–150  $\mu\text{m}$  wide stipe. *Ephymenium* indistinct, 6–12  $\mu\text{m}$  thick, suffused with a golden orange to orange-brown pigment between the apices of paraphyses, K–, N–. *Hypothecium* dark reddish brown to brown-black, 25–35  $\mu\text{m}$  thick, paraplectenchymatous, interspersed with minute granules that can diffuse into the lowest levels of the hymenium K–, I–, N+ orange-brown. *Hymenium* 45–55  $\mu\text{m}$  thick, mostly not interspersed with granules or oil globules, 1+ dark blue, K–, N–; the uppermost parts pale orange-brown, the pigment continuous with that of the epihymenium; *paraphyses* conglomerate in water but loosening in squash preparations with K, sparingly branched and anastomosed, long-celled, 1.5–2  $\mu\text{m}$  thick; apical cells slightly swollen, to 2  $\mu\text{m}$  wide, not pigmented. *Asci* narrowly clavate or cylindroclavate, 38–45  $\times$  7–10  $\mu\text{m}$ , 8-spored,  $\pm$  *Byssoloma*-type (Hafellner 1984), with a thin amyloid outer coat; tholus well-developed, uniformly amyloid, but with a very inconspicuous *masse axiale* bordered by a more intensely amyloid zone; ocular chamber low-conical or not apparent. *Ascospores* colourless, overlapping-uniseriate to irregularly biseriolate in the ascus, 3-septate at maturity, narrowly ellipsoid to oblong or short-fusiform, usually straight, occasionally a little bent, not constricted at the septa, (8.5–)11(–13)  $\times$  (2.5–)3(–4)  $\mu\text{m}$  [ $n = 50$ ], thin-walled, lacking a perispore; apices rounded to subacute; contents clear. *Pycnidia* moderately numerous, immersed, 80–150  $\mu\text{m}$  wide; apical wall medium glossy brown to blackish, cupulate in section, 25–45  $\mu\text{m}$  thick, apically with bilayered pigmentation resembling the proper excipulum of the apothecia; opening ostiolate or gaping, the apex lacking palisade hyphae; conidia filiform, curved or sigmoid, simple, 10–15(–20)  $\times$  0.5  $\mu\text{m}$ . *Chemistry*: Thallus K–, C–, KC–, PD–, UV+ blue; 4-O-demethylsuperconfluent acid (major), 2'-O-methylnorsuperphyllinic acid (minor), 2'-O-methylsuperphyllinic acid (trace) and superconfluent acid (trace) by HPLC.

*Etymology*: The epithet *macrocarpa* refers to the exceptionally large apothecia of this species.

#### Remarks

The prosoplectenchymatous proper exciple and filiform conidia are unequivocal in placing this lichen in *Fellhaneropsis*, as do attributes such as the unicellular, green photobiont, anastomosing paraphyses, *Byssoloma*-type asci and colourless, trans-septate ascospores. Its integrity as a new species is confirmed by the unique thallus chemistry and comparison with the much smaller-fruited foliicolous and other species of *Fellhaneropsis*, which (if fertile) have larger ascospores, some being persistently more than 3-septate. *Fellhaneropsis pallidonigrans*, the other corticolous Australian species, is most similar to the new species; however, that lichen has a thallus containing gyrophoric acid, indistinctly marginate, often mottled-piebald apothecia 0.2–0.5 mm wide with a colourless proper excipulum, a colourless to pale yellow hypothecium and mostly 3-septate ascospores measuring 11–20  $\times$  3–5  $\mu\text{m}$  (Kantvilas & Lücking 2009). The saxicolous, northern European *F. almqvistiorum* has broadly similar excipular and hypothecial anatomy and pigmentation in 0.2–0.6 mm wide apothecia, but the mostly 3-septate ascospores are 11–28  $\times$  3–5.5  $\mu\text{m}$ , and the conidia are 20–43  $\times$  1–1.2  $\mu\text{m}$  (Ekman 2015).

*Fellhaneropsis macrocarpa* is known only from the type locality, on the base of a palm in moist, subtropical forest with *Dracophyllum* and *Cyathea* on Lord Howe Island in the south-western Pacific Ocean. Associated species include *Anthracotheicum australiense* (Müll.Arg.) Aptroot, *A. gregale* (C.Knight) Aptroot, *A. toowoombense* (Müll.Arg.) Aptroot, *Dirinaria applanata* (Fée) D.D.Awasthi, *Lecanora helva* Stizenb., *L. melacarpella* Müll.Arg., *Parmotrema reticulatum* (Taylor) M.Choisy, *Pertusaria lordhowensis* A.W.Archer

& Elix, *P. montpittensis* A.W.Archer, *Pyrenula howeana* Aptroot, *P. neocolata* Aptroot, *P. nitidula* (Bres.) R.C.Harris, *Pyxine cocoes* (Sw.) Nyl., *Ramalina pacifica* Asahina and *R. peruviana* Ach.

***Fellhaneropsis tasmanica*** P.M.McCarthy, Kantvilas & Elix, sp. nov. Figs 1B, 3, 4B  
Mycobank Number: MB 820109

Differs from *Fellhaneropsis pallidonigrans* (Müll.Arg.) Kantvilas & Lücking by the corticate thallus that is areolate at maturity and lacks lichen substances (not ecorticate, continuous and containing gyrophoric acid), with significantly larger apothecia, (0.42–)0.81(–1.25) mm wide (*vs* 0.2–0.5 mm wide).

*Type*: Australia, Tasmania, Franklin-Gordon Wild Rivers Natl Park, Gordon River, near Richea Creek, 42°37'S, 146°22'E, alt. 450 m, on young limbs of an occasionally inundated *Nothofagus cunninghamii* on river bank, G. Kantvilas 31/09, 4.ii.2009 (holotype – HO 550047).

*Thallus* crustose, epiphloeodal, continuous and forming substantial colonies, pale greyish green to pale olive-green, dull to slightly glossy, mostly smooth to minutely and irregularly uneven, 100–200(–250)  $\mu\text{m}$  thick, rather yellowish green when wetted. *Areoles* shallowly concave (and with a slightly raised rim) to plane or faintly convex, rounded or angular and irregular in shape and with an entire or scalloped margin, frequently rimulose, 0.2–1.5(–2.5) mm wide, corticate, the largest areoles often becoming partially raised from the substratum which then develops a verruculose thallus surface. *Cortex* 10–15  $\mu\text{m}$  thick, hyaline, a tightly arranged palisade of thin-walled, anticlinal hyphae 1.5–2  $\mu\text{m}$  wide. *Algal layer* continuous or not, 40–70(–100)  $\mu\text{m}$  deep; cells bright green, globose, 5–10  $\mu\text{m}$  diam.; interstitial hyphae 1.5–2.5  $\mu\text{m}$  wide. *Medulla* a loose network of short-celled, thin-walled hyphae 2–4  $\mu\text{m}$  wide. *Prothallus* not apparent. *Apothecia* numerous, innate to adnate, mostly solitary and rounded or shallowly lobate, (0.42–)0.81(–1.25) mm wide [ $n = 100$ ], paired or in small, rounded or irregular clusters of up to 6 proliferated apothecia; proper margin very thin and inconspicuous, initially concolorous with or slightly paler than the disc, entire to flexuose or shallowly lobate, but soon becoming excluded; disc plane to slightly convex, medium to dark brown, dull, epruinose, slightly reddish and translucent when wetted. *Proper excipulum* prosoplectenchymatous, cupulate, 20–50  $\mu\text{m}$  thick (to 70  $\mu\text{m}$  thick when immature) and hyaline to pale brown laterally, the colour intensifying in K; hyphae radiating, anastomosing and tightly conglomerate, 2–3  $\mu\text{m}$  wide (the lumina 0.8–1.2  $\mu\text{m}$  wide), the outermost cells slightly broader and more rounded or no thicker than those subtending them; basal excipulum uneven, 20–80(–120)  $\mu\text{m}$  thick, hyaline, attached to the uppermost bark layers as a short and irregular central stipe or anchored by hyaline, thick-walled, 2.5–4  $\mu\text{m}$  wide hyphae; algal layer of the thallus not continuous beneath the centre of the excipulum base. *Ephymenium* indistinct, suffused with a pale orange-brown to medium brown pigment that penetrates the hymenium to a depth of 20–35  $\mu\text{m}$ , K+ paler brown (the pigment dissolving), N–. *Hypothecium* 20–50(–70)  $\mu\text{m}$  thick,  $\pm$  paraplectenchymatous, pale brown or pale yellowish to pale orange-brown, the colour intensifying in K, N–. *Hymenium* 55–75(–100)  $\mu\text{m}$  thick, distally pigmented, not interspersed with granules or oil globules, the lower half not pigmented but interspersed with minute granules, IKI+ dark blue, K–, N–; *paraphyses* conglomerate in water, not loosening in squash preparations with K, mostly simple, less commonly sparingly branched or anastomosed, long-celled, 1–2  $\mu\text{m}$  thick; apical cells neither swollen nor pigmented. Boundaries between the lower, granulose levels of the hymenium, the hypothecium and the excipulum base variable and often indistinct. *Asci* narrowly clavate or cylindroclavate, 45–60  $\times$  11–15  $\mu\text{m}$ , 8-spored,  $\pm$  *Byssoloma*-type (Hafellner 1984), with or without a thin amyloid outer coat; tholus well-developed, uniformly amyloid, but with an incon-

spicuous *masse axiale* bordered by a more intensely amyloid zone; ocular chamber not apparent. *Ascospores* colourless, biseriate to irregularly massed in the ascus, 3-septate at maturity, narrowly ellipsoid to oblong or short-fusiform, usually straight, occasionally a little bent, occasionally slightly constricted at the septa, (14–)19(–23) (4–)5(–6.5)  $\mu\text{m}$  [ $n = 60$ ], thin-walled, lacking a perispore; apices rounded to subacute; contents clear. *Pycnidia* numerous, almost completely immersed in the thallus, 80–160(–200)  $\mu\text{m}$  wide; apex initially concave and concolorous with the thallus, becoming slightly convex and pale to medium brown, with a ring-like margin 40–80  $\mu\text{m}$  thick around a punctate ostiole; pycnidial wall cupulate in section, the apex with anticlinal, palisade hyphae, hyaline and 15–20  $\mu\text{m}$  thick below; conidia aseptate, filiform, curved, arcuate or sigmoid, 15–40(–60)  $\times$  1–1.5  $\mu\text{m}$ .

*Chemistry*: Thallus K–, C–, KC–, PD–, UV–; no substances detected by TLC.

*Etymology*: The specific epithet refers to the new species being discovered in Tasmania.

### Remarks

*Fellhaneropsis tasmanica* is characterized by the green, distinctively corticate, areolate thallus lacking lichen substances, large, dark brown, innate to adnate and mostly plane apothecia, an inconspicuous and eventually excluded proper margin, a pale, prosoplectenchymatous excipulum and hypothecium, *Byssoloma*-type asci, 3-septate ascospores 14–23  $\times$  4–6.5  $\mu\text{m}$ , distinctive pycnidia and filiform conidia 15–40(–60)  $\times$  1–1.5  $\mu\text{m}$ . The corticolous *F. pallidonigrans*, from Victoria and Tasmania, has a thallus containing gyrophoric acid and apothecia 0.2–0.5 mm wide (Kantvilas and Lücking 2009), while the newly described *F. macrocarpa* has a rimose, but non-areolate, thallus containing a suite of orcinol depsides, convex and mostly persistently marginate apothecia 0.45–1.7 mm wide, a proper excipulum of radiating, conglutinate hyphae which is externally orange-brown and brown-black within, ascospores that are 8.5–13  $\times$  2.5–4  $\mu\text{m}$  and conidia 10–20  $\times$  0.5  $\mu\text{m}$ .

*Fellhaneropsis* is distinguishable from *Fellhanera* by its ascomatal anatomy and conidial shape (see above). However, the species have not been assessed by molecular methods, these being particularly relevant as some taxa (*F. rhododendri* and *F. subantarctica*) are known only from sterile material (Øvstedal & Gremmen 2006; Aptroot 2012), while *F. pallidonigrans* lacks pycnidia (Kantvilas & Lücking 2009), and an anomalous, paraplectenchymatous excipulum was reported from *F. australiana* (Lücking *et al.* 2001). While the robust thalli and comparatively large apothecia of the two new Australian taxa set them apart from the eight other species, these characters are particularly flimsy generic determinants. Therefore, pending molecular studies that, hopefully, will resolve the scope and composition of *Fellhaneropsis*, the generic placement of *F. macrocarpa* and *F. tasmanica* is appropriate.

*Fellhaneropsis tasmanica* is represented only by the type specimen which was collected from the bark of *Nothofagus cunninghamii* on a river bank in cool-temperate rainforest in south-western Tasmania.

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Figure 1. A, *Fellhaneropsis macrocarpa* (holotype); B, *F. tasmanica* (holotype). Scale bars: 2 mm.

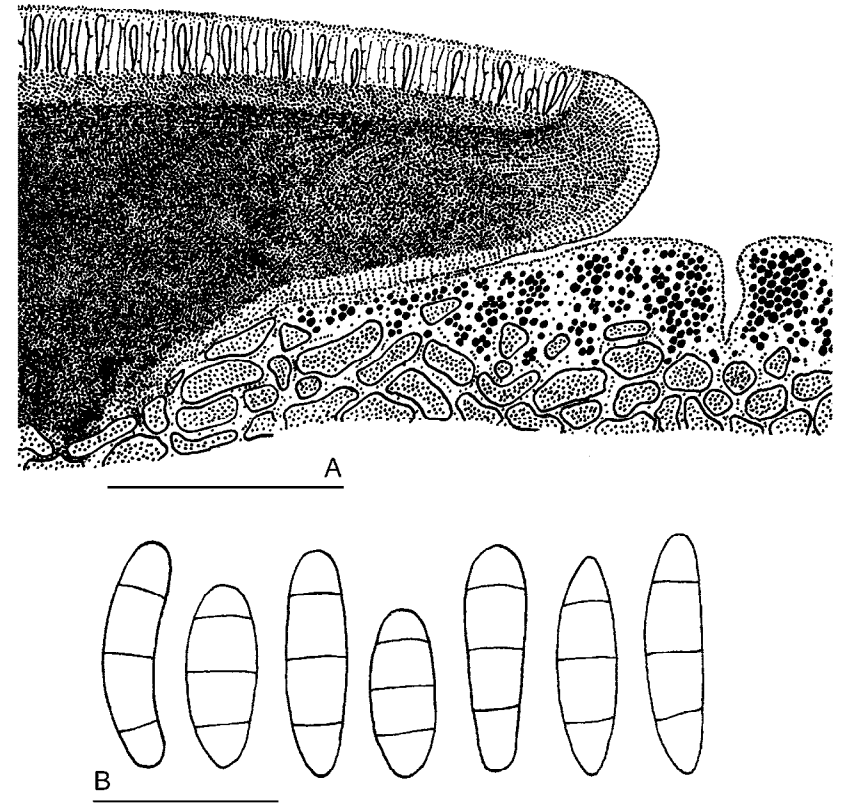


Figure 2. *Fellhaneropsis macrocarpa* (holotype). A, Part of a sectioned apothecium and adjacent thallus (semi-schematic); B, Ascospores. Scale bars: A = 0.2 mm; B = 10  $\mu$ m.

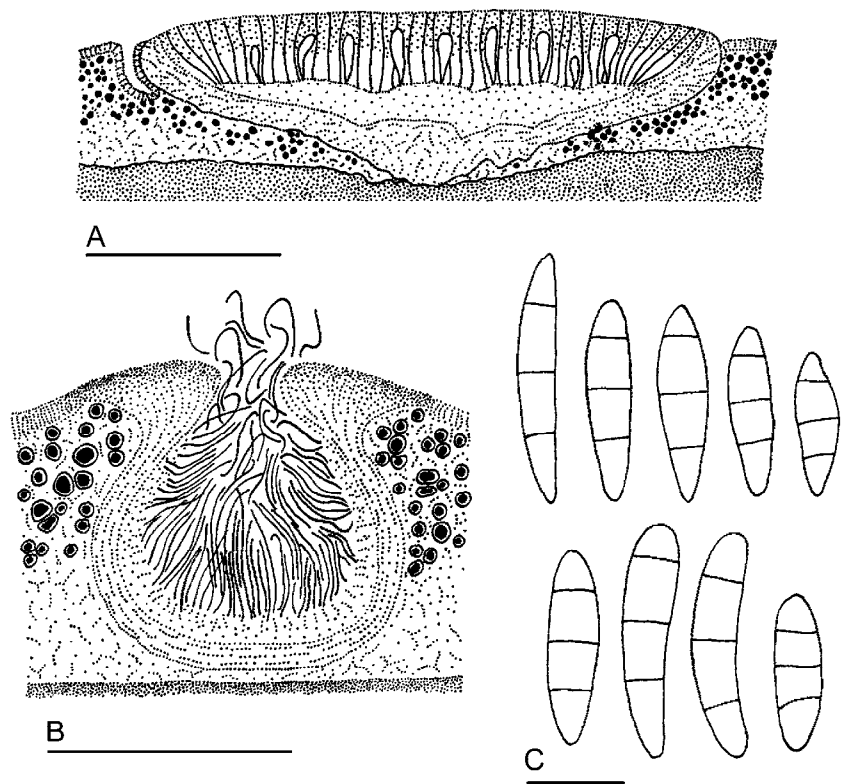


Figure 3. *Fellhaneropsis tasmanica* (holotype). A, Sectioned apothecium and adjacent thallus (semi-schematic); B, Sectioned pycnidium and adjacent thallus (semi-schematic); C, Ascospores. Scale bars: A= 0.2 mm; B= 0.1 mm; C = 10  $\mu$ m.

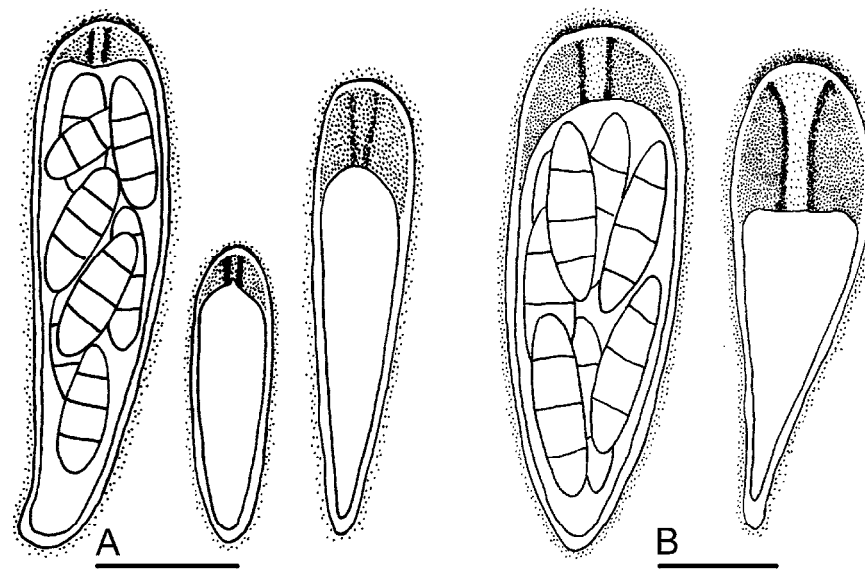


Figure 4. Mature and immature asci, with amyloid parts stippled. A, *Fellhaneropsis macrocarpa* (holotype); B, *F. tasmanica* (holotype). Scales bars: 10  $\mu$ m.

**Thirteen new species and a key to buellioid lichens (Caliciaceae, Ascomycota) in Australia**

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**Abstract**

Thirteen Australian species, *Amandinea conranensis* Elix & P.M.McCarthy, *Amandinea feraxioides* Elix & Kantvilas, *A. neoconglomerata* Elix, *Buellia albulella* Elix, *B. austroabstracta* Elix & Kantvilas, *B. durackensis* Elix & P.M.McCarthy, *B. ecclesensis* Elix, *B. halonioides* Elix, *B. northallina* Elix & Kantvilas, *B. poolensis* Elix, *B. servilosina* Elix & Kantvilas, *B. subadjuncta* Elix & Kantvilas and *B. tinderryensis* Elix & P.M.McCarthy, are described as new to science; *B. austroabstracta*, *B. halonioides*, *B. northallina* and *B. poolensis* are also reported from New Zealand. *Amandinea julianae* H.Mayrhofer & Elix, *Cratiria chloraceus* Marbach and *Sculptolumina serotina* (Malme) Marbach are new records for Australia, and the first is reported for the first time from Papua New Guinea. A key is provided to the 194 taxa of buellioid lichens in Australia.

This paper continues our investigation of *Buellia*-like lichens in Australia. It follows earlier treatments of *Buellia* and related genera (Elix 2009, 2011) and our additions and revisions to *Amandinea* (Elix & Kantvilas 2013a, 2016a; Blaha *et al.* 2016), *Buellia sens. lat.* (Elix & Kantvilas 2013b; Elix 2015b, 2016a; Elix *et al.* 2017), *Buellia sens. str.* (Elix & Kantvilas 2014a), *Baculifera* (Elix & Kantvilas 2014b), *Cratiria* (Elix 2014), *Monerolechia* (Elix 2015a) and other crustose Physciaceae (Elix & Kantvilas 2015, 2016b; Elix 2016b). In this paper, we document three new species of *Amandinea* and ten new saxicolous species of *Buellia* in the broad sense. *Cratiria chloraceus* Marbach and *Sculptolumina serotina* (Malme) Marbach are new records for Australia. We provide a key to the 194 species and infraspecific taxa of buellioid lichens currently known from Australia. Methods are as described in previous papers cited above.

**New species**

**1. *Amandinea conranensis*** Elix & P.M.McCarthy, sp. nov. Figs 1, 2  
Mycobank Number: **MB 821030**

Similar to *Amandinea porulosa* (Müll.Arg.) Elix, but differs in having smaller, often curved ascospores, 9–[11.6]–14 × 5–[6.1]–8 µm, and a non-inspersed hymenium.

*Type:* Australia, Victoria, East Gippsland, Cape Conran Coastal Park, West Cape, 37°49'43"S, 148°43'43"E, 3 m alt., on dead twigs of stunted *Banksia* above the high water mark, *J.A. Elix 46264 & P.M. McCarthy*, 30.x.2016 (holotype – CANB; isotype – MEL).

*Thallus* crustose, discontinuous, endophloeodal or epiphloeodal and membranaceous to rimose, to 10 mm wide and 0.5 mm thick; upper surface ecorticate, pale grey, olive-

green or grey-green, matt, becoming ± verruculose or granular; prothallus not apparent; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-; photobiont cells 7–17 µm diam. *Apothecia* 0.1–0.3 mm wide, lecideine, broadly adnate or rarely sessile, separate or in small groups; disc black, epruinose, initially weakly concave, then plane or weakly convex; proper exciple persistent, in section the outer zone dark brown to brown-black, 35–40 µm thick, K-, N-, inner zone brown. *Epithymenium* 10–13 µm thick, dark brown, K-, N-. *Hypothecium* dark brown to brown-black, 75–110 µm thick, K-. *Hymenium* 50–85 µm thick, colourless, not inspersed; paraphyses 1–1.5 µm wide, sparsely branched, with apices 4–5 µm wide and brown caps. *Asci* of the *Bacidia*-type, 8-spored. *Ascospores* *Buellia*-type, olive-brown to brown, ellipsoid, 9–[11.6]–14 × 5–[6.1]–8 µm, often curved, older spores constricted at septum; outer spore-wall microrugulate to smooth. *Pycnidia* immersed; ostiole black; conidia filiform, curved, 12–21 × 0.7–1 µm.

*Chemistry:* Thallus K-, P-, C-, UV-; no lichen substances detected.

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

**Remarks**

The new species is characterized by the crustose, discontinuous, endophloeodal or epiphloeodal and membranaceous to rimose, pale grey, olive-green or grey-green, verruculose or granular thallus, the small adnate to sessile, lecideine apothecia, the non-inspersed hymenium, 1-septate, *Buellia*-type ascospores that become constricted at the septum, and the absence of lichen substances. The New Zealand species *A. porulosa* is similar in having no obvious prothallus, scattered, broadly adnate to sessile apothecia up to 0.3 mm wide, similar filiform conidia and the absence of lichen substances. However, the mature *Buellia*-type ascospores of *A. porulosa* are significantly larger, 11–[14.1]–17 × 6–[7.1]–8.5 µm, and are rarely curved, and the hymenium is inspersed. Although the mature *Buellia*-type ascospores of *A. punctata* (Hoffm.) Coppins & Scheid. are often curved, they are larger than those of *A. conranensis*, 10–[13.5]–20 × 5–[7.5]–9 µm, and do not become constricted at the septum (Bungartz *et al.* 2007; Scheidegger 2009; Elix 2011).

At present, *A. conranensis* is known from the type locality in eastern Victoria and from a second site in southern New South Wales. Associated lichens include several species of *Caloplaca* and one of *Opegrapha*.

**SPECIMEN EXAMINED**

*New South Wales:* • Plantation Point, Vincentia, Jervis Bay, c. 200 m N of car park, 35°04'22"S, 150°41'41"E, 2 m alt., on dead *Banksia* above the high water mark, *J.A. Elix 46349 & P.M. McCarthy*, 19.iv.2017 (CANB).

**2. *Amandinea feraxioides*** Elix & Kantvilas, sp. nov. Fig. 3  
Mycobank Number: **MB 821031**

Similar to *Buellia ferax* Müll.Arg., but differs in having the subhymenium inspersed with oil droplets and granules.

*Type:* Australia, [New South Wales], Jervis Bay Territory, Bristol Point, 35°08'S, 150°44'E, 1 m alt., on coastal rocks, *G. Kantvilas 598/12*, 17.xi.2012 (holotype – HO).

*Thallus* crustose, forming extended patches to 30 mm wide, endolithic and not apparent, or epilithic, fragmentary and comprised of discontinuous, white flecks 0.2–0.7 mm wide and up to 0.6 mm thick; prothallus absent; medulla white, containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub>+), I-; photobiont cells 8–15 µm wide. *Apothecia* 0.2–0.8 mm wide, lecideine, broadly adnate or rarely sessile, scattered or crowded, rounded or often irregular through mutual pressure, occasionally becoming tuberculate; disc

black, epruinose, weakly concave to plane, sometimes becoming wrinkled with age; proper exciple distinct, thick, persistent, in section 25–60  $\mu\text{m}$  thick, with an outer zone black-brown, K+ yellow soon forming red, needle-like crystals, paler red-brown within. *Epithymenium* 10–12  $\mu\text{m}$  thick, brown to dark brown, N–. *Hypothecium* 75–150  $\mu\text{m}$  thick, dark red-brown to brown-black, K+ yellow then forming red, needle-like crystals. *Hymenium* 75–100  $\mu\text{m}$  thick, colourless, weakly interspersed with oil droplets; subhymenium 30–50  $\mu\text{m}$  thick, pale brown to brown, densely interspersed with oil droplets, with or without granules; paraphyses 1.2–1.5  $\mu\text{m}$  wide, simple to moderately branched, capitate, with apices 4–5  $\mu\text{m}$  wide and brown caps. *Asci* of the *Bacidia*-type, 8-spored. *Ascospores* of the *Buellia*-type, 1-septate, pale olive-green to brown, ellipsoid, 10–[12.3]–15  $\times$  5–[6.2]–8  $\mu\text{m}$ , not or very rarely constricted at the septum; outer spore wall microrugulate. *Pycnidia* very rare, immersed; ostiole black; conidia filiform, curved, 12–28  $\times$  0.7–1  $\mu\text{m}$ .

*Chemistry*: Best observed in squash preparations of thalline fragments or apothecial sections; K+ yellow, soon forming red, needle-like crystals (norstictic acid).

*Etymology*: The species is named for its similarity to *Buellia ferax*.

#### Remarks

The new species is characterized by the numerous, black, sessile apothecia that form clusters and become distorted by mutual pressure, by the endolithic or fragmentary thallus at the base of apothecia, the *Buellia*-type ascospores, 10–15  $\times$  5–8  $\mu\text{m}$ , the subhymenium densely interspersed with oil droplets, the curved, filiform conidia (12–28  $\mu\text{m}$  long) and the presence of norstictic acid. In many respects, it closely resembles the New Zealand species *Buellia ferax*, in that both contain norstictic acid and similar-sized *Buellia*-type ascospores. However, the hymenium and subhymenium of *B. ferax* are not interspersed with oil droplets or granules. Conidia have yet to be observed in that species. *Amandinea feraxioides* also resembles *A. conglomerata* Elix & Kantvilas (Elix & Kantvilas 2013) and *A. neoconglomerata* described below. However, both of those species lack lichen substances. In addition, the spores of *A. conglomerata* are somewhat longer, (10–)11–[13.1]–16(–17)  $\mu\text{m}$ , and are constricted at the septum, while the thallus of *A. neoconglomerata* lacks calcium oxalate.

*Amandinea feraxioides* 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. *sorediata* Elix & A.W.Archer, *Rinodina blastidiata* Matzer & H.Mayrhofer, *Rinodinella fertilis* (Körb.) Elix var. *fertilis*, *Tylothallia verrucosa* (Müll.Arg.) Kantvilas and *Xanthoparmelia australasica* D.J.Galloway.

#### SPECIMENS EXAMINED

*New South Wales*: • type locality, *G. Kantvilas 600/12 pr.p.*, 17.xi.2012 (HO); • Plantation Point, Vincentia, Jervis Bay, c. 1 km S of car park, 35°04'36"S, 150°31'35"E, 1–2 m alt., on sandstone rocks above the high water mark, *J.A. Elix 46353, 46354, 46403*, 19.iv.2017 (CANB).

*Victoria*: • East Gippsland, Cape Conran Coastal Park, Banksia Bluff Camp, 37°48'03"S, 148°44'30"E, c. 1 m alt., on mica schist rocks on the seashore, *J.A. Elix 46271*, 30.x.2016 (CANB).

#### 3. *Amandinea neoconglomerata* Elix, sp. nov.

Mycobank Number: MB 821032

Fig. 4

Similar to *Amandinea conglomerata* Elix & Kantvilas, but differs in having a subhymenium interspersed with granules and oil droplets, shorter ascospores, (8–)10–[11.6]–

14(–15)  $\mu\text{m}$  long, and a less conspicuous but often corticate thallus that lacks calcium oxalate.

*Type*: Australia, Victoria, East Gippsland, Cape Conran Coastal Park, West Cape, 37°49'43"S, 148°43'43"E, 3 m alt., on granite rocks above the high tide mark, *J.A. Elix 46277*, 30.x.2016 (holotype – CANB; isotype – MEL).

*Thallus* crustose, forming extensive patches to c. 30 mm wide, endolithic and inapparent, or epilithic, fragmentary and comprised of discontinuous, white or pale grey, corticate patches 0.2–0.5 mm wide at the base of apothecia; prothallus absent; medulla white, lacking calcium oxalate ( $\text{H}_2\text{SO}_4$ –), I–; photobiont cells 7–17  $\mu\text{m}$  wide. *Apothecia* 0.4–0.9 mm wide, lecideine, sessile, scattered or crowded, rounded or distorted through mutual pressure; disc black, epruinose, weakly concave to plane or rarely weakly convex, sometimes tuberculate; proper exciple distinct, thin, persistent, raised above the disc, in section 25–40  $\mu\text{m}$  thick, with the outer zone dark brown to black-brown, K–, brown within. *Epithymenium* 12–20  $\mu\text{m}$  thick, dark brown, K–, N–. *Hypothecium* 100–125  $\mu\text{m}$  thick, dark brown to black-brown, K–, N+ orange-brown. *Hymenium* 50–75  $\mu\text{m}$  thick, colourless, not interspersed with oil droplets; subhymenium 25–35  $\mu\text{m}$  thick, pale brown, densely interspersed with granules and oil droplets; paraphyses 1.2–1.5  $\mu\text{m}$  wide, simple to moderately branched; apices 4–5  $\mu\text{m}$  wide with dark brown caps. *Asci* of the *Bacidia*-type, 8-spored. *Ascospores* of the *Buellia*-type, 1-septate, brown, ellipsoid, (8–)10–[11.6]–14(–15)  $\times$  4–[5.4]–7  $\mu\text{m}$ , older spores with a saddle-shaped constriction; outer spore wall weakly ornamented. *Pycnidia* immersed to superficial, black; conidia filiform, curved, 16–25  $\times$  0.7–1  $\mu\text{m}$ .

*Chemistry*: Thallus K–, P–, C–, UV–; no lichen substances detected.

*Etymology*: The species is named after its similarity to *A. conglomerata*.

#### Remarks

The new species is characterized by the numerous, black, sessile apothecia that form clusters and become distorted by mutual pressure, the endolithic or fragmentary thallus at the base of the apothecia, the *Buellia*-type ascospores, 8–15  $\times$  4–7  $\mu\text{m}$ , the subhymenium densely interspersed with granules, the curved, filiform conidia, 19–25  $\mu\text{m}$  long, and the lack of lichen substances. It many respects, it closely resembles *A. conglomerata* (Elix & Kantvilas 2013). However, the spores in the latter species are somewhat longer, (10–)11–[13.1]–16(–17)  $\mu\text{m}$ , and are constricted at the septum. In addition, the subhymenium of *A. conglomerata* is densely interspersed with oil droplets but lacks granules, the fragmentary thallus is ecorticate but contains calcium oxalate and an orange pigment that can also be observed in *A. vitellina* Blaha, H.Mayrhofer & Elix (Blaha *et al.* 2016). By contrast, the fragmentary thallus of *A. neoconglomerata* is often corticate and lacks calcium oxalate and the orange pigment.

*Amandinea neoconglomerata* is a coastal species known from southern New South Wales, South Australia (Kangaroo Island), Victoria and Tasmania. It is associated with typical littoral species, including *Amandinea decedens* (Nyl.) Blaha, H.Mayrhofer & Elix, *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. *sorediata* Elix & A.W.Archer, *Rinodina blastidiata* Matzer & H.Mayrhofer, *Rinodinella fertilis* (Körb.) Elix var. *fertilis*, *Tylothallia verrucosa* (Müll.Arg.) Kantvilas, *Xanthoparmelia australasica* D.J.Galloway and *X. conranensis* (Elix) Elix.

#### SPECIMENS EXAMINED

*South Australia*: • Kangaroo Island, N end of Antechamber Bay, 35°47'S, 138°04'E, 1 m alt., on seashore rocks, *G. Kantvilas 390/11*, 18.ix.2011 (HO); • *loc. id.*, 5 m alt., on rocks in a grassy penguin colony, *G. Kantvilas 483/15*, 20.ix.2015 (HO); • Kangaroo Island,

Western River Cove, W end of beach, 35°40'S, 136°58'E, 2 m alt., on seashore rocks, *G. Kantvilas* 415/15, 416/15, 27.ix.2015 (HO); • Kangaroo Island, Hog Bay, 3 km E of Penneshaw, 35°43'S, 137°57'E, 15 m alt., on siliceous rocks in xeric supralittoral, *H.T. Lumbsch* 10897a, *A. Dickhäuser* & *H. Streimann*, 27.v.1994 (CANB).

New South Wales: • Keatings Rocks, c. 1.5 km N of Bermagui, 36°24'54"S, 150°03'55"E, 1–5 m alt., on slate rocks above the splash zone, *J.A. Elix* 46134, 46135, 10.ii.2016 (CANB); • cliffs just N of Barlings Beach, 14 km SSE of Batemans Bay, 35°49'49"S, 150°12'20"E, 1–3 m alt., on shale rocks along foreshore, *J.A. Elix* 46344, 19.xi.2016 (CANB).

Victoria: • type locality, on granite rocks along the seashore, *J.A. Elix* 46278, 46292, 30.x.2016 (CANB).

Tasmania: • Lime Bay, W end of beach, on littoral sandstone cliff-edge, *G. Kantvilas* 261/16, 15.x.2016 (HO).

**4. *Buellia albulella* Elix, sp. nov.**  
Mycobank Number: MB 821033

Fig. 5

Thallus lichenicolous on *Buellia albula* (Nyl.) Müll.Arg., with immersed apothecia 0.2–0.4 mm wide, white-pruinose discs and non-constricted, *Buellia*-type ascospores, 13–20(–25) × 8–12 µm.

Type: Australia, New South Wales, Limestone Valley Creek, 9 km NE of Canowindra, 33°29'S, 148°46'E, 680 m alt., on *Buellia albula* over weathered limestone rocks in pasture, *W.H. Ewers* 75, 11.x.1986 (holotype – CANB).

Thallus lichenicolous, developed within the medulla of the host (*Buellia albula*), the infected area surrounded by a brownish black ring. Apothecia 0.2–0.4 mm wide, scattered, lecideine, roundish, immersed; disc black, white-pruinose, concave to plane; proper excipulum persistent, black, raised above level of disc, white-pruinose, in section 25–40 µm thick, outer part aeruginose to brown-black, K–, N+ violet, inner part brown. Epithymenium 10–12 µm thick, dark brown, K–, N–. Hypothecium 40–60 µm thick, pale brown, K–. Hymenium 100–125 µm thick, colourless, not interspersed; paraphyses 1.5–1.7 µm wide, simple to sparingly branched, capitate, with apices dark brown, 3–4 µm wide. Asci of the *Bacidia*-type, 8-spored or fewer per ascus. Ascospores of the *Buellia*-type, not constricted, 1-septate, brown, narrowly ellipsoid, 13–20(–25) × 8–12 µm; outer spore-wall smooth to microrugulate. Pycnidia not seen.

Chemistry: Thallus K–, P–, C–, UV–; no lichen substances detected.

Etymology: The species is named after the host lichen.

**Remarks**

The host species, *B. albula*, is clearly distinguished from the infecting species by its much smaller ascospores, 10–13 × 5–6 µm, the dark brown excipulum (N– or N+ weak red-brown) and the presence of norstictic acid. *Buellia albulella* is characterized by the small, immersed apothecia with white-pruinose discs, the dark brown to black, marginal prothallus that delimits the infected region of the host lichen, the relatively large, non-constricted *Buellia*-type ascospores, 13–20(–25) × 8–12 µm, with a smooth to microrugulate outer spore-wall.

At present the new species is known from only the type locality. Associated species include *Buellia albula* Müll.Arg., *Caloplaca kantvilasii* S.Y.Kondr. & Kärnefelt, *C. mereschkowskiana* S.Y.Kondr. & Kärnefelt, *Diplozmia venustum* Körb., *Lecanora dispersa* (Pers.) Sommerf., *L. sphaerospora* Müll.Arg., *Rinodina bischoffii* (Hepp) A.Massal., *R. reagens* Matzer & H.Mayrhofer and *Placopyrenium trachyticum* (Haszl.) Breuss var. *trachyticum*.

**5. *Buellia austroabstracta* Elix & Kantvilas, sp. nov.**  
Mycobank Number: MB 821034

Fig. 6

Similar to *Buellia abstracta* (Nyl.) H.Olivier, but differs in having shorter, broader ascospores, 8–[10.5]–13 × 5–[5.6]–7 µm, and in containing medullary calcium oxalate.

Type: Australia, Tasmania, Chauncy Vale, 43°37'S, 147°16'E, 300 m alt., on exposed, dry, north-facing sandstone bluff, *G. Kantvilas* 444/14, 22.x.2014 (holotype – HO).

Thallus crustose, endolithic and not apparent or epilithic and consisting of a few white flecks, discontinuous, effuse and ecorticate; prothallus not apparent; photobiont cells 10–15 µm wide; medulla white, containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub>), 1–. Apothecia 0.1–0.5 mm wide, abundant, lecideine, roundish, scattered, broadly adnate to sessile; disc black, epruinose, plane to strongly convex; proper exciple distinct but excluded in convex apothecia, in section 25–35 µm thick, outer part dark brown, K–, N–, inner part brown. Epithymenium 8–10 µm thick, dark brown, K–, N–. Hypothecium 150–250 µm thick, dark brown to brown-black, K–. Hymenium 40–50 µm thick, colourless, not interspersed; subhymenium 10–15 µm thick, pale brown, not interspersed; paraphyses 1–2 µm wide, sparingly branched, the apices 4–5 µm wide and with brown caps. Asci 8-spored, *Bacidia*-type. Ascospores *Buellia*-type, 1-septate, pale brown then dark brown, ellipsoid, 8–[10.5]–13 × 5–[5.6]–7 µm [average length : width ratio 1.88], becoming constricted at the septum, not curved; outer wall smooth to finely ornamented. Pycnidia black, punctiform immersed; conidia bacilliform, 4–5 × 1–1.5 µm. Chemistry: Medulla K–, C–, PD–, UV–; no lichen substances detected.

Etymology: The species is named for its southern distribution and its similarity to *Buellia abstracta*.

**Remarks**

The endolithic or poorly developed, fragmentary, effuse thallus of this new species resembles *B. abstracta* from Europe and North America in that both are dominated by the minute, abundant, broadly adnate to sessile apothecia. However, *B. abstracta* lacks medullary calcium oxalate (Bungartz *et al.* 2004, 2007; Coppins *et al.* 2009; Giralt *et al.* 2011), and has somewhat longer, narrower, ascospores not constricted at the septum, 10–[11.7]–14 × 3–[4.6]–6 µm, with an average length : width ratio of 2.54. *Buellia austroabstracta* also resembles *B. canobolasensis* Elix & P.M.McCarthy, but the latter occurs on montane rocks, has an interspersed subhymenium and ascospores that are not constricted at the septum (Elix *et al.* 2017).

At present the new species is known from coastal and hinterland rocks in New South Wales, Tasmania and the South Island of New Zealand. In New South Wales, associated lichens include *Buellia aeruginosa* A.Nordin, Owe-Larsson & Elix, *B. cranwelliae* Zahlbr., *Ochrolechia apiculata* Verseghy, *Pertusaria subventosa* Malme var. *subventosa*, *P. xanthoplaca* Müll.Arg., *Rinodinella fertilis* (Körb.) Elix var. *fertilis* and *Xanthoparmelia australascia* D.J.Galloway.

**SPECIMENS EXAMINED**

New South Wales: • Warrai Beach, near Penguin Head, Culburra, 35°55'59"S, 150°46'46"E, 1–3 m alt., on S-facing sandstone rocks along foreshore, *J.A. Elix* 46379, 18.iv.2017 (CANB); • Black Head, Gerroa, 34°46'36"S, 150°49'19"E, 2–3 m alt., on sandstone rocks of foreshore cliffs, *J.A. Elix* 46433, 46436, 24.v.2017 (CANB).

New Zealand: • South Island, Nelson, Boulder Bank N of Nelson, 41°12'30"S, 173°18'E, on pebble, *H.Mayrhofer* 13126, *W. Malcolm* & *B. Polly*, 25.viii.1992 (GZU).



6. *Buellia durackensis* Elix & P.M. McCarthy, sp. nov.  
Mycobank Number: MB 821035

Fig. 7

Similar to *Buellia stellulata* (Taylor) Mudd var. *stellulata*, but differs in having broadly adnate to sessile apothecia, ascospores that are often curved and ultimately constricted at the septum, and a non-aeruginose, N– epihymenium.

*Type*: Australia. Western Australia, East Kimberley, Durack River Property, tributary of Palmer Creek, c. 18 km due S of Gibb River Road, 15°57'22"S, 127°34'35"E, 280 m alt., on dry, shaded sandstone, P.M. McCarthy 4429 pr.p., 3.vi.2014 (holotype – CANB).

*Thallus* crustose, to 30 mm wide, epilithic, areolate; areoles dispersed or becoming contiguous, irregular, angular, elongate to rounded, 0.1–0.3 mm wide; upper surface white to pale grey, matt, pruinose; prothallus black, marginal when abutting other lichens, or not apparent; photobiont cells 5–13 µm wide; medulla lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>–), I–. *Apothecia* 0.1–0.3 mm wide, lecideine, roundish, scattered, broadly adnate to sessile; disc black, epruinose, plane; proper exciple thin, persistent, in section 20–25 µm thick, dark brown, K–, N+ olive-black then orange-brown, inner part brown. *Epihymenium* 8–10 µm thick, dark brown, K–, N–. *Hypothecium* 70–80 µm thick, brown to dark brown, K–. *Hymenium* 55–65 µm thick, colourless, not interspersed; subhymenium c. 10 µm thick, pale brown; paraphyses 1–2 µm wide, sparingly branched, with apices 4–6 µm wide and brown caps. *Asci* 8-spored, *Bacidia*-type. *Ascospores* *Buellia*-type, 1-septate, brown, ellipsoid, 10–[12.1]–15 × 4–[5.2]–7 µm, becoming constricted at the septum, sometimes curved; outer wall smooth to finely ornamented. *Pycnidia* rare, punctiform, immersed; ostiole black; conidia bacilliform, 4–6 × 1 µm.

*Chemistry*: Thallus K+ yellow, C–, PD+ pale yellow, UV–; containing atranorin [major], 2'-O-methylperlatolic acid [minor].

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

#### Remarks

*Buellia durackensis* is characterized by the thin, crustose, areolate, white to pale grey thallus, the small, adnate to sessile apothecia, a dark brown, K– epihymenium, *Buellia*-type ascospores that are often curved and become constricted at the septum with age, and the presence of atranorin and 2'-O-methylperlatolic acid. Morphologically and chemically, it closely resembles *Buellia stellulata* var. *stellulata*, but the latter has mainly immersed apothecia, an aeruginose, K+ violet epihymenium and ascospores that are neither curved nor constricted at the septum (Bungartz *et al.* 2007; Elix 2011). *Buellia dispersa* A.Massal. also has chemistry identical to that of *B. durackensis*, but it differs in having a thick, bullate-areolate to subsquamulose or squamulose thallus with angular, concave squamules with a pruinose upper surface. In addition, the medulla of *B. dispersa* contains calcium oxalate, unlike *B. durackensis*, and the ascospores are somewhat larger, 10–19 × 5–8 µm.

At present, the new species is known from only the type locality. Associated species include *Australiaena streimannii* Matzer, H. Mayrhofer & Elix, *Caloplaca leptozona* (Nyl.) Zahlbr., *Diploschistes actinostomus* (Pers.) Zahlbr., *Dirinaria batavica* D.D. Awasthi, *Lecanora austrosorediosa* (Rambold) Lumbsch, *Monerolechia badia* (Fr.) Kalb and *Peltula euploca* (Ach.) Poelt ex Ozenda & Clauzade.

#### SPECIMEN EXAMINED

*Western Australia*: • type locality, on dry, shaded sandstone rocks, P.M. McCarthy 4428 pr.p., 3.vi.2014 (CANB).

7. *Buellia ecclesensis* Elix, sp. nov.  
Mycobank number: MB 821036

Fig. 8

Similar to *Buellia dispersa* A.Massal., but differs in having an aeruginose, K+ blue-green, N+ violet epihymenium and a subhymenium interspersed with oil droplets.

*Type*: Australia, Victoria, Victorian Volcanic Plain region, Mount Eccles, on rim near dry crater, 38°04'S, 141°56'E, on basalt, W.H. Ewers 11, 11.x.1986 (CANB – holotype).

*Thallus* crustose, continuous, rimose-areolate, to 20 mm wide and 0.5 mm thick; individual areoles irregular, angular, 0.3–1.2 mm wide; upper surface pale tan, dull, sometimes pruinose, esorediate; prothallus thin, black and marginal or not apparent; photobiont cells 8–23 µm wide; medulla white, containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub>+), I–. *Apothecia* 0.3–0.8 mm wide, lecideine, separate or rarely crowded, ± round, immersed to broadly adnate or rarely sessile; disc black, epruinose or grey-white-pruinose, plane, becoming convex; proper exciple thick, persistent, sometimes excluded in convex apothecia, in section 40–60 µm thick, the outer part dark brown to aeruginose-black, K–, N+ violet-brown, brown within. *Hypothecium* 125–225 µm thick, dark brown to brown-black, K+ yellow solution, N+ deep red-brown. *Epihymenium* 10–12 µm thick, dark brown to aeruginose-black, K+ blue-green, N+ violet or violet-brown. *Hymenium* 50–75 µm thick, colourless, not interspersed with oil droplets; subhymenium 30–50 µm thick, pale brown to brown, interspersed with oil droplets; paraphyses 1.5–2.0 µm wide, simple to sparsely branched, with apices 3–4 µm wide and brown caps. *Asci* of the *Bacidia*-type, 8-spored. *Ascospores* of the *Physconia*- then *Buellia*-type, 1-septate, brown, ellipsoid, 13–[16.1]–20 × 7–[7.9]–10 µm, becoming constricted at the septum; outer spore-wall microrugulate. *Pycnidia* punctiform, immersed; ostiole black; conidia bacilliform, 4.5–6.5 × 1–1.5 µm.

*Chemistry*: Cortex K+ pale yellow, C–, P+ pale yellow, UV–; containing atranorin (minor), 2'-O-methylperlatolic acid (major).

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

#### Remarks

Morphologically, *B. ecclesensis* closely resembles *B. dispersa*, a widespread saxicolous species known from semi-arid areas of Australia, south-western North America, northern Africa and Mediterranean Europe (Elix 2011). Both species are characterized by the presence of atranorin and 2'-O-methylperlatolic acid, as well as medullary calcium oxalate, and they have similar-sized ascospores. However, *B. dispersa* has a brown to dark brown, K–, N– epihymenium and a pale brown subhymenium that is not interspersed with oil droplets.

At present, the new species is known from western Victoria, where it occurs on basalt rocks in the volcanic plain region. Associated species include *Buellia halonia* (Ach.) Tuck., *Paraporpidia leptocarpa* (C.Bab. & Mitt.) Rambold & Hertel, *Pseudocyphellaria neglecta* (Müll.Arg.) H.Magn., *Rinodina thiomela* (Nyl.) Müll.Arg., *Rhizocarpon geographicum* (L.) DC., *Tephromela atra* (Huds.) Hafellner, *Xanthoparmelia atrocarnodes* (Elix & J.Johnst.) Elix and *X. mougeotina* (Nyl.) D.J.Galloway.

#### SPECIMENS EXAMINED

*Victoria*: • Victorian Volcanic Plain region, Mount Eccles, near Natural Bridge, 38°04'S, 141°56'E, on basalt on rim near dry crater, W.H. Ewers 38, 48, 11.x.1986 (CANB); • Victorian Volcanic Plain region, Pomborneit East Road, Stoney Rises, 2–4 km from main Warrnambool-Melbourne highway, 38°17'30"S, 143°21'E, on basalt outcrops, W.H. Ewers 1412, 30.viii.1987 (CANB).

8. *Buellia halonioides* Elix, sp. nov.  
Mycobank number: MB 821037

Fig. 9

Similar to *Buellia halonia* (Ach.) Tuck., but differs in having *Buellia*-type ascospores, in containing medullary calcium oxalate and in lacking roccellic acid.

*Type*: Australia, New South Wales, Warrumbungles National Park, Split Rock Track, 36 km W of Coonabarabran, 31°16'49"S, 148°58'42"E, 430 m alt., on sandstone in *Eucalyptus-Callitris* woodland, J.A. Elix 45451, 12.v.2005 (CANB – holotype).

*Thallus* crustose, continuous, rimose-areolate, to 40 mm wide and 0.25 mm thick; individual areoles 0.5–1.5 mm wide; upper surface off-white to pale tan, dull, appearing granular, crystalline or maculate, sometimes pruinose, esorediate; prothallus black and marginal or not apparent; photobiont cells 8–16 µm wide; medulla white, containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub><sup>+</sup>), I-. *Apothecia* 0.3–1 mm wide, lecideine, separate or rarely crowded, ± round, immersed to broadly adnate or rarely sessile; disc black, epruinose or grey-white-pruinose, weakly concave to plane or weakly convex; proper exciple thick, persistent, sometimes elevated above the disc, in section 30–70 µm thick, the outer part dark brown to brown-black, K-, brown within. *Hypothecium* 100–150 µm thick, dark brown to deep red-brown, K-, N-. *Epihymenium* 10–13 µm thick, brown to olive-brown, K-, N- or N+ pale violet-brown. *Hymenium* 70–90 µm thick, colourless, not interspersed with oil droplets; subhymenium 15–20 µm thick, pale brown; paraphyses 1.5–2.0 µm wide, simple to sparsely branched, with apices 2.5–3.5 µm wide and brown caps. *Asci* of the *Bacidia*-type, with 8 or fewer spores. *Ascospores* of the *Buellia*-type, 1-septate, brown, ellipsoid, 13–[15.6]–20 × 7–[7.8]–10 µm, becoming constricted at the septum; outer spore-wall microrugulate. *Pycnidia* punctiform, immersed; ostiole black; conidia bacilliform, 4.5–6 × 1 µm. *Chemistry*: Cortex K+ pale yellow, C+ yellow-orange, KC+ orange, P-, UV+ dull orange; containing atranorin (minor), arthothelin (major), thiophanic acid (minor or trace), 4,5-dichloronorlichexanthone (trace), 2,4-dichloronorlichexanthone (trace).

*Etymology*: The epithet reflects the similarity of this species to *Buellia halonia*.

#### Remarks

Morphologically, *B. halonioides* closely resembles *B. halonia*, a widespread saxicolous species known from Australia, North America, South America and South Africa (Elix 2011). Both are characterized by the presence of arthothelin or isoarthothelin, and they have similar-sized ascospores and a partially aeruginose epihymenium (N+ red-violet). However, *B. halonioides* has 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. halonioides* contains arthothelin as a major substance and contains high concentrations of calcium oxalate. The new species also resembles some specimens of *Buellia xantholeuca* Bungartz & U.Grube in that both have a chalky, pruinose upper surface, similar-sized *Buellia*-type ascospores and contain medullary calcium oxalate and xanthonenes. However, *B. xantholeuca* has a brown epihymenium and excipulum (N-), and it contains 2,5,7-trichloro-3-*O*-methylnorlichexanthone and isoarthothelin as the major xanthonenes present (Bungartz *et al.* 2011).

At present, the new species is known from South Australia, New South Wales and the South Island of New Zealand; it occurs on siliceous rocks in coastal and hinterland regions. Associated species include *Buellia stellulata* (Taylor) Mudd var. *stellulata*, *Paraporpidia leptocarpa* (C.Bab. & Mitt.) Rambold & Hertel, *Pertusaria melanospora* var. *sorediata* Elix & A.W.Archer, *Rhizocarpon geographicum* (L.) DC., *Tephromela atra* (Huds.)

Hafellner and *Xanthoparmelia australasica* D.J.Galloway.

#### SPECIMENS EXAMINED

*South Australia*: • Mount Lofty Ranges, 13.5 km N of Callington, on schist rocks in pasture, J.A. Elix 9438, 30.x.1981 (CANB); • Kangaroo Island, mouth of De Mole River, 18 km SSE of Cape Borda, 35°43'S, 136°46'E, 20 m alt., on large semi-exposed boulder in dry sclerophyll forest with *Casuarina*, *H. Streimann* 55072, 55079, 30.v.1994 (B, CANB).

*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 with *Buellia stellulata*].

9. *Buellia northallina* Elix & Kantvilas, sp. nov.

Fig. 10

Mycobank Number: MB 821038

Similar to *Buellia abstracta* (Nyl.) H.Olivier, but differs in having broader ascospores, 6–[6.9]–9 µm wide.

*Type*: Australia, Victoria, Brisbane Ranges, Spring Gully Picnic Area, on sheltered soft mudstone rocks of dry creek bed in dry sclerophyll forest, G. Kantvilas 185/00, 30.iv.2000 (holotype – HO; isotype – CANB).

*Thallus* to 30 mm wide, endolithic and not apparent or epilithic, very thin, discontinuous, effuse and ecorticate; upper surface pale grey-brown, matt; prothallus not apparent; photobiont cells 7–15 µm wide; medulla lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub><sup>-</sup>), I-. *Apothecia* 0.2–0.6 mm wide, abundant, lecideine, roundish, scattered, broadly adnate; disc black, epruinose, weakly concave to plane; proper exciple prominent, persistent, in section 20–25 µm thick, outer part brown-black, K+ yellow and soon forming red, needle-like crystals, N+ orange-brown, inner part brown. *Epihymenium* 8–10 µm thick, dark brown, N-. *Hypothecium* 50–80 µm thick, dark brown. *Hymenium* 50–60 µm thick, colourless, not interspersed; subhymenium 20–25 µm thick, pale brown, interspersed with oil droplets; paraphyses 1–2 µm wide, sparingly branched, with apices 4–5 µm wide and brown caps. *Asci* 8-spored, *Bacidia*-type. *Ascospores* *Buellia*-type, 1-septate, pale brown then dark brown, ellipsoid, 10–[11.7]–14 × 6–[6.9]–9 µm, rarely constricted at the septum; outer wall finely ornamented. *Pycnidia* rare, punctiform, immersed; ostiole black; conidia bacilliform, c. 3 × 1 µm. *Chemistry*: Medulla K+ yellow then red, C-, PD+ orange, UV-; containing norstictic acid [major], connorstictic acid [trace].

*Etymology*: The species is named after the apparent absence of a thallus.

#### Remarks

The endolithic or poorly developed, very thin, discontinuous, effuse thallus resembles *Buellia abstracta* from Europe and North America, in that both species are dominated by the small, abundant, broadly adnate to sessile apothecia. However, *B. abstracta* has significantly narrower ascospores (3–[4.6]–6 µm wide) (Coppins *et al.* 2009). *Buellia northallina* also resembles some depauperate forms of *Buellia austera* Elix & Kantvilas, but that species has larger, *Physconia*- then *Buellia*-type ascospores, 10–[13.5]–16 × 7–[8.2]–9.5 µm (Elix & Kantvilas 2016b).

The new species is known from the type locality and from a site in the South Island of New Zealand. In Victoria commonly associated lichens include *Lecidea capensis* Zahlbr., *Ramboldia petraeoides* (C.Bab. & Mitt.) Kantvilas & Elix, *Rhizocarpon geographicum* (L.) DC., *R. reductum* Th.Fr., *Xanthoparmelia incerta* (Kurok. & Filson) Elix & J.Johnst. and *X. mougeotina* (Nyl.) D.J.Galloway.

## SPECIMEN EXAMINED

New Zealand: • South Island, Otago, Lee Stream, Hindon Road, 45°45'18"S, 169°58'41"E, 2 m alt., on rock, *J. Murray* 0754, xi.1955 (BM).

**10. *Buellia poolensis*** Elix, sp. nov.  
Mycobank Number: **MB 821039**

Fig. 11

Similar to *Buellia cranwelliae* Zahlbr., but differs in having a thin, effuse or endolithic thallus and a brown-black, N+ orange-brown excipulum.

*Type:* Australia, New South Wales, S of Pooles Beach, 3.5 km S of Mystery Bay, 36°18'56"S, 150°07'47"E, 1–3 m alt., on shale rocks along the foreshore, *J.A. Elix* 46312 *pr.p.*, 18.xi.2016 (holotype – CANB).

*Thallus* to 20 mm wide, crustose, discontinuous, effuse, very thin, rimose, to 0.1 mm thick, or endolithic and not apparent; upper surface white to pale grey, matt; prothallus not apparent; photobiont cells 10–18 µm wide; medulla containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub>+,) I–. *Apothecia* 0.2–1.2 mm wide, lecideine, roundish or distorted, scattered, broadly adnate to sessile and constricted at the base; disc black, epruinose to rarely white-pruinose, plane to weakly convex; proper exciple prominent, persistent, often wavy and elevated above disc, in section 25–50 µm thick, outer part dark brown to brown-black, K–, N+ orange-brown, inner part brown. *Epithymenium* 10–13 µm thick, dark brown, N–. *Hypotheicum* 100–180 µm thick, brown to brown-black. *Hymenium* 60–90 µm thick, colourless, not interspersed; subhymenium 25–45 µm thick, pale brown to pale red-brown, not interspersed; paraphyses 1–2 µm wide, sparingly branched, with apices 4–6 µm wide and dark brown caps. *Asci* 8-spored, *Bacidia*-type. *Ascospores* *Buellia*-type, 1-septate, pale brown then dark brown, ellipsoid, 10–[12.0]–14 × 5–[5.9]–8 µm, constricted at the septum or not; outer wall smooth to finely ornamented. *Pycnidia* punctiform, immersed; ostiole black; conidia bacilliform, 3–5 × 1 µm. *Chemistry:* Thallus K–, P–, C–, UV–; no lichen substances detected.

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

**Remarks**

Both the new species and *B. cranwelliae* inhabit coastal, siliceous rocks in south-eastern Australia, and are characterized by the presence of medullary calcium oxalate, the absence of lichen substances and similar-sized *Buellia*-type ascospores and bacilliform conidia. However, *B. cranwelliae* has a much better-developed, thicker (to 1.5 mm) thallus that becomes sublobate and placodiform at the margins. In addition, it has a dark brown to brown-black excipulum that reacts N+ greenish-black and K+ to give a deep yellow solution in part (Elix 2016c). *Buellia mayrhoferae* Elix & Kantvilas occurs in a similar habitat, has bacilliform conidia and lacks lichen substances, but it has somewhat larger ascospores and lacks medullary calcium oxalate (Elix 2016a).

The new species is known from coastal localities in southern New South Wales and in the South Island of New Zealand. In New South Wales it associates with typical littoral species, including *Buellia aeruginosa* A.Nordin, Owe-Larsson & Elix, *B. stellulata* (Taylor) Mudd var. *stellulata*, *Catillaria australittoralis* Kantvilas & van den Boom, *Jackelxia ligulata* Körb.) S.Y.Kondr., Fedorenko, S.Stenroos, Kärnefelt & A.Thell, *Pertusaria melanospora* var. *sorediata* Elix & A.W.Archer, *Rinodina blastidiata* Matzer & H. Mayrhofer, *Rinodinella fertilis* (Körb.) Elix var. *fertilis*, *Tylothallia verrucosa* (Müll.Arg.) Kantvilas and *Xanthoparmelia australasica* D.J.Galloway.

## SPECIMENS EXAMINED

New South Wales: • Pooles Beach, 3 km S of Mystery Bay, 36°18'46"S, 150°07'57"E, 1–3 m alt., on coastal rocks near car park, *P.M. McCarthy* 4537 *pr.p.*, 18.xi.2016 (CANB).

New Zealand: • South Island, Nelson, NE of Nelson, Cable Bay, Ataata Point, 41°09'38"S, 173°24'48"E, 0–7 m alt., on coastal granite rock, *J. Blaha* 0046, 6.iv.2001 (GZU).

**11. *Buellia servilosina*** Elix & Kantvilas, sp. nov.  
Mycobank Number: **MB 821040**

Fig. 12

Similar to *Monerolechia badia* (Fr.) Kalb, but differs in lacking an independent thallus and in having ascospores that are often curved and become broadly fusiform and constricted with age, with subacute or narrowed apices.

*Type:* Australia, Tasmania, Slaves Bay, 40°55'S, 144°39'E, 5 m alt., on *Xanthoparmelia mougeotina* on seashore quartzite outcrops, *G. Kantvilas* 410/14, 17.ix.2014 (holotype – HO).

*Thallus* lichenicolous, initially developed on the upper cortex of the host (*Xanthoparmelia mougeotina*), which often becomes discoloured brownish then decorticate in infected areas, ultimately leaving the isolated apothecia of the infecting *Buellia*. *Apothecia* 0.2–0.5 mm wide, scattered, lecideine, roundish, broadly adnate but soon sessile; disc black, epruinose, weakly concave then plane; proper margin persistent, black, in section 30–40 µm thick, outer part brown-black, K–, N–, inner part brown. *Epithymenium* 8–10 µm thick, dark brown, K–, N–. *Hypotheicum* 100–140 µm thick, dark brown to brown-black, K–. *Hymenium* 60–75 µm thick, colourless, not interspersed; subhymenium 25–40 µm thick, brown; paraphyses 1.6–2 µm wide, simple to sparingly branched, with apices dark brown, 4–5 µm wide. *Asci* of the *Bacidia*-type, 8-spored or fewer. *Ascospores* of the *Buellia*-type, 1-septate, olive-brown to brown, ellipsoid, 11–[13.3]–18 × 5–[5.9]–8 µm, rarely older spores constricted, outer spore-wall finely ornamented. *Pycnidia* not seen.

*Chemistry:* Thallus K–, P–, C–, UV–; no lichen substances detected.

*Etymology:* The species is named after the type locality, from the Latin *servilis* (relating to a slave) and *sinus* (a bay).

**Remarks**

Both *Monerolechia badia* and *B. servilosina* grow closely associated with or parasitic on *Xanthoparmelia* species, but *M. badia* differs in developing an independent, bullate, subsquamulose to distinctly squamulose thallus, and has shorter ascospores, 10–[11.9]–15 × 5–[6.5]–8 µm (Elix 2011, 2015a). Furthermore, the shape of the ascospores differs, i.e. straight, non-constricted and with obtuse apices in *M. badia*, but often curved, with older spores becoming broadly fusiform, and constricted with subacute or narrowed apices in *B. servilosina*.

At present the new species is known from only the type locality, where it occurs on *Xanthoparmelia mougeotina* on quartzite seashore rocks. Commonly associated species include *Buellia halonia* (Ach.) Tuck., *Rinodina thiomela* (Nyl.) Müll.Arg., *Lecanora farinacea* Fée, *Ramboldia petraeoides* (Bab. & Mitt.) Kantvilas & Elix and numerous *Xanthoparmelia* species, including *X. flavescens* (Gyeln.) Hale, and *X. scabrosa* (Taylor) Hale.

**12. *Buellia subadjuncta*** Elix & Kantvilas, sp. nov.  
Mycobank Number: **MB 821041**

Figs 13, 14

Similar to *Amandinea adjuncta* (Th.Fr.) Hafellner, but differs in having smaller ascospores and bacilliform conidia.

*Type:* Australia, South Australia, Kangaroo Island, Cape St Albans, 35°48'S, 138°07'E,

40 m alt., on *Caloplaca lateritia* on boulders and large rock outcrops in coastal grassy shrubland, *G. Kantvilas* 398/15, 21.ix.2015 (holotype – HO).

*Thallus* lichenicolous, developed on the rudimentary thallus or prothallus of the host [*Caloplaca lateritia* (Taylor) Zahlbr.]. *Apothecia* 0.3–0.5 mm wide, scattered or in groups, lecideine, roundish, broadly adnate; disc black, epruinose, weakly concave to plane; proper excipulum persistent, black, initially raised above level of disc, in section 40–50  $\mu\text{m}$  thick, outer part dark brown, K–, N–, inner part brown. *Epithymenium* 10–12  $\mu\text{m}$  thick, dark brown, K–, N–. *Hypothecium* 80–110  $\mu\text{m}$  thick, mid-brown to dark brown, K–. *Hymenium* 55–65  $\mu\text{m}$  thick, colourless, not interspersed; subhymenium 25–30  $\mu\text{m}$  thick, pale brown; paraphyses 1.5–1.7  $\mu\text{m}$  wide, simple to sparingly branched, with apices dark brown, 4–6  $\mu\text{m}$  wide. *Asci* of the *Bacidia*-type, 8-spored. *Ascospores* initially of the *Pachysporaria*- or *Physconia*-type, of the *Buellia*-type when mature, becoming constricted, 1-septate, brown, ellipsoid, 12–[14.3]–16  $\times$  7–[7.9]–10  $\mu\text{m}$ ; outer spore-wall finely ornamented. *Pycnidia* superficial; conidia bacilliform, 4–5  $\times$  1–1.2  $\mu\text{m}$ . *Chemistry*: Thallus K–, P–, C–, UV–; no lichen substances detected.

*Etymology*: The epithet reflects the superficial similarity of the new species to *Amandinea adjuncta*.

### Remarks

*Buellia subadjuncta* is a distinctive species, characterized by its lichenicolous habit, the dark brown epithymenium and hypothecium, bacilliform conidia, the unusual ascospore ontogeny (Fig. 14) and the lack of lichen substances. Superficially, it resembles *Amandinea adjuncta*, a lichenicolous species occurring on *Lecanora straminea* Wahlb. ex Ach. and *Rinodina olivaceobrunnea* C.W.Dodge & G.E.Baker in the Northern Hemisphere (Hafellner 2004), and also reported on *Caloplaca* from the Auckland Islands (Galloway 2007). The two species differ in the size of their ascospores and form of their conidia. *Amandinea adjuncta* has larger *Buellia*-type ascospores, 14–18  $\times$  7.5–9  $\mu\text{m}$ , and curved, and curved, filiform conidia, 15–20  $\times$  0.7–1  $\mu\text{m}$ .

At present, the new species is known from only the type locality. Associated lichens include *Amandinea decedens* (Zahlbr.) Blaha, H.Mayrhofer & Elix, *Buellia aeruginosa* A.Nordin, Owe-Larsson & Elix, *B. stellulata* (Taylor) Mudd var. *stellulata*, *Caloplaca gallowayi* S.Y.Kondr., Kärnefelt & Filson, *Catillaria austrolittoralis* Kantvilas & van den Boom, *Diploicia canescens* subsp. *australasica* Elix & Lumbsch, *Halecania subsquamosa* (Müll.Arg.) van den Boom & H.Mayrhofer and *Tylothallia verrucosa* (Müll.Arg.) Kantvilas.

**13. *Buellia tinderryensis*** Elix & P.M.McCarthy, sp. nov. Fig. 15  
Mycobank Number: **MB 821042**

Similar to *Buellia sequax* (Nyl.) Zahlbr., but differs in having an aeruginose excipulum and epithymenium and larger ascospores, 15–[17.8]–23  $\times$  8–[9.5]–12  $\mu\text{m}$  that are constricted at the septum and have rounded apices.

*Type*: Australia. New South Wales, Tinderry Range, Tinderry Road, 9 km ESE of Michelago, 35°44'31"S, 149°15'52"E, 1140 m alt., on granite rocks in *Eucalyptus* woodland with large granite outcrops, *J.A. Elix* 46231, 7.ix.2016 (holotype – CANB; isotypes – HO, NSW).

*Thallus* to 20 mm wide, epilithic, areolate to subsquamulose; areoles dispersed or becoming contiguous, irregular, angular to rounded, 0.1–0.5 mm wide; upper surface pale grey, matt, epruinose; prothallus black, prominent, marginal and between adjacent areoles; photobiont cells 8–20  $\mu\text{m}$  wide; medulla lacking calcium oxalate ( $\text{H}_2\text{SO}_4$ –), I–. *Apothecia* 0.1–0.5 mm wide, lecideine, roundish, scattered, immersed;

disc black, epruinose, plane; proper exciple thin, persistent, in section 30–40  $\mu\text{m}$  thick, outer part aeruginose-black, K+ blue-green, N+ violet, inner part brown. *Epithymenium* 10–12  $\mu\text{m}$  thick, deeply aeruginose, K–, N+ violet. *Hypothecium* 30–40  $\mu\text{m}$  thick, brown to dark brown, K–. *Hymenium* 100–125  $\mu\text{m}$  thick, colourless, interspersed with oil droplets; subhymenium 10–15  $\mu\text{m}$  thick, pale brown, interspersed with oil droplets; paraphyses 1–2  $\mu\text{m}$  wide, sparingly branched, with apices 2.5–3.5  $\mu\text{m}$  wide and aeruginose caps. *Asci* 8-spored, *Bacidia*-type. *Ascospores* *Buellia*-type, 1-septate, deep green then brown, ellipsoid, 15–[17.8]–23  $\times$  8–[9.5]–12  $\mu\text{m}$ , becoming constricted at the septum, not curved; outer wall finely ornamented. *Pycnidia* rare, punctiform, immersed; ostiole black; conidia ellipsoid, c. 3  $\times$  1.5  $\mu\text{m}$ . *Chemistry*: Medulla K+ yellow, C–, PD+ pale yellow, UV–; containing atranorin [major], diploicin [major].

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

### Remarks

The new species is characterized by the crustose, areolate to subsquamulose thallus in which the pale grey squamules are surrounded by a prominent, black prothallus, the non-amyloid medulla, immersed apothecia, the intensely aeruginose, N+ violet excipulum and epithymenium, an interspersed hymenium, 1-septate, *Physconia*- then *Buellia*-type ascospores, short, ellipsoid conidia and the presence of atranorin and diploicin. *Buellia sequax* often has a similar areolate to subsquamulose thallus and identical chemistry, but it differs in having adnate to sessile apothecia, a brown, N– excipulum and epithymenium, smaller, *Dirinaria*- then *Physconia*- and ultimately *Buellia*-type ascospores, 11–[14]–18  $\times$  5–[6.5]–8  $\mu\text{m}$ , and longer, bacilliform conidia, 4–5  $\times$  1–1.2  $\mu\text{m}$  (Giralt *et al.* 2011). Superficially, *B. tinderryensis* resembles some depauperate forms of *Buellia stellulata* (Taylor) Mudd var. *stellulata*, but that species has much smaller, *Buellia*-type ascospores, 8–[9.9]–13  $\times$  4.5–[5.5]–7  $\mu\text{m}$  and contains atranorin, 2'-*O*-methylperlatolic acid,  $\pm$  confluent acid and  $\pm$  roccellic acid (Elix 2011).

At present, the new species is known from only the type locality. Associated species include *Acarospora citrina* (Taylor) Zahlbr. ex Rech., *Buellia homophyllia* (C.Knight.) Zahlbr., *Caloplaca sideritis* (Tuck.) Zahlbr., *Lecanora farinacea* Fée, *Ramboldia petraeoides* (C.Bab. & Mitt.) Kantvilas & Elix, *Rhizocarpon flavomedullosum* Elix & P.M.McCarthy, *R. geographicum* (L.) DC., *Xanthoparmelia mougeotina* (Nyl.) D.J.Galloway, *X. rubrereagens* (Gyeln.) Hale and *X. subnuda* (Kurok.) Hale.

### New records for Australia

**1. *Amandinea julianeae*** H.Mayrhofer & Elix, *Australasian Lichenology* **79**, 39 (2016)  
This species was previously known from New Zealand and Norfolk Island (Blaha *et al.* 2016). It is characterized by the crustose, areolate to verrucose-areolate, pale grey to pale brown or orange-brown thallus, the broadly adnate to sessile apothecia with pruinose discs, a medulla containing clumps of yellow-orange pigment, the small 1-septate, *Physconia*- then *Buellia*-type ascospores, 10–[11.1]–13  $\times$  5–[6.6]–8  $\mu\text{m}$ , which are not constricted at the septum, curved, filiform conidia and the absence of lichen substances. Illustrations and a detailed description in provided in Blaha *et al.* (2016).

### SPECIMENS EXAMINED

*New South Wales*: • 0.5 km W of Callala Point, Callala Bay, Jervis Bay, 35°00'22"S, 150°43'07"E, 1–3 m alt., on coastal shale rocks, *J.A. Elix* 46351 & P.M. McCarthy, 19.iv.2017 (CANB); • Outer Tubes, 1 km NW of Point Perpendicular, Beecroft Peninsula, 35°05'17"S, 150°48'00"E, 7–10 m alt., on quartzitic sandstone rocks on coastal cliffs, *J.A. Elix* 46390, 19.iv.2017 (CANB).

**2. *Cratiria chloraceus*** Marbach, *Biblioth. Lichenol.* **74**, 175 (2000) Fig. 16  
*Type:* New Caledonia, Grande Terre, Province Nord, east coast, road from Lindéraligue, several km SE of Hienghène, 20°42'S, 164°57'E, 2 m alt., on *Rhizophora* sp. in mangroves, K. & A. Kalb 27433, viii.1994 (holotype – herb. KALB).

*Thallus* corticolous, crustose, to 40 mm wide and 1 mm thick, rimose-areolate to verrucose-areolate or corrugated and warted; upper surface creamy white, yellow-white or pale yellow; prothallus black, marginal or not apparent; photobiont cells 6–11 µm wide; medulla lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-. *Apothecia* 0.4–1 mm wide, broadly adnate but soon sessile and constricted at the base; disc plane to weakly convex, yellow-grey-pruinose; proper exciple thin, persistent, in section 50–70 µm thick, outer part brown-black, K+ intense red, inner part brown. *Epithymenium* 10–12 µm thick, brown, K-, N-. *Hypotheceum* 120–150 µm thick, dark brown to brown-black, K-. *Hymenium* 75–100 µm thick, colourless, interspersed with oil droplets; paraphyses 1.5–2 µm wide, sparingly branched, with apices 2.5–3.5 µm wide and pale brown caps. *Asci* 8-spored, *Bacidia*-type. *Ascospores* of the *Cratiria*- or *Buellia*-type, 1-septate, olive-brown to brown, ellipsoid to broadly fusiform, 12–[16.9]–20 × 6–[7.6]–10 µm, becoming constricted at the septum, the spore-walls often thickened apically and with a rugulate outer surface. *Pycnidia* rare, punctiform, immersed; ostiole black; conidia bacilliform, 4–6 × 1 µm.

*Chemistry:* Thallus K+ yellow, C+ yellow-orange, P-, UV+ dull orange; containing arthothelin (major), thuringione (major or minor), 4,5-dichloronorlichexanthone (trace), ± 6-O-methylarthothelin (trace).

This species was previously known from New Caledonia (Marbach 2000). It is characterized by a yellow-white to pale yellow crustose thallus, sessile to broadly adnate apothecia to 1 mm wide with pruinose discs, 8-spored asci, a black-brown excipulum that reacts K+ intense red, an interspersed hymenium, ellipsoid to broadly fusiform ascospores, 12–20 × 6–10 µm, and the presence of arthothelin and thuringione.

#### SPECIMENS EXAMINED

*Queensland:* • 2 km S of Forrest Beach, 15 km SE of Ingham, 18°42'S, 146°18'E, 2 m alt., on *Alphitonia* in *Acacia-Alphitonia*-dominated regrowth forest, J.A. Elix 15965 & H. Streimann, 22.vi.1984 (CANB).

*Papua New Guinea:* • Morobe Province, Tauri River, Menyamya, 7°07'S, 145°59'E, 1200 m alt., on *Casuarina* trunk, H. Streimann 18943, 29.iv.1982 (CANB).

**3. *Sculptolumina serotina*** (Malme) Marbach, *Biblioth. Lichenol.* **74**, 302 (2000)

Figs 17, 18

*Buellia serotina* Malme, *Ark. Bot.* **21A**, 40 (1927)

*Type:* Brazil, Matto Grosso, Santa Anna da Chapada, in margine silvulas, G.O.A. Malme 2440, 23.ii.1894 (lectotype – S, not seen).

*Thallus* corticolous, crustose, continuous or dispersed, to 40 mm wide and 70 µm thick, rimose or thin and membranaceous; upper surface off-white, yellow-brown to olive-brown or dark brown, pruinose or often diffusely soresiate; prothallus dark grey, marginal or absent; photobiont cells 8–15 µm wide; medulla lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-. *Apothecia* 0.3–0.6 mm wide, broadly adnate but soon sessile and constricted at the base; disc plane to convex, epruinose; proper exciple thin, persistent or excluded in convex apothecia, in section 20–40 µm thick, outer part brown-black, K-, inner part brown. *Epithymenium* 10–13 µm thick, dark brown to olive-brown, K-, N-. *Hypotheceum* 100–150 µm thick, brown to dark brown, K-. *Hymenium* 80–110 µm thick, colourless, interspersed with oil droplets; paraphyses 1.5–2 µm wide, sparingly branched, with apices 2.5–3.5 µm wide and brown caps. *Asci* (4–6)–8-spored, *Bacidia*-

type. *Ascospores* of the *Serotina*-, *Pachysporaria*- or *Mischoblastia*-type, 1-septate, olive-brown to brown, ellipsoid, 18–[21.7]–23(–30) × 10–[11.6]–13(–18) µm, not constricted at the septum, the spore-walls with a microrugulate or rugulate outer surface; ontogeny of type B (Marbach 2000). *Pycnidia* rare, punctiform, immersed; ostiole black. *Conidia* filiform, straight to weakly curved, 14–20 × 0.7–1 µm.

*Chemistry:* Thallus K-, C-, KC+ pale red, P-, UV+ blue-white; containing lobaric acid (major).

This species was previously known from Central and South America (Marbach 2000). It is characterized by a thin, white, grey, ochre or olive-brown crustose thallus containing lobaric acid, often with dispersed pruina and diffuse soredia on the upper surface, asci with 4–8 spores, an interspersed hymenium, 1-septate ascospores of the *Serotina*-, *Pachysporaria*- or *Mischoblastia*-type, 18–30 × 10–18 µm, and the straight to slightly curved, filiform conidia, 14–20 × 0.7–1 µm. This is the first report of conidia for this species (Giralt *et al.* 2009).

#### SPECIMENS EXAMINED

*Queensland:* • Great Dividing Range, W of Wilsons Peak, N of road from Killarney to Boonah, 28°15'S, 152°28'E, c. 900 m alt., on bark on edge of subtropical rainforest, J. Hafellner 16314 & N. Stevens, 7.ix.1986 (GZU).

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**Keys to buellioid lichens in Australia** (notes: species marked with an asterisk have not yet been formally described, and spore types are illustrated in Fig. 19)

- 1 Thallus growing on bark, wood, soil, or other lichens .....2  
**1:** Thallus growing on rock .....3
- 2 Thallus lacking lichen substances (testing – with K, C, PD, UV, and TLC) ....  
 .....**Key A**  
**2:** Thallus containing lichen substances (testing + with K, C, PD, UV, or TLC) .  
 .....**Key B**
- 3 Thallus lacking lichen substances (testing – with K, C, PD, UV, and TLC) ....  
 .....**Key C**  
**3:** Thallus containing lichen substances (testing + with K, C, PD, UV, or TLC) .  
 .....**Key D**

**Key A**

- 1 Thallus growing on bark or wood .....2  
**1:** Thallus growing on soil or other lichens .....22
- 2 Ascospores 1–3-septate or submuriform .....3  
**2:** Ascospores 1-septate .....5
- 3 Ascospores 1–3-septate .....**Baculifera metaphragmia**  
**3:** Ascospores submuriform .....4
- 4 Ascospores 13–20 × 6.5–10 µm; thallus crustose to subsquamulose .....  
 .....**Diplotomma alboatrum**  
**4:** Ascospores 25–30 × 9–12 µm; thallus endophloedal .....**Diplotomma sp. A\***
- 5 Ascospores *Orcularia*-type; conidia filiform, curved .....6  
**5:** Ascospores *Callispora*-, *Physconia*-, *Mischoblastia*- or *Buellia*-type; conidia various .....9
- 6 Ascospores persistently *Orcularia*-type, 10–22 µm long .....7  
**6:** Ascospores initially *Orcularia*-type, then *Physconia*-type, 12–28 µm long ....8
- 7 Ascospores 10–[13.5]–16 × 5–[6.8]–8.5 µm .....**Orcularia elixii**  
**7:** Ascospores 11–[15.5]–22 × 6.5–[8.0]–10 µm .....**Orcularia insperata**
- 8 Ascospores 12–18 × 6–10 µm .....**Amandinea stajscii**  
**8:** Ascospores 20–28 × 9–14 µm .....**Amandinea dudleyensis**
- 9 Hymenium densely interspersed with oil droplets; ascospores *Callispora*- or *Mischoblastia*-type .....10  
**9:** Hymenium not or weakly interspersed with oil droplets; ascospores *Physconia*- or *Buellia*-type .....11
- 10 Ascospores *Callispora*-type, 30–38 × 12–16 µm; conidia bacilliform, 4–6 µm long .....**Buellia levieri**  
**10:** Ascospores *Mischoblastia*-type, 18–31 × 9–13 µm; conidia filiform, 11–21 µm long .....**Sculptolumina japonica**
- 11 Ascospores 5–11 × 4.5–5.5 µm; conidia narrowly ellipsoid, 5–11 × 1.5–3 µm long .....**Buellia schaeereri**  
**11:** Ascospores 10–30 × 5–13 µm; conidia bacilliform or filiform, 4–38 µm long .....12
- 12 Ascospores 17–30 × 7–13 µm .....13  
**12:** Ascospores 10–20 × 5–8 µm .....16
- 13 Hymenium interspersed; conidia filiform, curved, 18–38 µm long .....14  
**13:** Hymenium not interspersed; conidia bacilliform or absent .....15
- 14 Ascospores *Buellia*-type, with apical wall-thickenings, 22–30 × 9–14 µm; conidia 18–28 µm long .....**Amandinea occidentalis**  
**14:** Ascospores *Physconia*- to *Buellia*-type, lacking apical wall-thickenings, 17–25 × 7–12 µm; conidia 25–38 µm long .....**Amandinea pillagaensis**

15	Ascospores <i>Buellia</i> -type, straight, 16–30 × 7–12 μm; conidia bacilliform, 5–6 μm long.....	<b>Baculifera macromera</b>
15:	Ascospores <i>Buellia</i> -type, often curved, 17–26 × 9–13 μm; conidia not seen.....	<b>Amandinea montana</b>
16	Epihymenium deep green, N+ black or dark purple-grey; conidia bacilliform, straight, 8–12 μm long.....	<b>Baculifera xylophila</b>
16:	Epihymenium brown, N–; conidia filiform or bacilliform.....	17
17	Ascospores persistently <i>Buellia</i> -type; conidia filiform or bacilliform.....	18
17:	Ascospores initially <i>Physconia</i> -type, then <i>Buellia</i> -type; conidia filiform.....	20
18	Ascospores 9–14 μm long.....	<b>Amandinea conranensis</b>
18:	Ascospores 12–19 μm long.....	19
19	Ascospores 12–15 × 7–9 μm; conidia filiform, curved, 14–20 μm long.....	<b>Amandinea punctata</b>
19:	Ascospores 12–19 × 5–8 μm; conidia bacilliform, 4–6 μm long.....	<b>Buellia extenuatella</b>
20	Apothecia initially lecanorine, then biatorine and lecideine; juvenile ascospore locules lachrymiform (tear-shaped).....	<b>Amandinea ropinii</b>
20:	Apothecia lecideine throughout; juvenile ascospore locules spherical or clavate.....	21
21	Ascospores 11–16 μm long; thallus crustose or absent, esorediate.....	<b>Amandinea extenuata</b>
21:	Ascospores 13–20 μm long; thallus often becoming subsquamulose and soreciate.....	<b>Amandinea lignicola</b> var. <b>australis</b>
22	Thallus growing on soil; ascospores 15–20 × 6.5–8.5 μm ..	<b>Buellia epigaella</b>
22:	Thallus growing on other lichens.....	23
23	Thallus growing on <i>Xanthoparmelia mougeotina</i> ; ascospores <i>Buellia</i> -type, 14–18(–24) × 5–8 μm, rarely constricted at the septum.....	<b>Buellia servilosina</b>
23:	Thallus growing on crustose lichens.....	24
24	Thallus growing on <i>Buellia albula</i> ; ascospores <i>Buellia</i> -type, 13–20(–25) × 8–12 μm, not constricted at the septum.....	<b>Buellia albulella</b>
24:	Thallus growing on <i>Caloplaca</i> ; ascospores <i>Physconia</i> -type, then <i>Buellia</i> -type, 12–16 × 7–10 μm, constricted at the septum.....	<b>Buellia subadjuncta</b>

#### Key B

1	Thallus growing on bark or wood.....	2
1:	Thallus growing on soil.....	60
2	Ascospores 1–3-septate or submuriform.....	3
2:	Ascospores 1-septate.....	7
3	Ascospores submuriform; thallus soreciate.....	<b>Buellia griseovirens</b>
3:	Ascospores 1–3-septate; thallus esorediate.....	4
4	Medulla intense red; chiodectonic acid present.....	<b>Gassicurtia capricornica</b>
4:	Medulla white; chiodectonic acid absent.....	5

5	Thallus K+ yellow; stictic acid present.....	<b>Cratiria</b> sp. <b>A*</b>
5:	Thallus K+ red; norstictic acid present.....	6
6	Thallus thick, crustose; atranorin present; tropical.....	<b>Cratiria lauricassiae</b>
6:	Thallus thin or endophloedal; atranorin absent; temperate.....	<b>Baculifera metaphragmioides</b>
7	Thallus K+ red; norstictic acid present.....	8
7:	Thallus K– or K+ yellow; norstictic acid absent.....	28
8	Hymenium densely inspersioned with oil droplets.....	9
8:	Hymenium not inspersioned with oil droplets.....	18
9	Epihymenium K+ violet.....	10
9:	Epihymenium K–.....	12
10	Asci with 16 ascospores.....	<b>Buellia pleiotera</b>
10:	Asci with 8 or fewer ascospores.....	11
11	Asci 8-spored; ascospores 13–22 × 5.5–8 μm; 4,5-dichlorolichexanthone absent.....	<b>Buellia bahiana</b>
11:	Asci (2–)4(–8)-spored; ascospores 18–30 × 8–14 μm; 4,5-dichlorolichexanthone present.....	<b>Buellia mesospora</b>
12	Ascospores more than 22 μm long.....	13
12:	Ascospores less than 22 μm long.....	14
13	Ascospores smooth, with pronounced subapical wall-thickenings.....	<b>Buellia fraudans</b>
13:	Ascospores strongly ornamented, with weak subapical wall-thickenings.....	<b>Buellia subcrassata</b>
14	Ascospores subglobose, 12–14 × 8–11 μm; 4,5-dichlorolichexanthone present.....	<b>Buellia ventricosa</b>
14:	Ascospores ellipsoidal, 14–22 × 8–14 μm; 4,5-dichlorolichexanthone absent.....	15
15	Epihymenium olive-brown or blackish green, N+ black or purple-grey; atranorin absent.....	16
15:	Epihymenium brown, N–; atranorin present.....	17
16	Upper surface glossy; thallus thick, warty or subsquamulose.....	<b>Buellia rechingeri</b>
16:	Upper surface dull; thallus thin, smooth.....	<b>Buellia conspirans</b>
17	Ascospores 15–20 × 7–10 μm; hafellic acid absent.....	<b>Cratiria amphorea</b>
17:	Ascospores 16–23 × 8–14 μm; hafellic acid present.....	<b>Cratiria subtropica</b>
18	Apothecial discs pruinose; pruina UV+ intense red, yellow or orange.....	19
18:	Apothecial discs epruinose or white-pruinose; pruina UV–.....	
19	Ascospores 12–16 per ascus; pruina UV+ orange.....	<b>Stigmatochroma macCarthyi</b>
19:	Ascospores 8 per ascus.....	20

20	Pruina UV+ intense red; parietin present .....	<b>Stigmatochroma epimarta</b>	
20:	Pruina UV+ intense yellow; lichexanthone present .....	<b>Stigmatochroma adaucta</b>	
21	Epihymenium olive-green or blackish green, N+ black or deep purple-grey .....		22
21:	Epihymenium yellow-grey to orange-brown or brown, N-.....		23
22	Ascospore wall rugulate; apothecia usually white-pruinose; atranorin absent.....	<b>Baculifera entochlora</b>	
22:	Ascospore wall smooth or microrugulate; apothecia epruinose; atranorin present .....	<b>Baculifera pseudomicromera</b>	
23	Atranorin absent; thallus K-, PD-.....		24
23:	Atranorin present; thallus K+ yellow, PD+ pale yellow .....		25
24	Apothecia epruinose; epihymenium K+ dark brown to blackish brown; ascospores 15–23 × 7–12 μm .....	<b>Baculifera epifuscenscens</b>	
24:	Apothecia pruinose; epihymenium K-; ascospores 14–25 × 6–9 μm.....	<b>Baculifera intermedioides</b>	
25	Ascospores 17–28 × 7–14 μm; conidia 4–6 μm or 8–11 μm long.....		26
25:	Ascospores 12–21 × 6–8 μm; conidia 4–6 μm long.....		27
26	Ascospores with weak subapical and septal wall-thickenings; conidia 8–11 μm long.....	<b>Baculifera orosa</b>	
26:	Ascospores with weak apical wall-thickenings only; conidia 4–6 μm long .....	<b>Cratiria americana</b>	
27	Disc black; ascospores with strong apical wall-thickenings; paraphyses interspersed with oil droplets.....	<b>Cratiria obscurior</b>	
27:	Disc reddish to black; ascospores with weak apical wall-thickenings; paraphyses not interspersed .....	<b>Cratiria rutilantoides</b>	
28	Thallus K+ yellow, PD+ pale yellow; atranorin present.....		29
28:	Thallus K-, PD-; atranorin absent .....		39
29	Hymenium densely interspersed with oil droplets .....		30
29:	Hymenium not interspersed with oil droplets.....		37
30	Medulla yellow or ochre; secalonic acid B and other pigments present .....	<b>Buellia pigmentosa</b>	
30:	Medulla white; secalonic acid B and other pigments absent.....		31
31	Asci 2-spored.....		32
31:	Asci 3–8-spored.....		33
32	Ascospores 22–42 × 10–16 μm .....	<b>Buellia dissa</b>	
32:	Ascospores 38–61 × 15–24 μm .....	<b>Buellia pseudotetrapla</b>	
33	Asci 3–4-spored .....	<b>Buellia tetrapla</b>	
33:	Asci usually 8-spored .....		34

34	Ascospores with strong subapical wall-thickenings; diploicin present ....	35
34:	Ascospores with weak subapical or apical wall-thickenings; diploicin absent .....	36
35	Ascospore wall rugulate; lumina straight.....	<b>Buellia demutans</b>
35:	Ascospore wall smooth; lumina curved .....	<b>Buellia parastata</b>
36	Ascospores with weak apical wall-thickenings; hafellic acid present .....	<b>Cratiria subtropica</b>
36:	Ascospores with weak subapical wall-thickenings; hafellic acid absent.....	<b>Buellia disciformis</b>
37	Ascospores 13–17 × 5.5–7 μm; epihymenium olive-green or blackish green, N+ black or deep purple-grey .....	<b>Baculifera micromera</b>
37:	Ascospores 16–23 × 7–14 μm; epihymenium brown, N-.....	38
38	Ascospores 7–9 μm wide; conidia filiform, curved, 24–27 μm long.....	<b>Amandinea subduplicata</b>
38:	Ascospores 8–14 μm wide; conidia bacilliform, straight, 4–6 μm long.....	<b>Cratiria verdonii</b>
39	Ascospores <i>Dirinaria</i> - or <i>Mischoblastia</i> -type .....	40
39:	Ascospores <i>Cratiria</i> -, <i>Physconia</i> - or <i>Buellia</i> -type .....	42
40	Ascospores <i>Dirinaria</i> -type, 12–20 × 8–11 μm; thallus bright yellow, K+ orange, C+ orange; xantholepinone A present .....	<b>Endohyalina gillamsensis</b>
40:	Ascospores <i>Mischoblastia</i> -type, 18–31 × 9–18 μm; thallus grey to olive-brown .....	41
41	Medulla pigmented in part, K+ violet; anthraquinones present.....	<b>Sculptolumina japonica</b>
41:	Medulla white throughout, K-.....	<b>Sculptolumina serotina</b>
42	Medulla intense red; chiodectonic acid present .....	43
42:	Medulla white; chiodectonic acid absent.....	44
43	Thallus densely isidiate .....	<b>Gassicurtia blencoensis</b>
43:	Thallus lacking isidia .....	<b>Gassicurtia coccinea</b>
44	Thallus C+ orange, UV+ intense yellow or orange; xanthonenes present ....	45
44:	Thallus C-, UV-; xanthonenes absent .....	59
45	Thallus sorediate.....	46
45:	Thallus esorediate .....	48
46	Ascospores 15–28 × 7–10 μm; thiophanic and gyrophoric acids present .....	<b>Buellia yilliminningensis</b>
46:	Ascospores 10–15 × 4.5–6.5 μm; thiophanic and gyrophoric acids absent .....	47
47	Thallus olive-green; 4,5-dichlorolichexanthone and lobaric acid present ....	<b>Amandinea efflorescens</b> var. <b>efflorescens</b>
47:	Thallus yellow-green to orange-grey; arthothelin and thuringione present.....	<b>Amandinea efflorescens</b> var. <b>pseudohypopelidna</b>



48	Hymenium densely inspersion with oil droplets	49
48:	Hymenium not inspersion with oil droplets	53
49	Apothecial discs pruinose; ascospores with apical wall-thickenings; arthothelin and thuringione present	50
49:	Apothecial discs epruinose; ascospores with subapical wall-thickenings; 4,5-dichlorolichexanthone present	52
50	Excipulum K-.....	<b>Cratiria melanochlora</b>
50:	Excipulum K+ orange-red or red-violet	51
51	Excipulum K+ orange-red; ascospores 17–[22.5]–28 × 8–[10.1]–13 μm	.....
51:	Excipulum K+ red-violet; ascospores 12–[16.9]–20 × 6–[7.6]–10 μm	.....
		<b>Cratiria chloraceus</b>
52	Epihymenium olive-brown, K+ purple	<b>Buellia reagenella</b>
52:	Epihymenium brown to olive-brown, K-	<b>Buellia xanthonica</b>
53	Apothecia grey-brown-pruinose; thiophanic acid present	54
53:	Apothecia epruinose; thiophanic acid present or absent	55
54	Excipulum red in part, K+ violet solution	<b>Gassicurtia pseudosubpulcella</b>
54:	Excipulum brown to red-brown, K+ yellow	<b>Gassicurtia subpulcella</b>
55	Epihymenium red, K+ crimson solution; lichexanthone, barbatic and chiodectonic acids present	<b>Gassicurtia victoriana</b>
55:	Epihymenium brown, no coloured solution with K	56
56	Ascospores 9–13 × 5–8 μm; upper surface UV+ yellow or orange; lichexanthone or thuringione present	57
56:	Ascospores 12–19 × 6–8 μm; upper surface UV+ orange; thiophanic acid present	58
57	Upper surface UV+ orange; thuringione and arthothelin present	.....
57:	Upper surface UV+ yellow; lichexanthone, barbatic and obtusatic acids present	<b>Amandinea diorista</b> var. <b>hypopelidna</b> <b>Gassicurtia catasema</b>
58	Epihymenium K+ intense red-brown; medulla white	<b>Gassicurtia vaccinii</b>
58:	Epihymenium K-; medulla with small patches of dull purple-brown pigment [K-, H <sub>2</sub> SO <sub>4</sub> + blue-violet]	<b>Gassicurtia gallowayi</b>
59	Epihymenium red, K+ crimson solution; ascospores 10–18 × 5–7 μm; barbatic and chiodectonic acids present	<b>Gassicurtia victoriana</b>
59:	Epihymenium K-; ascospores 7–12 × 3–4 μm; testacein present	<b>Buellia testaceina</b>
60	Thallus C-, UV-; xanthonones absent	61
60:	Thallus C+ orange, UV+ intense yellow or orange; xanthonones present	62
61	Medulla white; K+ intense red, K+ yellow or K-; atranorin, bourgeanic or norstictic acids present	<b>Buellia subcoronata</b>
61:	Medulla pigmented red in part; pigmented medulla K+ pale purple	<b>Monerolechia glomerulans</b>

62	Thallus lacking calcium oxalate (H <sub>2</sub> SO <sub>4</sub> -); arthothelin and thuringione present	<b>Buellia</b> sp. <b>A*</b>
62:	Thallus containing calcium oxalate (H <sub>2</sub> SO <sub>4</sub> +); arthothelin present, thuringione present or absent	63
63	Ascospores more than 9.5 μm wide; thallus effigurate-lobate	<b>Buellia georgei</b>
63:	Ascospores to 9.5 μm wide; thallus effigurate-lobate or crustose-squamulose	64
64	Thallus effigurate-lobate; arthothelin and thuringione present	.....
64:	Thallus crustose to squamulose; arthothelin present, thuringione absent	<b>Buellia lobata</b> <b>Buellia dijiana</b>

### Key C

1	Ascospores 3-septate or submuriform; on limestone	2
1:	Ascospores 1-septate; on limestone or siliceous rocks	3
2	Ascospores submuriform	<b>Diplotomma albostratum</b>
2:	Ascospores 3-septate	<b>Diplotomma venustum</b>
3	Upper surface granular-sorediate	<b>Buellia amandineaformis</b>
3:	Upper surface not sorediate	4
4	Thallus growing on limestone	5
4:	Thallus growing on siliceous rocks	7
5	Apothecia lecanorine; ascospores <i>Rinodinella</i> -type, 12–21 × 5–7 μm	.....
5:	Apothecia lecideine; ascospores <i>Buellia</i> -type, 8–15 × 4–9 μm	<b>Rinodinella dubyanoides</b> 6
6	Epihymenium aeruginose, N+ violet	<b>Buellia subalbula</b>
6:	Epihymenium brown, N-	<b>Buellia albula</b>
7	Thallus initially lichenicolous; crustose or squamulose	8
7:	Thallus never lichenicolous; crustose or endolithic	9
8	Areoles and/or squamules aggregated to form elevated, broccoli-like glomerules; medulla often pigmented red-orange in patches	<b>Monerolechia glomerulans</b>
8:	Areoles and/or squamules not aggregated or forming elevated glomerules; medulla white	<b>Monerolechia badia</b>
9	Thallus epilithic, crustose	10
9:	Thallus endolithic, not apparent, or with few, scattered, thalline flecks	34
10	Epihymenium aeruginose, N+ violet; on montane rocks	.....
10:	Epihymenium brown, N- or N+ greenish black then orange-brown	<b>Buellia epiaeruginosa</b> 11
11	Ascospores with marked medial wall-thickenings, <i>Orcularia</i> - to <i>Physconia</i> -type; conidia curved, filiform	12
11:	Ascospores without medial wall-thickenings or with weak medial wall-thickenings during spore ontogeny, <i>Buellia</i> -type; conidia straight, bacilliform or curved, filiform	15

12	Apothecia to 1 mm diam., often pruinose.....	13
12:	Apothecia to 0.6 mm diam., not pruinose.....	14
13	Ascospores 14–18 × 6–9 μm; subhymenium inspersed; with or without SV-1.....	<b>Amandinea variabilis</b>
13:	Ascospores 17–23 × 10–14 μm; subhymenium not inspersed with oil droplets; with or without variolaric acid.....	<b>Amandinea decedens</b>
14	Apothecia immersed; thallus cream-coloured to pale brown, weakly verrucose; ascospores 7.5–10 μm wide.....	<b>Amandinea otagensis</b>
14:	Apothecia broadly adnate; thallus dirty white to grey-brown, rimose-areolate; ascospores 6–8 μm wide.....	<b>Amandinea pelidna</b>
15	On coastal and lowland rocks.....	16
15:	On montane rocks.....	31
16	Ascospores <i>Buellia</i> -type, without medial wall-thickenings.....	17
16:	Ascospores with weak medial wall-thickenings during spore ontogeny, but soon disappearing.....	21
17	Conidia bacilliform, straight, 3–6 μm long.....	18
17:	Conidia filiform, curved, 12–30 μm long.....	20
18	Thallus lacking calcium oxalate (H <sub>2</sub> SO <sub>4</sub> -).....	<b>Buellia sp. B*</b>
18:	Thallus containing calcium oxalate (H <sub>2</sub> SO <sub>4</sub> +).....	19
19	Thallus thick, corticate, continuous.....	<b>Buellia cranwelliae</b>
19:	Thallus of scattered ecorticate areoles.....	<b>Buellia poolensis</b>
20	Mature ascospores not constricted at septum; prothallus usually absent; conidia 12–18 μm long.....	<b>Amandinea punctata</b>
20:	Mature ascospores constricted at septum; prothallus broad, marginal; conidia 20–30 μm long.....	<b>Amandinea prothallinata</b>
21	Ascospores 12–25 × 7–16 μm.....	22
21:	Ascospores 10–16 × 5–9 μm.....	24
22	Medulla I+ blue; ascospores 15–26 × 8–14 μm... ..	<b>Amandinea austroconiops</b>
22:	Medulla I-.....	23
23	Ascospores often curved, 18–[21.8]–25 × 10–[12.8]–16 μm; spore-wall rugulate.....	<b>Amandinea destituta</b>
23:	Ascospores not curved, 12–[16.5]–22 × 7–[8.5]–11 μm; spore-wall microrugulate.....	<b>Amandinea coniops</b>
24	Ascospores 12–16 × 6–9 μm, elongate-ellipsoidal.....	25
24:	Ascospores 10–13 × 5–7 μm, broadly ellipsoidal.....	28
25	Conidia bacilliform, straight, 5–8 μm long.....	<b>Buellia mayrhoferae</b>
25:	Conidia filiform, curved, 15–30 μm long.....	26

26	Subhymenium inspersed with oil droplets; thallus fragmentary or absent.....	<b>Amandinea conglomerata</b>
26:	Subhymenium not inspersed with oil droplets; thallus thick or rimose-areolate.....	27
27	Mature ascospores often constricted; thallus thick, warty; prothallus absent; apothecia to 1.5 mm wide.....	<b>Amandinea litoralis</b>
27:	Mature ascospores not or very rarely constricted; thallus thin, rimose-areolate; prothallus often black and prominent; apothecia to 0.8 mm wide.....	<b>Amandinea fuscoatratura</b>
28	Ascospores often constricted; prothallus pale or absent.....	<b>Amandinea australasica</b>
28:	Ascospores not constricted.....	29
29	Thallus discontinuous, verruculose to granulose, white to pale orange; prothallus absent; thallus containing orange pigment.....	<b>Amandinea vitellina</b>
29:	Thallus rimose-areolate, continuous, grey to brown or dark brown; prothallus often present; orange pigment present or absent.....	30
30	Thallus brown or dark brown; prothallus often dark and prominent; disc epruinose; thallus lacking orange pigment.....	<b>Amandinea brunneola</b>
30:	Thallus white to pale grey-brown; prothallus grey-white or not apparent; disc often grey-white-pruinose; thallus containing orange pigment.....	<b>Amandinea julianae</b>
31	Medulla I+ blue; ascospores 15–27 × 8–14 μm... ..	<b>Amandinea austroconiops</b>
31:	Medulla I-.....	32
32	Ascospores 10–13 × 5–8 μm; thallus effuse or membranaceous.....	<b>Amandinea nebulosa</b>
32:	Ascospores 12–20 × 6–10 μm; thallus thick, rimose-areolate or verrucose.....	33
33	Conidia curved, filiform, 20–30 μm long; thallus thick, of congested verrucules.....	<b>Amandinea isabellina</b>
33:	Conidia straight, bacilliform, 8–13 μm long; thallus rimose-areolate.....	<b>Buellia ewersii</b>
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34:	On coastal and hinterland rocks; subhymenium inspersed or not.....	35
35	Subhymenium inspersed with oil droplets or granules.....	36
35:	Subhymenium not inspersed with oil droplets or granules.....	37
36	Subhymenium inspersed with oil droplets; ascospores 11–17 μm long; thallus containing calcium oxalate (H <sub>2</sub> SO <sub>4</sub> +) and orange pigment... ..	<b>Amandinea conglomerata</b>
36:	Subhymenium inspersed with granules and oil droplets; ascospores 8–15 μm long; thallus lacking calcium oxalate (H <sub>2</sub> SO <sub>4</sub> -) and orange pigment.....	<b>Amandinea neoconglomerata</b>
37	Ascospores 12–15 × 6–8 μm.....	38
37:	Ascospores 8–14 × 3–7 μm.....	39

38	Ascospores constricted; conidia straight, bacilliform, 3–6 $\mu\text{m}$ long .....	<b>Buellia sp. C*</b>
38:	Ascospores not constricted; conidia curved, filiform, 12–18 $\mu\text{m}$ long .....	<b>Amandinea punctata</b>
39	Thallus containing calcium oxalate ( $\text{H}_2\text{SO}_4+$ ) .....	<b>Buellia austroabstracta</b>
39:	Thallus lacking calcium oxalate ( $\text{H}_2\text{SO}_4-$ ) .....	40
40	Conidia bacilliform, 3–5 $\mu\text{m}$ long; ascospores 5–7 $\mu\text{m}$ wide .....	<b>Buellia sp. B*</b>
40:	Conidia curved, filiform, 15–30 $\mu\text{m}$ long; ascospores 4–[4.9]–5.5 $\mu\text{m}$ wide ..	<b>Amandinea sp. A*</b>

#### Key D

1	Ascospores 1–3-septate or submuriform .....	2
1:	Ascospores 1-septate .....	7
2	Epihymenium brown, N–; ascospores 1–3-septate or submuriform .....	3
2:	Epihymenium aeruginose, N+ violet; ascospores submuriform .....	6
3	Thallus K+ red, C–; norstictic acid present; ascospores submuriform .....	
3:	Thallus K–, C+ orange; arthothelin present; ascospores 1–3-septate .....	4
4	Ascospores usually 3-septate, not curved, 12–18 $\times$ 5–7.5 $\mu\text{m}$ ; Qld .....	
4:	Ascospores rarely 2- or 3-septate, often curved; A.C.T. or Tas. ....	5
5	Ascospores 19–30 $\times$ 7–13 $\mu\text{m}$ ; Tas. ....	<b>Tetramelas allisoniae</b>
5:	Ascospores 15–22 $\times$ 6–9 $\mu\text{m}$ ; A.C.T. ....	<b>Tetramelas concinnus</b>
6	Thallus K–, C+ orange; isoarthothelin present; coastal .....	<b>Buellia aeruginosa</b>
6:	Thallus K+ red, C–; norstictic acid present; montane ...	<b>Buellia bogongensis</b>
7	Thallus sorediate, bright yellow; rhizocarpic acid present .....	
7:	Thallus esorediate; rhizocarpic acid absent .....	8
8	Thallus K+ red; norstictic acid present .....	9
8:	Thallus K+ yellow or K–; norstictic acid absent .....	30
9	Hymenium or subhymenium interspersed with oil droplets .....	10
9:	Hymenium and subhymenium not interspersed with oil droplets .....	13
10	Epihymenium K+ violet; Tas. ....	<b>Buellia claricollina</b>
10:	Epihymenium brown or aeruginose, K– .....	11
11	Epihymenium aeruginose; N+ red-violet; A.C.T., Tas. ....	<b>Buellia patearoana</b>
11:	Epihymenium brown, N–; Qld, N.T. ....	12
12	Apothecia adnate to sessile: medulla I– .....	<b>Cratiria vioxanthina</b>
12:	Apothecia immersed; medulla I+ blue-violet .....	<b>Cratiria burleighensis</b>
13	Thallus growing on limestone .....	14
13:	Thallus growing on siliceous rocks .....	16

14	Epihymenium brown, N– .....	<b>Buellia albula</b>
14:	Epihymenium aeruginose, N+ violet .....	15
15	Medulla containing calcium oxalate ( $\text{H}_2\text{SO}_4+$ ); atranorin absent .....	
15:	Medulla lacking calcium oxalate, ( $\text{H}_2\text{SO}_4-$ ); atranorin present .....	<b>Buellia subalbula</b>
		<b>Buellia fluviicygnorum</b>
16	Thallus squamulose, initially lichenicolous .....	<b>Monerolechia norstictica</b>
16:	Thallus crustose, not lichenicolous .....	17
17	Epihymenium aeruginose, N+ violet or purple-brown .....	18
17:	Epihymenium brown, N– .....	22
18	Medulla containing calcium oxalate ( $\text{H}_2\text{SO}_4+$ ); atranorin absent .....	19
18:	Medulla lacking calcium oxalate ( $\text{H}_2\text{SO}_4-$ ); atranorin present or absent .....	20
19	Apothecial discs epruinose; subhymenium not interspersed with oil droplets .....	
19:	Apothecial discs white-pruinose; subhymenium interspersed ..	<b>Rinodinella fertilis</b> var. <b>fertilis</b>
		<b>Buellia kantvilasii</b>
20	Apothecia remaining immersed; atranorin absent .....	<b>Buellia aethalea</b>
20:	Apothecia superficial at maturity; atranorin present or absent .....	21
21	Ascospores 10–16 $\times$ 5–8 $\mu\text{m}$ , rarely constricted .....	
21:	Ascospores 12–20 $\times$ 6–10 $\mu\text{m}$ , often constricted .....	<b>Buellia spuria</b> var. <b>amblyogona</b>
		<b>Buellia homophylia</b>
22	Medulla containing calcium oxalate ( $\text{H}_2\text{SO}_4+$ ) .....	23
22:	Medulla lacking calcium oxalate ( $\text{H}_2\text{SO}_4-$ ) .....	24
23	Thallus endolithic or consisting of fragmentary, ecorticate, white flecks .....	
23:	Thallus epilithic, consisting of convex, verrucose areoles .....	<b>Amandinea feraxioides</b>
		<b>Buellia maunakeensis</b>
24	Thallus UV+ orange; 4,5-dichlorolichexanthone present; apothecia initially lecanorine or cryptolecanorine .....	<b>Buellia mamillana</b>
24:	Thallus UV–; 4,5-dichlorolichexanthone absent; apothecia lecideine .....	25
25	Thallus endolithic and not apparent .....	26
25:	Thallus epilithic, crustose .....	27
26	Ascospores 8–12 $\times$ 4–7 $\mu\text{m}$ .....	<b>Buellia sp. D*</b>
26:	Ascospores 10–14 $\times$ 6–9 $\mu\text{m}$ .....	<b>Buellia northallina</b>
27	Apothecia remaining immersed; atranorin present; montane .....	
27:	Apothecia superficial at maturity; atranorin absent; lowland or coastal ..	<b>Buellia austroalpina</b>
		28
28	Conidia filiform, curved, 15–30 $\mu\text{m}$ long; prothallus black, marginal; on coastal rocks .....	<b>Amandinea devilliersiana</b>
28:	Conidia bacilliform, straight, 4–10 $\mu\text{m}$ long; prothallus absent; on hinterland rocks .....	29

29	Ascospores 5–7 $\mu\text{m}$ wide; conidia 4–6 $\mu\text{m}$ long; mainland .....	<b>Buellia kimberleyana</b>
29:	Ascospores 7–9 $\mu\text{m}$ wide; conidia 8–10 $\mu\text{m}$ long; Tas .....	<b>Buellia austera</b>
30	Thallus K+ yellow or K+ yellow then pale red; atranorin or hypostictic acid present .....	31
30:	Thallus K–; atranorin and hypostictic acid absent .....	55
31	Thallus growing on limestone; subhypotheceum red... <b>Buellia cinnabarina</b>	
31:	Thallus growing on siliceous rocks; subhypotheceum brown or brown-black .....	32
32	Hymenium densely inspersioned with oil droplets .....	<b>Buellia procellarum</b>
32:	Hymenium not inspersioned with oil droplets .....	33
33	Epithymenium aeruginose, N+ violet or purple-brown .....	34
33:	Epithymenium brown, N– .....	43
34	Medulla containing calcium oxalate ( $\text{H}_2\text{SO}_4+$ ); atranorin present or not ..	35
34:	Medulla lacking calcium oxalate ( $\text{H}_2\text{SO}_4-$ ); atranorin present .....	36
35	Ascospores <i>Rinodinella</i> -type, 10–15 $\times$ 5–8 $\mu\text{m}$ ; hypostictic acid present .....	
	..... <b>Rinodinella fertilis</b> var. <b>hypostictica</b>	
35:	Ascospores <i>Physconia</i> - then <i>Buellia</i> -type, 13–20 $\times$ 7–10 $\mu\text{m}$ ; atranorin and 2'- <i>O</i> -methyl-perlatolic acid present .....	<b>Buellia ecclesensis</b>
36	Thallus K+ yellow then pale red; hypostictic acid present .....	
	..... <b>Buellia inturgescens</b>	
36:	Thallus K+ yellow or yellow-orange; hypostictic acid absent .....	37
37	Apothecia adnate to sessile .....	38
37:	Apothecia immersed, rarely becoming adnate .....	41
38	Thallus K+ yellow; PD+ pale yellow; only atranorin present .....	
	..... <b>Buellia cranfieldii</b>	
38:	Thallus K+ intense yellow or yellow-orange; PD+ deep yellow or orange; pannarin, stictic or psoromic acids present .....	39
39	Thallus K+ intense yellow; PD+ yellow; psoromic acid present .....	
	..... <b>Buellia psoromica</b>	
39:	Thallus K+ yellow-orange; PD+ orange; stictic acid or pannarin present ..	40
40	Ascospores 10–16 $\times$ 5–8 $\mu\text{m}$ ; stictic acid present.. <b>Buellia spuria</b> var. <b>spuria</b>	
40:	Ascospores 16–28 $\times$ 8–12 $\mu\text{m}$ ; pannarin present .....	<b>Buellia pannarina</b>
41	Ascospores 15–23 $\times$ 8–12 $\mu\text{m}$ ; diploicin present .....	<b>Buellia tinderryensis</b>
41:	Ascospores 9–15 $\times$ 5–8 $\mu\text{m}$ ; diploicin absent .....	42
42	Thallus with atranorin, $\pm$ roccellic acid .....	<b>Buellia stellulata</b> var. <b>tasmanica</b>
42:	Thallus with atranorin, 2'- <i>O</i> -methylperlatolic, $\pm$ confluent, $\pm$ roccellic acids .....	<b>Buellia stellulata</b> var. <b>stellulata</b>
43	Thallus subcrustose, placodioid, bullate-areolate or squamulose .....	44
43:	Thallus crustose .....	47

44	Thallus bullate-areolate to squamulose; 2'- <i>O</i> -methylperlatolic acid present .....	<b>Buellia dispersa</b>
44:	Thallus placodioid, effigurate-lobate; diploicin present .....	45
45	Thallus esorediate .....	<b>Diploicia africana</b>
45:	Thallus soresediate .....	46
46	Buellolide and canseolide present .. <b>Diploicia canescens</b> subsp. <b>australasica</b>	
46:	Buellolide and canseolide absent.... <b>Diploicia canescens</b> subsp. <b>canescens</b>	
47	Medulla containing calcium oxalate ( $\text{H}_2\text{SO}_4+$ ); hafellic acid present .....	
	..... <b>Buellia fallax</b>	
47:	Medulla lacking calcium oxalate ( $\text{H}_2\text{SO}_4-$ ); hafellic acid absent .....	48
48	Thallus C+ orange, UV+ orange; xanthonones present .....	49
48:	Thallus C–, UV–; xanthonones absent .....	51
49	Ascospores subglobose, 7–9 $\times$ 6–7 $\mu\text{m}$ ; thuringione present .....	
	..... <b>Buellia desertorum</b>	
49:	Ascospores ellipsoid, 12–23 $\times$ 6–12 $\mu\text{m}$ ; 2,5,7-trichloro-3- <i>O</i> -methylnorlich-exanthonone present .....	50
50	Ascospores 12–17 $\times$ 6–9 $\mu\text{m}$ ; subhymenium not inspersioned with oil droplets .....	<b>Buellia subarenaria</b>
50:	Ascospores 16–22 $\times$ 8–11 $\mu\text{m}$ ; subhymenium inspersioned .....	<b>Buellia arenaria</b>
51	Apothecia adnate to sessile; medulla white .....	52
51:	Apothecia mainly immersed, rarely becoming adnate; medulla white or pigmented .....	53
52	Ascospores 10–15 $\times$ 4–6 $\mu\text{m}$ , often curved; thallus fragmentary .....	
	..... <b>Buellia durackensis</b>	
52:	Ascospores 16–22 $\times$ 8–10 $\mu\text{m}$ , not curved; thallus rimose, continuous .....	
	..... <b>Buellia herveyensis</b>	
53	Lower medulla orange-brown; pigmented medulla I+ blue-violet; ascospores <i>Physconia</i> - then <i>Buellia</i> -type .....	<b>Buellia maficola</b>
53:	Medulla white throughout, I– .....	54
54	Hymenium inspersioned with oil droplets; medulla PD+ orange; stictic acid present; ascospores straight, <i>Cratiria</i> - then <i>Buellia</i> -type; tropical .....	
	..... <b>Cratiria streimanii</b>	
54:	Hymenium not inspersioned; medulla PD+ pale yellow; stictic acid absent; ascospores often curved, <i>Callispora</i> - then <i>Buellia</i> -type; subtropical .....	
	..... <b>Buellia insularicola</b>	
55	Thallus C+ red, UV–; gyrophoric, $\pm$ 5- <i>O</i> -methylhiassic acids present .....	56
55:	Thallus C+ orange or C–, UV+ or UV–; gyrophoric and 5- <i>O</i> -methylhiassic acids absent .....	58
56	Ascospores <i>Mischoblastia</i> -type, 16–24 $\times$ 9–14 $\mu\text{m}$ .....	<b>Buellia sp. E*</b>
56:	Ascospores <i>Buellia</i> -type, 7–20 $\times$ 4–10 $\mu\text{m}$ .....	57

57 Apothecia lecideine; subhymenium inspersed with oil droplets; conidia bacilliform, straight, 5–11 $\mu\text{m}$ long; margins not radiate-plicate .....	<b>Buellia poimeneae</b>
57: Apothecia lecanorine to biatorine; subhymenium not inspersed; conidia filiform, curved, 14–25 $\mu\text{m}$ long; margins often radiate-plicate .....	<b>Australiaena streimannii</b>
58 Ascospores <i>Dirinaria</i> -type .....	59
58: Ascospores <i>Buellia</i> -type or <i>Physconia</i> -type .....	60
59 Thallus autonomous; hymenium densely inspersed with oil droplets; prothallus black, marginal; diploicin and xantholepinone A present .....	<b>Endohyalina arachniformis</b>
59: Thallus lichenicolous on <i>Lecanora</i> sp.; hymenium not inspersed; diploicin present, xantholepinone A absent .....	<b>Endohyalina insularis</b>
60 Thallus C+ orange, UV+ orange; xanthonenes present .....	61
60: Thallus C–, UV–; xanthonenes absent .....	78
61 Medulla containing calcium oxalate ( $\text{H}_2\text{SO}_4^+$ ) .....	62
61: Medulla lacking calcium oxalate ( $\text{H}_2\text{SO}_4^-$ ) .....	64
62 Epithymenium N+ violet; arthothelin present; on siliceous rocks .....	<b>Buellia halonioides</b>
62: Epithymenium brown, N–; arthothelin present or absent; on limestone or siliceous rocks .....	63
63 Ascospores 16–24 $\times$ 9–14 $\mu\text{m}$ ; arthothelin present; on limestone .....	<b>Buellia georgei</b>
63: Ascospores 11–20 $\times$ 6–10 $\mu\text{m}$ ; 2,5,7-trichloro-3- <i>O</i> -methylnorlichexanthone present; on siliceous rocks or limestone .....	<b>Buellia xantholeuca</b>
64 Apothecia initially lecanorine or cryptolecanorine .....	65
64: Apothecia always lecideine .....	67
65 Epithymenium N+ purple; disc densely pruinose; arthothelin present .....	<b>Buellia weberi</b>
65: Epithymenium N–; disc epruinose; 4,5-dichlorolichexanthone present .....	66
66 Conidia filiform, curved; lobaric, perlatolic or gyrophoric acids present .....	<b>Australiaena streimannii</b>
66: Conidia bacilliform, straight; stictic acid present .....	<b>Buellia mamillana</b>
67 Ascospores <i>Orcularia</i> - then <i>Physconia</i> -type; conidia curved, filiform, 15–25 $\mu\text{m}$ long .....	<b>Amandinea prospersa</b>
67: Ascospores <i>Physconia</i> - or <i>Buellia</i> -type; conidia straight, bacilliform, 4–12 $\mu\text{m}$ long .....	68
68 Subhypotheceum red or red-brown, K+ intense red solution .....	<b>Buellia hyporosea</b>
68: Subhypotheceum brown, K– .....	69
69 Medulla I+ blue-violet .....	70
69: Medulla I– .....	72

70 Ascospores 10–18 $\times$ 6–11 $\mu\text{m}$ ; epithymenium aeruginose, N+ violet .....	<b>Buellia macveanii</b>
70: Ascospores 15–30 $\times$ 6–13 $\mu\text{m}$ ; epithymenium brown, N– .....	71
71 Ascospores 19–30 $\times$ 7–13 $\mu\text{m}$ ; Tas. ....	<b>Tetramelas allisoniae</b>
71: Ascospores 15–22 $\times$ 6–9 $\mu\text{m}$ ; A.C.T. ....	<b>Tetramelas concinnus</b>
72 Ascospores <i>Physconia</i> -type; disc often pruinose; subhymenium pale brown .....	73
72: Ascospores <i>Buellia</i> -type; disc epruinose; subhymenium greenish or brown .....	74
73 Epithymenium N+ violet; isoarthothelin and roccellic acid present .....	<b>Buellia halonia</b>
73: Epithymenium brown, N–; 2,5,7-trichloro-3- <i>O</i> -methylnorlichexanthone present .....	<b>Buellia subarenaria</b>
74 Conidia 8–12 $\mu\text{m}$ long; subhymenium pale brown; 4,5-dichlorolichexanthone or 3- <i>O</i> -methylthiophanic acid present; tropical .....	75
74: Conidia 4–9 $\mu\text{m}$ long; subhymenium greenish; arthothelin present; subalpine or alpine .....	77
75 Ascospores 15–23 $\times$ 7–12 $\mu\text{m}$ ; 4,5-dichlorolichexanthone present .....	<b>Buellia dimbulahensis</b>
75: Ascospores 10–16 $\times$ 5–9 $\mu\text{m}$ ; 3- <i>O</i> -methylthiophanic acid and derivatives present .....	76
76 Upper surface with globose isidia .....	<b>Buellia polyxanthonica</b> var. <b>isidiata</b>
76: Upper surface not isidiate .....	<b>Buellia polyxanthonica</b> var. <b>polyxanthonica</b>
77 Conidia 4–6 $\mu\text{m}$ long; thallus margins not placodioid; montane-subalpine .....	<b>Buellia ocellata</b>
77: Conidia 6–9 $\mu\text{m}$ long; thallus margins placodioid; alpine .....	<b>Buellia jugorum</b>
78 Thallus squamulose to lobulate; margins not radiate-plicate; apothecia lecideine; conidia bacilliform, straight, 4–7 $\mu\text{m}$ long; confluent acid present .....	<b>Buellia bohleensis</b>
78: Thallus crustose; margins often radiate-plicate; apothecia lecanorine to biatorine; conidia filiform, curved 14–25 $\mu\text{m}$ long; lobaric, perlatolic or gyrophoric acids present .....	<b>Australiaena streimannii</b>

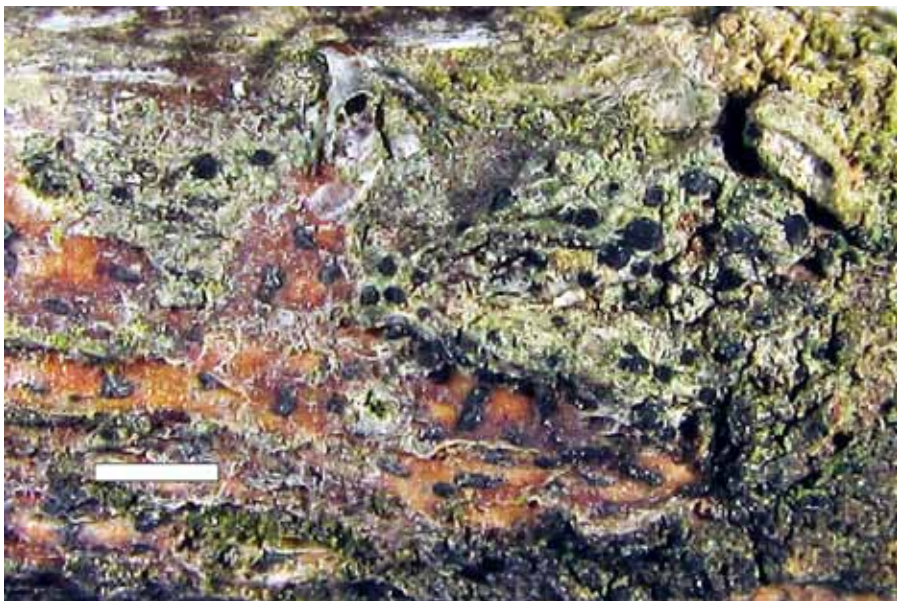


Figure 1. *Amandinea conranensis* (holotype in CANB). Scale = 1 mm.

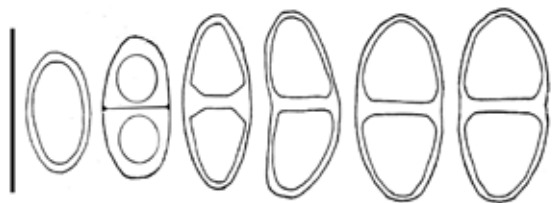


Figure 2. Ascospore ontogeny of *A. conranensis*. Scale = 10  $\mu$ m.

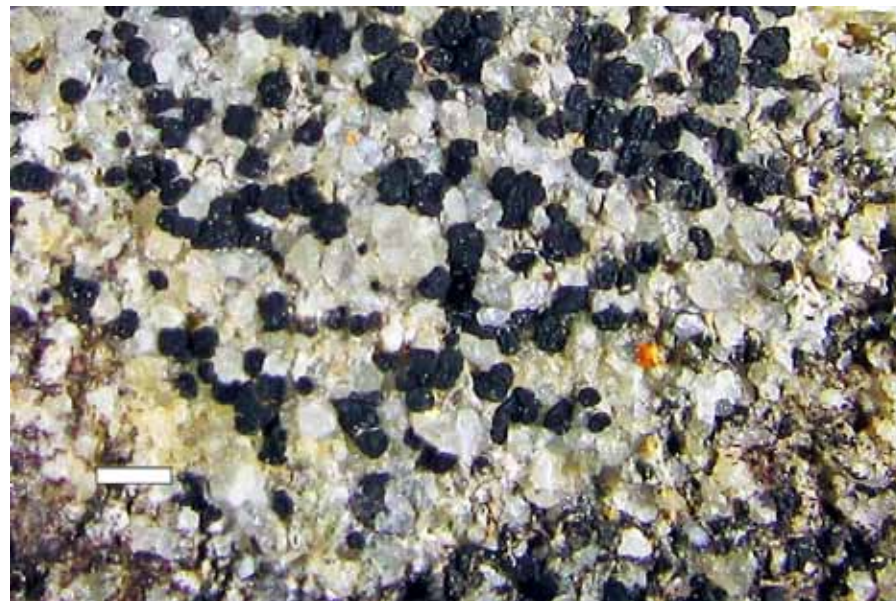


Figure 3. *Amandinea feraxioides* (holotype in HO). Scale = 1 mm.

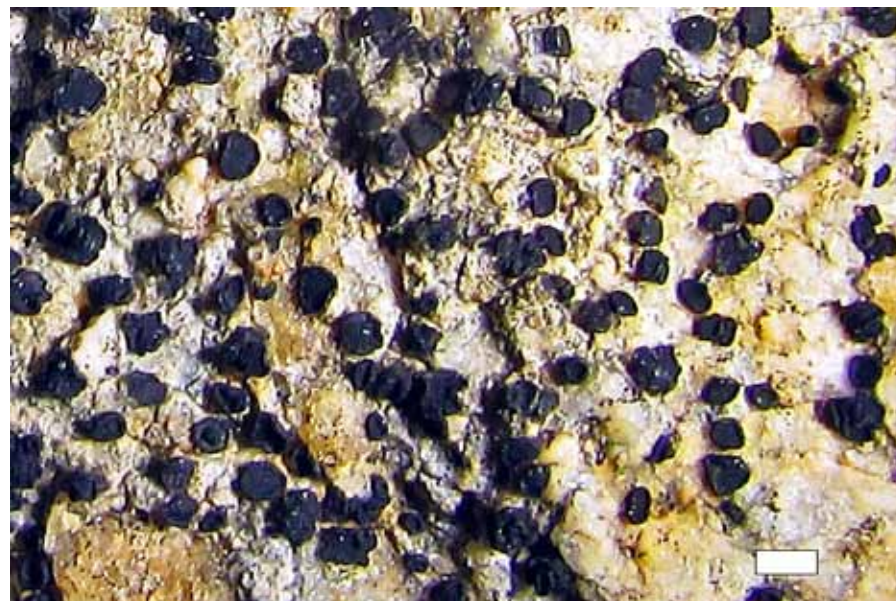


Figure 4. *Amandinea neoconglomerata* (holotype in CANB). Scale = 1 mm.

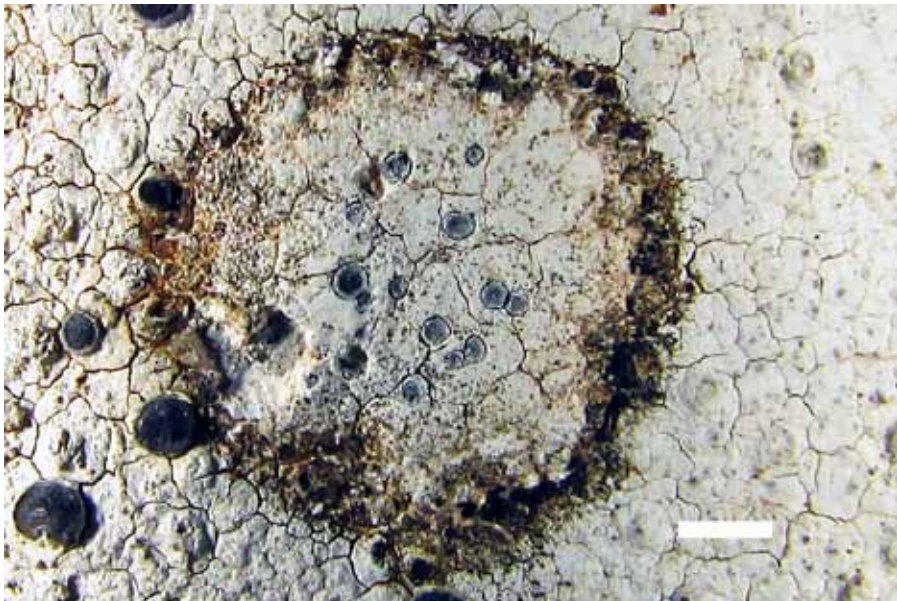


Figure 5. *Buellia albulella* (holotype in CANB). Scale = 1 mm.

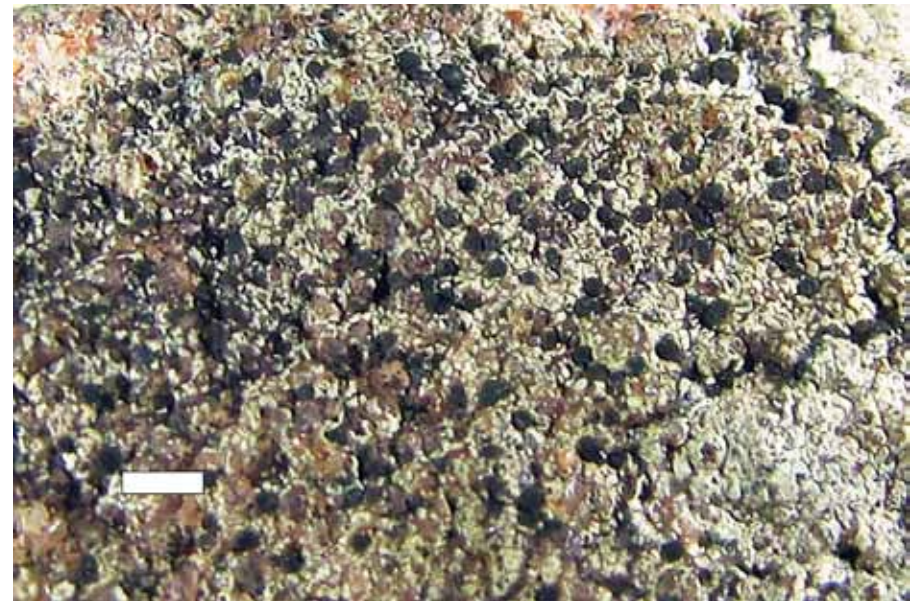


Figure 7. *Buellia durackensis* (holotype in CANB). Scale = 1 mm.



Figure 6. *Buellia austroabstracta* (holotype in HO). Scale = 1 mm.



Figure 8. *Buellia ecclesensis* (holotype in CANB). Scale = 1 mm.



Figure 9. *Buellia halonioides* (holotype in CANB). Scale = 1 mm.

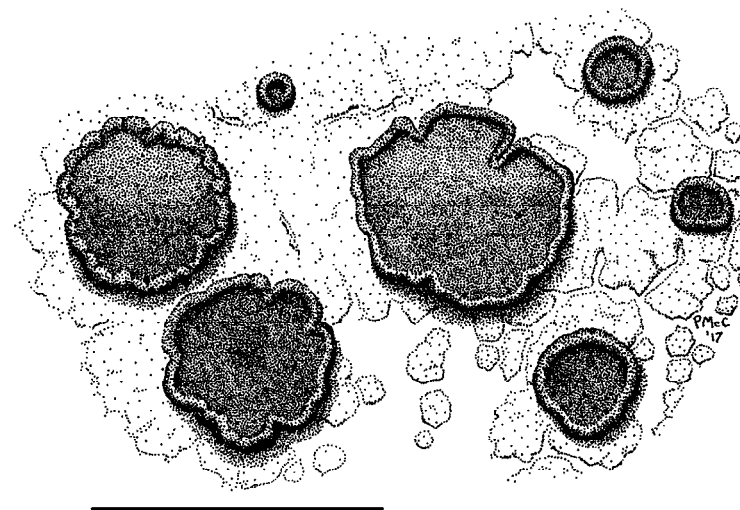


Figure 11. *Buellia poolensis* (holotype in CANB). Scale = 1 mm.



Figure 10. *Buellia northallina* (isotype in CANB). Scale = 1 mm.

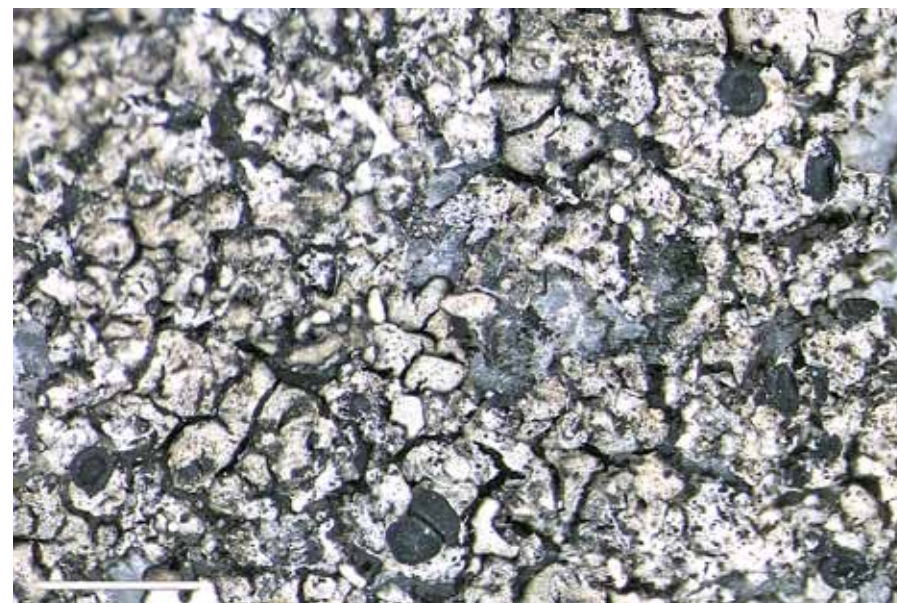


Figure 12. *Buellia servilosina* (holotype in HO). Scale = 1 mm.



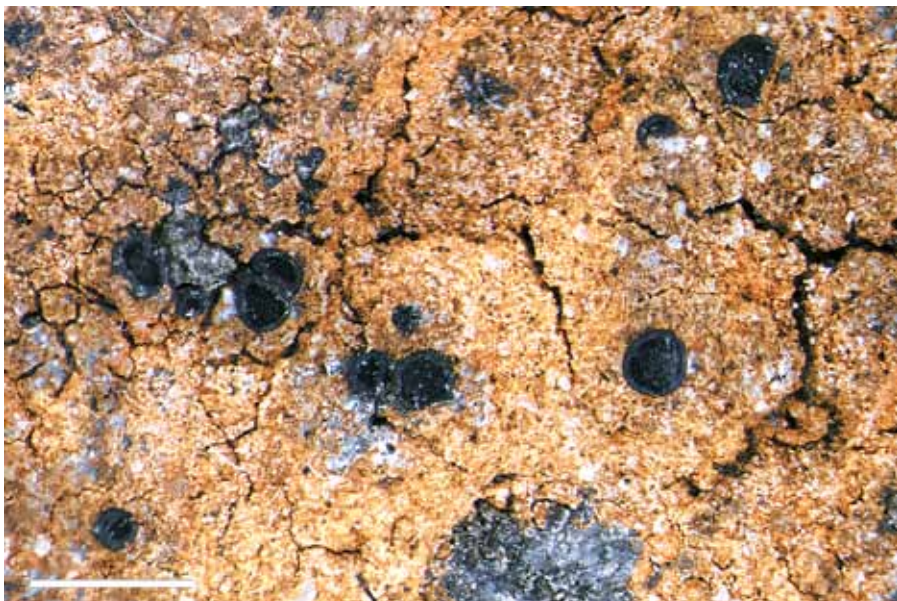


Figure 13. *Buellia subadjuncta* (holotype in HO). Scale = 1 mm.

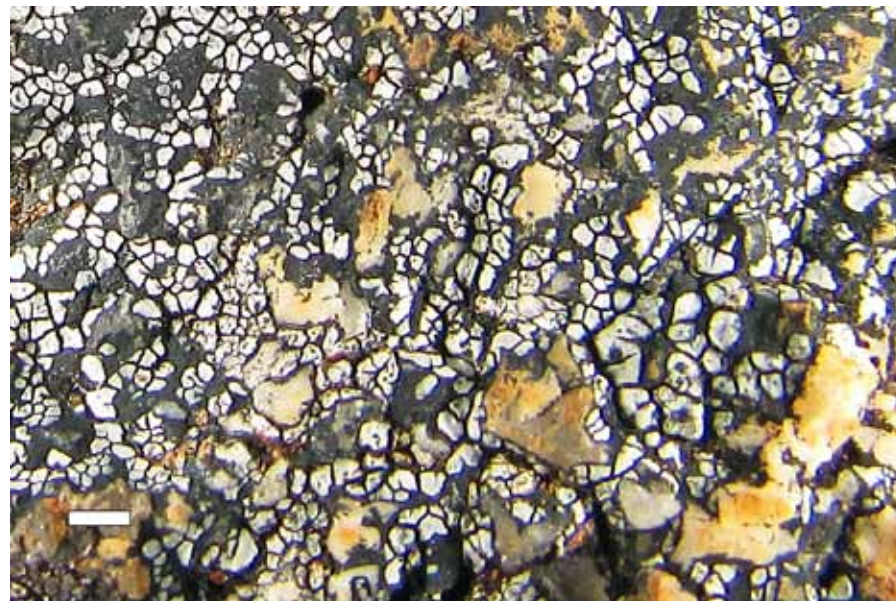


Figure 15. *Buellia tinderryensis* (holotype in CANB). Scale = 1 mm.



Figure 14. Ascospore ontogeny of *B. subadjuncta*. Scale = 10  $\mu$ m.

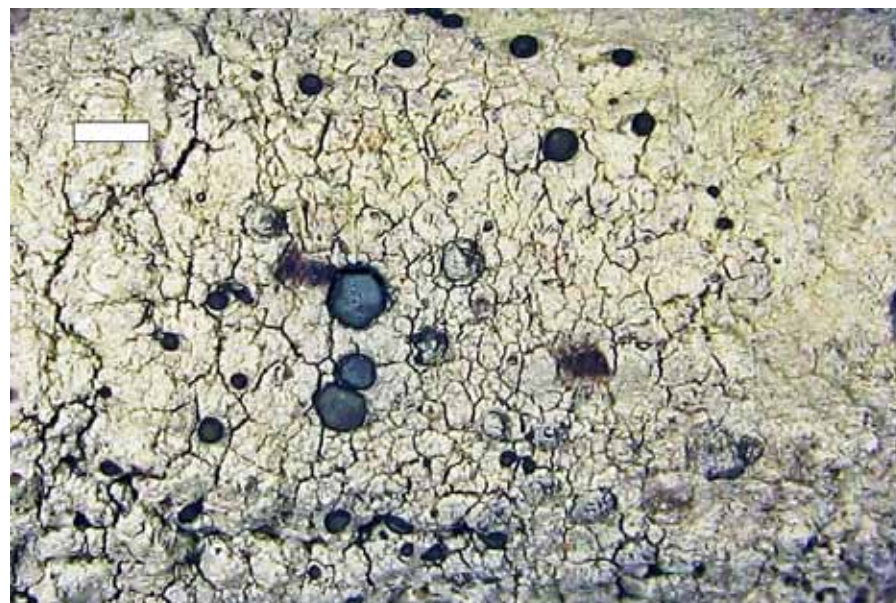


Figure 16. *Cratiria chloraceus* (Elix 15965 in CANB). Scale = 1 mm.



Figure 17. *Sculptolumina serotina* (Hafellner 16314 in GZU). Scale = 1 mm.

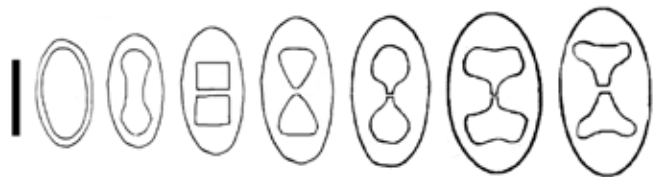


Figure 18. Ascospore ontogeny of *S. serotina*. Scale = 10  $\mu$ m.

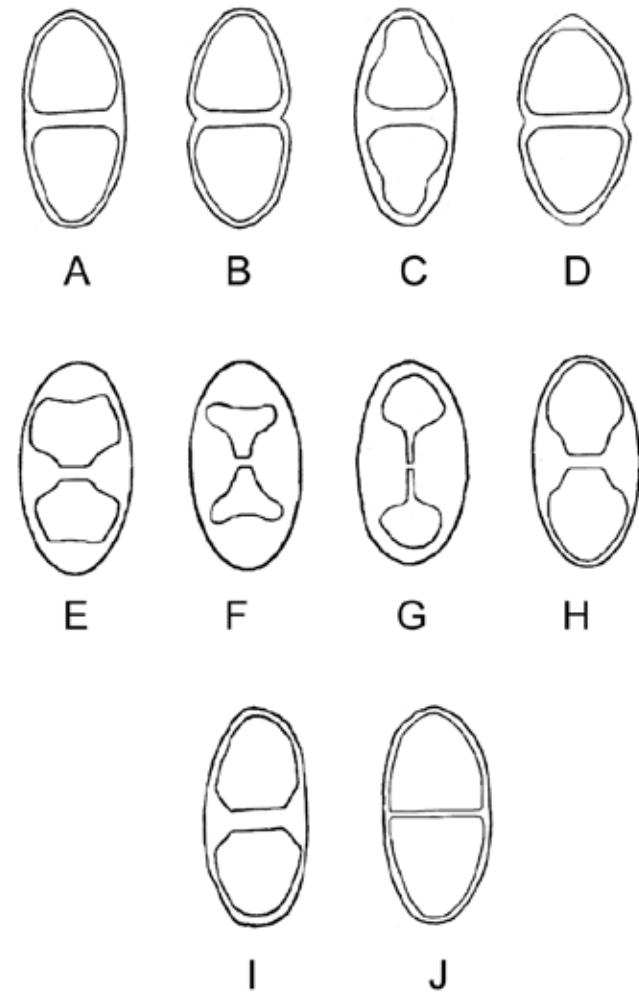


Figure 19. Types of ascospores. A = *Buellia*-type; B = *Buellia*-type (constricted); C = *Callispora*-type; D = *Cratiria*-type; E = *Dirinaria*-type; F = *Mischoblastia*-type; G = *Orcularia*-type; H, I = *Physconia*-type; J = *Rinodinella*-type.

### Three new species and eight new records of saxicolous buellioid lichens (Caliciaceae, Ascomycota) from New Zealand's Subantarctic Islands

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#### Abstract

*Amandinea antipodensis* Elix, *A. hypopallida* Elix and *Buellia prothallina* Elix are described as new to science. *Amandinea austroconiops* Elix & Kantvilas, *A. litoralis* (Zahlbr.) Elix & H.Mayrhofer, *A. nitrophila* (Zahlbr.) Elix, *A. subcervina* (Nyl.) Elix and *A. variabilis* (Zahlbr.) Elix, Blaha & H.Mayrhofer are reported for the first time from Campbell Island. *Buellia hypopurpurea* Elix & A.Knight, *B. stellulata* (Taylor) Mudd var. *stellulata* and *Monerolechia badia* (Fr.) Kalb are new records for Antipodes Island. A key is provided for the saxicolous species collected on New Zealand's subantarctic islands.

The Antipodes, Auckland, Campbell and Snares Islands and associated islets are subantarctic islands located in the Southern Ocean between New Zealand and Antarctica. The Auckland Islands (Motu Maha) lie approximately 360 km south of Stewart Island (Rakiura) at 50°41'S, 166°16'E, and Campbell Island (Motu Ihupuku) lies 600 km south of Stewart Island at 52°33'S, 169°09'E. Antipodes Island (Moutere Mahue) is approximately 860 km south-east of Stewart Island, at 49°41'S, 178°46'E. The Snares (Tini Heke) is a small island group lying about 100 km southwest of Stewart Island at 48°01'S, 166°32'E. Most of the islands are volcanic in origin, with some older granites and sedimentary rocks. The archipelagos have a subpolar oceanic climate with fairly constant cool and mild weather throughout the year (Te Ara 2016).

The Auckland Islands, with a total land area of 625 km<sup>2</sup>, are the largest of New Zealand's subantarctic island groups. Auckland Island, the main island, has an approximate land area of 510 km<sup>2</sup> and a length of 42 km. It is notable for its steep cliffs and rugged terrain, which rises to over 600 m. The southern end of the island broadens to a width of 26 km. There, the narrow channel of Carnley Harbour separates the main island from Adams Island (area approximately 100 km<sup>2</sup>), which is even more mountainous, reaching a height of 705 m at Mount Dick. The channel is the remains of the crater of an extinct volcano, and Adams Island and the southern part of the main island form the crater rim. The main island features many sharply incised inlets, notably Port Ross at the northern end. Forest cover is restricted to the Auckland Islands, where *Olearia lyallii* is a significant feature of the vegetation along with southern rata (*Metrosideros umbellata*), the main species in the coastal forests. Beaten by the constant winds, the rata forests lining the shores can reach 20 m high and form a contorted network of branches below and a compact canopy above. No equivalent forest exists on the Campbell or Antipodes island groups. The shoreline forest of rata is succeeded at higher altitudes by shrubland and then open tussock grassland (Fineran 1971; Te Ara 2016).

The Campbell Island group is the most southerly of the New Zealand subantarctic islands. Campbell Island covers approximately 113 km<sup>2</sup>, and is surrounded by numerous stacks, rocks, and islets. It is mountainous, rising to over 500 m in the south at Mt Honey (558 m), while a long fjord, Perseverance Harbour, nearly bisects the island, opening out to sea on the east coast. Campbell Island is thought to have been formed for the most part by a shield volcano that erupted periodically, covering about two-thirds of the surface. On the west coast, there are thick layers of ash with pyroclastic inclusions, and numerous basaltic dykes intrude into sedimentary rock. Because of its southerly latitude, the island supports no native trees, and is largely covered in shrubland, herbfield and tussock grassland. The tallest species are *Dracophyllum longifolium* and *D. scoparium*, which form a dwarf forest three to five

metres tall (Meurk *et al.* 1994; Te Ara 2016).

The Antipodes Islands group consists of one main island, Antipodes Island, approximately 20 km<sup>2</sup> in area. The islands are steep, and cliffs and rocky reefs line the majority of the coasts. The highest point is Mount Galloway at 366 m in the north of the main island, which also forms part of the group's most recently active volcano (Godley 1989; Te Ara 2016).

The Snares consist of the main island, North East Island and the smaller Broughton Island, plus the somewhat isolated Western Chain Islands lying about 5 km to the WSW. As a group of islands, the Snares cover a total area of approximately 3.5 km<sup>2</sup>. Forests of *Olearia lyallii* are the dominant feature across about 80% of the main island, forming a canopy over 5 m tall in places. Apart from a few eastern parts, all the islands of the Snares group are bordered by steep cliffs (Te Ara 2016).

Eleven taxa of buellioid lichens have previously been reported from these islands, namely *Amandinea adjuncta* (Th.Fr.) Hafellner, *A. diorista* var. *hypopellidna* (Stirt.) Marbach & Kalb, *A. fuscoatratula* (Zahlbr.) Elix, *A. porulosa* (Müll.Arg.) Elix, *Buellia albula* (Nyl.) Müll.Arg., *B. aucklandica* C.W.Dodge, *B. hypopurpurea* Elix & A.Knight, *B. mawsonii* C.W.Dodge, *B. seppeltii* Elix, *B. stellulata* (Taylor) Mudd var. *stellulata* and *B. stellulata* var. *tasmanica* Elix & Kantvilas (Fineran 1971; Galloway 2007; Elix 2017; Elix *et al.* 2017). Three further species have been reported: *Buellia atroflavella* (Nyl.) Müll.Arg., a later synonym of *Rhizocarpon superficiale* (Schaer.) Vain., *Buellia citrina* H.Magn., a later synonym of *Rinodina thiomela* (Nyl.) Müll.Arg. and *Buellia exsoluta* (Nyl.) Müll.Arg., a later synonym of *Rinodina subtubulata* (C.Knight) Zahlbr.

In this contribution, three new saxicolous buellioid lichens are described from the islands. In addition, eight new records are reported for Antipodes and Campbell Islands.

#### Methods

Observations and measurements of thallus and apothecium anatomy, asci, ascospores and conidia 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 pretreatment in K. Chemical constituents were identified by thin-layer chromatography (TLC) (Elix 2014) and comparison with authentic samples. Most of the collections were made by Dr R.C. Harris and the late Dr H.A. Imshaug in 1969–1972, and are housed in MSC.

#### New species

##### 1. *Amandinea antipodensis* Elix, sp. nov.

Fig. 1

Mycobank Number: **MB 820261**

Similar to *Amandinea coniops* (Wahlenb.) M.Choisy ex Scheid. & H.Mayrhofer, but differs in having a granular, off-white to pale creamy white upper surface, immersed apothecia, a colourless to pale yellow hypothecium, an interspersed hypothecium and subhymenium and a medulla containing high concentrations of calcium oxalate.

*Type:* New Zealand, Antipodes Island, sea cliffs W of Hut Cove and seashore at Hut Cove, 49°40'01"S, 178°48'29"E, on rock, R.C. Harris 5845, 16.ii.1970 (holotype – MSC).

*Thallus* crustose, to 35 mm wide and 0.8 mm thick, epilithic, rhizomorphous; upper surface off-white to pale creamy white, matt, granular, cracked; prothallus marginal, brown to black or not apparent; photobiont cells 10–15 µm wide; medulla containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub><sup>+</sup>), I–. *Apothecia* 0.2–0.6 mm wide, abundant, lecideine, roundish, scattered or crowded, immersed to just adnate; disc black, epruinose, weakly concave to plane; proper exciple thin, persistent, in section 40–75 µm thick, outer part dark brown, K–, N–, inner part brown. *Epithymenium* 10–12 µm thick, brown to dark brown,

K-, N-. *Hypothecium* 75–125 µm thick, colourless to pale yellow, K-, inspersed with oil droplets and minute crystals. *Hymenium* 70–100 µm thick, colourless, not inspersed; subhymenium 30–40 µm thick, colourless, inspersed with minute oil droplets; paraphyses 1–2.5 µm wide, sparingly branched, with apices 4–5 µm wide and hyaline to pale brown caps. *Asci* (4–)8-spored, *Bacidia*-type. *Ascospores* *Physconia*- then *Buellia*-type, 1-septate, pale then dark brown, ellipsoid, 13–[15.4]–18 × 5–[7.5]–9 µm, becoming constricted at the septum, sometimes curved, outer wall rugulate. *Pycnidia* very common, punctiform, immersed; ostiole brown to black. *Conidia* curved, filiform, 12–18 × 0.7–1 µm.

*Chemistry*: Thallus K-, P-, C-, UV-; no lichen substances detected.

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

#### Remarks

*Amandinea antipodensis* is characterized by the crustose, rimose, continuous, off-white to creamy white thallus with a granular upper surface, the inspersed subhymenium and hypothecium, a medulla containing high concentrations of calcium oxalate, the *Physconia*- then *Buellia*-type ascospores that have a microrugulate to rugulate outer wall, and by the lack of lichen substances. In many respects *A. antipodensis* resembles *A. hypopallida* described below. However, the latter has a minutely fissured, often brownish upper surface, a medulla that lacks calcium oxalate, somewhat larger ascospores, 14–22 × 7–10 µm, and longer conidia (18–25 µm). *Amandinea nitrophila* (Zahlbr.) Elix also has mainly immersed apothecia and an inspersed subhymenium, but differs in having a smooth brown upper surface, somewhat shorter ascospores and a dark brown to brown-black hypothecium (Blaħa *et al.* 2016).

At present, the new species is known from Antipodes Island, the Auckland Islands, Campbell Island and the Snares Islands. Associated lichens include *Amandinea austroconiops* Elix & Kantvilas, *A. nitrophila*, *Buellia stellulata* (Taylor) Mudd var. *stellulata*, *Carbonea phaeostoma* (Nyl.) Hertel, several *Caloplaca* species, *Lecidea lygomma* Nyl. and *Rhizocarpon oxydatum* Fryday.

#### SPECIMENS EXAMINED

*Auckland Islands*: • Shoe Island, Port Ross, NE tip, c. 3 m alt., on rock, *C.D. Meurk s.n.*, 6.iv.1980 (GZU).

*Campbell Island*: • vicinity of penguin rookeries at Penguin Bay, NE of Yvon Villarceau Peak, on rocks, *H.A. Imshaug* 46598, 46601, 5.i.1970 (MSC); • near Bull Rock, 52°29'S, 169°13'E, on ledges of mollymawk rookery, *H.A. Imshaug* 47282, 19.i.1970 (MSC).

*The Snares Islands*: • unspecified locality, on rock, *F. Newcombe*, xii.1947 (BM).

#### 2. *Amandinea hypopallida* Elix, sp. nov.

Figs 2, 3

Mycobank Number: MB 820262

Similar to *Amandinea coniops*, but differs in having a thick, creamy white or brownish white, smooth, finely fissured thallus, immersed apothecia, a colourless to pale yellow hypothecium and an inspersed subhymenium.

*Type*: New Zealand, Campbell Island, N side of base of Courrejolles Peninsula, on ledges of mollymawk rookery, *H.A. Imshaug* 46283, 30.xii.1969 (holotype – MSC).

*Thallus* crustose, to 50 mm wide and 1 mm thick, epilithic, rimose; upper surface creamy white or brownish white, matt, finely fissured, cracked; prothallus marginal, pale brown to brown or not apparent; photobiont cells 10–15 µm wide; medulla lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>–), I-. *Apothecia* 0.2–1 mm wide, abundant, lecideine, roundish, scattered or crowded, immersed, often deformed by mutual pressure; disc

black, epruinose, weakly concave to plane; proper exciple thin, persistent, in section 40–50 µm thick, outer part dark brown to brown, K-, N-, inner part pale brown. *Epithymenium* 10–13 µm thick, brown to dark brown, K-, N-. *Hypothecium* 125–225 µm thick, colourless to pale yellow or very pale brown, K-. *Hymenium* 70–100 µm thick, colourless, not inspersed; subhymenium 30–40 µm thick, colourless, inspersed with oil droplets; paraphyses 1–2.5 µm wide, sparingly branched, with apices 5–6 µm wide and brown caps. *Asci* (6–)8-spored, *Bacidia*-type. *Ascospores* *Physconia*- then *Buellia*-type, 1-septate, pale then dark brown, ellipsoid, 14–[17.4]–22 × 7–[8.6]–10 µm, becoming constricted at the septum, rarely curved, outer wall microrugulate to rugulate. *Pycnidia* very common, punctiform, immersed; ostiole brown to black. *Conidia* curved, filiform, 17–25 × 0.7–1 µm.

*Chemistry*: Thallus K-, P-, C-, UV-; no lichen substances detected.

*Etymology*: The species is named after its colourless to pale brown hypothecium.

#### Remarks

*Amandinea hypopallida* is characterized by the crustose, rimose, continuous, white or brownish white thallus, the inspersed subhymenium, the *Physconia*- then *Buellia*-type ascospores that have a microrugulate to rugulate outer wall, and by the lack of lichen substances. The new species is rather similar to *A. coniops*, a common saxicolous species in New Zealand and Antarctica (Elix & Kantvilas 2016). However, *A. coniops* has adnate apothecia, a brown hypothecium and a non-inspersed subhymenium. In addition, rather than having a more-or-less smooth, finely fissured thallus, that of *A. coniops* is bullate-areolate to sublobate where the individual areoles become aggregated and imbricate to form a secondarily bullate, warted or subsquamulose crust. *Amandinea nitrophila* has mainly immersed apothecia, a smooth thallus and an inspersed subhymenium, but differs in having somewhat shorter ascospores and a dark brown to brown-black hypothecium (Blaħa *et al.* 2016).

At present, the new species is known from Campbell Island and the Snares Islands. Associated lichens include *Amandinea austroconiops* Elix & Kantvilas, *A. nitrophila*, *Buellia stellulata* (Taylor) Mudd var. *stellulata*, *Carbonea phaeostoma* (Nyl.) Hertel, several *Caloplaca* species, *Lecidea lygomma* Nyl. and *Rhizocarpon oxydatum* Fryday.

#### SPECIMENS EXAMINED

*Campbell Island*: • shoreline on E side of Tucker Cove, on marine rocks, *R.C. Harris* 4495, 24.xii.1969 (MSC); • stream NE of Mt Sorenson, on rock, *R.C. Harris* 5105, 6.i.1970 (MSC); • S side of Perversance Harbour and 1.6 km W of South Point, on marine rock, *R.C. Harris* 5315, 13.i.1970 (MSC); • type locality, on ledges of mollymawk rookery, *H.A. Imshaug* 46294, 30.xii.1969 (MSC); • W side of Monument Harbour, on rocks along shore, *H.A. Imshaug* 46696, 8.i.1970 (MSC); • S side of Perversance Harbour opposite Moubray Hill, on coastal rocks, *H.A. Imshaug* 47148, 16.i.1970 (MSC); • near Bull Rock, 52°29'S, 169°13'E, on ledges of mollymawk rookery, *H.A. Imshaug*, 47291, 19.i.1970 (MSC).

*The Snares Islands*: • unspecified locality, on rock, *F. Newcombe*, xii.1947 (BM).

#### 3. *Buellia prothallina* Elix, sp. nov.

Fig. 4

Mycobank Number: MB 820263

Similar to *Buellia lignoides* Filson, but differs in having a non-amyloid medulla, a brown, N- epithymenium, larger ascospores and in lacking norstictic acid.

*Type*: New Zealand, Campbell Island, summit of Mt Dumas, 52°34'01"S, 169°04'01"E, alt. 503 m, on rock in wet grassland and upland peat bogs, *R.C. Harris* 5027, 2.i.1970 (holotype – MSC).

*Thallus* crustose, to 60 mm wide and 0.1 mm thick, continuous, areolate; areoles scattered over a thick, black prothallus, irregular, angular, 0.5–1.5 mm wide; upper surface yellow-white to pale brown, smooth; prothallus black, prominent, extending marginally and between adjacent areoles; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-; photobiont cells 10–15 µm wide. *Apothecia* 0.2–0.5 mm wide, abundant, lecideine, roundish, immersed, scattered or crowded and deformed by mutual pressure; disc black, epruinose, weakly concave, rarely plane, sometimes gyrose; proper exciple thin, persistent, in section 30–40 µm thick, outer part dark brown to brown-black, K-, N+ deep red-brown, inner part brown. *Epithymenium* 12–15 µm thick, pale brown, K-, N-. *Hypothecium* 100–225 µm thick, dark brown to brown-black, K-. *Hymenium* 100–125 µm thick, colourless, not interspersed; subhymenium 50–60 µm thick, colourless to pale brown, not interspersed; paraphyses 1–2.5 µm wide, sparingly branched, with apices 3–4 µm wide and pale brown caps. *Asci* (4–)8-spored, *Bacidia*-type. *Ascospores* *Physconia*- then *Buellia*-type, 1-septate, pale then dark brown, ellipsoid, 14–[16.1]–19 × 7–[8.1]–10 µm, becoming constricted at the septum, outer wall rugulate. *Pycnidia* punctiform, immersed; ostiole black. *Conidia* bacilliform, straight, 6.5–10 × 1 µm.

*Chemistry*: Thallus K-, P-, C-, UV-; no lichen substances detected

*Etymology*: The species is named after its prominent black prothallus.

#### Remarks

*Buellia prothallina* is characterized by the crustose thallus, with dispersed, yellow-white to pale brown areoles, the prominent, black prothallus, the immersed apothecia, the non-amyloid medulla, 1-septate, *Physconia*- then *Buellia*-type ascospores with a rugulate outer wall, the bacilliform conidia and the lack of lichen substances. In some respects, *B. prothallina* is similar to *B. lignoides*, a common saxicolous species in Antarctica (Filson 1966; Øvstedal & Lewis Smith 2004) in that both species have small thalline areoles dispersed on an extensive black prothalline mat. However, *B. lignoides* has an amyloid medulla, an aeruginose, N+ red-violet epithymenium, smaller ascospores, 10–14 × 8–9 µm, and often contains norstictic acid. *Buellia epiaeruginosa* Elix is also somewhat similar, but it differs in having a much-reduced prothallus, immersed then broadly adnate or rarely sessile apothecia and an aeruginose, N+ red-violet epithymenium (Elix 2016).

At present, the new species is known from Campbell Island and the Auckland Islands. Associated lichens include *Amandinea austroconiops* Elix & Kantvilas, *A. nitrophila* (Zahlbr.) Elix, *Buellia stellulata* (Taylor) Mudd var. *stellulata*, *Carbonea phaeostoma* (Nyl.) Hertel, several *Caloplaca* species, *Lecidea lygomma* Nyl. and *Rhizocarpon oxydatum* Fryday.

#### SPECIMENS EXAMINED

*Auckland Island*: • summit of Cloudy Peak, 50°34'37"S, 166°08'42"E, alt. 465 m, on rock, H.A. Imshaug 57555 *pr.p.*, 7.i.1973 (MSC).

*Campbell Island*: • W end of Lyall Ridge, on rock outcrops, H.A. Imshaug 46152, 26.xii.1969 (MSC); • summit of Mt Honey, 52°34'16"S, 169°09'47"E, alt. 568 m, on rock outcrops in feldmark, H.A. Imshaug 46407, 31.xii.1969 (MSC); • summit of Mt Sorenson, on rock crags, H.A. Imshaug 47330, 19.i.1970 (MSC).

#### New records for Antipodes and Campbell Islands

##### 1. *Amandinea austroconiops* Elix & Kantvilas, *Australas. Lichenol.* 78, 23 (2016)

This species was previously known from Tasmania and the South Island of New Zealand (Elix & Kantvilas 2016). It is characterized by its crustose, white to grey-white, rimose-areolate thallus, broadly adnate to rarely sessile, lecideine apothecia, 0.3–1 mm wide, relatively large, 1-septate *Physconia*- then *Buellia*-type ascospores, 15–[19.6]–25 ×

8–[11.2]–14 µm, which become constricted at the septum and have rugulate outer walls, the curved, filiform conidia, (15–)20–27 × 0.7–1 µm, the amyloid medulla, interspersed hymenium and the lack of lichen substances. A detailed description and illustrations are given in Elix & Kantvilas (2016).

#### SPECIMENS EXAMINED

*Campbell Island*: • just W of camp Cove, on isolated rock outcrop in *Dracophyllum* scrub, R.C. Harris 5396, 15.i.1970 (MSC); • summit ridge of St. Col Peak, alt. 365 m, on rock outcrops in tussock grassland, H.A. Imshaug 45961, 45963, 22.xii.1969 (MSC); • NE of Beeman Station, on coastal rocks with adjacent *Dracophyllum* and *Hebe*, H.A. Imshaug 47209, 17.i.1970 (MSC).

##### 2. *Amandinea litoralis* (Zahlbr.) H.Mayrhofer & Elix, *Australas. Lichenol.* 79, 40 (2016)

This species was previously known from the North and South Islands of New Zealand, Tasmania and Norfolk Island (Blaha *et al.* 2016). It is characterized by the crustose, markedly verrucose and areolate to distinctly warted or subsquamulose, pale grey to grey-brown thallus, the broadly adnate to sessile apothecia, the non-amyloid medulla, the broad colourless, inner zone of the excipulum, 1-septate, *Physconia*- then *Buellia*-type ascospores, 12–17 × 6–9 µm, curved, filiform conidia, 16–27 µm long, and the absence of lichen substances. A detailed description is given in Blaha *et al.* (2016).

#### SPECIMENS EXAMINED

*Campbell Island*: • bay opposite Dent Island, on top of limestone cliff, R.C. Harris 4695, 4705, 28.xii.1969 (MSC); • Penguin Bay, NE of Yvon Villarceau Peak, on rock in vicinity of penguin rookeries, H.A. Imshaug 46603, 5.i.1970 (MSC); • N side of Perversance Harbour, E of Moubray Hill, on rocks in tussock grassland above sea cliffs, H.A. Imshaug 46867, 12.i.1970 (MSC).

##### 3. *Amandinea nitrophila* (Zahlbr.) Elix, *Australas. Lichenol.* 77, 40 (2015)

This species was previously known from Heard Island, the North and South Islands of New Zealand and southern South America (Blaha *et al.* 2016). It is characterized by the crustose, rimose- to verrucose-areolate, grey-white to grey-brown or brown thallus, the broadly immersed to adnate apothecia, the non-amyloid medulla, interspersed subhymenium, 1-septate, *Physconia*- then *Buellia*-type ascospores, 12–20 × 7–12 µm, the curved, filiform conidia (12–27 µm), and the absence of lichen substances. A detailed description is given in Blaha *et al.* (2016).

#### SPECIMENS EXAMINED

*Campbell Island*: • E side of Tucker Cove, on maritime rocks, R.C. Harris 4514 *pr.p.*, 24.xii.1969 (MSC); • *loc. id.*, H.A. Imshaug 46740, 46749, 46754, 9.i.1970 (MSC) • S side of Perversance Harbour, 1.6 km W of South Point, on rock of cliff face in tall *Dracophyllum* scrub, R.C. Harris 5456, 16.i.1970 (MSC); • N side of base of Courrejollies Peninsula, on ledges of mollymawk rookery, H.A. Imshaug 46289, 30.xii.1969 (MSC); • Penguin Bay, NE of Yvon Villarceau Peak, on rock in vicinity of penguin rookeries, H.A. Imshaug 46609, 5.i.1970 (MSC); • W side of Monument Harbour, on rocks along shore, H.A. Imshaug 46694 *pr.p.*, 8.i.1970 (MSC).

##### 4. *Amandinea subcervina* (Nyl.) Elix, *Australas. Lichenol.* 81, 9 (2017)

This species was known previously from southernmost South America (Lamb 1968) and Macquarie Island (Elix 2017). It is characterized by a continuous rimose to rimose-areolate, pale grey to grey-brown or tawny brown thallus that lacks secondary lichen substances and is often delimited by a dark prothallus, its small and often immersed lecideine apothecia, 0.2–0.5 mm wide, with *Physconia*- then *Buellia*-type ascospores, 15–[17.9]–22 × 8–[9.8]–13 µm, which become constricted at maturity and have a

rugulate outer spore-wall, and curved, filiform conidia, 12–22 × 0.7–1 μm. A detailed description is given in Lamb (1968).

#### SPECIMENS EXAMINED

*Campbell Island*: • shoreline on E side of Tucker Cove, on maritime rocks, R.C. Harris 4515 *pr.p.*, 24.xii.1969 (MSC); • N side of base of Courrejolles Peninsula, on ledges of mollymawk rookery, H.A. Imshaug 46302, 30.xii.1969 (MSC); • W side of Monument Harbour, on rocks along shore, H.A. Imshaug 46700, 8.i.1970 (MSC).

*Stewart Island*: • Port Pegasus, Noble Island, 47°12'43"S, 167°39'47"E, alt. 1–10 m, on maritime rocks, B.W. Hayward *s.n.*, 6ii.1989 (GZU).

**5. *Amandinea variabilis*** Elix, Blaha & H.Mayrhofer, *Australas. Lichenol.* **79**, 43 (2016)  
This species was previously known from southern Victoria, Tasmania and the North and South Islands of New Zealand (Blaha *et al.* 2016). It is characterized by having immersed then broadly adnate or sessile apothecia, *Orcularia*- then *Physconia*-type ascospores, (11–)13–16.0–18(–20) × 6–8.7–12 μm, which are swollen at the septum, a subhymenium interspersed with oil droplets and the lack of lichen substances. *Amandinea otagensis* (Zahlbr.) Blaha, H.Mayrhofer & Elix is similar, but differs in having mainly immersed apothecia, a non-interspersed subhymenium and shorter ascospores (12)–14.1–16(–17) μm). A detailed description is given in Blaha *et al.* (2016).

#### SPECIMEN EXAMINED

*Campbell Island*: • W side of Monument Harbour, on rocks along shore, H.A. Imshaug 46697, 8.i.1970 (MSC).

**6. *Buellia hypopurpurea*** Elix & A.Knight, *Australas. Lichenol.* **80**, 47 (2017)

This endemic species was recently described from the South Island of New Zealand and Campbell Island (Elix *et al.* 2017).

#### SPECIMEN EXAMINED

*Antipodes Island*: • c. 0.4 km S of Hut Cove, on rock outcrop in tussock grassland, R.C. Harris 5811 *pr.p.*, 16.ii.1970 (MSC).

**7. *Buellia stellulata*** (Taylor) Mudd, *Man. Brit. Lich.*: 216 (1861) var. **stellulata**

In New Zealand this cosmopolitan species is known from coastal rocks in both the North and South Islands (Galloway 2007). A detailed description is given in Elix (2011).

#### SPECIMENS EXAMINED

*Antipodes Island*: • c. 0.4 km S of Hut Cove, on rock outcrop in tussock grassland, R.C. Harris 5801B, 5810 *pr.p.*, 16.ii.1970 (MSC).

**8. *Monerolechia badia*** (Fr.) Kalb, *Biblioth. Lichenol.* **88**, 312 (2004)

In New Zealand this cosmopolitan species was previously known from the South Island (Galloway 2007). A detailed description is given in Elix (2011).

#### SPECIMEN EXAMINED

*Antipodes Island*: • c. 0.4 km S of Hut Cove, on rock outcrop in tussock grassland, R.C. Harris 5811 *pr.p.*, 16.ii.1970 (MSC).

#### Key to the saxicolous buellioid lichens in New Zealand's subantarctic islands

- 1: Thallus containing lichen substances ..... 2  
1: Thallus lacking lichen substances ..... 5

- 2: Hypothecium orange-brown, K+ purple; anthraquinones present ..... **Buellia hypopurpurea**  
2: Hypothecium dark brown to brown-black, K-; anthraquinones absent ..... 3  
3: Ascospores 18–30 μm long ..... **Buellia seppeltii**  
3: Ascospores 8–15 μm long ..... 4  
4: Atranorin, ± roccellic acid present ..... **Buellia stellulata** var. **tasmanica**  
4: Atranorin, 2'-O-methylperlatolic, ± confluent, ± roccellic acids present ..... **Buellia stellulata** var. **stellulata**  
5: Thallus squamulose, initially lichenicolous ..... **Monerolechia badia**  
5: Thallus crustose, never lichenicolous ..... 6  
6: Thallus of small scattered areoles on a dominant black prothallus/hypothallus; conidia straight, bacilliform, 6.5–10 μm long ..... **Buellia prothallina**  
6: Prothallus marginal or absent; conidia curved, filiform, 15–30 μm long ..... 7  
7: Medulla I+ blue; ascospores 15–[19.6]–26 × 8–[11.2]–14 μm ..... **Amandinea austroconiops**  
7: Medulla I- ..... 8  
8: Medulla containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub>+ ) ..... **Amandinea antipodensis**  
8: Medulla lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-) ..... 9  
9: Ascospores with strong medial wall-thickenings, *Orcularia* to *Physconia*-type, 14–18 × 6–9 μm; subhymenium interspersed ..... **Amandinea variabilis**  
9: Ascospores with weak medial wall-thickenings during spore ontogeny, mature spores *Buellia*-type; subhymenium interspersed or not ..... 10  
10: Ascospores 14–22 × 7–13 μm ..... 11  
10: Ascospores 12–16 × 6–9 μm ..... 13  
11: Mature ascospores constricted; hypothecium pale brown to hyaline ..... **Amandinea hypopallida**  
11: Mature ascospores not constricted; hypothecium dark brown to black-brown ..... 12  
12: Thallus thin, rimose-areolate; ascospores 14–[16.3]–20 × 7–[8.7]–12 μm; subhymenium interspersed ..... **Amandinea nitrophila**  
12: Thallus thick, chinky; ascospores 15–[17.9]–22 × 8–[9.8]–13 μm; subhymenium not interspersed ..... **Amandinea subcervina**  
13: Mature ascospores often constricted; thallus thick, warty; prothallus absent; apothecia to 1.5 mm wide ..... **Amandinea litoralis**  
13: Mature ascospores rarely constricted; thallus thin, rimose-areolate; prothallus often black and prominent; apothecia to 0.8 mm wide ..... **Amandinea fuscoatratura**

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Figure 1. *Amandinea antipodensis* (holotype in MSC). Scale = 1 mm.



Figure 2. *Amandinea hypopallida* (holotype in MSC). Scale = 1 mm.

A new species and new record of *Candelariella*  
(lichenized Ascomycota, Candelariaceae) from Australia

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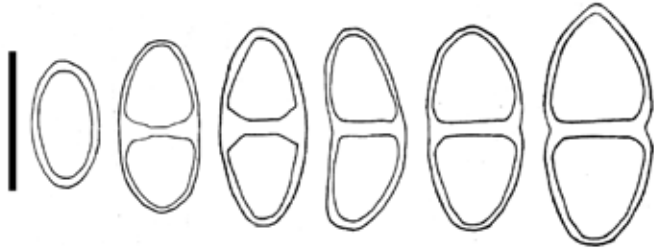


Figure 3. Ascospore ontogeny of *A. hypopallida*. Scale = 10  $\mu\text{m}$ .

**Abstract**

*Candelariella australiensis* P.M.McCarthy & Elix, sp. nov., is described from granite in the A.C.T. and the Northern Tablelands, N.S.W. *Candelariella rosulans* (Müll.Arg.) Zahlbr. is reported for the first time from Australia (N.S.W., N.T., Qld and W.A.). A key is provided to the four saxicolous species of the genus known from Australia.

*Candelariella* Müll.Arg. includes approximately 50 species growing on rock, bark, wood and soil, mainly in temperate to subarid regions of both hemispheres. Their morphology ranges from crustose and nondescript, granular, verrucose or areolate, or placodioid to squamulose, with or without soralia. The thallus is usually yellowish (containing pulvinic acid and its derivatives), although some species are tinged with or predominantly green or grey. Apothecia are usually lecanorine, the proper excipulum being visible only in section, with a hyaline hypothecium and a hymenium of sparingly branched paraphyses, asci with distinctively amyloid apices and eight or more, simple or 1-septate ascospores (Hakulinen 1954; Poelt 1969; Clauzade & Roux 1985; Filson 1992; Westberg 2004, 2007a, b, c; Westberg & Nash 2007; Gilbert & James 2009; Westberg *et al.* 2011).

In his treatment of the Australian species, Filson (1992) documented three that were exclusively corticolous, while three others occurred only on rock, *viz.* *C. aurella* (Hoffm.) Zahlbr., *C. spraguei* (Tuck.) Zahlbr. and *C. vitellina* (Hoffm.) Müll.Arg. The inclusion of *C. spraguei* was an error — that North American species has very distinctive, elongate and curved to sigmoid ascospores  $30\text{--}57 \times 3.5\text{--}5 \mu\text{m}$  (Hakulinen 1954; Westberg 2007c; Westberg & Nash 2007) quite unlike those reported by Filson (1992); it was subsequently excluded from the Australian flora (Filson 1996). A reassessment of some of the specimens attributed by Filson (1992) to *C. spraguei*, as well as several more recent collections, have led to the identification of *C. rosulans* (Müll.Arg.) Zahlbr. and the closely related and newly described *C. australiensis*, which has a significantly shallower hymenium and smaller asci and ascospores.

**Methods**

Observations and measurements of thallus and apothecium anatomy, asci, ascospores and conidia were made on hand-cut sections mounted in water and treated with 10% potassium hydroxide (K). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K. Chemical constituents were identified by thin-layer chromatography (TLC) and high-performance liquid chromatography (HPLC, Elix 2014) and comparison with authentic samples.

*Candelariella australiensis* P.M.McCarthy & Elix, sp. nov.  
Mycobank Number: MB 821131

Figs 1, 3A

Differs from *C. rosulans* (Müll.Arg.) Zahlbr. in having a thinner hymenium ( $45\text{--}60 \mu\text{m}$  vs  $50\text{--}80 \mu\text{m}$ ), smaller asci ( $35\text{--}55 \times 11\text{--}16 \mu\text{m}$  vs  $45\text{--}64 \times 13\text{--}22 \mu\text{m}$ ) and smaller ascospores [ $8\text{--}13(15) \times 4\text{--}5(6) \mu\text{m}$  vs  $11\text{--}19(22) \times 5\text{--}7.5(8) \mu\text{m}$ ].



Figure 4. *Buellia prothallina* (holotype in MSC). Scale = 1 mm.



*Type:* Australia, Australian Capital Territory, Gudgenby River Gorge, west bank, 4.5 km S of Tharwa, 35°44'S, 149°04'E, alt. 620 m, on mossy granite, *J.A. Elix 6112*, 26.vi.1979 (holotype – CANB).

*Thallus* saxicolous, squamulose, forming small, scattered colonies to 4 mm wide. *Squamules* pale bright yellow, dull, smooth or lightly pulverulent due to encrusted lichen substances, initially rounded and plane to convex, becoming plane to slightly convex and peltate and, eventually, rosulate and forming convex, tightly contiguous but non-imbricate clusters, ± uniformly adnate to the substratum, to 0.2(–0.3) mm thick, the margins not or slightly raised; rosulate squamules 0.2–1(–1.5) mm wide, the marginal lobes shallowly concave to plane or slightly convex, mostly isodiametric or slightly radially elongate, 0.1–0.3(–0.4) mm wide. *Upper cortex* 10–15(–20) µm thick, dominated and often largely obscured by an opaque layer of lichen substances, this subtended by 8–15 µm of rounded, thick-walled, pseudoparenchymatous cells 2–4 µm wide; lower cortex similar to the upper near lobe margins, not apparent elsewhere. *Algae* occupying most of the thallus thickness, dense above, comparatively sparse below; cells chlorococcoid, ± globose, 8–16(–20) µm wide; interstitial hyphae short-celled, 2–3(–5) µm wide. *Medulla* poorly defined, the loose hyphae long-celled, 2–3 µm thick; attached to the substratum by hyaline rhizohyphae that are 2.5–4.5 µm wide, thin-walled and long-celled. *Apothecia* numerous, mostly scattered, occasionally in small clusters, lecanorine, sessile or sessile, rounded, or irregular in outline due to mutual pressure, (0.36–)0.58(–0.92) mm diam. [*n* = 95]; disc plane to slightly convex, concolorous with the thallus or slightly darker and greenish yellow, dull, smooth or pulverulent; margin prominent and persistent, thickly pulverulent, concolorous with the thallus, 60–100(–120) µm thick, entire to crenulate and often becoming irregularly flexuose, anatomically identical with the thallus. *Proper excipulum* hyaline throughout, 15–20(–25) µm thick laterally and above most of the apothecial base, prosoplectenchymatous, with rather short, periclinal cells [4–7(–8) × 2–4 µm], forming a central stipe 60–100 µm wide. *Hypothecium* hyaline, heavily interspersed with oil globules, 80–100(–130) µm thick, non-amyloid. *Hymenium* 45–60 µm thick, not interspersed with granules or oil globules, IKI+ blue. *Epithymenium* dominated by an opaque layer of encrusted lichen substances 10–20 µm thick. *Paraphyses* not conglutinate in water, mostly simple or with sparse distal branches, long-celled, 1–1.5(–2.5) µm thick; apical cells scarcely swollen or narrowly ellipsoid to clavate, hyaline, to 3(–4) µm wide. *Asci* narrowly to broadly clavate, *Candelariella*-type, 8-spored, 35–55 × 11–16 µm [*n* = 50], with an abrupt or more gradually tapering stalk; apex broadly rounded, with an initially thick, later thin, partially amyloid tholus that is IKI– distally, IKI+ dark blue laterally towards the tholus base and much paler blue in the lower centre; ocular chamber distinct in immature asci only. *Ascospores* colourless, simple, irregularly arranged in the ascus, narrowly ellipsoid to oblong-ellipsoid, less commonly oblong, lacking a perispore, usually straight, rarely slightly curved, with rounded or subacute ends, occasionally a little broader towards the distal end, the contents commonly vacuolate and granulose, (8–)12.1(–15) × (4–)4.8(–6) µm [*n* = 75]. *Pycnidia* numerous, immersed in the thallus or in low-convex to subconical swellings that are concolorous with the thallus or have a minute, slightly darker ostiole, globose or pyriform, 60–90 µm wide; lateral and basal walls hyaline, 5–7 µm thick; conidiogenous layer not convoluted, the hyphae simple or branched from the base, 1.5–3 µm wide basally, tapering to c. 1 µm; conidia budding apically, narrowly ellipsoid to oblong, 2–3(–3.5) × 0.7–1 µm [*n* = 50].

*Chemistry:* Thallus K–, C–, KC–, PD–, UV–; pulvinic dilactone (major), pulvinic acid (minor), calycin (minor) by TLC.

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

## Remarks

*Candelariella australiensis* is characterized by a bright yellow, thinly corticate and peltate to rosulate thallus, moderately large apothecia with a prominent and persistent margin surrounding a plane to slightly convex disc, a rather thin hymenium, comparatively small, 8-spored asci and small, simple ascospores of 8–15 × 4–6 µm. It is most similar to *C. rosulans* from western U.S.A. and Iran, but the latter has a thicker hymenium and larger asci and ascospores (Westberg 2004, 2007c; Westberg *et al.* 2011; Westberg & Sohrabi 2012; and see below). Other noteworthy, although not necessarily diagnostic, characters of the new species include the thickly pulverulent thalli and thalline margins of apothecia, predominantly plane apothecial discs and diminutive conidia. Moreover, while the thalli of the new species are K–, those of the Australian collections of *C. rosulans* are K+ pale reddish. The two collections of *C. australiensis*, along with those of *C. rosulans* (see below), were misidentified by Filson (1992) as the North American *C. spraguei*.

The new species is currently known from granite outcrops in the A.C.T. and in the Northern Tablelands, N.S.W.

## ADDITIONAL SPECIMEN EXAMINED

*New South Wales:* • Northern Tablelands, 5 km E of Glen Innes along Highway 38, alt. 1000 m, 29°44'S, 151°48'E, on granite, *J.A. Elix 2746*, 18.viii.1976 (B, CANB).

*Candelariella rosulans* (Müll.Arg.) Zahlbr., *Cat. Lich. Univ.* 5, 802 (1928) Figs 2, 3B

[*Caloplaca spraguei* auct. non (Tuck.) Zahlbr.: R.B.Filson, *Fl. Australia* 54, 99 (1992), *pro parte*]

*Thallus* saxicolous, squamulose. *Squamules* bright yellow to greenish yellow, initially rounded to oblong, strongly convex, becoming plane to slightly convex and peltate and, eventually, rosulate and forming convex, tightly contiguous but non-imbricate clusters up to 5 mm wide, uniformly adnate to the substratum, 0.1–0.2(–0.3) mm thick, or the margins slightly raised, the surface smooth, predominantly dull and pulverulent due to encrusted lichen substances. *Upper cortex* 15–25 µm thick, dominated and often largely obscured by an opaque layer of lichen substances, this subtended directly by rounded to angular, thin-walled, pseudoparenchymatous cells; lower cortex similar to the upper near lobe margins, not apparent elsewhere. *Algal cells* occupying most of the thallus, ± globose, 8–16(–22) µm wide. *Medulla* thin, poorly defined and discontinuous or up to 60 µm thick, attached to the substratum by hyaline, thin-walled, long-celled rhizohyphae. *Apothecia* sparse to very numerous, scattered or in clusters, lecanorine, adnate to subsessile, concolorous with the thallus or a little darker and similarly smooth or pulverulent, (0.22–)0.65(–1.02) mm diam. [*n* = 276]; disc plane to moderately convex, occasionally shallow-concave or markedly convex, usually pulverulent; margin initially entire, usually flexuose-crenulate with age and frequently nodulose, persistent, 70–120 µm thick, occasionally almost excluded. *Thalline margin* anatomically identical with the thallus. *Proper excipulum* hyaline throughout, 12–25 µm thick laterally and above most of the apothecial base, forming an inconspicuous to distinct, central stipe 50–90(–120) µm wide. *Hypothecium* hyaline, interspersed with oil droplets, 50–80(–100) µm thick. *Hymenium* 50–80 µm thick, amyloid. *Epithymenium* dominated by an opaque layer of encrusted lichen substances 15–25 µm thick. *Asci* narrowly to broadly clavate, *Candelariella*-type, 8-spored, 45–64 × 13–22 µm [*n* = 40; occasionally 6-spored; one 4-spored ascus seen (*J.A. Elix 9163*) with ascospores 16–17 × 10–11 µm]. *Ascospores* colourless, usually simple, rarely 1-septate, ellipsoid to oblong-ellipsoid or oblong, straight or slightly curved, with rounded ends, occasionally slightly broader towards the distal end, the contents commonly vacuolate and granulose, granules and small vacuoles sometimes aggregating in a transverse, medial band, (11–)16.3(–22) × (5–)6.3(–8) µm [*n* = 308]. *Pycnidia* numerous, immersed

in the thallus, with a concolorous or very slightly darker ostiole, or in convex to hemispherical swellings, hyaline throughout, 50–110  $\mu\text{m}$  wide; conidia narrowly ellipsoid to oblong or bacilliform, (1–)1.5– 2.5(–3)  $\times$  0.5–0.8(–1)  $\mu\text{m}$  [ $n = 50$ ].

**Chemistry:** Thallus K+ pale reddish, C–, KC–, PD–, UV–; calycin (major/minor), pulvinic dilactone (major/minor), pulvinic acid (minor) and unknowns by TLC and HPLC.

#### Remarks

A rather common lichen on siliceous rocks in western U.S.A., the highly variable *C. rosulans* can be characterized by a yellow, convex-areolate to peltate or lobate-squamulose thallus, rather large, lecanorine apothecia with a persistent, entire or crenulate to nodulose margin, 8-spored asci and comparatively large and elongate ascospores (Westberg 2004, 2007c). It has also been reported from Iran, and it possibly occurs in China as the synonymous *C. oleifera* H.Magn. (Westberg & Sohrabi 2012). However, as emphasized by Westberg (2007c) and Westberg & Sohrabi (2012), *C. rosulans*, as it is currently circumscribed, is heterogeneous and in need of revision, ideally aided by molecular methods. Consequently, the identification of the Australian specimens must remain somewhat tentative, and while they differ from accounts of North American and Asian material, the significance of those disparities is uncertain. Thus, ascospores reported from North American and Iranian collections [(4–)4.5–6(–7)  $\mu\text{m}$  and (3–)4–6(–7)  $\mu\text{m}$  wide, respectively] are somewhat narrower than in the Australian material, while the conidia of American specimens are appreciably larger (2.5–3.5  $\times$  1.5  $\mu\text{m}$ ; Westberg 2007c).

*Candelariella rosulans* is known mainly from siliceous rocks (one specimen on compacted, siliceous soil) in the warm-temperate south-west of W.A., in drier habitats in central Australia (N.T.) and southern Qld and in the much milder conditions of the Southern Tablelands of N.S.W. A specimen cited by Filson (1992, as *C. spraguei*) from northern S.A. was not seen, while a collection from the A.C.T. cited by him is *C. australiensis* (see above).

#### SPECIMENS EXAMINED

**New South Wales:** • Southern Tablelands, Morton Natl Park, 7 km NE of Nerriga, 35°04'S, 150°10'E, 750 m alt., on exposed sandstone in open *Eucalyptus* woodland, *J.A. Elix* 9163, 18.x.1981 (CANB); • Southern Tablelands, Bulee Gap, 8 km NE of Nerriga, just S of Morton Natl Park, 35°05'18"S, 150°08'22"E, 690 m alt., on sandstone in open *Eucalyptus* woodland with *Acacia* and *Kunzea* understorey, *J.A. Elix* 39710, 31.x.2007 (CANB).

**Northern Territory:** • Forster Range, ridge 20 km S of Barrow Creek, 21°38'S, 133°44'E, 610 m alt., on sheltered sandstone ledge, *J.A. Elix* 11204 & *L.A. Craven*, 13.ix.1983 (CANB); • Macdonnell Range, 10 km N of Alice Springs, 1.5 km W of Stuart Highway, 23°37'S, 133°52'E, 680 m alt., on sandstone ledge in open mulga woodland, *J.A. Elix* 11355 & *L.A. Craven*, 18.ix.1983 (CANB).

**Queensland:** • Warrego district, c. 4 km N of Yenloora Homestead, along road to Dynevor Downs, 28°23'43"S, 144°09'17"E, on conglomerate rock with scattered, low *Acacia brachystachya* and *A. aneura*, *R.W. Purdie* 4622, 7.viii.1997 (CANB).

**Western Australia:** • 33 km NE of Eneabba, Cockatoo Canyon, junction of Bunney Road and Nebrua Road, 29°33'51"S, 115°27'04"E, 245 m alt., on lateritic rock in mallee *Eucalyptus* woodland with *Melaleuca*, *Acacia* and *Callitris*, *J.A. Elix* 28845, 5.v.2004 (CANB); • Karolin Rock, 20 km NW of Bulfinch, 31°59'01"S, 118°55'05"E, 370 m alt., compacted, siliceous soil on granite monolith with isolated *Acacia* and *Eucalyptus*, *J.A. Elix* 32575, 29.iv.2004 (CANB); • Darling Plateau, Brookton Highway Nature Reserve, 25 km W of Brookton, 32°23'50"S, 116°44'03"E, 285 m alt., on lateritic rock in *Eucalyptus* woodland, *J.A. Elix* 38735, 5.iv.2006 (CANB, PERTH).

#### Key to the saxicolous species of *Candelariella* in Australia

- 1 Asci 16–32-spored ..... **C. vitellina**  
 1: Asci 8-spored (rarely fewer) ..... 2
- 2 Thallus crustose, granular, dispersed or evanescent; on calcareous rock ..... **C. aurella**  
 2: Thallus of peltate or rosulate squamules; on siliceous rock ..... 3
- 3 Ascospores 8–13(–15)  $\times$  4–5(–6)  $\mu\text{m}$ ; asci 35–55  $\times$  11–16  $\mu\text{m}$ ; hymenium 45–60  $\mu\text{m}$  thick ..... **C. australiensis**  
 3: Ascospores 11–19(–22)  $\times$  5–7.5(–8)  $\mu\text{m}$ ; asci 45–64  $\times$  14–22  $\mu\text{m}$ ; hymenium 50–80  $\mu\text{m}$  thick ..... **C. rosulans**

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Figure 1. *Candelariella australiensis* (holotype). Scale bars: 2 mm.

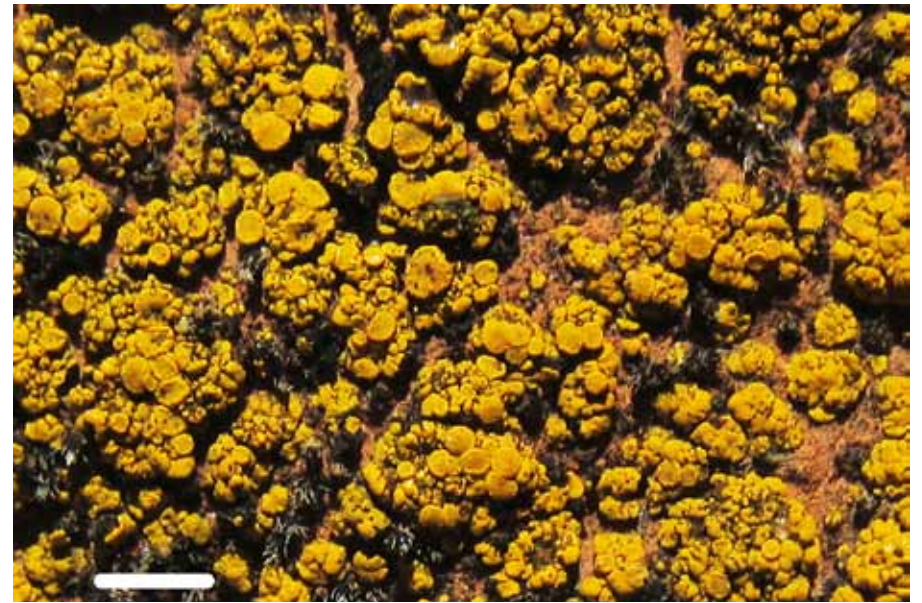


Figure 2. *Candelariella rosulans* (J.A. Elix 32575, CANB). Scale bar: 2 mm.

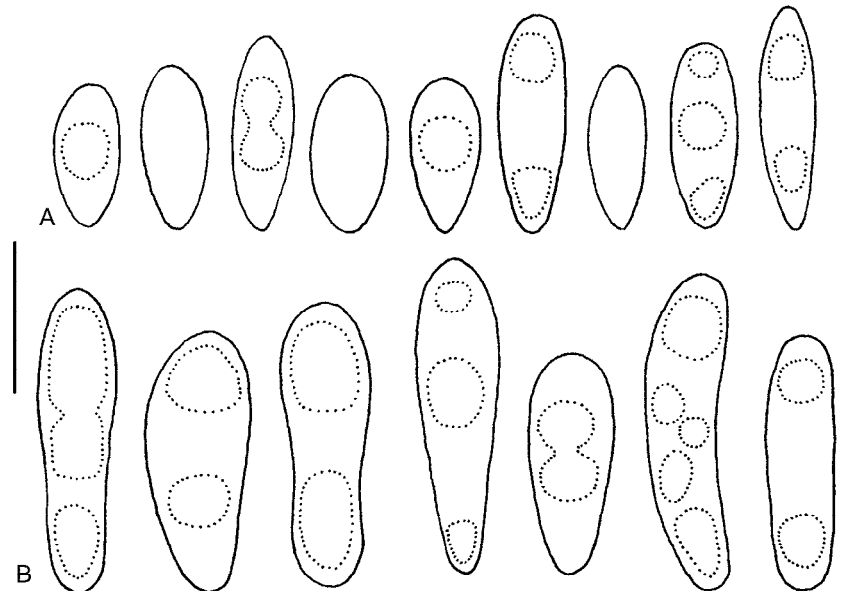


Figure 3. Ascospores of *Candelariella australiensis* (A, holotype) and *C. rosulans* (B, J.A. Elix 39710, CANB). Scale bar: 10  $\mu$ m.

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

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**Abstract**

*Buellia patearoana* Elix & A.Knight, *B. suttonensis* Elix & A.Knight, and *B. tuapekensis* Elix & A.Knight, are described as new to science. In addition, *Buellia sharpiana* Lendemer & R.C.Harris is recorded for the first time in New Zealand. *Buellia patearoana* also occurs in Tasmania.

This paper continues our investigation of *Buellia*-like lichens in New Zealand, and follows from the previous accounts of *Buellia* and related genera (Elix *et al.* 2015, 2017; Elix & Mayrhofer 2016, 2017; Elix & de Lange 2017) and our additions and revisions to *Amandinea* (Blaħa *et al.* 2016; Mayrhofer *et al.* 2016). Here, we describe three new saxicolous species of *Buellia* in the broad sense. Methods are as described in previous papers cited above.

**The new species**

**1. *Buellia patearoana* Elix & A.Knight, sp. nov.**  
Mycobank Number: **MB 821456**

Fig. 1

Similar to *Buellia homophyllia* (C.Knight) Zahlbr., but differs in having larger ascospores, 15–[17.6]–21 × 8–[10.3]–12 μm, an interspersed subhymenium and in lacking atranorin.

*Type*: New Zealand, South Island, Otago, Rock and Pillar Range, 1160–1190 m alt., on schist tors below summit, *F.J. Walker & C. Meurk RP 13*, 18.ix.1981 (holotype – BM 001231305).

*Thallus* crustose, rimose-areolate, to 35 mm wide and 0.2–1 mm thick, the individual areoles irregular, angular, 0.1–1 mm wide, sometimes becoming bullate; upper surface white to grey-white or yellow-white, often white-maculate; prothallus black, marginal or not apparent; photobiont cells 8–15 μm wide. *Medulla* white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I+ violet-blue in part. *Apothecia* 0.2–1 mm wide, abundant, lecideine, scattered and roundish to crowded and distorted by mutual pressure, immersed but ultimately broadly adnate, rarely sessile and constricted at base; disc black, epruinose, plane to convex; proper exciple thick, distinct, persistent, rarely excluded in older, convex apothecia, in section 50–75 μm thick; outer part aeruginose-black, K-, N+ purple; inner part brown. *Epihymenium* 12–15 μm thick, aeruginose to brown-black, K+ blue-green, N+ purple. *Hypothecium* 200–250 μm thick, dark brown to brown-black, K+ orange, forming red, needle-like crystals. *Hymenium* 70–100 μm thick, colourless, not interspersed; subhymenium 20–30 μm thick, pale brown, interspersed with oil droplets; paraphyses 1–2 μm wide, sparingly branched, with apices 4–5 μm wide an with aeruginose caps. *Asci* (6–)8-spored, *Bacidia*-type. *Ascospores* *Physconia*- then *Buellia*-type, 1-septate, brown to dark brown, broadly ellipsoid, 15–[17.6]–21 × 8–

[10.3]–12 μm, rarely constricted at the septum, not curved; outer wall rugulate. *Pycnidia* common, immersed, black, punctiform; conidia bacilliform, 4–6 × 1–1.5 μm. *Chemistry*: Thallus K+ yellow then red, C-, PD+ orange-red, UV-; containing norstictic acid (major), conorstictic acid (minor), atranorin (trace or absent).

*Etymology*: The species is named after the type locality, *patearoa*, the traditional Southern Māori name for the Rock and Pillar Range.

**Remarks**

The new species resembles *B. homophyllia*, which is present in New Zealand and Australia. Both species contain norstictic acid, have immersed to broadly adnate, lecideine apothecia with epruinose discs, 1-septate, *Buellia*-type ascospores and bacilliform conidia. However, *B. homophyllia* has smaller ascospores, 11–[14.4]–21 × 5–[7.2]–10 μm and a non-interspersed subhymenium, and contains significant quantities of atranorin in the thallus (Elix 2011). Chemically, *B. patearoana* is identical to *B. aethalea* (Ach.) Th.Fr., and sometimes co-occurs with that species. However, *B. aethalea* has smaller apothecia (to 0.5 mm wide) that remain immersed, and are angular to irregularly circular (comma-shaped), predominantly in the centre of the areoles. Furthermore, *B. aethalea* lacks an interspersed subhymenium, usually has smaller ascospores, and the ascospores have a microrugulate outer spore-wall (Elix 2011).

At present the new species is known from siliceous rocks in the Rock and Pillar Range in central Otago, South Island, New Zealand, and from subalpine areas of Tasmania. Associated species in New Zealand include *Amandinea subbadioatra* (C.Knight) Elix & Kantvilas, *Aspicilia caesiocinerea* (Nyl.) Arnold, *Buellia aethalea*, *B. maungatuensis* Elix & H.Mayrhofer, *Candelariella vitellina* (Ehrh.) Müll.Arg., *Lecidea lygomma* Nyl., *Ramboldia petraeoides* (Nyl. ex C.Bab. & Mitt.) Kantvilas & Elix, *Rhizocarpon geographicum* (L.) DC., *R. reductum* Th.Fr. and *Xanthoparmelia mougeotina* (Nyl.) D.J.Galloway.

**SPECIMENS EXAMINED**

**Australia: Tasmania**: • Mt Tyndall, 41°55'48"S, 145°35'23"E, 950 m alt., on conglomerate outcrop in segeland heath, *G. Kantvilas 97/86*, 5.iii.1986 (BM, HO).

**New Zealand**: • **Otago**: • Rock and Pillar Range, above Leaning Lodge towards carpark, 45°25'04"S, 170°05'10"E, 1239 m alt., on schist outcrops, *A. Knight s.n.*, 6.xii.2014 (CANB, OTA 064316); • South Island, Otago, Rock and Pillar Range, ridge above tarn, 45°24'30"S, 170°05'07"E, 1386 m alt., on underhang of schist tor, *A. Knight s.n.*, 6.xii.2014 (CANB, OTA 064314).

**2. *Buellia suttonensis* Elix & A.Knight, sp. nov.**  
Mycobank Number: **MB 821457**

Fig. 2

Similar to *Buellia epigaea* (Pers.) Tuck., but differs in having smaller ascospores, 10–[11.6]–15 × 5–[5.9]–7 μm, and in lacking medullary calcium oxalate.

*Type*: New Zealand, South Island, Otago, Sutton Salt Lake, 45°34'30"S, 170°05'07"E, 253 m alt., on sandy soil crust at northern end of lake, *A. Knight s.n.*, 3.vii.2016 (holotype – OTA 069124; isotype – CANB).

*Thallus* crustose, endolithic and not apparent or epilithic, thin and rimose or thicker and verrucose to bullate-areolate, 0.3–1.5 mm thick, grey-white to pale brown, often centred around the base of apothecia; prothallus not apparent; photobiont cells 10–25 μm wide. *Medulla* white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-. *Apothecia* 0.1–0.9 mm wide, abundant, lecideine, scattered and roundish to crowded and distorted by mutual pressure, broadly adnate to sessile; disc black, epruinose, plane to weakly convex; proper exciple thin, distinct, persistent, in section 25–45 μm thick; outer part brown-black, K-, N+ orange-brown; inner part brown. *Epihymenium* 10–13 μm thick,

dark brown, K-, N-. *Hypothecium* 85–170 µm thick, dark brown to brown-black, K-, *Hymenium* 40–60 µm thick, colourless, not interspersed; subhymenium 20–35 µm thick, brown, not interspersed; paraphyses 1–2 µm wide, sparingly branched; apices 5–6 µm wide, with brown caps. *Asci* (4–)8-spored, *Bacidia*-type. *Ascospores* *Buellia*-type, 1-septate, pale brown then dark brown, ellipsoid, 10–[11.6]–15 × 5–[5.9]–7 µm, becoming constricted at the septum, not curved; outer wall smooth to finely ornamented. *Pycnidia* immersed, black, punctiform; conidia bacilliform, 3–6.5 × 1 µm. *Chemistry*: Medulla K-, C-, PD-, UV-; no lichen substances detected.

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

#### Remarks

The terricolous collections of this new species resemble those of *B. epigaea* from Europe, Central Asia and North America in that all have areolate to bullate thalli, immersed to sessile, lecideine apothecia, 1-septate, *Buellia*-type ascospores and bacilliform conidia. However, *B. epigaea* has significantly larger ascospores, 14–[18.3]–26 × 6–[8.4]–11 µm, finely white-pruinose apothecial discs, somewhat longer conidia (5–7 µm), and contains copious amounts of calcium oxalate in the medulla (Trinkaus & Mayrhofer 2000). Unlike *B. epigaea*, which grows on calcareous soil and over mosses, *B. suttonensis* occurs on saline soil and on siliceous rocks. *Buellia suttonensis* also resembles the Australian *B. epigaella* Elix & Kantvilas, a terricolous species growing on sandy loams which lacks medullary calcium oxalate. However, *B. epigaella* has larger ascospores, 14–[17.4]–20 × 6–[7.6]–9 µm, and curved, filiform conidia (12–20 µm) (Elix & Kantvilas 2013). The saxicolous collections of *B. suttonensis* closely resemble *B. austroabstracta* Elix & Kantvilas, but that species contains medullary calcium oxalate (Elix *et al.* 2017).

The type of the new species occurs on saline soil, but it is more common on coastal rocks subjected to salt spray. The terricolous *Caloplaca cirrochroides* (Vain.) Zahlbr. is associated with *B. suttonensis* at the type locality, but common lichens associated with coastal collections include *Amandinea decedens* (Nyl.) Blaha, *H. Mayrhofer* & Elix, *Buellia cranwelliae* Zahlbr., *Ochrolechia apiculata* Veseghy, *Rinodinella fertilis* (Körb.) Elix var. *fertilis* and *Xanthoparmelia australasica* D.J. Galloway.

#### SPECIMENS EXAMINED

**New Zealand:** North Island: *North Auckland*: • Leigh, Goats Island beach to Cape Rodney, 36°16'S, 174°48'E, 0–20 m alt., on coastal rocks, *H. Mayrhofer* 6746 & G.J. Samuels, 7.i.1985 (GZU); • *Auckland*: Kawakawa Bay, E of Auckland, Papanui Point, 35°56'S, 175°13'48"E, 3–5 m alt., on coastal rocks, *H. Mayrhofer* 5869 & G.J. Samuels, 8.i.1985 (GZU); • Anawhata Bay, W of Auckland, 36°55'30"S, 174°27'30"E, 0–20 m alt., on coastal rocks, *H. Mayrhofer* 6777 & G.J. Samuels, 9.i.1985 (GZU); • Rangitoto Island, 36°48'30"S, 174°51'30"E, 0–10 m alt., on lava, *H. Mayrhofer* 6802, *H. Hertel* & J.E. Braggins, 10.i.1985 (GZU); • Orere Point, S of Kawakawa Bay, E of Auckland, 35°57'S, 175°15'E, 0–10 m alt., on coastal rocks, *H. Mayrhofer* 6967 & G.J. Samuels, 12.i.1985 (GZU); • *Hawkes Bay*: 4 km NW of Purerere, E of Waipukurau, 40°05'S, 176°50'E, c. 100 m alt., on rocks, *H. Mayrhofer* 11577 & E. Hierzer, 17.viii.1992 (GZU); South Island: *Canterbury*: • Banks Peninsula, Tumbledown Bay, S of Little River, 43°51'12"S, 172°46'01"E, 0–5 m alt., on coastal basalt rocks, *J. Blaha* 0003, 11.iii.2001 (GZU). • Banks Peninsula, Hickory Bay, 43°46'45"S, 172°05'48"E, 0–20 m alt., on coastal basalt rocks, *J. Blaha* 0032, 15.iii.2001 (GZU). • *Otago*: Sutton Salt Lake, 45°33'36"S, 170°05'07"E, 225 m alt., on schist outcrop by track, W-branch near fork, *A. Knight* & A. Webb *s.n.*, 3.vii.2016 (OTA 069126); • type locality, on sandy soil crust at N end of lake, *A. Knight* *s.n.*, 3.vii.2016 (OTA 069123).

**3. *Buellia tuapekensis*** Elix & A. Knight, sp. nov.  
Mycobank Number: MB 821458

Fig. 3

Similar to *Buellia northallina* Elix & Kantvilas, but differs in having a better-developed thallus and longer ascospores, 12–[13.6]–16 µm.

*Type*: New Zealand, South Island, Otago, Tuapeka West, Youngs Farm, 45°54'47"S, 169°30'11"E, 305 m alt., on low schist outcrops in pasture, *A. Knight* *s.n.*, 15.xii.2014 (holotype – OTA 065257; isotype – CANB).

*Thallus* crustose, thin and membranaceous, discontinuous, to 25 mm wide and 0.2 mm thick, pale tan to pale yellow-brown; prothallus not apparent; photobiont cells 8–15 µm wide. *Medulla* white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-. *Apothecia* 0.1–0.5 mm wide, abundant, lecideine, scattered and roundish to crowded and distorted by mutual pressure, broadly adnate; disc black, epruinose, plane to convex; proper exciple thin, distinct, persistent or excluded in convex apothecia, in section 30–50 µm thick; outer part brown-black, K-, N+ orange-brown; inner part brown. *Epilhymenium* 10–13 µm thick, dark olive-brown, K-, N-. *Hypothecium* 100–150 µm thick, dark brown to brown-black, with a K+ yellow-orange solution in part. *Hymenium* 60–85 µm thick, colourless, not interspersed; subhymenium 20–35 µm thick, pale brown, interspersed with oil droplets; paraphyses 1–2 µm wide, sparingly branched; apices 5–6 µm wide, with brown caps. *Asci* 8-spored, *Bacidia*-type. *Ascospores* *Buellia*-type, 1-septate, pale brown then dark brown, ellipsoid, 12–[13.6]–16 × 5–[6.5]–8 µm, rarely constricted at the septum, not curved; outer wall smooth to microrugulate. *Pycnidia* immersed, black, punctiform; conidia bacilliform, 4–5 × 1 µm.

*Chemistry*: Medulla K+ yellow-orange solution, C-, PD-, UV-, containing norstictic acid (minor).

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

#### Remarks

The new species resembles *B. northallina* from Australia in that both species contain norstictic acid, have broadly adnate, lecideine apothecia with epruinose discs, 1-septate, small, *Buellia*-type ascospores, a subhymenium interspersed with oil droplets and bacilliform conidia. However, *B. northallina* has significantly shorter ascospores, 10–[11.7]–14 µm long, and a more rudimentary thallus, being typically endolithic and not apparent, or else epilithic, very thin, effuse and ecorticate (Elix *et al.* 2017).

At present the new species is known from the two localities in central Otago, South Island, New Zealand, where it occurs on siliceous rocks. Associated species include *Amandinea subbadioatra* (C. Knight) Elix & Kantvilas, *Aspicilia caesiocinerea* (Nyl.) Arnold, *Buellia maungatuensis* Elix & H. Mayrhofer, *Candelariella vitellina* (Ehrh.) Müll. Arg., *Lecidea lygomma* Nyl., *Ramboldia petraeoides* (Nyl. ex C. Bab. & Mitt.) Kantvilas & Elix, *Rhizocarpon geographicum* (L.) DC., *R. reductum* Th. Fr. and *Xanthoparmelia mougeotina* (Nyl.) D.J. Galloway.

#### SPECIMEN EXAMINED

**New Zealand:** • *Otago*: • SW of Dunedin, Mount Maungatua, c. 500 m W of summit, 45°54'S, 170°08'E, c. 850 m alt., on rock, *H. Mayrhofer* 10492 *pr.p.*, *H. Hertel* & A.F. Mark, 31.i.1985 (GZU).

#### New record

***Buellia sharpiana*** Lendemer & R.C. Harris, *Castanea* 78, 114 (2013)

The species was known previously from North America (Lendemer & Harris 2013). It is characterized by an areolate, yellowish to grey thallus, the areoles typically

aggregated with age, the presence of arthothelin (C+ orange), an amyloid medulla, immersed apothecia often occurring singly in each areole, an aeruginose, N+ red-violet epihymenium, a colourless hymenium, *Buellia*-type ascospores, 11–[12.4]–14 × 7.5–[8.2]–9 μm and bacilliform conidia, 4.5–7 × 1–1.3 μm. It is morphologically very similar to *B. ocellata* (Flot.) Korb., but that species has a nonamyloid medulla and larger ascospores, 12–[14.7]–18 × 7–[9.0]–11 μm. A detailed description is given in Lendemer & Harris (2013).

#### SPECIMEN EXAMINED

**New Zealand:** • *Canterbury*: Malvern County, N side of Route 73 along the Craigieburn River, on rock on grassy hillside, R.C. Harris 6544, 24.i.1971 (MSC).

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Figure 1. *Buellia patearoana* (A. Knight s.n., OTA 064314). Scale = 1 mm.



Figure 2. *Buellia suttonensis* (holotype in OTA). Scale = 1 mm.



Figure 3. *Buellia tuapekensis* (H. Mayrhofer 10492 *pr.p.*, GZU). Scale = 1 mm.

**A new species of *Diorygma* (Graphidaceae, lichenized Ascomycota), and notes on *Diaphorographis queenslandica***

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**Abstract:** *Diorygma streimannii* A.W.Archer & Elix, the first species of *Diorygma* found to contain neotricone, is described as new to science. Contrary to previous reports, *Diaphorographis queenslandica* Kalb & A.W.Archer contains protocetraric acid.

**Introduction**

The genus *Diorygma* was introduced by Eschweiler (1824), and subsequently *D. hieroglyphicum* (Pers.) Staiger & Kalb was chosen as the lectotype for the genus (Staiger 2002). A preliminary account published in 2004 (Kalb *et al.* 2004) listed 24 species and their synonyms, together with a key to the known species. In 2014, three new species were described and a revised world key was published (Feuerstein *et al.* 2014); that key listed a total of 52 species. References to *perstictic* acid in the key are misspellings of *peristictic* acid. A few months later, another species was described from Florida (Seavey & Seavey 2014), and a further species, from New Caledonia, was described in 2014 (Papong *et al.* 2014), raising the total to 54. Eleven species occur in Australia (Archer 2009; Archer & Elix 2009), and the new species *Diorygma streimannii* (*vide infra*) increases the total to 12.

The genus *Diaphorographis* A.W.Archer & Kalb was introduced in 2009 (Kalb *et al.* 2009) based on *D. queenslandica* Kalb & A.W.Archer. The genus is distinguished from *Graphis* Adans. by I- ascospores, and from *Carbacanthographis* Staiger & Kalb (Staiger 2002) by the absence of periphysoids. The protologue cited two species from Australia (Queensland), New Caledonia and the Solomon Islands, both of which were reported to lack lichen compounds.

Both *Diaphorographis* and *Diorygma* were placed in the subfamily Graphidoideae Rivas Plata, Lücking & Lumbsch (Lücking *et al.* 2016), but the supporting citation made no mention of *Diaphorographis* (Rivas Plata *et al.* 2012). Because no molecular data are available to determine the exact position of *Diaphorographis* in the Ascomycota, the two genera are retained here in the family Graphidaceae.

In the present work, chemical constituents were identified by thin-layer chromatography (Elix 2014) and by comparison with authentic samples.

**The new species**

*Diorygma streimannii* A.W.Archer & Elix, sp. nov.  
Mycobank Number: **MB 817906**

Figs 1 & 2

Similar to *Diorygma rufopruinosum* (A.W.Archer) Kalb, Staiger & Elix, but differs in having a black epithecium with a white pruina and in containing neotricone.

Type: Australia, Queensland, Cow Bay, Cape Tribulation National Park, 26 km NNE of Mossman, 16°14'S, 145°29'E, alt. 2 m, on *Casuarina* trunk, H. Streimann 46006 *pr.p.*, 6.xii.1990; holotype: CANB.

Thallus corticolous, off-white; surface smooth and matt, lacking isidia and soralia. Apothecia disciform, sessile, usually circular, sometimes distorted, 0.7–1.2 mm in diam.; epithecium black, with a white pruinose layer; hymenium 160–200 µm tall, I–, not interspersed; exciple non-carbonized. Ascospores 1 per ascus, ellipsoid, hyaline, muriform, 120–160 × 32–40 µm, I+ blue.

**Chemistry:** neotricone (major), norstictic acid (minor), salazinic acid (minor), norperistictic acid (minor) and protocetraric acid (minor).

**Etymology:** The species is named after the collector, Heinar Streimann (1938–2001), who made important contributions to the study of Australian mosses and lichens.

*Diorygma streimannii* is characterized by the disciform, sessile apothecia, a non-carbonized exciple, a non-interspersed hymenium, asci with a single muriform ascospore and in particular the presence of neotricone as the major lichen compound. At present the new species is known from only the type specimen. It is distinguished from *P. rufopruinosum* by the black epithecium, hyaline to slightly brown in *P. rufopruinosum* (Kalb *et al.* 2004), and the presence of neotricone.

Neotricone was first isolated from *Phaeographis syngraphizans* (Wright) Zahlbr. and *P. neotricosa* Redinger (Elix *et al.* 2003), and was later reported from *Pertusaria neotriconica* Elix & A.W.Archer (Elix & Archer 2007).

Species of *Diorygma* contain several β-orcinol depsidones, among them norstictic acid, stictic acid, protocetraric acid and salazinic acid. Neotricone too is a β-orcinol depsidone, related to norstictic acid but with the aldehyde group replaced by a carboxy group and the cyclic hemiacetal replaced by a γ-lactone (Fig. 2). Neotricone has not been reported previously from *Diorygma*.

#### Notes on *Diaphorographis queenslandica*

The genus *Diaphorographis* A.W.Archer & Kalb (Graphidaceae) was introduced in 2009 (Kalb *et al.* 2009), based on *D. queenslandica* Kalb & A.W.Archer from Queensland. The type species is characterized by numerous conspicuous, scattered, sessile apothecia concolorous with the thallus, hemispherical to subspherical, 0.6–0.9 mm in diam., with a groove on the upper surface (Fig. 4). The proper exciple is completely carbonized, 80–120 µm thick, covered by a thin thalline coating with a non-interspersed hymenium 250–400 µm tall. Ascospores are 1 per ascus, fusiform-ellipsoid, hyaline, muriform, (140–)180–250 × 20–25 µm, and I– (Fig. 5).

The species was originally reported to lack lichen compounds, but a recent re-examination of the type specimen found it to contain protocetraric acid. The two additional specimens cited below also contain protocetraric acid. The genus is known from northern Queensland, New Caledonia and the Solomon Islands (Kalb *et al.* 2009).

#### ADDITIONAL SPECIMENS EXAMINED

**Queensland:** • Cow Bay, Tribulation National Park, 26 km NNE of Mossman, 16°14'S, 145°29'E, alt. 2 m, strand vegetation dominated by *Calophyllum inophyllum*, *Terminalia* and *Hibiscus tiliaceus*; on *Casuarina* trunk, *H. Streimann* 46006 *pr.p.*, 6.xii.1990 (CANB); • road from Gordonvale to Yarrabah, c. 10 km E of Cairns, wet-sclerophyll forest with *Eucalyptus*, palms and grasses, 16°55'S, 145°51'E, on bark; *H.T. Lumbsch* 11158g, 1.viii.1996 (CANB).

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Fig. 1 *Diorygma streimannii* (holotype). Scale = 1 mm.



Fig. 2 *Diorygma streimannii*. Ascospore. Scale - 50  $\mu$ m.

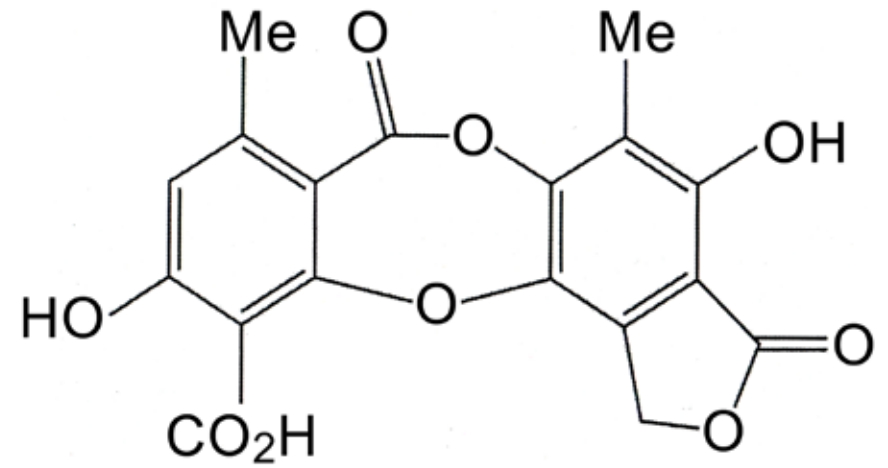


Fig. 3. Neotricone molecular structure.



Fig. 4. *Diaphorographis queenslandica* (Lumbsch 11158q). Scale = 1 mm.



Fig. 5. *Diaphorographis queenslandica*. Ascospores with iodine. Scale = 50  $\mu\text{m}$ .

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