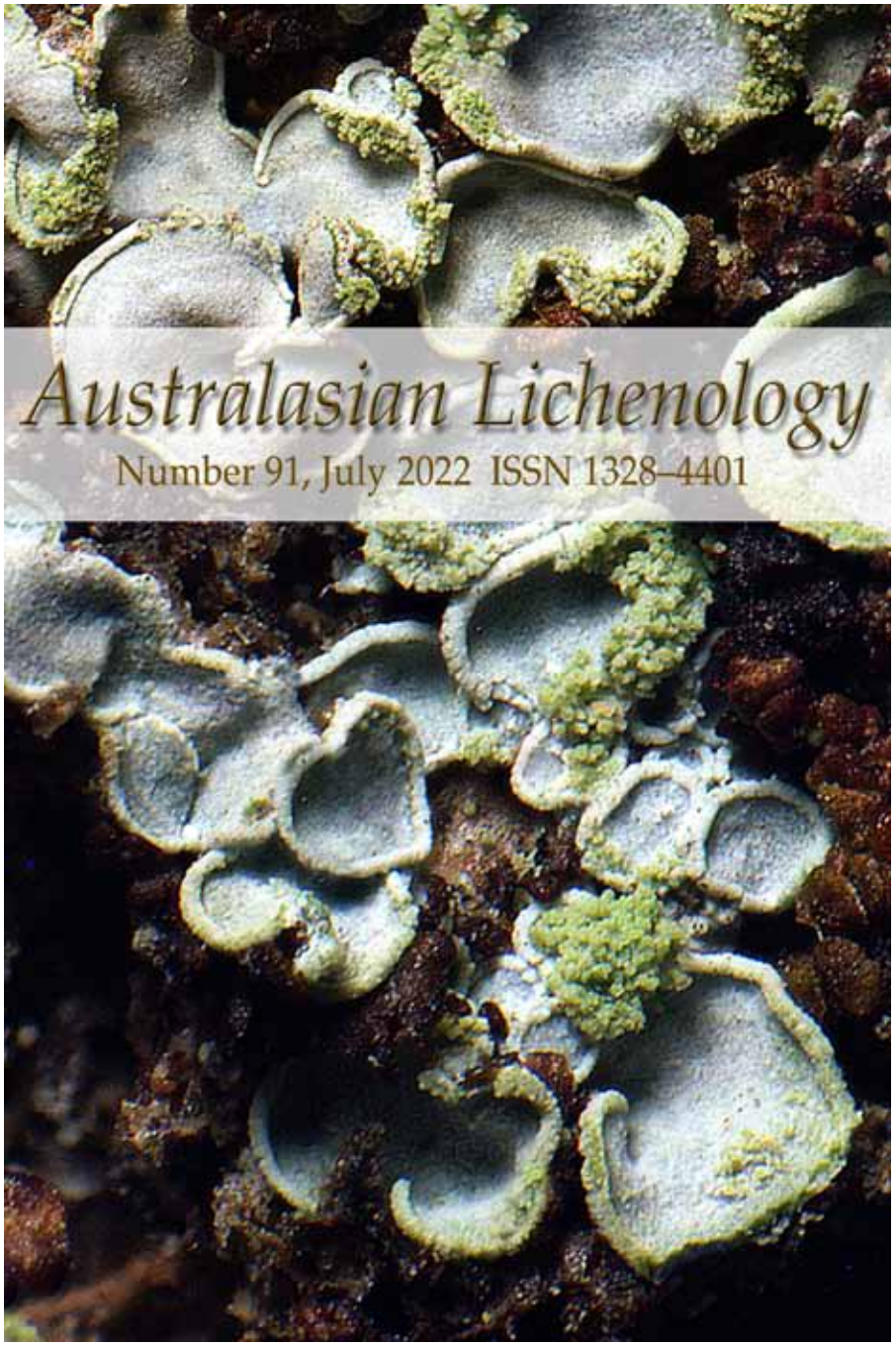

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Normandina pulchella is readily identified by its distinctive blue-green colour and its ear-like squamules, which have raised and strongly in-rolled margins. It colonizes a range of substrata, including rock, tree bark, moist humus, leaves, and even other lichens, and it's moderately tolerant of air pollution. It often produces dense patches of moss-green soredia on the surface and margins of its squamules, but ascomata and conidiomata are unknown. Occasional reports of perithecia have mostly been dismissed as fruiting bodies produced by *Lauderlindsaya borreri* or other lichenicolous Ascomycetes. Often overlooked because of its small size, it's nearly cosmopolitan in its distribution.

1 mm

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New and interesting saxicolous species of *Opegrapha* (Ascomycota, Opegraphaceae) from eastern Australia

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Abstract

Three species of *Opegrapha* Ach. are described as new. The sympatric *O. australis* and *O. oraria* occur on coastal siliceous rocks in eastern Victoria and southern New South Wales, both having thin, pale and inconspicuous thalli, with short, narrow, mostly sessile black lirellae with a basally closed, largely carbonized proper excipulum, a shallow, non-inspersed hymenium and *Varia*-type asci. However, the former has (3–)5-septate ascospores 12–18 × 2.5–4.5 µm, while those of *O. oraria* are mostly 3-septate and 12–18 × 3–6 µm. *Opegrapha howeana*, from sheltered basalt in lowland, subtropical forest in Lord Howe Island, has a thin, delicately rimose, greenish grey thallus, elongate and simple to sparingly branched, adnate to subsessile lirellae with rounded or truncate ends, a slit-like disc and a closed excipulum base, broad asci, mainly 7-septate ascospores, 24–36 × 5.5–9 µm, most with enlarged median cells and a distinct perispore. Two other species, *O. diaphoriza* Nyl. and *O. spodopolia* Nyl., are reported for the first time from rocky seashores in southern New South Wales, the latter also in eastern Victoria.

Introduction

The genus *Opegrapha* Ach. *sens. lat.*, with *c.* 300 species, is predominantly corticolous, but it also occurs on leaves and, frequently, as a parasite of other lichens, while a smaller minority occur directly on rock or soil. Most have a tropical or subtropical distribution, but there is also significant diversity at temperate latitudes in both hemispheres. Recent phylogenetic studies have seen the genus lose taxa to other families of Arthoniales and to genera including *Alyxoria*, *Arthonia*, *Fouragea*, *Gyrographa*, *Pseudoschismatomma* and *Zwackhia* (Ertz *et al.* 2009, 2014; Ertz & Tehler 2011; Frisch *et al.* 2014; Ertz 2020). These changes have yet to be incorporated into the Australian lichen checklist (McCarthy 2020).

Following this realignment of species, based primarily on the results of molecular studies, the circumscription of *Opegrapha sens. str.* is now more problematic in terms of having diagnostic morphological characters that contrast with, for example, *Alyxoria*. Nevertheless, most species have a crustose, ecorticate thallus with *Trentepohlia* or *Phycopeltis* (foliicolous species only), usually without lichen substances. Ascomata are lirelliform and non-stromatic, with a partially or completely carbonized excipulum, anastomosing paraphysoids, mostly 8-spored, fissitunicate asci, elongate ascospores with three or more transverse septa, and conidia that are aseptate and ellipsoidal, bacilliform or arcuate (Hayward 1977; Clauzade & Roux 1985; Torrente & Egea 1989; Ertz & Egea 2007; Galloway 2007; Lücking 2008; Ertz 2009; Ertz *et al.* 2009; Pentecost & James 2009; Seavey *et al.* 2014; Wieczorek 2018; Cannon *et al.* 2021a; Nimis 2021).

Forty-eight species and infraspecific taxa of *Opegrapha sensu lato* have been reported from Australia (McCarthy 2020), but many identifications, including those of supposedly endemic taxa, require re-assessment. Recent additions to the flora have included several maritime, saxicolous taxa reported from South Australia and Tasmania (Elix & McCarthy 2017; Kantvilas 2019; Kantvilas *et al.* 2020). This contribution is based largely on specimens collected from rocky seashores in south-eastern mainland Australia during 2016–2018. These include two newly described taxa and additional new records, while another new saxicolous species is reported from subtropical forest on Lord Howe Island in the south-western Pacific Ocean.

Methods

Observations and measurements of photobiont cells, thalline and ascomatal anatomy, asci, ascospores, and conidia were made on hand-cut sections mounted in water. Calcium oxalate was detected by treatment of thallus sections with a 10% aqueous solution of sulfuric acid; it

forms colourless, needle-shaped crystals. Asci were observed in Lugol's Iodine (I), with and without pretreatment in K.

New species

Opegrapha australis P.M.McCarthy, sp. nov. Fig. 1
MycoBank No.: **MB 843517**

Characterized by the thin, pale and inconspicuous thallus with short, narrow, mostly sessile black lirellae, 0.15–0.8(–1) × (0.08–)0.12–0.2(–0.35) mm; proper excipulum basally closed and predominantly carbonized, enclosing a shallow, non-inspersed hymenium with *Varia*-type asci and (3–)5-septate ascospores, 12–18 × 2.5–4.5 µm.

Type: Australia. New South Wales, South Coast, Pooles Beach, 3 km S of Mystery Bay, 36°18'46"S, 150°07'57"E, *c.* 1 m alt., on exposed shale outcrops along foreshore, *P.M. McCarthy 4556B*, 18.xi.2016 (holotype – CANB).

Thallus crustose, epilithic, usually inconspicuous, often patchy and effuse, off-white to pale creamy grey or pale greyish green, forming poorly defined colonies to *c.* 30 mm wide, not cracked, to *c.* 50 µm thick on smooth surfaces, to *c.* 150(–250) µm thick in pits and minute fissures in the substratum, ecorticate, I–, not containing calcium oxalate (H_2SO_4–). *Algae Trentepohlia*, solitary or in short filaments; cells broadly ellipsoid to subglobose, 7–15(–21) × 6–13(–18) µm; interstitial hyphae long-celled, 2–3 µm thick. *Prothallus* not apparent. *Ascomata* sparse to numerous, lirelliform, adnate to subsessile or sessile and constricted at the base, scattered or contiguous, occasionally overlapping, usually elongate, straight or slightly to markedly bent, unbranched to very sparingly branched, 0.15–0.8(–1) × (0.08–)0.12–0.2(–0.35) mm [*n* = 75], with subacute or acute ends, jet-black, usually rather glossy; margin smooth or minutely to coarsely uneven, epruinose; disc slit-like or slightly to markedly gaping, dull black, smooth, usually epruinose, occasionally with minute scattered specks or clumps of white pruina to 50–80 µm wide. *Proper excipulum* closed below the hymenium, uniformly brown-black, K+ blackish, not or scarcely overgrown by the thallus, 30–55 µm thick laterally, the apices convergent (with slit-like discs) or erect (with open discs); excipulum base (70–) 120–160 µm thick, occasionally forming a broad 'root' that penetrates to 200 µm, paraplectenchymatous in thin section. *Hypothecium* 15–20 µm thick, brown-black, not inspersed, K–, KI–. *Hymenium* 50–70 µm thick, hyaline, not inspersed with granules or oil globules, weakly amyloid throughout, KI+ pale blue, I+ red-brown. *Epihymenium* (10–)15–20 µm thick, dark brown, K+ blackish brown. *Paraphysoids* conglutinate in water, separating in K, richly branched and anastomosing throughout, short-celled to moderately long-celled, 1–1.5(–1.8) µm thick; apical cell and a few subtending cells often dark brown, the apices usually not swollen but occasionally to 2.5(–3) µm wide. *Asci* ± *Varia*-type (*sensu* Torrente & Egea 1989), 8-spored, mostly cylindrical or cylindroclavate, laterally thin-walled, 34–53 × 10–16 µm [*n* = 56]; apex rounded, with a 2–3 µm thick tholus, this occasionally with a minute, conical to tuberculate ocular chamber 1–2 µm wide with a KI+ medium blue cap, the remainder of the tholus non-amyloid or very weakly amyloid; ascoplasm KI+ orange-brown. *Ascospores* ± *Calcarea*-type (*sensu* Torrente & Egea 1989), (3–)5-septate, irregularly biseriate or more massed in the ascus, persistently colourless, narrowly oblong to fusiform, with rounded or subacute apices, straight or somewhat curved, not or only slightly constricted at the septa, but occasionally markedly so at the middle septum, (12–)14.5(–18) × (2.5–)3.5 (–4.5) µm [*n* = 120]; perispore initially thin, usually not apparent at maturity; cells of ± equal size throughout spore ontogeny; contents clear. *Pycnidia* not seen.

Etymology: The epithet *australis* (L., southern) refers to the distribution of the new species in a global and Australian context.

Remarks

Opegrapha australis is most similar to the sympatric *O. oraria* (see below), both having thin, often effuse, rather pale and inconspicuous thalli, as well as comparatively narrow and short, sessile, black lirellae with a proper excipulum that is closed at the base. Furthermore, they share a rather shallow, non-inspersed hymenium and cylindrical or cylindroclavate asci of the *Varia*-type (*sensu* Torrente & Egea 1989). They are distinguished, however, by their ascospores, these being (3–)5-septate and (12–)14.5(–18) × (2.5–)3.5(–4.5) µm in *O. australis*, broader and with fewer septa in *O. oraria* [3(–4)-septate and (12–)15(–18) × (3–)4.5(–6) µm]. Another comparable species is the silicolous and shade-loving *O. cesareensis* Nyl. from north-western and southern Europe. While that lichen has mostly 4–5(–7)-septate ascospores [(13–) 15–22(–26) × 4–5 µm], the disc is persistently slit-like, the hymenium is deeper (80–90 µm thick) and the smooth and often mosaic-forming thallus has a distinctly lilac tint (Clauzade & Roux 1985; Cannon *et al.* 2021a; Nimis 2021).

The new species is known from several siliceous rocky seashores in eastern Victoria and southern New South Wales. However, this rather nondescript and inconspicuous species is likely to be far more widely distributed and abundant in similar habitats in coastal southern Australia, including Tasmania. Associated lichens include *Amandinea decedens* (Nyl.) Blaha, H.Mayrhofer & Elix, *Angiactis banksiae* (Müll.Arg.) Kantvilas & Stajsic, *Buellia cranwelliae* Zahlbr., *Catillaria aff. austrolittoralis* Kantvilas & van den Boom, *Enterographa cretacea* P.M.McCarthy & Elix, *Opegrapha oraria*, *O. spodopolia*, *Porina corrugata* Müll.Arg., *P. guentheri* (Flot.) Zahlbr. *P. whinrayi* P.M.McCarthy, *Solenopsora vulturiensis* A.Massal. and *Thelenella tasmanica* H.Mayrhofer & P.M.McCarthy.

ADDITIONAL SPECIMENS EXAMINED
New South Wales: ● South Coast, Green Cape Peninsula, Haycock Point, 36°57'03"S, 149°56'10"E, *c.* 1.5 m alt., on hard, sheltered sandstone on the seashore, *P.M. McCarthy 4753*, 21.iii.2018 (CANB); ● type locality, *P.M. McCarthy 4531, 4557, 4558*, 18.xi.2016 (CANB).
Victoria: ● East Gippsland, Cape Conran Coastal Park, Banksia Bluff Camp, 37°48'03"S, 148°44'30"E, *c.* 1 m alt., on deeply sheltered mica schist on the seashore, *P.M. McCarthy 4516*, 30.x.2016 (CANB).

Opegrapha howeana P.M.McCarthy, sp. nov. Figs 2 & 4
MycoBank No.: **MB 843518**

Characterized by the thin, delicately rimose greenish grey thallus, elongate and simple to sparingly branched, adnate to subsessile lirellae with rounded or truncate ends, with a slit-like disc above and a closed excipulum at the base, with comparatively broad asci, mainly 7-septate ascospores, 24–36 × 5.5–9 µm, most with enlarged median cells and a distinct perispore.

Type: Australia, New South Wales, Lord Howe Island, Max Nicholls Track, 31°31'08"S, 159°03'01"E, 100 m alt., on sheltered basalt in lowland, subtropical forest on a broad ridge, *J.A. Elix 42400*, 9.ii.1995 (holotype – CANB).

Thallus crustose, epilithic, rather inconspicuous, forming small, well-delimited colonies, or patchy and effuse, pale to medium greenish grey, dull, *c.* 50–80 µm thick, sparingly to richly but delicately rimose, not areolate, ecorticate, I–, not containing calcium oxalate (H_2SO_4–). *Algae Trentepohlia*; cells broadly ellipsoid to subglobose, solitary or in short filaments, 7–15(–18) × 6–14(–16) µm; interstitial hyphae long-celled, 1.5–2.5 µm thick. *Prothallus* not apparent, or thin and dark grey to dull blackish. *Ascomata* moderately numerous, lirelliform, dull jet-black, adnate to subsessile and constricted at the base, scattered, elongate, 0.5–1.5(–4) mm long, 0.15–0.35 mm wide [*n* = 42], straight, slightly to markedly curved or serpentine, unbranched to very sparingly branched, with truncate or rounded ends, epruinose; margin smooth or minutely to coarsely uneven and fissured; disc slit-like. *Proper excipulum* closed below the hypothecium, uniformly brown-black, eventually carbonized and brittle, not overgrown by the thallus, 35–60(–70) µm thick laterally, the apices convergent; excipulum

base usually 70–110(–150) µm thick, usually tapering and often visible in section as a penetrating 'root', K–. *Hypothecium* 20–35(–45) µm thick, medium greenish brown, inspersed with minute granules, KI–, K–. *Hymenium* 75–100 µm thick, hyaline or with a pale greenish tint, not inspersed, weakly amyloid throughout, KI+ pale blue, I+ red-brown. *Epihymenium c.* 20 µm thick, dark greyish brown, K+ paler but more intensely brown. *Paraphysoids* moderately conglutinate in water, separating in K, richly branched and anastomosing throughout, short-celled to moderately long-celled, 0.8–1.2 µm thick; apices neither swollen nor pigmented. *Asci* intermediate between *Varia*- and *Vulgata*-types (*sensu* Torrente & Egea 1989), 8-spored, broadly ellipsoid or broadly clavate, laterally thin-walled, 42–58 × 21–25 µm [*n* = 22]; apex rounded, with a tholus 2–4 µm thick, lacking an ocular chamber throughout its development, but with a KI+ medium blue cap at maturity, the remainder of the tholus non-amyloid or very weakly amyloid; ascoplasm KI+ reddish or orange-brown. *Ascospores* ± *Varia*-type (*sensu* Torrente & Egea 1989), (5–)7-septate, irregularly massed in the ascus or in 2 overlapping fascicles of 4, colourless or, finally, collapsing slightly and pale to medium brown, narrowly oblong-cylindrical to fusiform, usually with subacute apices, straight or somewhat curved, not or very weakly constricted at the septa, (24–)29(–36) × (5.5–)7(–9) µm [*n* = 50]; some cylindrical spores with locules of ± equal size, fusiform spores with the median 1 or 2 locules markedly larger, the remainder diminishing in size towards the apices; wall to 1(–1.5) µm thick at maturity; perispore smooth, becoming 1–1.5(–2) µm thick; spore contents clear to coarsely granular. *Pycnidia* sparse, semi-immersed to almost superficial, hemispherical to subglobose, dull black, 80–100 µm wide. *Conidia* hyaline, simple, straight, bacilliform, 3–5 (–6) × *c.* 0.5 µm.
Chemistry: No substances detected by TLC (Elix 2022).

Etymology: The species is named after its type locality.

Remarks

Opegrapha howeana has a finely rimose but otherwise rather nondescript thallus, elongate lirellae [0.5–1.5(–4) × 0.15–0.35 mm] with rounded or truncate ends and a slit-like, epruinose disc, a basally closed proper excipulum, comparatively broad asci and narrowly oblong-cylindrical to fusiform, (5–)7-septate ascospores, 24–36 × 5.5–9 µm, mostly with 1 or 2 enlarged median cells.

Several species formerly included in *Opegrapha* but, following molecular investigations (e.g. Ertz *et al.* 2014) now referable to *Alyxoria* (Lecanographaceae), merit comparison with *O. howeana*. Thus, the mainly calcicolous, European and North American *A. mougeotii* (A.Massal.) Ertz, Frisch & G.Thor has similar ascospore dimensions, septation and enlarged median cells. However, like most of its congeners, its lirellae have acute ends and a widely exposed disc (Clauzade & Roux 1985, as *Opegrapha*; Wieczorek 2018; Cannon *et al.* 2021b). Interestingly, Clauzade & Roux (1985) included the Spanish endemic and basalt-inhabiting *Opegrapha cavernicola* Llimona & R.G.Werner in the synonymy of *O. mougeotina*. That species has a whitish thallus, a white-pruinose disc, mostly 7-septate ascospores less than 4 µm wide and filiform-arcuate conidia (Llimona & Werner 1975). *Alyxoria paraxanthodes* (Nyl.) Ertz & Coppins, endemic to Great Britain and Ireland, has a greenish yellow thallus, shorter lirellae, also with an exposed disc, and 4–5-septate ascospores (Cannon *et al.* 2021b). Furthermore, uncommon calcicolous thalli of the almost ubiquitous *A. varia* (Pers.) Ertz & Tehler have 4–6-septate ascospores that become red-brown with age (Ertz & Egea 2007; Wieczorek 2018; Cannon *et al.* 2021b). While the Australasian *O diaphoriza* (see below) has a superficially similar thallus and ascomata, the hymenium is granular-inspersed and the (3–)5-septate ascospores are only 17–27 µm long.

The type and only known locality of *O. howeana* is situated near the northern tip of Lord Howe Island on the Max Nicholls (Memorial) Track, which runs for approximately 2 km from Old Settlement Beach to Mount Eliza up through lowland forest and ending at an exposed cliff top *c.* 150 m above the sea. This suite of habitats is rich in bark- and rock-inhabiting lichens; it also includes the type localities of several saxicolous crusts, *viz. Dichoporis fractans* (P.M.McCarthy) S.H.Jiang, Lücking & Sérus., *Enterographa reticulata* P.M.McCarthy, *Fissurina howeana* (A.W.Archer) A.W.Archer, *Lepra miniatescens* (A.W.Archer & Elix) A.W.Archer & Elix, *Porina howeana* P.M.McCarthy and *Swinscowia rupestris* (P.M.McCarthy) S.H.Jiang, Lücking & Sérus.

Opegrapha oraria P.M.McCarthy, sp. nov. Figs 3 & 5
MycoBank No.: **MB 843519**

Similar to *Opegrapha australis*, but differs in ascospore septation and width, i.e. 3(–4)-septate and (3–)4.5(–6) µm wide, as opposed to (3–)5-septate and (2.5–)3.5(–4.5) µm wide.

Type: Australia. Victoria, East Gippsland, Cape Conran Coastal Park, Banksia Bluff Camp, 37°48'03"S, 148°44'30"E, *c.* 1 m alt., on deeply sheltered mica schist on the seashore, *P.M. McCarthy 4515*, 30.x.2016 (holotype – CANB).

Thallus crustose, epilithic, inconspicuous, patchy and often effuse, off-white or pale grey-green to pale yellowish brown, not or very sparingly rimose, rarely areolate, 60–150(–250) µm thick, the thallus most noticeable in minute pits and fissures in the rock, ecorticate, I–, not containing calcium oxalate (H_2SO_4–). *Algae Trentepohlia*, solitary or in short filaments, usually dominating the thallus but not occupying a discrete layer; cells broadly ellipsoid to subglobose, 6–16(–20) × 6–14(–17) µm; interstitial hyphae long-celled, 2–3.5 µm thick. *Prothallus* not apparent. *Ascomata* sparse to very numerous, lirelliform, adnate to subsessile or sessile and constricted at the base, scattered or contiguous in small clusters, not overlapping, initially ± rounded to oblong, 0.3–0.6 × 0.15–0.25 mm, later more elongate, straight or slightly to markedly bent, unbranched to very sparingly branched, alternatively ± isodiametric or more elongate and with a broader, open disc, 0.5–1(–1.4) × 0.2–0.45(–0.6) mm [*n* = 100], with truncate, rounded or subacute ends, jet-black, dull to distinctly glossy, epruinose throughout; margin smooth or minutely to coarsely uneven and fissured; disc slit-like or, later, gaping and dull black, smooth or with very faint, elongate fissures. *Proper excipulum* closed below the hymenium, uniformly brown-black, K+ blackish, not overgrown by the thallus, 35–60(–80) µm thick laterally, the apices convergent (when the disc is slit-like) or erect (when the disc is more open); excipulum base usually (40–)80–120 µm thick, occasionally taking the form of a 'root' that penetrates 150–250(–300) µm, paraplectenchymatous in thin section, the cells 3–5 µm wide. *Hypothecium* 15–25 µm thick, pale to medium greenish brown, K–, KI–. *Hymenium* 55–70(–80) µm thick, hyaline or with a pale greenish tint, not inspersed, weakly amyloid throughout, KI+ blue, I+ red-brown. *Epihymenium* 15–20(–25) µm thick, medium to dark brown, with or without green flecks, K+ crimson or K+ blackish. *Paraphysoids* slightly conglutinate in water, separating in K, richly branched and anastomosing, short-celled to moderately long-celled (distally), (0.5–)0.8–1.2(–1.8) µm thick; apical cell and a few subtending cells usually dark brown, the apices often slightly swollen, rounded and up to 2 µm thick. *Asci* ± *Varia*-type (*sensu* Torrente & Egea 1989), 8-spored, broadly ellipsoid, cylindrical or cylindroclavate, laterally thin-walled, 35–57 × 12–16 µm [*n* = 73]; apex rounded or appearing almost truncate, with a 2–3 µm thick tholus, this occasionally with a minute, conical to tuberculate ocular chamber 1–2 µm wide which has a KI+ medium blue cap, the remainder of the tholus non-amyloid; ascoplasm KI+ reddish or orange-brown. *Ascospores* ± *Calcarea*-type (*sensu* Torrente & Egea 1989), 3(–4)-septate, irregularly biseriate or more massed in the ascus, persistently colourless, narrowly oblong to fusiform, with rounded or subacute apices, straight or slightly curved, not or very weakly constricted at the septa, (12–)15(–18) × (3–)4.5(–6) µm [*n* = 244]; perispore occasionally visible on immature spores, 0.5–1 µm thick, inconspicuous and less than 0.5 µm thick at maturity; cells of ± equal size throughout spore ontogeny, their contents clear. *Pycnidia* usually sparse or absent, occasionally numerous, semi-immersed to superficial and hemispherical to subglobose, black, (60–)80–120 µm wide. *Conidia* hyaline, simple, straight, bacilliform, 3.5–5(–7) × *c.* 0.5 µm.

Etymology: The epithet *oraria* (L., of the coast), indicates the preferred habitat of this lichen.

Remarks
While the diagnostic ascospore characters that separate *O. oraria* from the otherwise similar and sympatric *O. australis* are outlined above, this is also one of very few species in or recently excluded from *Opegrapha* having a pale and comparatively inconspicuous, silicolous thallus, a basally closed excipulum and, most significantly, small 3-septate ascospores (less than 20 µm long). A rather similar lichen, at least in terms of habit and gross morphology, is the mainly Northern Hemisphere species *Arthonia calcarea* (Turner ex Sm.) Ertz & Diederich (syn. *O. calcarea* Turner ex Sm.). However, that species is almost exclusively calcicolous, and it is further separated from the Australian taxon by its broadly clavate to subglobose, *Arthonia*-type asci, a K+ greenish excipulum and epihymenium, clavate ascospores and broader conidia (Clauzade & Roux 1985; Torrente & Egea 1989; Wieczorek 2018; Cannon *et al.* 2020, 2021a; Nimis 2021). *Alyxoria culmigena* (Lib.) Ertz, with *Opegrapha herbarum* Mont. in its synonymy, is an even more ubiquitous species, its range including southern Australia (McCarthy 2020). This predominantly corticolous and lignicolous taxon occasionally grows on sandstone, and while it has some strong morphological and anatomical similarities with *O. ornaria*, the ascospores are larger, (16–)18–24(–26) × (4–)5–7(–8) µm, and they often turn reddish brown after maturity (Ertz & Egea 2007; Wieczorek 2018; Cannon *et al.* 2021b).

The new lichen, like *O. australis* (see above), is known from siliceous seashore rocks in southern New South Wales and eastern Victoria. *Opegrapha oraria* shares a similar range of habitat and associated lichens, and it is likely to be found in coastal communities elsewhere in southern Australia.

ADDITIONAL SPECIMENS EXAMINED
New South Wales: ● South Coast, Jervis Bay, *c.* 1 km S of Plantation Point, Vincentia, 35°04’22”S, 150°41’41”E, *c.* 2–3 m alt., on sheltered sandstone on the seashore, *P.M. McCarthy 4595*, 23.v.2017 (CANB); ● South Coast, Jervis Bay, Callala Bay, 0.5 km W of Callala Point, 35°00’22”S, 150°43’07”E, *c.* 1.5 m alt.**,** on unstable, vertical shale cliff receiving sea spray and soil runoff from above, *P.M. McCarthy 4948, 4949*, 19.iv.2017 (CANB); ● *loc. id.*, *J.A. Elix 46368*, 19.iv.2017 (CANB); ● *loc. id.*, *J.A. Elix 46384, 46387*, 23.v.2017 (CANB).
Victoria: ● East Gippsland, Quarry Beach, 6 km SW of Mallacoota, near airfield, 37°36’03”S, 149°43’41”E, *c.* 1.5 m alt., on deeply shaded sandstone on the seashore, *P.M. McCarthy 4504*, 30.x.2016 (CANB); ● type locality, on moderately sheltered mica schist on the seashore, *P.M. McCarthy 4510*, 30.x.2016 (CANB).

Other species

Opegrapha diaphoriza Nyl., *Lich. Nov. Zel.* 114 (1888) Figs 6 & 8D, E

This maritime, siliceous species is known from rocky seashores in New Zealand, and it also occurs in subantarctic Macquarie Island (Hayward 1977; Galloway 2007). Reported here for the first time from the Australian mainland, it has an effuse and very thin, greenish grey thallus. The dull black, sessile ascomata are 0.5–1.5(–2) mm long and 0.2–0.4 mm wide [*n* = 30], straight to slightly curved or flexuose and simple to once-branched, with a slit-like disc and a carbonized proper excipulum that is closed and thickened at the base. The hymenium is heavily inspersed with minute granules, the clavate-cylindrical asci are 65–72 × 17–24 µm [*n* = 15], and the (3–)5-septate ascospores are comparatively thick-walled, fusiform to oblong-fusiform and 17–27 × 5–8 µm [*n* = 63]. One or 2 cells in the middle of 5-septate spores are often markedly larger than those closer to the apices.

SPECIMENS EXAMINED
New South Wales: ● South Coast, Tomakin, Barlings Beach**,** 35°49’49”S, 150°12’20”E, alt. 1.5 m, on sheltered shale cliff on the foreshore, *P.M. McCarthy 4563, 4565A*, 19.xi.2016 (CANB).

Opegrapha spodopolia Nyl., *J. Linn. Soc. Bot.* **9**, 257 (1865) Figs 7 & 8A–C

The highly variable thallus of *O. spodopolia* can be thin and effuse to thick, well delimited and rimose to scurfy-areolate, off-white or pale to medium or darker grey, or yellowish brown to pale greenish brown, with or (usually) without a black prothallus. The black, lirelliform ascomata are semi-immersed and adnate to superficial and sessile, simple to sparingly branched, ± isodiametric or 0.4–1.2(–2) mm long and 0.2–0.5(–0.65) mm wide [*n* = 100], usually with blunt ends and a contorted and sometimes grossly uneven surface, with an irregular, slit-like apex or a narrow, gaping and epruinose disc. The proper excipulum is blackish in section, contiguous with or arching away from the hymenium (then with whitish tissue between the two layers) and 40–80(–110) um thick at the sides, but open at the base (in marked contrast to the other saxicolous species documented here). The epihymenium is 15–30 µm thick and mid-brown to dark brown, while the anastomosing paraphysoids are (0.7–)1–1.5(–2) µm thick, and the clavate, 8-spored asci are 58–80 × 14–21 µm [*n* = 51]; together they form a usually non-inspersed, amyloid hymenium that is 70–100(–130) µm deep, this layer being subtended by a pale brown to pale or medium olive hypothecium, (30–)50–80(–100) µm thick, inspersed or not by minute oil globules. The persistently colourless and narrowly fusiform ascospores are (3–)5–6(–7)-septate, with cells of ± equal size, straight or slightly curved, sometimes markedly constricted at the primary septum, and they measure (17–)24(–28) × (4–)5(–6.5) µm [*n* = 113], with a usually thin perispore at maturity (thickening in K). The sparse pycnidia contain bacilliform conidia 4.5–7.5 × *c.* 1 µm. No lichen substances were detected by TLC (Elix 2022).

First described from southern New Zealand (see Hayward 1977; Galloway 1985), *O. spodopolia* was recently reported from Kangaroo Island, South Australia (Kantvilas 2019). It is also rather common on sheltered, siliceous seashore rocks in Tasmania (Kantvilas *et al.* 2020), and it is recorded here for the first time from similar substrata and habitats in eastern Victoria and southern New South Wales.

SPECIMENS EXAMINED
New South Wales: ● South Coast, Callala Bay, 0.5 km W of Callala Point, 35°00’22”S, 150°43’07”E, 0.5**–**2 m alt., on unstable, vertical shale cliff receiving sea spray and soil runoff from above, *P.M. McCarthy 4577*, 19.iv.2017 (CANB); ● South Coast, Black Head, Gerroa, 34°46’36”S, 150°49’19”E, 2–3 m alt., on sandstone rocks of foreshore cliffs, *P.M. McCarthy 4586*, 24.v.2017 (CANB); • *loc. id.*, *J.A. Elix 46440* (CANB); ● South Coast, Pooles Beach, 3 km S of Mystery Bay, 36°18’46”S, 150°07’57”E, 1–3 m alt., on exposed shale outcrops along foreshore, *P.M. McCarthy 4533, 4534, 4535, 4556A*, 18.xi.2016 (CANB); ● *loc. id.*, *J.A. Elix 46298, 46303* (CANB); ● South Coast, Merimbula Point, 3 km SE of Merimbula, 36°54’S, 149°56’E, 8 m alt., on exposed siliceous rocks above the foreshore, *H.T. Lumbsch & H. Streimann 8614g*, 16.vi.1991 (CANB); ● South Coast, Tomakin, cliffs just N of Barlings Beach**,** 35°49’49”S, 150°12’20”E, 1–3 m alt., on sheltered shale cliff on the foreshore, *J.A. Elix 46329, 46340*, 18–19.xi.2016 (CANB); ● South Coast, Tomakin Cove, Melville Point, 35°49’48”S, 150°11’25”E, alt. *c.* 1.5 m, on sheltered shale cliff on the foreshore, *P.M. McCarthy 4947*, 6.xi.2021 (CANB); ● South Coast, Green Cape Peninsula, Haycock Point, 7.5 km ESE of Pambula, 36°57’03”S, 149°56’10”E, *c.* 1.5 m alt., on hard, sheltered sandstone on the seashore, *P.M. McCarthy 4752*, 21.iii.2018 (CANB); ● *loc. id.*, *J.A. Elix 46589, 46591* (CANB); ● South Coast, 5 km N of Bermagui, Camel Rock, 36°22’41”S, 150°04’37”E, alt. *c.* 3 m, on sheltered quartzitic sandstone on the seashore, above the splash zone, *P.M. McCarthy 4627, s.n.*, 10.ii.2016 (CANB); ● *loc. id.*, *J.A. Elix 46125, 46128* (CANB).
Victoria: ● East Gippsland, Quarry Beach, 6 km SW of Mallacoota, near airfield, 37°36’03”S, 149°43’41”E, 1–3 m alt., on deeply shaded sandstone on the seashore, *P.M. McCarthy 4498, 4500, 4501, 4502, 4506, 4512*, 30.x.2016 (CANB).

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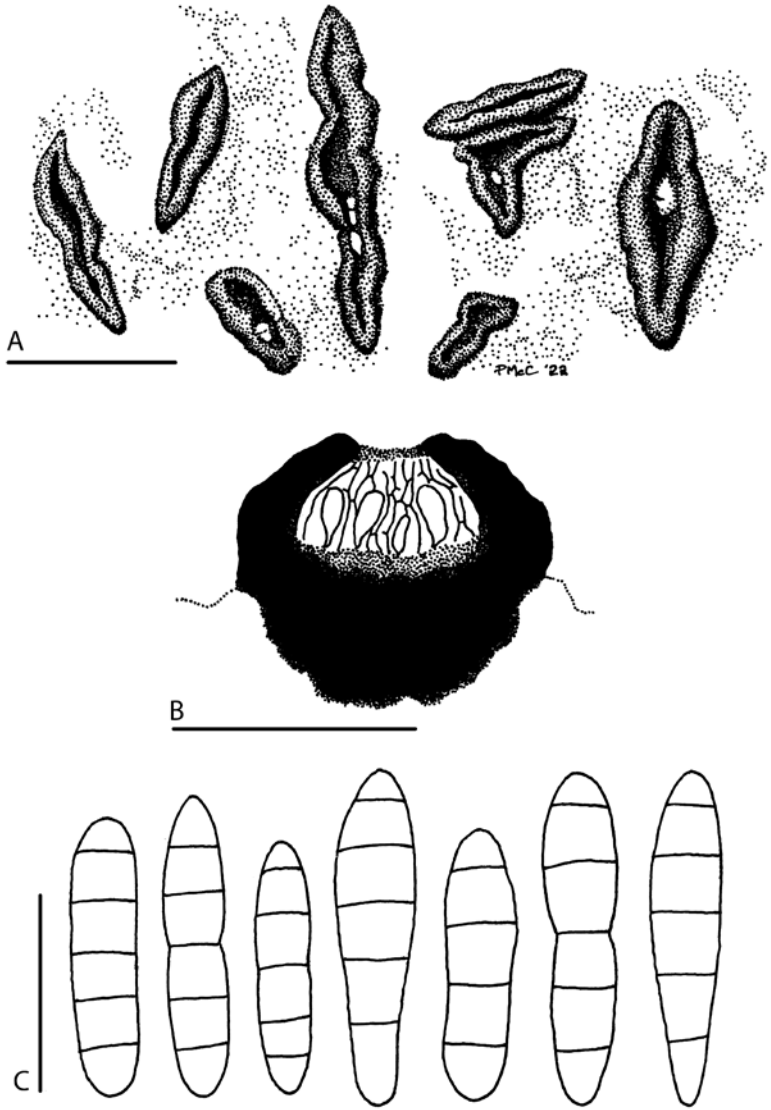

Figure 1. *Opegrapha australis* (A, holotype; B, *P.M. McCarthy 4516*; C, various specimens). A, Habit of thalli and ascomata; B, Vertical section of an ascoma (across the short axis, semi-schematic); C, Ascospores. Scales: A = 0.5 mm; B = 0.2 mm; C = 10 µm.

Figure 2. *Opegrapha howeana* (holotype). Scales: 2 mm.

Figure 3. *Opegrapha oraria* (*P.M. McCarthy 4948*). Scale: 1 mm.

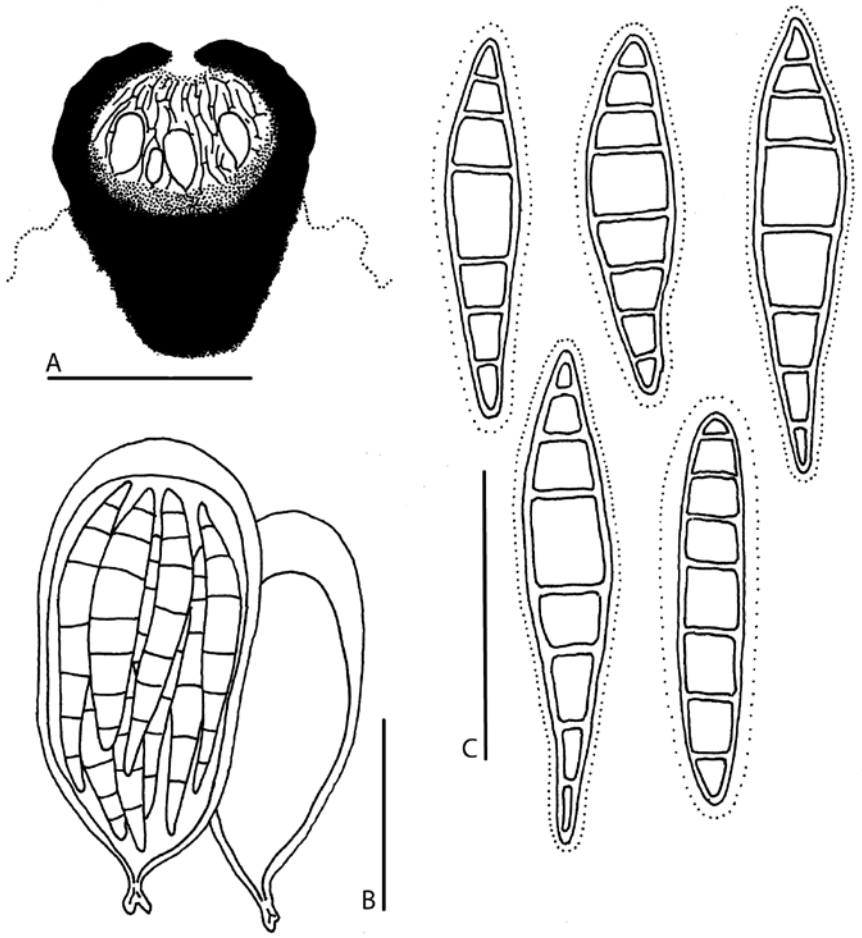

Figure 4. *Opegrapha howeana* (holotype). A, Vertical section of an ascoma (across the short axis, semi-schematic); B, Mature and immature asci; C, Ascospores. Scales: A = 0.2 mm; B, C = 20 µm.

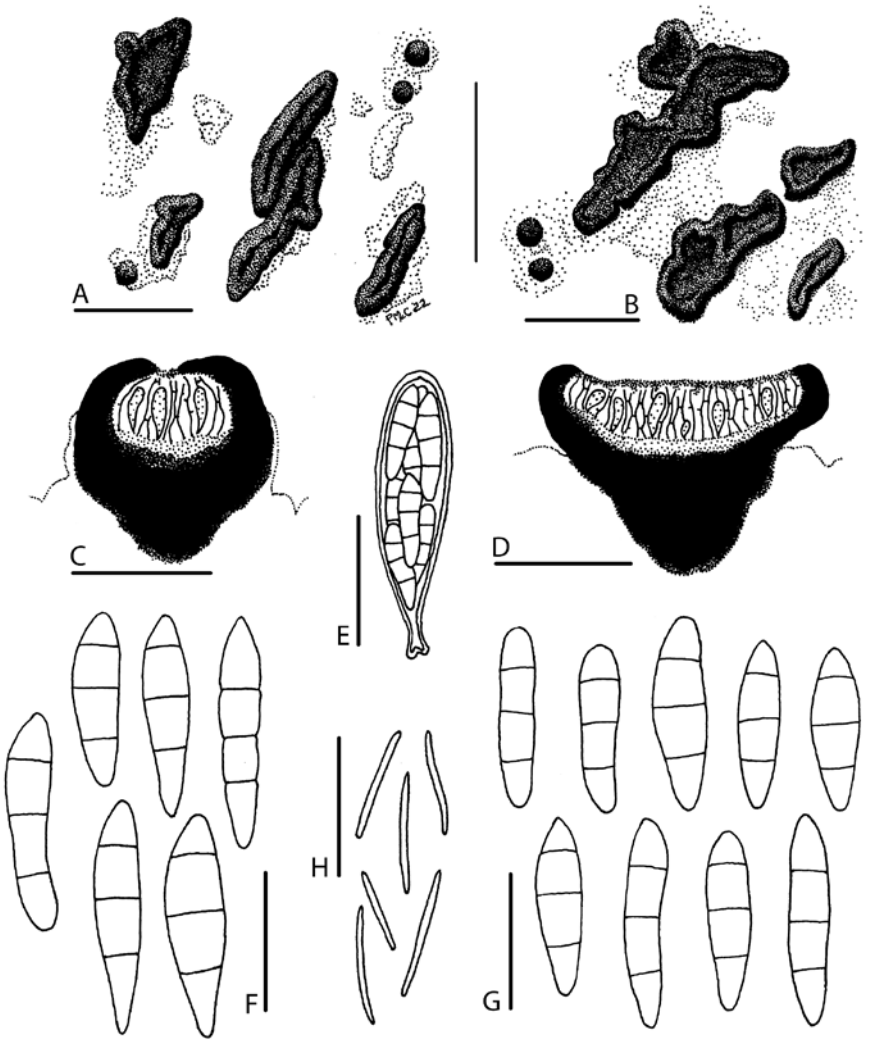

Figure 5. *Opegrapha oraria* (A, E, F, H, *P.M. McCarthy 4595*; B, D, G, *P.M. McCarthy 4948*; C, holotype). A, B, Habit of thalli, ascomata and pycnidia; C, D, Vertical sections of ascomata (across the short axis, semi-schematic); E, Mature ascus; F, G, Ascospores; H, Conidia. Scales: A, B = 0.5 mm; C, D = 0.2 mm; E = 20 µm; F, G = 10 µm; H = 5 µm.

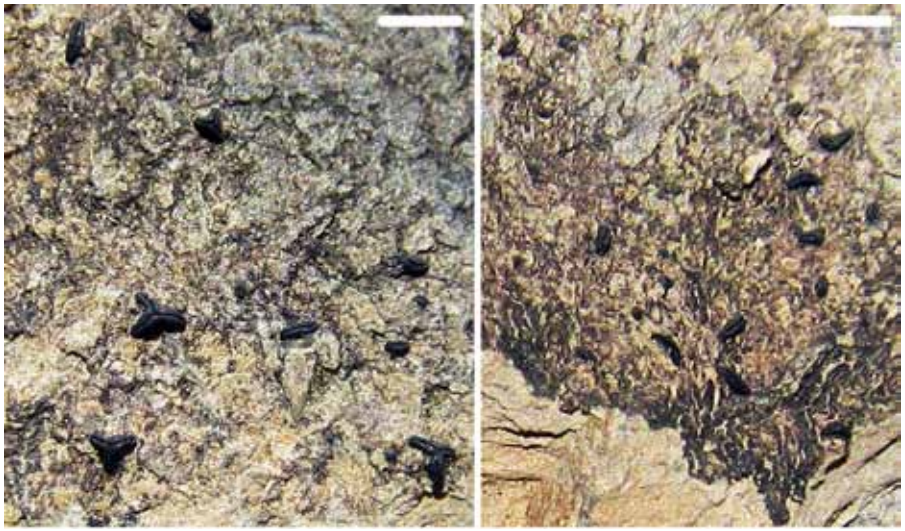

Figure 6. *Opegrapha diaphoriza* (*P.M. McCarthy 4563*). Scales: 2 mm.

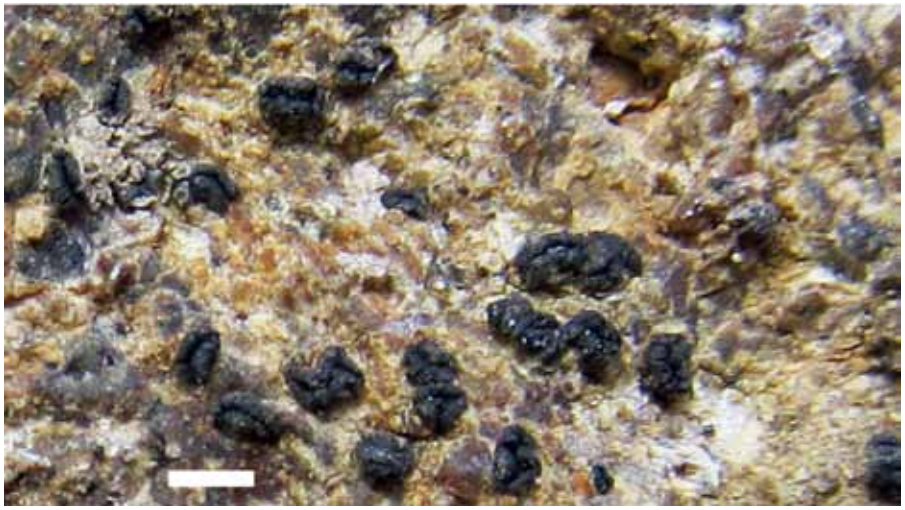

Figure 7. *Opegrapha spodopolia* (*P.M. McCarthy 4947*). Scale: 1 mm.

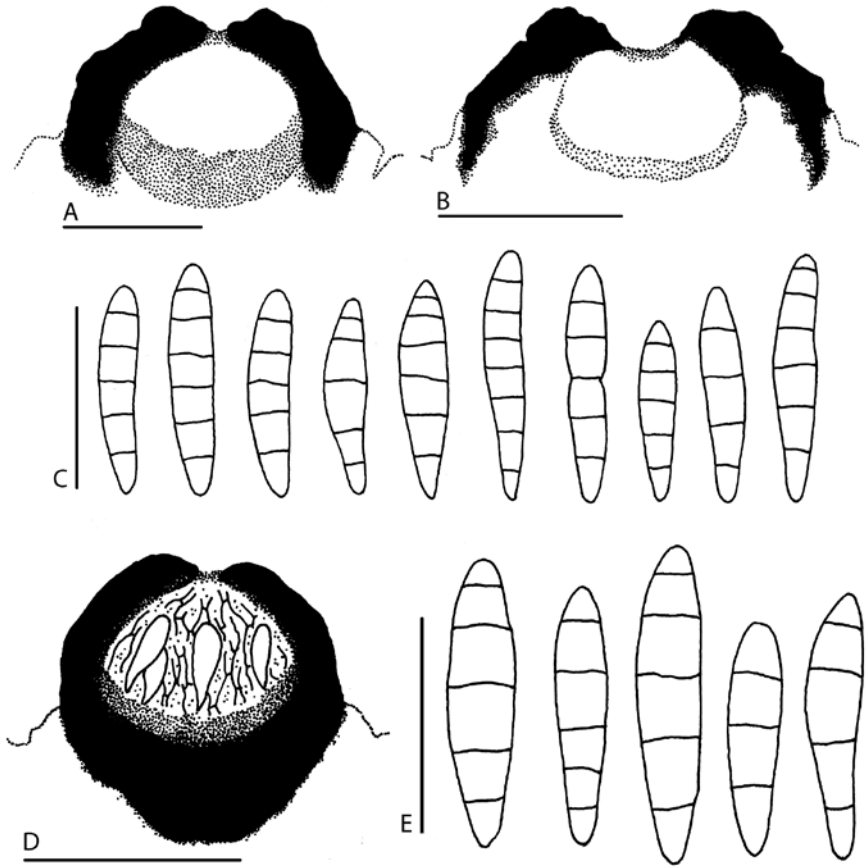

Figure 8. *Opegrapha spodopolia* (A–C) and *O. diaphoriza* (D, E). A, B, Vertical sections of ascomata (across the short axis, semi-schematic; A, *P.M. McCarthy 4503*; B, *P.M. McCarthy 4534*); C, Ascospores (various specimens); D, Vertical section of an ascoma (across the short axis, semi-schematic; *P.M. McCarthy 4563*); E, Ascospores (*P.M. McCarthy 4563*). Scales: A, B, D = 0.2 mm; C, E = 20 µm.

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

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Abstract
Buellia subarnoldii Elix & H.Mayrhofer and *Tetramelas africanus* Elix & H.Mayrhofer, from South Africa, are described as new to science.

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

Methods
Observations and measurements of photobiont cells, thallus and apothecium anatomy, asci, ascospores and pycnidia were made on hand-cut sections mounted in water and 10% KOH (K). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K. Medullary sections were treated with 10% sulfuric acid (H_2SO_4) and apothecial sections with 50% nitric acid (N). Chemical constituents were identified by thin-layer chromatography (Elix 2022) and comparison with authentic samples.

New species

1. Buellia subarnoldii Elix & H.Mayrhofer, sp. nov. Fig. 1
MycoBank No.: **MB 842952**

Similar to *Buellia arnoldii* Servít, but differs in having a saxicolous thallus, larger ascospores and usually fewer spores per ascus.

Type: Republic of South Africa, *Natal*, Royal National Park, W of Plowman's Kop, below gorge "The Crack", 28°41′S, 28°55′E, *c*. 1850 m alt., on large S-exposed boulders, *D. Triebel & G. Rambold 6814*, 10.iii.1990 (holotype – M).

Thallus crustose, to 40 mm wide and 0.5 mm thick, immersed to rimose-areolate; areoles rounded to irregular, 0.5–1.5 mm wide, crowded and contiguous; upper surface off-white to pale grey-brown, dull, smooth, epruinose; prothallus black, marginal and between areoles or not apparent; photobiont cells 6–11 µm wide; medulla white, lacking calcium oxalate (H_2SO_4–), I–. *Apothecia* 0.5–1.5 mm wide, lecideine, separate and ± round or becoming distorted, adnate to sessile; disc black, epruinose, plane to convex with age. *Excipulum* distinct, thin, excluded in older, convex apothecia, in section 25–50 µm thick; outer part dark brown, K–, N–, brown within. *Hypothecium* 125−150 µm thick, dark brown merging with the brown-black central stipe. *Epihymenium* 10–15 µm thick, brown, K–, N–. *Hymenium* 120–150 µm thick, colourless, densely inspersed with oil droplets. *Paraphyses* 1.5–2.5 µm wide, simple to sparsely branched, the apices 3–3.5 µm wide and with brown caps. *Asci Bacidia*-type, usually with 2–4 spores, rarely with 8 spores. *Ascospores Callispora*-type, 1-septate, brown, ellipsoid, 22–[*32.3*]–45 × 13–[*16.0*]–21 µm, becoming constricted at the septum, often curved; outer spore-wall smooth to finely ornamented. *Pycnidia* common, black, immersed, punctiform. *Conidia* bacilliform, 4–5 × 1 µm.
Chemistry: Thallus K+ yellow, P+ pale yellow, C–, UV–; containing atranorin.

Etymology: The species is named after its superficial similarity to *Buellia arnoldii*.

Remarks
Buellia subarnoldii is characterized by the crustose, off-white to pale grey-brown, immersed to rimose-areolate thallus with lecideine apothecia 0.5–1.5 mm wide, the non-amyloid medulla, the densely inspersed hymenium, usually with 2–4-spored asci, the ellipsoid, 1-septate, *Callispora*-type ascospores, 22–45 × 13–21 µm, and the presence of atranorin. *Buellia arnoldii*, a corticolous European species, is similar in having a densely inspersed hymenium, *Callispora*-type ascospores and in containing atranorin, but it differs in having 8-spored asci with smaller ascospores, 23–30 × 11–14 µm (Foucard *et al*. 2002; Coppins *et al*. 2009). *Buellia procellarum* A.Massal., a common, saxicolous South African species, is also very similar, but differs in having a thinner hymenium, 80–110 µm, slightly smaller ascospores, 22–40 × 10–18 µm, with a rugulate outer spore-wall and in containing additional diploicin and isofulgidin (Elix 2009).
Buellia subarnoldii is known from three collections, where it co-occurs with several *Lecidella* and *Lecidea* species and *Tetramelas africanus* (described below).

ADDITIONAL SPECIMENS EXAMINED
Republic of South Africa. *Cape Province.* ● Massenberg, 40 km S of Velddrif, E of R27, 28 km N of crossing with road to Darling/Yzerfontein, 33°07'S, 18°08'E, 120–140 m alt., on rocks and boulders at W slope of hill, *D. Treibel & G. Rambold 8449* 6.iv.1990 (M). *Orange Free State.* ● Golden Gate Highlands National Park, summit of Wodenhouse Kop, 28°33'S, 28°38'E, 2434 m alt., on W-exposed rocks, *D. Treibel & G. Rambold 6619*, 7.iii.1990 (M).

2. Tetramelas africanus Elix & H.Mayrhofer, sp. nov. Fig. 2
MycoBank No.: **MB 842953**

Similar to *Tetramelas allisoniae* Elix, H.Mayrhofer & Glenny, but differs in having a thinner hymenium, 75–100 µm thick, and significantly longer conidia, 8–11 µm long.

Type: Republic of South Africa. *Natal*. Royal National Park, W of Plowman's Kop, below gorge "The Crack", 28°41′S, 28°55′E, *c*. 1850 m alt., on large S-exposed boulders, *D. Triebel & G. Rambold 6829*, 10.iii.1990 (holotype – M).

Thallus crustose, areolate to verrucose-areolate, to 40 mm wide and 0.5 mm thick; areoles irregular, angular, 0.1–0.6 mm wide, contiguous to separate; upper surface pale yellow-grey to grey-white, dull, epruinose; prothallus black and marginal or not apparent; photobiont cells 7–13 µm wide; medulla white, lacking calcium oxalate (H_2SO_4–), I+ purple. *Apothecia* 0.2–0.8 mm wide, lecideine, separate and ± round, adnate to sessile; disc black, epruinose, plane, soon becoming convex. *Excipulum* prominent, elevated above disc but excluded in older, convex apothecia, in section 40–70 µm thick, the outer part dark brown, K−, N−, paler brown within. *Hypothecium* 60−80 µm thick, brown to dark brown merging into a brown-black stipe, 120−150 µm thick. *Epihymenium* 10–13 µm thick, brown to dark brown, K−, N−. *Hymenium* 75–100 µm thick, colourless, not inspersed but ± with scattered oil droplets; subhymenium 15−30 µm thick, pale brown to brown. *Paraphyses* 1.5–2 µm wide, simple to sparsely branched, the apices 3–3.5 µm wide with brown caps. *Asci Bacidia*-type, 8-spored or with fewer spores (4 or 5). *Ascospores* initially of the *Callispora*-type, then of the *Buellia*-type, 1-septate, brown, ellipsoid to broadly fusiform, 18–[*21.8*]–27 × 10–[*11.1*]–13 µm, becoming constricted at the septum, sometimes with 1 or 2 endosepta when mature; outer spore-wall finely ornamented (microrugulate). *Pycnidia* immersed, punctiform. *Conidia*

elongate-bacilliform, 8–11 × 1–1.5 µm.
Chemistry: thallus K+ yellow, C+ orange, KC+ deep orange, P–, UV+ orange; containing arthothelin (major), 4,5-dichloronorlichexanthone (trace).

Etymology: The species is named after its occurrence in Africa.

Remarks

Tetramelas africanus is characterized by the crustose, pale yellow-grey to grey-white, areolate to verrucose-areolate thallus with lecideine apothecia 0.2–0.8 mm wide, the amyloid medulla, the non-inspersed hymenium, asci with 8 or fewer, ellipsoid to broadly fusiform, 1-septate, *Callispora*- then *Buellia*-type ascospores, 18–27 × 10–13 µm, and the presence of arthothelin. In many respects it resembles *T. allisoniae*, a saxicolous species known from New Zealand (Elix & Mayrhofer 2017). Both lichens are characterized by the presence of arthothelin, an amyloid medulla and similar ascospores (sometimes with 1 or 2 endosepta) and apothecial anatomy including similar reactions of the hypothecium and epihymenium. However, *T. allisoniae* has a thicker hymenium, 110–130 µm thick, and shorter conidia, 3–5.5 µm long. Interestingly, *T. africanus* has much longer conidia than reported for any other species of this genus.

At present, *T. africanus* is known from two collections where it co-occurs with a *Lecidea* species, *Buellia spuria* (Schaer.) Anzi and *B. subarnoldii* (described above).

ADDITIONAL SPECIMEN EXAMINED

Republic of South Africa. *Orange Free State.* ● Golden Gate Highlands National Park, trail to Glen Reenen-Brandwag below Wodenhouse Kop, shortly before Brandwag, below chain ladder, 28°32'S, 28°38'E, *c*. 2030 m alt., on boulders below overhanging rock wall, *D. Treibel & G. Rambold 6742*, 8.iii.1990 (M).

Acknowledgements

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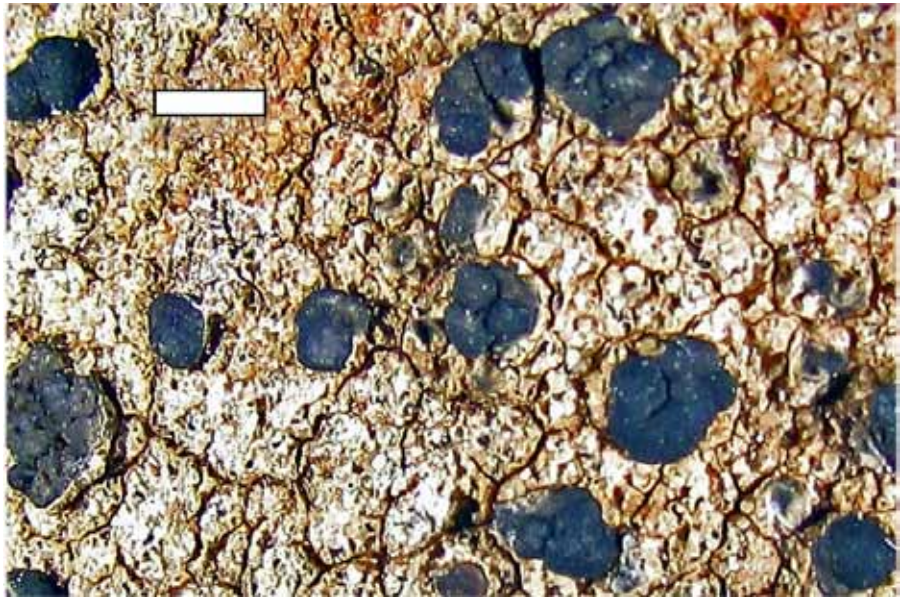

Figure 1. *Buellia subarnoldii* (holotype in M). Scale = 2 mm.

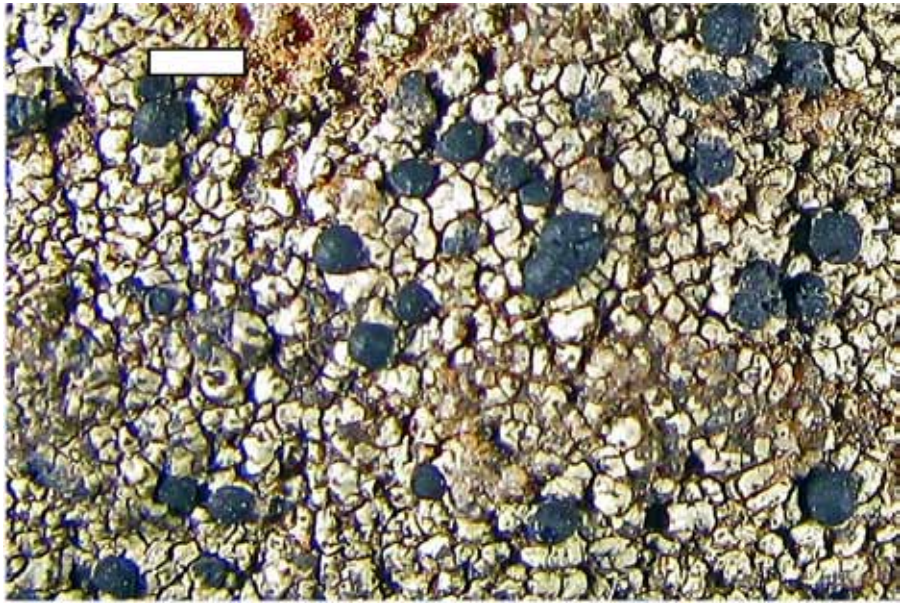

Figure 2. *Tetramelas africanus* (holotype in M). Scale = 1 mm.

Synonymy in species of *Trapelia* (lichenized Ascomycota, Trapeliaceae) from Australia

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Abstract

Species of the genus *Trapelia* are notoriously variable and difficult to identify. Although previous taxonomic studies have taken advantage of molecular data to confirm the placement and delimitation of species, most Australian taxa, including the recently described *T. atrocarpa*, *T. terrestris* and *T. rosettiformis*, have not been the subject of molecular study. Here, ITS sequences were generated for 11 species of *Trapelia* occurring in Australia and integrated to a dataset of mostly European *Trapelia* taxa. As a result, due to poor phylogenetic and morphological differentiations, synonymies are proposed for the three species *T. atrocarpa* (syn. *T. terrestris*), *T. pruinosa* (syn. *T. rosettiformis*) and *T. placodioides* (syns *T. thieleana* and *T. occidentalis*). Together with a few Welsh *T. elacista* specimens, *T. atrocarpa* is found to be closely related to *T. elacista*. A key to the nine *Trapelia* species currently accepted from Australia is provided.

Introduction

Trapelia M.Choisy is a small but widely distributed genus of crustose to squamulose species occurring on various substrata (bark, rock and soil). Among other characters, it is distinguishable by its hemiangiocarpic apothecia that rupture the upper cortex during their development, aseptate ascospores, and crustose to squamulose or placodioid thalli (Kantvilas *et al.* 2014). *Trapelia* belongs to the family Trapeliaceae, together with several other genera, including *Lambiella* Hertel, *Placopsis* (Nyl.) Linds., *Placynthiella* Elenkin, *Rimularia* Nyl. and *Trapeliopsis* Hertel & Gott.Schneid. (Resl *et al.* 2015). *Trapelia* is currently not monophyletic, as the cephalodiate genus *Placopsis* has been shown to be nested within this genus (Kantvilas *et al*. 2014; Resl *et al.* 2015; Schneider *et al.* 2016). The first molecular revisions of *Trapelia* species focused on Australian taxa (Kantvilas *et al.* 2014) and those from Great Britain and the Falkland Islands (Orange 2018). Those two studies showed that several inferred lineages were unrecognized and that the diversity of *Trapelia* species had been underestimated. They also highlighted the difficulties in circumscribing taxa with pronounced morphological and anatomical variation.

Fourteen species of *Trapelia* have been described or reported from Australia (Kantvilas & Elix 2007; Kantvilas *et al.* 2014; Elix & McCarthy 2019, 2020a, 2020b; McCarthy 2020), including the widespread and probably cosmopolitan *T. coarctata* (Sm.) M.Choisy and *T. placodioides* Coppins & P.James, as well as the Australasian *T. macrospora* Fryday and eleven Australian endemics, *viz. T. atrocarpa* Elix & P.M.McCarthy (Fig. 2), *T. calvariana*, Kantvilas & Lumbsch (Fig. 3), *T. concentrica* Elix & P.M.McCarthy (Fig. 4), *T. crystallifera* Kantvilas & Elix (Fig. 5), *T. kosciuszkoensis* Elix (Fig. 6), *T. lilacea* Kantvilas & Elix (Fig. 7), *T. occidentalis* Elix, *T. pruinosa* Elix & P.M.McCarthy (Fig. 10), *T. rosettiformis* Elix & P.M.McCarthy (Fig. 11), *T. terrestris* Elix & P.M.McCarthy and *T. thieleana* Kantvilas, Lumbsch & Elix. In an effort to verify the integrity of the recently described species, we have undertaken a molecular study of the available Australian material of *Trapelia*.

Material and methods

Morphology and chemistry

For the most part this study is based on herbarium material in CANB. Observations and measurements of photobiont cells, thallus and apothecium anatomy, asci, ascospores and pycnidia were made on hand-cut sections mounted in water and 10% KOH (K). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K. Medullary sections were treated with 10% sulfuric acid (H_2SO_4) and apothecial sections with 50% nitric acid (N). Chemical constituents were identified by thin-layer chromatography (Elix 2022) and comparison with authentic samples.

Molecular: *taxon and gene sampling*

Herbarium specimens of Australian *Trapelia* were used for molecular analysis (Table 1). The fungal DNA barcode ITS (the internal transcribed spacer region) was chosen as a phylogenetic marker for this study. In total, sequences were generated from 44 Australian specimens, including five type specimens. Sequence data available in GenBank for *Trapelia* species and those from closely related genera (*Lambiella*, *Orceolina*, *Placopsis*, *Placynthiella*, *Rimularia* and *Trapeliopsis*; Kantvilas *et al.* 2014; Resl *et al.* 2015; Orange 2018) were also added to the dataset. The genera *Lambiella* and *Rimularia* were chosen as an outgroup based on previous phylogenetic studies (Kantvilas *et al.* 2014; Resl *et al.* 2015). In total, the dataset included 150 specimens, 112 of them from the genus *Trapelia*.

Molecular: *DNA extractions, amplification and sequencing*

Two methods were used to generate ITS sequences (Table 1). For 17 taxa, a long-read amplicon sequencing approach as described in Gueidan *et al.* (2019) and Gueidan & Li (2022) was used. In brief, specimens were extracted using the Invisorb Spin Plant Mini Kit (Stratec Molecular, Berlin, Germany), ITS amplified with ITS1F and ITS4 (White *et al.* 1990; Gardes & Bruns 1993) tagged with a universal primer sequence, then reamplified with indexed universal primers. The amplicon library was prepared and sequenced on a Sequel I platform at Macrogen (Seoul, Republic of South Korea). For the other 27 taxa, genomic DNA was obtained using a protocol modified from Zolan & Pukkila (1986), as described in Gueidan *et al.* (2007). The primers ITS1F and ITS4 were used to amplify ITS. One micro-litre of a 1, 1/10, or 1/100 dilution of genomic DNA was added to the following PCR mix: 5 µl MyFi buffer (Bioline, London, UK), 1 µl of each primer (10 µM), 1 µl MyFi DNA polymerase, and water to a total volume of 25 µl. The PCR reactions were performed on a Mastercycler thermal cycler (Eppendorf, Hamburg, Germany). The PCR program for ITS was as follows: 3 min at 95°C, followed by 35 cycles of the three steps 30 sec at 95°C (denaturation), 30 sec at 53°C (annealing), 90 sec at 72°C (extension), and a final extension time of 10 min at 72°C. PCR product clean-up and Sanger sequencing were carried out by Macrogen (Seoul, Republic of South Korea).

Molecular: *alignments and phylogenetic analyses*

Sanger sequences were edited using Sequencher v. 5.4.6 (Gene Codes Corporation, Ann Arbor, Michigan, USA). PacBio sequences were edited using SMRT Tools v. 7.0.1 (Pacific Biosciences, Menlo Park, CA, USA) and denoised with DADA2 (Callahan *et al.* 2016), as described in Gueidan & Li (2022). GenBank and newly obtained sequences were manually aligned using Mesquite v. 3.61 (Maddison & Maddison 2011), and ambiguously aligned regions were manually delimited and excluded as in Lutzoni *et al.* (2000). jModelTest2 v. 2.1.10 (Darriba *et al.* 2012) was used to infer the substitution model as implemented on the CIPRES Web Portal (http://www.phylo.org; Miller *et al.* 2010). The dataset was then analyzed using a Bayesian approach with MrBayes v. 3.2.6 (Ronquist *et al.* 2011), as implemented on the CIPRES Web Portal. Two analyses of four chains were run for 5 million generations and trees were sampled every 500 generations. For the two runs, parameter convergence and required burn-in sample were checked using Tracer v. 1.6 (Rambaut *et al.* 2014). The remaining trees were used to estimate the posterior probabilities with the "compute consensus" command in PAUP* (Swofford 2002). The consensus tree was computed with the sumt command in

MrBayes and visualized in PAUP*. Additional support values were obtained from a tree search and a RAxML fast bootstrap analysis of 1,000 pseudoreplicates using the CIPRES Web Portal (RAxML v. 8.2.12; Stamatakis *et al.* 2005, 2008). The tree figure was edited with Illustrator v. 26.0.3 (Adobe, San Jose, CA, USA).

Results and discussion

Although the overall thallus morphology of the Australian *Trapelia* species was highly variable, the distinctly squamulose species (*T. crystallifera* and *T. pruinosa*) could be reliably distinguished from the remaining crustose and areolate taxa. The most reliable traditional taxonomic character was thallus chemistry, namely gyrophoric acid (major) versus 5-*O*-methylhiascic acid (major). Average ascospore size was also a useful distinguishing character, but the presence or absence of calcium oxalate in the thallus and of surface pruina proved of no consequence.

For the molecular analysis, the ITS alignment had a total of 1,155 characters. After introns and ambiguous regions were excluded, 459 characters remained, including 273 distinct alignment patterns. The proportion of missing data in the alignment was 10.48%. For the Bayesian analysis, parameters and tree topology rapidly converged, and a burn-in of 10% of the trees was removed from the tree sample. The Bayesian consensus tree is shown in Figure 1, with posterior probabilities (PP). Bootstrap support (BS) obtained with RAxML are also reported on the tree. The resulting tree topology does not disagree with Resl *et al.* (2015), with the clade including *Placopsis*, *Placynthiella*, *Trapelia* and *Trapeliopsis* supported as monophyletic (98% PP, 88% BS). However, due to our limited data (ITS only), the relationships among the four genera are not supported (Fig. 1). *Placynthiella* is supported as monophyletic (100% PP and BS), and appears as sister to the three other genera, but with low support (100% PP, 73% BS). *Trapeliopsis* and *Placopsis* are both resolved as monophyletic (99% PP and 63% BS, and 100% PP and BS, respectively), but they are nested within *Trapelia*, although with no support.

Within *Trapelia*, the placement and monophyly of species treated in Orange (2018) were confirmed (Fig. 1). This included the non-Australian species *T. collaris*, *T. corticola*, *T. elacista*, *T. glebulosa*, *T. involuta*, *T. obtegens*, *T. sitiens*, *T. stipitata* and *T. tristis*. The two newly sampled Australian species *T. concentrica* and *T. crystallifera* are also supported as monophyletic (100% PP and 95% BS, and 100% PP and BS, respectively). The cosmopolitan and generitype species *T. coarctata* is also monophyletic (99% PP, 85% BS), but none of the Australian material sampled corresponded to that taxon. Moreover, no Australian material of *T. macrospora* could be sourced, but the sister relationship between a specimen from New Zealand and *T. sitiens* is confirmed (Orange 2018). As in Orange (2018), specimens of *T. placodioides* and *T. thieleana* clustered in a single clade, although with low support (100% PP, 68% BS). No clear delimitation can be drawn between those two species based on ITS. Similarly, based on ITS, no clear delimitation can be drawn between the Australian species *T. terrestris* and *T. atrocarpa* (including three European specimens of *T. elacista*), nor between *T. pruinosa* and *T. rosettiformis*. The Australian species *T. lilacea* is well supported as sister to the clade formed of *T. pruinosa* and *T. rosettiformis* (100% PP, 97% BS). Australian specimens of the species *T. calvariana* cluster together with unidentified specimens of *Trapelia* from the Falklands Islands (Orange 22381, 23379, 23172), although with no support.

Based on these phylogenetic results, morpho-anatomical observations were carried out on Australian material. Due to absence of unambiguous diagnostic characters for several species, four synonymies were proposed (see Taxonomy section). As mentioned above, the overall thallus morphology of the Australian *Trapelia* species is highly variable, both within the distinctly squamulose species (*T. crystallifera* [Fig. 5] and *T. pruinosa* [Figs 10 and 11]) as well as among the crustose and areolate taxa. The most reliable traditional taxonomic character was thallus chemistry, namely the occurrence of gyrophoric acid (major) or 5-*O*-methylhiascic acid (major), as well as the average ascospore size. More particularly, the squamulose *T. pruinosa* and *T. rosettiformis* were found to be synonymous even though the type of the former has a dense, coarsely crystalline surface pruina and relatively small, more or less flat squamules to 1.2 mm wide, whereas the latter has an epruinose upper surface and large, elevated, rosette-forming squamules up to 4 mm wide (compare Figs 10 and 11). The crustose or microareolate *T. atrocarpa* and *T. terrestris* were primarily differentiated by the presence of large quantities of calcium oxalate in the former. However, molecular studies confirmed that this was of no taxonomic significance. The morphological variation within *T. placodioides* was particularly variable, from subsquamulose-areolate and esorediate (as in *T. occidentalis*, Fig. 9), to continuous-crustose and esorediate or with sparse surface granules (as in *T. thieleana*) to continuous-crustose with definite soralia (Fig. 8).

A previous molecular taxonomic investigation of *Trapelia* (Orange 2018) had inferred, based on ITS, a highly supported clade for *Trapelia elacista* (100% maximum likelihood bootstrap). This clade was divided into two relatively well-supported groups, one of which contained, among others, the Welsh specimens Orange 23623, 22891 and 23456. Those two clades were considered as a single species, because no morphological and few phylogenetic divergences could be found (Orange 2018). In our phylogeny (Fig. 1), those three specimens cluster together with all specimens of *T. atrocarpa* and *T. terrestris* (now *T. atrocarpa*, because the two species are synonymized below), although with moderate support (72% BS). The close relationship between *T. elacista* and *T. atrocarpa* is supported by their chemistry (gyrophoric acid major) and their morphology (growth form, ascocarp development and ascospore size). Because those two species are phylogenetically distinct and have disjunct geographic distributions, they were not synonymized. Further work with broader taxon and gene sampling will be necessary to further test their delimitation.

Nine species of *Trapelia* are currently accepted from Australia, eight of which are represented in our tree (*T. atrocarpa*, *T. coarctata*, *T. concentrica*, *T. crystallifera*, *T. lilacea*, *T. macrospora*, *T. placodioides* and *T. pruinosa*). No sequences from *T. kosciuszkoensis* could be obtained as part of this study. Whether or not *T. coarctata* actually occurs in Australia remains to be determined; no recent collections of it were encountered in the present study. A key to the Australian *Trapelia* species is provided below.

Taxonomy

New synonyms

Trapelia atrocarpa Elix & P.M.McCarthy, *Australas. Lichenol.* **86**, 102 (2020)
Syn. nov. *Trapelia terrestris* Elix & P.M.McCarthy, *Australas. Lichenol.* **87**, 43 (2020)

Trapelia pruinosa Elix & P.M.McCarthy, *Australas. Lichenol.* **86**, 105 (2020)
Syn. nov. *Trapelia rosettiformis* Elix & P.M.McCarthy, *Australas. Lichenol.* **87**, 41 (2020)

Trapelia placodioides Coppins & P.James, *Lichenologist* **16**, 257 (1984)
Syn. nov. *Trapelia thieleana* Kantvilas, Lumbsch & Elix, *Austral. Syst. Bot.* **27**, 400 (2015)
Syn. nov. *Trapelia occidentalis* Elix, in J.A. Elix & P.M. McCarthy, *Australas. Lichenol.* **87**, 40 (2020)

Key to *Trapelia* in Australia

1 Soralia present.....2
1: Soralia absent.....3

2 Thallus squamulose or subsquamulose..... **T. pruinosa**[1]
2: Thallus crustose, coherent, continuous..... **T. placodioides**

3 Thallus squamulose 4
3: Thallus crustose; surface continuous, rimose or areolate.....5

4 Thallus containing 5-*O*-methylhiascic acid (major)..... **T. pruinosa**
4: Thallus containing gyrophoric acid (major)..... **T. crystallifera**

5 Ascospores 17–34 × 12–20 µm; apothecia persistently immersed; alpine 6
5: Ascospores 9–30 × 4–15 µm; apothecia immersed at first, then adnate to sessile ... 7

6 Ascospores 25–34 µm long; hypothecium 150–180 µm thick; gyrophoric acid (major); Tasmania ..... **T. macrospora**
6: Ascospores 17–30 µm long; hypothecium 70–100 µm thick; 5-*O*-methylhiascic acid (major); N.S.W. ..... **T. kosciuszkoensis**

7: Thallus surface scabrid, mealy, coarsely crystalline; disc pruinose at least in part ... . **T. concentrica**
7: Thallus surface smooth to rugulose, not crystalline; disc epruinose 8

8 Thallus containing 5-*O*-methylhiascic acid (major) 9
8: Thallus containing gyrophoric acid (major) 10

9 Ascospores 16–23 × 9–15 µm; conidia 10–17 µm long; thallus containing additional 5-methoxylecanoric acid ..... **T. lilacea**
9: Ascospores 11–19 × 5–11 µm; conidia 13–30 µm long; thallus lacking 5-methoxy-lecanoric acid ..... **T. calvariana**

10 Thallus micro-areolate; ascospores 15–30 µm long ..... **T. atrocarpa**
10: Thallus forming extensive patches; ascospores 14–21 µm long .... **T. placodioides**

[1] in older, markedly pruinose specimens, the pruina often erodes, and such specimens can appear sorediate.

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We thank Dr Chris Cargill and Ms Judith Curnow of CANB for their kind cooperation in providing us with ready access to key collections. Ms Lan Li is also thanked for her valuable support with the molecular work. The molecular work was partly funded by a BushBlitz Taxonomy Research grant to CG.

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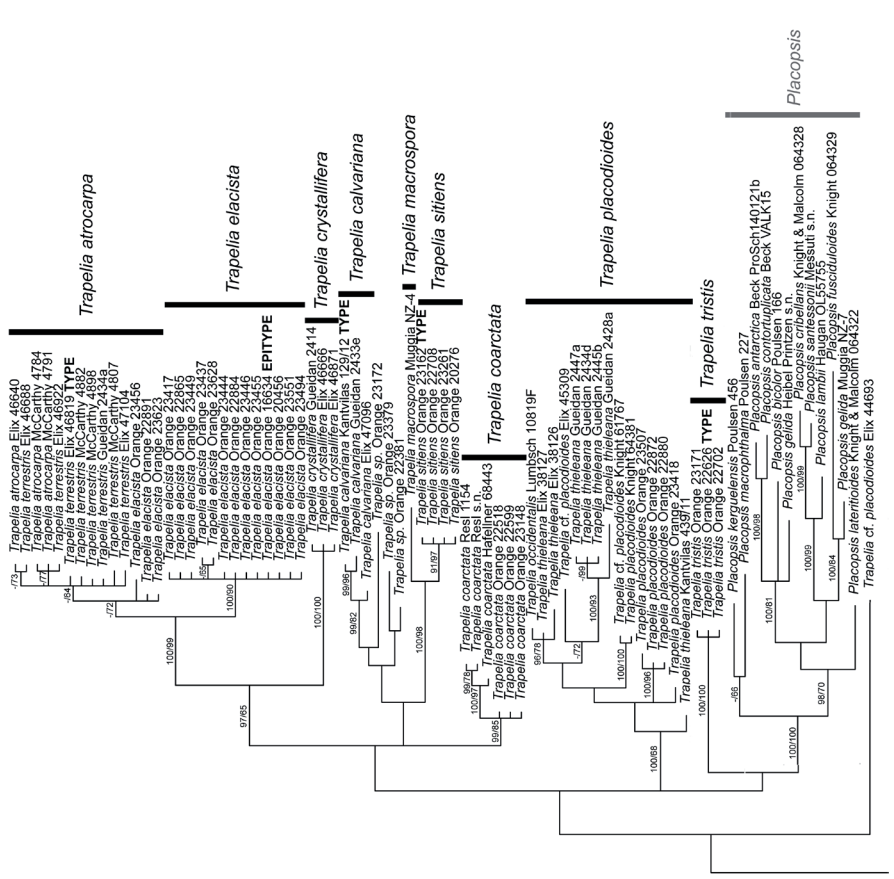

Figure 1. Phylogenetic relationships within the family Trapeliaceae, with a focus on the genus *Trapelia* and Australian *Trapelia* species. Bayesian consensus tree with posterior probabilities and bootstrap values (PP/BS) shown above or below the branches when greater than 95% and 60%, respectively. *Lambiella* and *Rimularia* were used as outgroups. Type specimens of *Trapelia* species are indicated in the tree.

	Species	Collection number, Herbarium	Collection site	ITS accession
1	*Trapelia atrocarpa*	Elix 46640 (CANB)	ACT, Australia	**OM955152***
2	*Trapelia atrocarpa*	McCarthy 4784 (CANB)	ACT, Australia	**OM955153**
3	*Trapelia atrocarpa*	McCarthy 4791 (CANB)	ACT, Australia	**OM955154**
4	*Trapelia calvariana*	Kantvilas 129/12 (HO) - TYPE	TAS, Australia	KU672613
5	*Trapelia cf. calvariana*	Gueidan 2433e (CANB)	ACT, Australia	**OM955156***
6	*Trapelia cf. calvariana*	Elix 47096 (CANB)	ACT, Australia	**OM955155**
7	*Trapelia coarctata*	Resl 1154 (GZU)	Austria	KR017098
8	*Trapelia coarctata*	Resl s.n. (cultured mycobiont: GZU)	Austria	KR017092
9	*Trapelia coarctata*	Hafellner 68443 (GZU)	Austria	KR017097
10	*Trapelia coarctata*	Orange 22518 (NMW)	Falkland Islands	KX961313
11	*Trapelia coarctata*	Orange 22599 (NMW)	Falkland Islands	KX961314
12	*Trapelia coarctata*	Orange 23148 (NMW)	Falkland Islands	KX961335
13	*Trapelia collaris*	Orange 17512 (NMW) - TYPE	Wales	KX961309
14	*Trapelia collaris*	Orange 23420 (NMW)	Wales	KX961344
15	*Trapelia collaris*	Orange 23434 (NMW)	Wales	KX961350
16	*Trapelia collaris*	Orange 22886 (NMW)	Wales	KX961331
17	*Trapelia collaris*	Orange 22890 (NMW)	Wales	KX961333
18	*Trapelia collaris*	Orange 22844 (NMW)	Wales	KX961316
19	*Trapelia collaris*	Orange 23436 (NMW)	Wales	KX961351
20	*Trapelia concentrica*	McCarthy 4891 (CANB)	NSW, Australia	**OM955157***
21	*Trapelia concentrica*	Gueidan 2434b (CANB)	ACT, Australia	**OM955158***
22	*Trapelia concentrica*	McCarthy 4693 (CANB)	NSW, Australia	**OM955159**
23	*Trapelia concentrica*	McCarthy 4813 (CANB)	ACT, Australia	**OM955160**
24	*Trapelia concentrica*	Elix 46713 (CANB) - TYPE	ACT, Australia	**OM955161**
25	*Trapelia corticola*	Orange 23618 (NMW)	Wales	KY797788
26	*Trapelia corticola*	Spribille 30032 (GZU)	Idaho, USA	KR017135
27	*Trapelia crystallifera*	Gueidan 2414 (CANB)	ACT, Australia	**OM955162***
28	*Trapelia crystallifera*	Elix 46666 (CANB)	ACT, Australia	**OM955163***
29	*Trapelia crystallifera*	Elix 46871 (CANB)	NSW, Australia	**OM955164**
30	*Trapelia elacista*	Orange 23417 (NMW)	Wales	KX961342
31	*Trapelia elacista*	Orange 22865 (NMW)	Wales	KX961319
32	*Trapelia elacista*	Orange 23449 (NMW)	Wales	KX961357
33	*Trapelia elacista*	Orange 23437 (NMW)	Wales	KX961352
34	*Trapelia elacista*	Orange 23444 (NMW)	Wales	KX961355
35	*Trapelia elacista*	Orange 22884 (NMW)	Wales	KX961330
36	*Trapelia elacista*	Orange 23446 (NMW)	Wales	KX961356
37	*Trapelia elacista*	Orange 23455 (NMW)	Wales	KX961360
38	*Trapelia elacista*	Orange 16634 (NMW) - EPITYPE	England	KX961308
39	*Trapelia elacista*	Orange 20456 (NMW)	Wales	KX961311
40	*Trapelia elacista*	Orange 23551 (NMW)	Germany	KX961382
41	*Trapelia elacista*	Orange 23628 (NMW)	Wales	KY797791
42	*Trapelia elacista*	Orange 23456 (NMW)	Wales	KX961361
43	*Trapelia elacista*	Orange 22891 (NMW)	Wales	KX961334
44	*Trapelia elacista*	Orange 23494 (NMW)	England	KX961372
45	*Trapelia elacista*	Orange 23623 (NMW)	Wales	KY797790
46	*Trapelia glebulosa*	Orange 23427 (NMW)	Wales	KX961348
47	*Trapelia glebulosa*	Orange 22874 (NMW)	Wales	KX961322
48	*Trapelia glebulosa*	Orange 23441 (NMW)	Wales	KX961353
49	*Trapelia glebulosa*	Orange 23428 (NMW)	Wales	KX961349
50	*Trapelia involuta*	Orange 22879 (NMW)	Wales	KX961326
51	*Trapelia involuta*	Orange 22876 (NMW)	Wales	KX961324
52	*Trapelia involuta*	Orange 23425 (NMW)	Wales	KX961347
53	*Trapelia involuta*	Orange 22873 (NMW)	Wales	KX961321
54	*Trapelia involuta*	Orange 23443 (NMW)	Wales	KX961354
55	*Trapelia involuta*	Orange 22861 (NMW)	Wales	KX961318
56	*Trapelia lilacea*	Kantvilas 245/11 (HO)	TAS, Australia	KU672611
57	*Trapelia lilacea*	Kantvilas 355/05 (HO)	TAS, Australia	KU672612
58	*Trapelia lilacea*	Elix 38737 (CANB)	WA, Australia	**OM955165***
59	*Trapelia lilacea*	Elix 38738 (CANB)	WA, Australia	**OM955166***
60	*Trapelia macrospora*	Muggia NZ-4 (GZU)	North Island, New Zealand	KR017102
61	*Trapelia obtegens*	Orange 16214 (NMW)	England	KX961306
62	*Trapelia obtegens*	Orange 22878 (NMW)	Wales	KX961325
63	*Trapelia obtegens*	Orange 22861b (NMW)	Wales	KX961317
64	*Trapelia obtegens*	Orange 23338 (NMW)	Wales	KX961339
65	*Trapelia occidentalis*	Lumbsch 10819F (CANB)	WA, Australia	**OM955167**
66	*Trapelia placodioides*	Orange 23507 (NMW)	England	KX961374
67	*Trapelia placodioides*	Orange 22872 (NMW)	Wales	KX961320
68	*Trapelia placodioides*	Orange 22880 (NMW)	Wales	KX961327
69	*Trapelia placodioides*	Orange 23418 (NMW)	Wales	KX961343
70	*Trapelia placodioides*	Knight 64381 (OTA)	South Island, New Zealand	KU844758
71	*Trapelia cf. placodioides*	Knight 61767 (OTA)	South Island, New Zealand	KU672615
72	*Trapelia cf. placodioides*	Elix 44693 (CANB)	QLD, Australia	**OM955168**
73	*Trapelia cf. placodioides*	Elix 45309 (CANB)	NSW, Australia	**OM955169**
74	*Trapelia pruinosa*	Gueidan 2505a (CANB)	ACT, Australia	**OM955170***
75	*Trapelia pruinosa*	Gueidan 2433b (CANB)	ACT, Australia	**OM955171***
76	*Trapelia pruinosa*	Elix 46743 (CANB)	NSW, Australia	**OM955172***
77	*Trapelia pruinosa*	Elix 46962 (CANB)	ACT, Australia	**OM955173**
78	*Trapelia pruinosa*	Elix 46785 (CANB) - TYPE	ACT, Australia	**OM955174**
79	*Trapelia pruinosa*	Elix 46843 (CANB)	NSW, Australia	**OM955175**
80	*Trapelia pruinosa*	Elix 47071 (CANB)	NSW, Australia	**OM955176**
81	*Trapelia pruinosa*	Elix 46927 (CANB)	ACT, Australia	**OM955177**
82	*Trapelia pruinosa*	Elix 46987 (CANB)	ACT, Australia	**OM955178**
83	*Trapelia pruinosa*	Elix 47102a (CANB)	ACT, Australia	**OM955179**
84	*Trapelia rosettiformis*	Elix 46746 (CANB) - TYPE	NSW, Australia	**OM955180**
85	*Trapelia rosettiformis*	Elix 46936 (CANB)	ACT, Australia	**OM955181**
86	*Trapelia rosettiformis*	Elix 47023 (CANB)	ACT, Australia	**OM955182**
87	*Trapelia sitiens*	Orange 23162 (NMW) - TYPE	Falkland Islands	KX961336
88	*Trapelia sitiens*	Orange 22708 (NMW)	Falkland Islands	KY800909
89	*Trapelia sitiens*	Orange 23261 (NMW)	Falkland Islands	KY800910
90	*Trapelia sitiens*	Orange 20276 (NMW)	Falkland Islands	KX961310
91	*Trapelia stipitata*	Lendemer 18687 (GZU)	Pennsylvania, USA	KR017096
92	*Trapelia terrestris*	Elix 46688 (CANB)	ACT, Australia	**OM955183**
93	*Trapelia terrestris*	Elix 46922 (CANB)	NSW, Australia	**OM955184**
94	*Trapelia terrestris*	Elix 46819 (CANB) - TYPE	ACT, Australia	**OM955185**
95	*Trapelia terrestris*	McCarthy 4882 (CANB)	ACT, Australia	**OM955186**
96	*Trapelia terrestris*	McCarthy 4898 (CANB)	NSW, Australia	**OM955187**
97	*Trapelia terrestris*	Gueidan 2434a (CANB)	ACT, Australia	**OM955188***
98	*Trapelia terrestris*	McCarthy 4807 (CANB)	ACT, Australia	**OM955189***
99	*Trapelia terrestris*	Elix 47104 (CANB)	ACT, Australia	**OM955190**
100	*Trapelia thieleana*	Elix 38127 (CANB)	WA, Australia	KU672616
101	*Trapelia thieleana*	Kantvilas 439/11 (HO) - TYPE	WA, Australia	KU672614
102	*Trapelia thieleana*	Gueidan 2447a (CANB)	ACT, Australia	**OM955191***
103	*Trapelia thieleana*	Gueidan 2434d (CANB)	ACT, Australia	**OM955192***
104	*Trapelia thieleana*	Gueidan 2428a (CANB)	ACT, Australia	**OM955193***
105	*Trapelia thieleana*	Gueidan 2445b (CANB)	ACT, Australia	**OM955194***
106	*Trapelia thieleana*	Elix 38126 (CANB)	WA, Australia	**OM955195**
107	*Trapelia tristis*	Orange 23171 (NMW)	Falkland Islands	KX961337

Table 1. List of taxa included in the molecular phylogeny, with collection numbers, herbaria, countries of collection and ITS accession numbers. Accession numbers in bold correspond to sequences generated as part of this study. Sequences generated with the long read amplicon sequencing protocol are indicated by a star. These sequences correspond to material collected and/or sequenced as part of a BushBlitz Taxonomy Research project.

108	*Trapelia tristis*	Orange 22626 (NMW) - TYPE	Falkland Islands	KX961315
109	*Trapelia tristis*	Orange 22702 (NMW)	Falkland Islands	KY800908
110	*Trapelia sp.*	Orange 23379 (NMW)	Falkland Islands	KX961341
111	*Trapelia sp.*	Orange 23172 (NMW)	Falkland Islands	KX961338
112	*Trapelia sp.*	Orange 22381 (NMW)	Falkland Islands	KX961312
113	*Placopsis kerguelensis*	Sochting 9398 (C)	Crozet Islands	AY212814
114	*Placopsis antarctica*	Beck ProSch140121b (M)	Antarctica	MH670330
115	*Placopsis bicolor*	Poulsen 166 (C)	Kerguelen Islands	AY212817
116	*Placopsis contortuplicata*	Beck VALK15/01alII (M)	Antarctica	MH670337
117	*Placopsis cribellans*	Knight & Malcolm 064328 (OTA)	South Island, New Zealand	KU844762
118	*Placopsis fusciduloides*	Knight 064329 (OTA)	South Island, New Zealand	KU844756
119	*Placopsis gelida*	Heibel & Printzen s.n. (ESS)	Portugal	AF274091
120	*Placopsis gelida*	Muggia NZ-7 (GZU)	South Island, New Zealand	KR017055
121	*Placopsis lambii*	Haugan OL55755 (O)	Norway	AY212819
122	*Placopsis lateritioides*	Knight & Malcolm 064322 (OTA)	South Island, New Zealand	KU844740
123	*Placopsis macrophthalma*	Poulsen 227 (C)	Kerguelen Islands	AY212820
124	*Placopsis santessonii*	Messuti s.n. (hb. Lumbsch)	Chile	AY212826
125	*Placynthiella dasaea*	BC-084-1 (WSL)	Switzerland	KX132967
126	*Placynthiella icmalea*	Lumbsch 12059a (hb. Lumbsch)	Germany	AF274082
127	*Placynthiella oligotropha*	Timdal OL182032 (O)	Norway	MK811853
128	*Placynthiella oligotropha*	Bendiksby OL175738 (O)	Norway	MK812378
129	*Placynthiella uliginosa*	AFTOL-ID 1365 (DUKE)	*not available*	HQ650633
130	*Placynthiella sp.*	Bjoerk s.n. (GZU)	Canada	MH636005
131	*Placynthiella sp.*	Spribille 35911 (GZU)	Montana, USA	MH636004
132	*Trapeliopsis californica*	McCune 24126 (OSC)	Oregon, USA	AF353567
133	*Trapeliopsis congregans*	Kantvilas 729/03 (FR)	TAS, Australia	MH636006
134	*Trapeliopsis flexuosa*	AFTOL-ID 1028 (DUKE)	*not available*	HQ650634
135	*Trapeliopsis granulosa*	Niemann s.n. (ESS)	Sweden	AF274087
136	*Trapeliopsis gymnidiata*	Ertz 16241 (BR)	Canary Islands	MN483160
137	*Trapeliopsis pseudogranulosa*	Timdal OL208001 (O)	Norway	MK812568
138	*Trapeliopsis steppicus*	McCune 24293 (OSC)	Washington, USA	AF353574
139	*Trapeliopsis viridescens*	Palice 5966 (hb. Palice)	Czech Republic	KR017155
140	*Trapeliopsis wallrothii*	Hafellner 47381 (GZU)	Canary Islands	AF353575
141	*Rimularia badioatra*	McCarthy & Pitcher s.n. (MSC)	Newfoundland, Canada	KR017120
142	*Rimularia gibbosa*	Spribille s.n. (GZU)	Austria	KR017129
143	*Rimularia gibbosa*	Spribille & Wagner s.n. 1 (GZU)	Montana, USA	KR017111
144	*Rimularia gibbosa*	Spribille & Wagner s.n. 2 (GZU)	Montana, USA	KR017107
145	*Rimularia intercedens*	Thor 23122 (UPS)	Sweden	KR017134
146	*Rimularia intercedens*	Westberg s.n. (S)	Austria	KR017119
147	*Rimularia limborina*	Westberg 12-070 (S)	Norway	KR017108
148	*Lambiella arenosa*	McCune 30459 (OSC)	Oregon, USA	MF464549
149	*Lambiella furvella*	Westberg 09-098 (S)	Sweden	KR017118
150	*Lambiella insularis*	Westberg 09-360 (S)	Sweden	KR017101

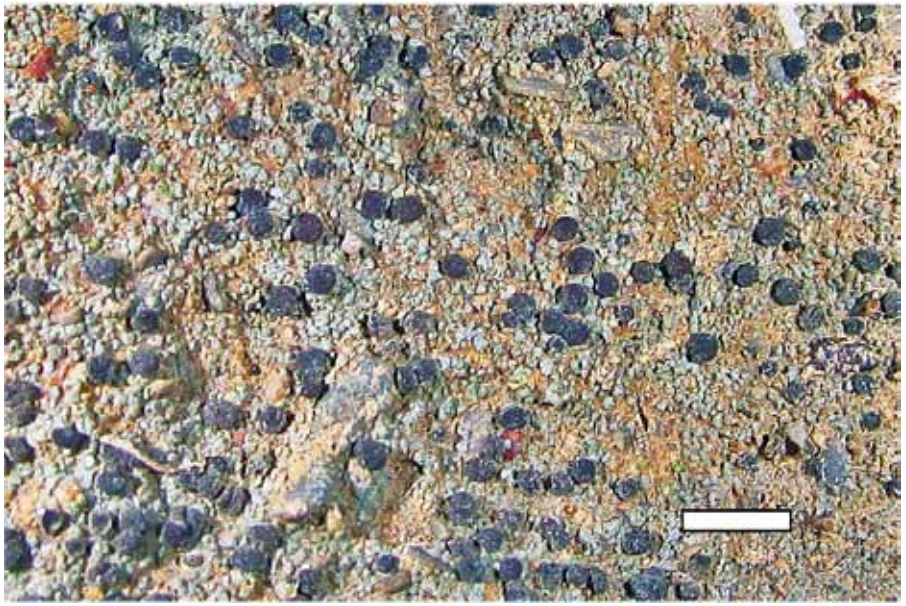

Figure 2. *Trapelia atrocarpa* (holotype of *T. terrestris* in CANB). Scale: 2 mm.

Figure 3. *Trapelia calvariana* (*Elix 47106* in CANB). Scale: 2 mm.

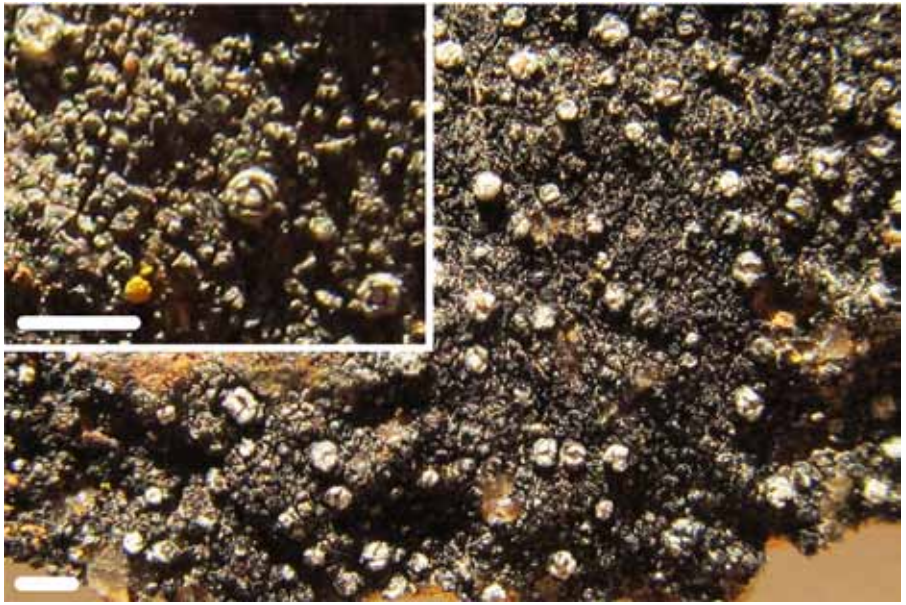

Figure 4. *Trapelia concentrica* (*McCarthy 4693* in CANB). Scale: 1 mm (2 mm in close-up).

Figure 5. *Trapelia crystallifera* (*Elix 47058* in CANB). Scale: 2 mm.

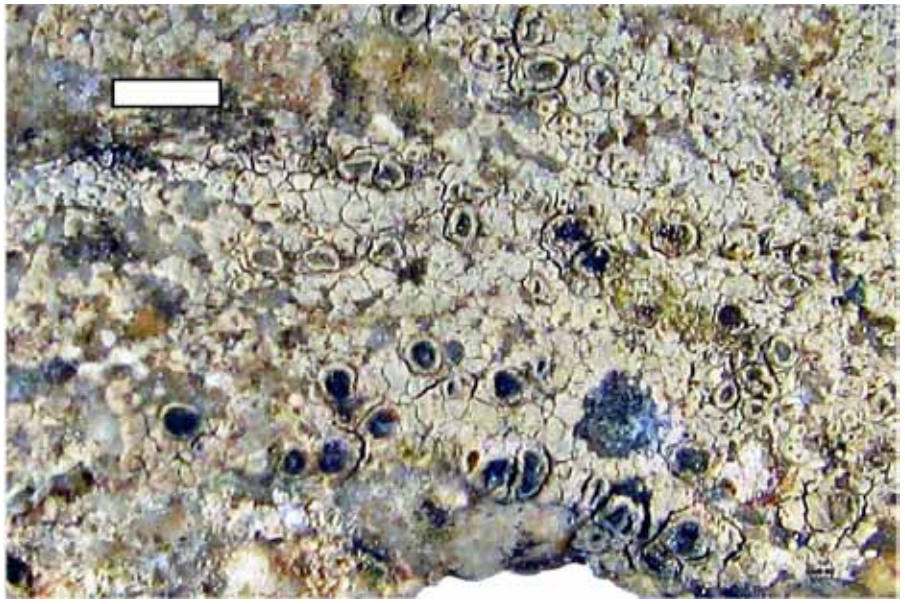

Figure 6. *Trapelia kosciuszkoensis* (holotype in CANB). Scale: 2 mm.

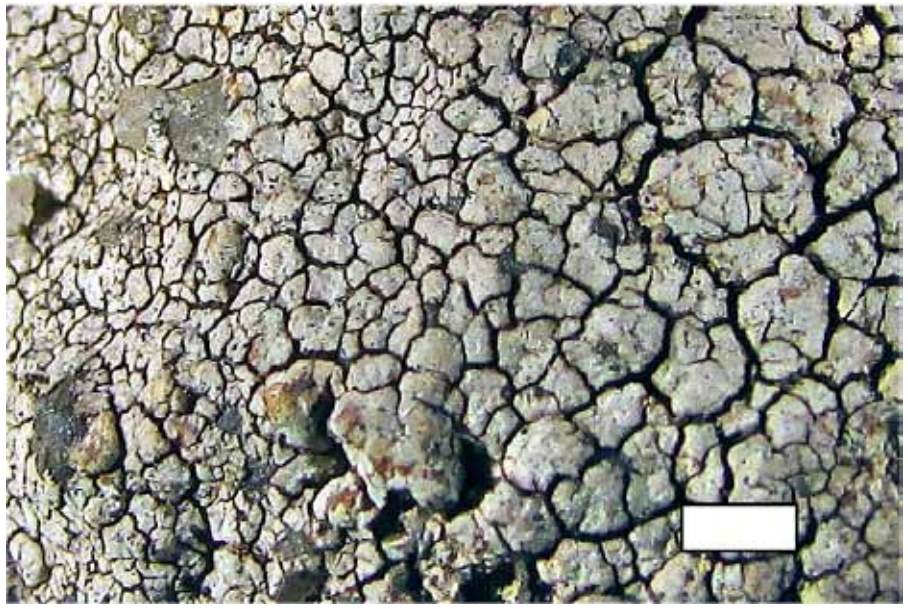

Figure 7. *Trapelia lilaceae* (*Elix 3221* in CANB). Scale: 2 mm.

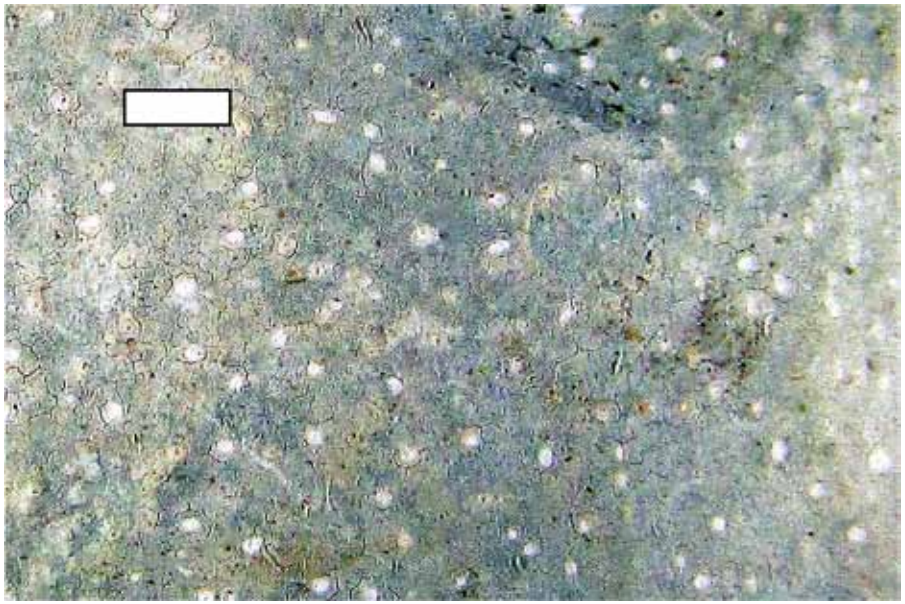

Figure 8. *Trapelia placodioides*, sorediate form (*Elix 45309* in CANB). Scale: 1 mm.

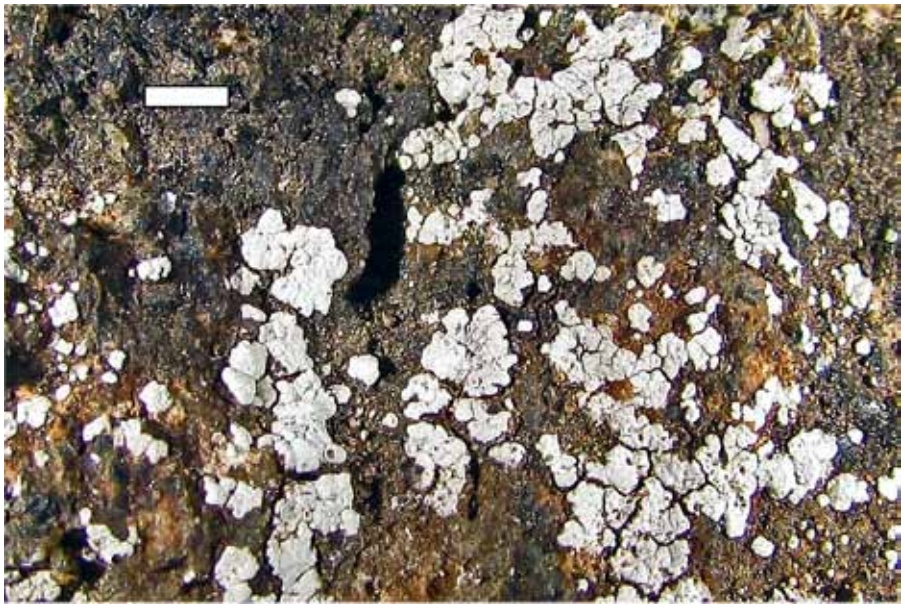

Figure 9. *Trapelia placodioides*, areolate form (*Lumbsch 10819F* in CANB). Scale: 2 mm.

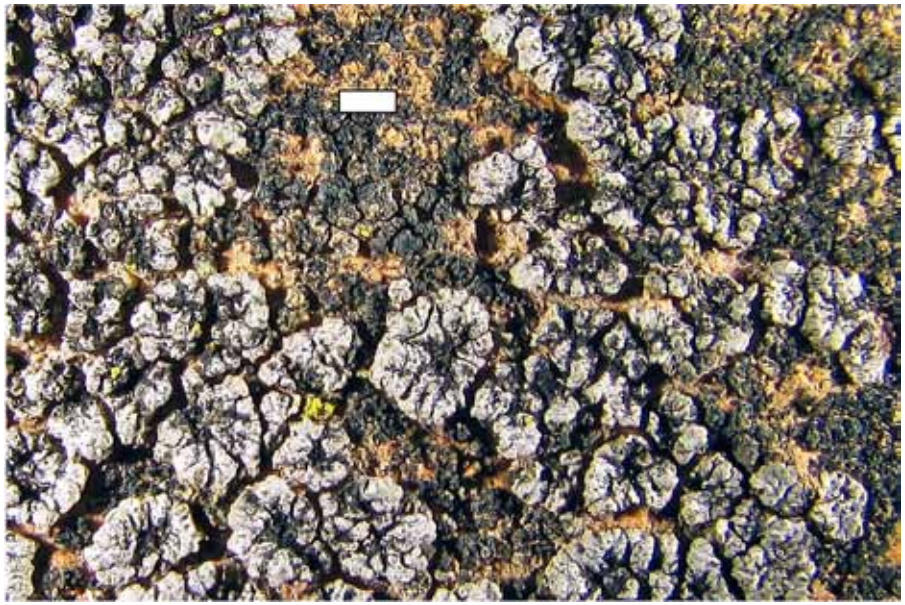

Figure 10. *Trapelia pruinosa* (holotype of *T. rosettiformis* in CANB). Scale: 1 mm.

Figure 11. *Trapelia pruinosa* (holotype in CANB). Scale: 2 mm.

Pannaria microphyllizans (Nyl.) P.M.Jørg. from New Zealand restudied and compared with *P. athroophylla* (Stirt.) Elvebakk & D.J.Galloway and the three new species *Pannaria cassa*, *P. kantvilasii* and *P. wrightiorum*

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Abstract

Pannaria microphyllizans, a previously misunderstood species, is shown here to have gibbose perispores with long-tailed apical extensions, and to lack TLC-detectable chemistry. It is related to *P. athroophylla*, a species with different phyllidia, a chemistry of isovicanicin and leprolomin, and spores of the same type but differing in several details. The latter has been too widely interpreted in New Zealand, because there are two more previously undescribed phyllidiate taxa. *Pannaria wrightiorum* contains vicanicin, leprolomin and scabrosin esters, has short phyllidia and characteristic spore details. *Pannaria kantvilasii* has the same chemistry, but distinctly different spores, revealing a position within the *P. leproloma* group. *Pannaria cassa*, a third new species described here, is primarily fertile and is related to *P. microphyllizans*, having the same chemistry and spore type. Apart from *P. kantvilasii*, the taxa dealt with here belong to the same group within *Pannaria* as the South American *P. patagonica*. The phyllidiate species in the group develop characteristic prothalli that recruit lichenized thallus fragments. The species dealt with here are probably widespread in New Zealand, although their distributions are insufficiently known. *Pannaria wrightiorum* is strikingly common on Campbell Island, and *P. kantvilasii* also occurs in Tasmania.

Introduction

Two decades ago, Jørgensen (2001) treated two former *Psoroma* species as *Pannaria leproloma* (Nyl.) P.M.Jørg. and *P. microphyllizans* (Nyl.) P.M.Jørg., then considered to be sorediate and phyllidiate members of the *P. sphinctrina* (Mont.) Tuck. ex Hue complex. That was the first modern recombination of tripartite, foliose *Psoroma* species into *Pannaria*. Many subsequent studies have contributed to an increased knowledge of the group (*see* Elvebakk & Elix 2017). Elvebakk & Elix reviewed its diverse secondary chemistry, described two new species, and concluded that the group then included 24 species.

The group is still very incompletely known. Recent Pannariaceae phylogenies, such as Passo *et al.* (2008), Ekman *et al.* (2014), Magain & Sérusiaux (2014) and Elvebakk *et al.* (2020), each included ten or fewer samples of the group, and no phylogenetic studies have yet addressed a more detailed phylogeny of *Pannaria*. Such a study is now planned with the aim of defining clades and, when a reasonable level of knowledge has been reached, to produce determination keys of species within those clades. That requires descriptions of new taxa, particularly from New Zealand, which is the centre of diversity of the foliose, tripartite species.

The present study defines *Pannaria microphyllizans* as a starting point. It was briefly suggested to be associated with *P. athroophylla* instead of being in the *P. sphinctrina* group by Elvebakk (2013), who left the topic for a future study. That requires a restudy of *P. athroophylla*, and the studies of those species have revealed two new phyllidiate species as well as an apparently new fertile counterpart of *P. microphyllizans*. The aim of the present study is, therefore, to describe those new species and revise the descriptions of *P. athroophylla* and *P. microphyllizans*.

Material and methods

This paper is based on material from AK, B, BM, CHR, H, HO, MSC, OTA and TROM. Ascospore structure was studied in water mounts and restricted to spores liberated from their asci. Detailed drawings were made of *c.* 400 spores from 56 specimens. Copies of the sketches were added to the specimen packets. Thin-layer chromatography of acetone extracts followed standardized procedures and used solvents A and C (Orange *et al.* 2010). Roughly one-third of the specimens cited were studied by TLC. Nomenclature of ascospore structure follows Nordin (1997).

The species

Pannaria athroophylla (Stirt.) Elvebakk & D.J.Galloway, *Australas. Lichenol.* **53**, 5 (2003)
Figs 1, 2 and 12A
Basionym: *Psoroma athroophyllum* Stirt., *Rep. Trans. Glasgow Soc. Fld. Nat.* **1**, 21 (1873)
≡ *Psoroma subpruinosum* var. *athroophyllum* (Stirt.) C.Knight, *Trans. New Zealand Inst.* **7**, 365 (1875)

Type: New Zealand: *sine loco*, Buchanan #245. Deposit from Otago Museum prepared by James Murray in 1961. Mixed collection including one specimen with *Pseudocyphellaria flavicans* (Hook.f. & Tayl.) Vain. (= probably *P. pickeringii* D.J.Galloway) and *Lopadium fuscoluteum*. (GLAM – lectotype (*n.v.*); BM – isolectotype!; WELT L2064 – isolectotype!)

Psoroma athroophyllum was lectotypified by Galloway (1985: 470) from a GLAM collection cited as Buchanan # 45 from "Tinakori Hills, Wellington". As shown in Fig. 1, Buchanan's collection number should be 245. As explained by Jørgensen (2003), the publication of *Phloepannaria athrophylla* by Zahlbruckner (1941: 276) was rendered invalid because the older name *Psoroma buchananii* was cited as a synonym.

Thallus corticolous, foliose, closely attached, ± free at the margins, forming rosettes 3–10 cm wide. *Lobes* 0.5–1.5 mm wide, *c.* 1.5 mm thick, weakly concave to flat, subdichotomously branched. *Upper surface* smooth, matt, green in the field when moist, pale greenish grey when dry; herbarium specimens becoming ochraceous. *Phyllidia* initially marginal, later also laminal, often forming a crust in the central part, always branched, 0.1–0.2 mm wide, up to 5 mm tall, 0.05–0.1 mm thick, erect, fragile and with a distinctly white lower side. *Upper cortex* 25–30 µm thick, paraplectenchymatous, with lumina up to 10 × 15 µm, weakly ellipsoid, and arranged perpendicular to the surface with thin, *c.* 2 µm thick walls, surface weakly sclerenchymatic. *Chlorobiont layer* 15–20 µm thick, of *Trebouxia* cells, globose or subglobose, 7–17 µm in diam., the chloroplasts angular and papillose. *Medulla* 70–100 µm thick. *Lower surface* ecorticate, whitish to pale ochraceous along the margins, mostly hidden centrally by a cover of bluish black to black rhizinomorphs, *c.* 0.5 mm long, mostly pencil-shaped and esquarrose, extending as a 2–6 mm wide prothallus, where the rhizinomorphs are partly orientated horizontally along the substratum, and partly vertically, in both cases with frequent lichenizations forming tiny thallus granules, squamules, occasionally lobe systems and often cephalodia. *Cephalodia* common, laminal on the upper surface, occasionally also on the lower surface or directly on the prothallus, *c.* 0.5–1.5 mm wide, distinctly pulvinate, subdivided and dissected when mature. *Cyanobiont Nostoc*, with cells greyish green, globose to irregularly subglobose, 4–8 µm in diam., arranged within indistinct 15–30 µm wide glomeruli and without visible chain structures. *Apothecia* uncommon, laminal, substipitate, 0.5–1.5 mm in diam.; disc chestnut-brown, plane to weakly concave or convex; *thalline margin* crenate-striate, 0.2–0.4 mm wide, sometimes with phyllidia; *epithecium* brown, 10–15 µm tall; *hymenium* colourless, intensely IKI+ blue, *c.* 70–80 µm thick; *hypothecium* pale brown, 60–80 µm, IKI negative; chlorobiont layer present below; *asci* clavate, 8-spored, *c.* 80 × 15–20 µm, without internal IKI+ apical structures; *paraphyses* simple, septate, 2–3 µm wide, with adglutinate and indistinctly swollen apices. *Ascospores* hyaline, non-septate, regularly ellipsoid, 13–18 × 7–10 µm; *perispores* 23–38 × 9–13 µm, gibbose laterally, single gibbae rather small, 2–3 µm wide, 1–1.5 µm tall, mostly regular like large verrucae, apical extensions 7–10 µm long, forming a filiform apex, gradually narrowing from a 3–5 µm wide, moderately swollen base. *Pycnidia* not seen.
Chemistry: (by TLC) isovicanicin and leprolomin (mostly major), and one or two unidentified terpenoids.

Remarks

The species is easily recognized by its long, narrow, branched and fragile phyllidia, often forming a dense, thick crust in central parts of the thalli. All other phyllidiate species have much shorter, less branched and more robust phyllidia. The lobes of *P. athroophylla* are also thin and quite closely appressed to the substratum. All specimens have a black, peripheral prothallus, with partly erect hyphae, and the prothallus always recruits numerous small chlorobiont thallus fragments, some developing into rather large lobe systems. The prothallus frequently also recruits cephalodia separate from chlorobont thallus fragments. Passo *et al.* (2020) argued against the interpretation of such a prothallus structure in their concept of *P. athroophylla* from Argentina. The species also has distinct ascospores that are conspicuously regularly ellipsoid, whereas in other phyllidiate taxa they are weakly ovoid to lenticular. The apical perispore extensions are modelately long and swollen at the base, and the lateral gibbae are also moderately tall, 1.5–2 µm.

Thallus chemistry is characterized by the presence of isovicanicin and leprolomin; in contrast specimens with vicanicin, leprolomin and scabrosin esters characterize two different, newly described species (see below). Isovicanicin is most easily told apart from vicanicin immediately after analysis when the spot is greenish *versus* bluish for vicanicin, before they become concolorous. Then they differ again after a longer period of storage, when isovicanicin spots from solvent A turn orange-brown, in contrast with vicanicin spots that become dirty violet.

Pannaria athroophylla was briefly dealt with by Elvebakk & Galloway (2003), who transferred it from *Psoroma* and cited two chemotypes, one with isovicanicin and leprolomin, the other with vicanicin and leprolomin. It was cited from New Zealand only by Galloway (2007). It was published as common in southern Argentina by Passo *et al.* (2020). However, material from southern South America is not dealt with here.

Pannaria athroophylla from New Zealand is now presented with 12 specimens and is less common than anticipated. It is known from between 730 and 1405 m in the Taranaki and Tongariro national parks on the North Island, and in the latter area it was collected in the uppermost, subalpine *Fuscospora cliffortioides* forests. It is known from scattered localities in forests of the South Island. I collected four samples along the Oakune Road in Tongariro in 2019, and because few herbarium specimens have yet been studied thoroughly in contrast to other phyllidiate species, its frequency in Tongariro indicates that it might be more widespread elsewhere as well. *Pannaria athroophylla* as interpreted here has not been found among the numerous unpublished collections from the Auckland and Campbell Islands determined as *Psoroma athroophyllum* by H.A. Imshaug and R.C. Harris. They collected extensively there during 1969 and 1970, with collections primarily deposited at MSC, but with numerous duplicates held by other herbaria around the world.

ADDITIONAL SPECIMENS EXAMINED

New Zealand. *Taranaki*: ● Taranaki/Egmont National Park, North Egmont, Nature Walk just S of the Visitor Centre, 39°15’15”S, 174°05’45”E, alt. 960 m, on *Podocarpus*, *A. Elvebakk 16*:*161*, 26.ii.2016 (TROM L-42873); *Manawatū-Whanganui*: ● Tongariro National Park, 5 km NE of Oakune, along Oakune Mountain Road, start of Blyth Track, 39°21’36.2” S, 175°28’07”E, alt. 980 m, *A. Elvebakk 19*:*125*, 30.iii.2019 (TROM L-44426); ● *c.* 2 km above Rimu Walk, near the road, 39°22’42” S, 175°26’30”E, alt. 730 m, on trunk of *Pseudopanax gilliesii* near the roadside in a *Lophosoria* (*Nothofagus*) *menziesii* forest admixed with rimu, *A. Elvebakk 19*:*165*, 1.iv.2019 (TROM, L-44486); ● upper part of Oakune Mountain Road, *c.* 1.5 km below Turoa Ski Centre, in the uppermost subalpine *Fuscospora cliffortioides* forest situated in a steep, N-facing slope near the road, 39°18’52.5” S, 175°30’35”E, alt. 1405 m, *A. Elvebakk 19*:*133*, 31.iii.2019 (TROM, L-44460); ● *loc. id., A. Elvebakk 19*:*135* (TROM L-44462); *Tasman*: ● track from Flora Saddle to Mount Arthur Hut, 41°12’S, 172°44’E, alt. 1080 m, on bark of *Nothofagus solandri* var. *cliffortioides*, *B.W. Hayward & A.E. Wright 11243*, 13.i.1991 (AK 204439); ● Cobb Valley, 41°0-S, 172°3-’E, *J.K. Bartlett*, 1975–1985 (AK 203368); *Otago*: ● *c.* 7 km S of Haast Pass, along Makarora River near Cameron’s Creek, 44°09.34’S, 169°18.13’E, alt. 360 m, on old trunk of *Nothofagus menziesii* in a forest edge bordering a meadow, *A. Elvebakk 02*:*466*, 6.xii.2002 (TROM L-44544); ● Tuapeca West, Knight Bush, 45°54’32” S, 169°29’49” E, alt. 227 m, bark in regenerating *Kunzea ericoides*/broadleaf forest, on steep sunny NW face, *A. Knight*, 20.iii.2011 (OTA 61753; TROM L-42422); ● Dunedin, Leith Saddle Track, 45°47’51” S, 170°30’ 34” E, alt. 390 m, bark of *Pseudowintera colorata*, mixed mist forest, *A. Knight*, 9.x.2020 (OTA 61747; TROM L-42423); ● *c.* 190 km N of Lake Wanaka, 1 km NW of Makarora, along Makarora Bush Nature Walk, at Pipson Creek, 44°13.72’S, 169°14.45’E, alt. 380 m, on *Nothofagus menziesii* in the forest, *A. Elvebakk 02*:*46*, 6.xii.2002 (TROM L-44548).

Pannaria cassa Elvebakk, sp. nov. Figs 3, 4 and 13A
Mycobank No.: **MB 844587**

Similar to *Pannaria patagonica* (Malme) Elvebakk & D.J.Galloway, but with narrower lobes, the perispore apical extensions longer and the thallus lacking secondary compounds detectable by TLC.

Type: New Zealand. South Island, Southland, Fiordland National Park, Lake Gunn, 44°53’S, 168°05’E, alt. 1800 ft, on trunk of mountain beech (*Nothofagus solandri* var. *cliffortioides*), *C.J. West*, 1.iii.1990 (WELT L4014–holotype!).

Thallus corticolous, foliose, closely attached, ± free at the margins, forming rosettes 5–12 cm wide. *Lobes* 1–3 mm wide, 0.2–0.3 mm thick, concave to flat, subdichotomously branched, elongating peripherally. *Upper surface* smooth, weakly glossy, green in the field when moist, pale greenish grey when dry, herbarium specimens becoming ochraceous. *Upper cortex* 40–60 µm thick, paraplectenchymatous with the lowermost lumina weakly elongate, *c.* 13 × 15 µm, walls 2–3 µm, and arranged perpendicular to the surface. *Chlorobiont layer* 30–40 µm thick, of *Trebouxia* cells, globose to irregularly short-ellipsoid, 7–13 µm, the chloroplasts angular. *Medulla* 100–150 µm thick. *Lower surface* ecorticate, ochraceous, with scattered pale, esquarrose rhizinomorphs; prothallus not seen. *Cephalodia* common, laminal both on the upper and lower surfaces, mostly small, *c.* 0.5 mm wide, pulvinate or divided into pulvinate parts. *Cyanobiont Nostoc*, with cells greyish green, globose to irregularly subglobose, 3–8 µm in diam., arranged within indistinct glomeruli and without visible chain structures. *Apothecia* common, laminal, substipitate, 1–2 mm in diam.; disc chestnut-brown, plane to weakly concave; thalline margin crenulate-striate, 0.1–0.2 mm wide; *epithecium* pale brown, *c.* 20 µm tall; *hymenium* colourless, intensely IKI+ blue, *c.* 60–80 µm thick; *hypothecium* pale brown, 60–80 µm, IKI negative; *chlorobiont layer* present below; *asci* clavate, 8-spored, 80–100 × 15–20 µm, without internal IKI+ apical structures; *paraphyses* simple, septate, 2–4 µm wide, partly with slightly swollen apices. *Ascospores* hyaline, non-septate, ellipsoid, often weekly asymmetrical or lenticular, 11–15 × 7.5–11.5 µm; *perispores* 20–35 × 11–15 µm, gibbose laterally, single gibbae 2–5 µm wide, 2–3 µm tall, irregularly arranged, apical extensions 7–12 µm long, forming a filiform apex, sometimes absent, abruptly narrowing from a 5–10 µm wide, swollen base. *Pycnidia* not seen.
Chemistry: nil by TLC.

Etymology: The epithet “*cassus*” (L., empty or devoid of) refers to the absence of secondary compounds.

Remarks

This species might be considered as the fertile counterpart of *P. microphyllizans*. However, its ascospores are shorter, and prothalli have not been observed. A total of 30 spore sketches were made from five samples. The perispores are of the same type as *P. microphyllizans* with strongly swollen and often irregular lateral gibbae and large and wide basal parts of the apical extensions. The combination of a negative thallus chemistry and characteristic perispores is unique among primarily fertile tripartite *Pannaria* species, even from some yet undescribed taxa. While several specimens have previously been determined as *P. patagonicum* Malme,

that is a South American species containing vicanicin. A closer study of the spores of *P. patagonica* is in preparation.

The endemic *P. cassa* is reported here with eight specimens from New Zealand. Two are from the North Island, from 930 and 1000 m in Taranaki / Mt Egmont National Park, and the remainder are from the South Island regions of Canterbury, West Coast and Southland.

ADDITIONAL SPECIMENS EXAMINED

New Zealand. *Taranaki*: ● Mount Egmont National Park, at North Egmont Chalet, 39°16'S, 174°06'E, alt. 930 m, in mixed podocarp-hardwood rainforest, on bark of *Senecio elaeagnifolius*, *L. Tibell 14971*, 25.xi.1983 (UPS L-97531); ● Pouakai Range, 0.8 km NNW of Display Centre at Dawson Falls, at junction of Ridge Walk and Waingongoro Track, 39°19'S, 174°06'E, alt. 1000 m, in high montane *Weinmannia racemosa-Podocarpus hallii* forest, *L. Tibell 18886*, 5.i.1990 (UPS L-18163); *Canterbury*: ● Peel Forest, 43°53'S, 171°14'E, alt. 1300 ft, occasional on bark of forest trees, *A.E. Wright 8992*, 10.viii.1989 *(*AK 192986); ● Clarence Ecological Region, Manakau Ecological District, Fyffe-Palmer Scenic Reserve, Podocarp Loop track, 42°20'S, 173°38'E, alt. 450 m, on bark of mature miro in tall podocarp forest, *A.E. Wright 12282*, 29.x.1993 (AK 215393); ● *c.* 10 km N of Lake Wanaka, 500 m N of Makarora, 44°13.73'S, 169°14.45'E, alt. 380 m, on trunks of *Nothofagus fusca*, *A. Elvebakk 02:431*, 6.xii.2002 (TROM L-43876); *West Coast*: ● along Haast River, 300 m SE of Roaring Billy Falls, 43°56.35'S, 169°17.13'E, alt. 20 m, on bark of *Nothofagus menziesii* in gallery forest along the gravelly river banks, *A. Elvebakk 02*:*561*, 8.xii.2002 (TROM L-44526; UPS); ● *loc. id*., *A. Elvebakk 02*:*567* (TROM L-44520; AK).

Pannaria kantvilasii Elvebakk, sp. nov. Figs 5, 6 and 13
MycoBank No.: **MB 844588**

Similar to *Pannaria leproloma*, but with distinct, dorsiventral phyllidia instead of coarse isidia, and narrower, more glossy, less tomentose and less laciniate lobes, and perispores more clearly verruculose with distinct pulvinate apical extensions.

Type: Australia. *Tasmania*: Flinders Island, Walkers Lookout, 40°03'S, 148°05'E, alt. 400 m, on *Pomaderris apetala* in wet, low, scrubby woodland, *G. Kantvilas 31/07*, 3.iv.2007 (HO 544047–holotype).

Thallus corticolous, foliose, closely attached, ± free at the margins, forming rosettes 5–12 cm wide. *Lobes* 1–2 mm wide, 0.15–0.25 mm thick, concave, irregularly to subdichotomously branched, coalescing except in a narrow peripheral zone. *Upper surface* smooth, matt to weakly glossy, indistincly tomentose only in youngest parts, green in the field when moist, pale greenish grey when dry, herbarium specimens becoming ochraceous. *Phyllidia* marginal, 0.4–0.8 mm wide, 0.1–0.15 mm thick, weakly ascending, initially isodiametric and constricted at the base, later moderately branched. *Upper cortex* 40–50 µm thick, paraplectenchymatous, with the lowermost lumina elongate and arranged perpendicular to the surface. *Chlorobiont layer* 20–30 µm thick, of large *Trebouxia* cells, globose to irregularly short-ellipsoid, 7–20(–25) µm, the chloroplasts angular and papillose. *Medulla* 70–150 µm thick. *Lower surface* ecorticate, whitish to ochraceous, partly hidden by a dense and felty, black cover of strongly squarrose rhizinomorphs, forming a hypothallus that rarely projects beyond the thallus as a prothallus. *Cephalodia* scattered, laminal on the upper surface, occasionally also on the lower surface, mostly small, *c.* 0.5 mm wide and pulvinate, more rarely up to 2.5 mm and pulvinate with radiating fissures. *Cyanobiont Nostoc*, with cells bluish green, globose to subglobose, 3–7 µm in diam., arranged within indistinct glomeruli and without visible chain structures. *Apothecia* common, laminal, substipitate, 1–2.5 mm in diam.; disc pale rufous brown, plane to weakly concave, without thalline granules, sometimes with weak concentric depression structures; *thalline margin* crenulate-striate, 0.2–0.3 mm wide; *epithecium* pale brown, 10–15 µm tall; *hymenium* colourless, intensely IKI+ blue, *c.* 100 µm thick; *hypothecium* pale brown, 60–80 µm, IKI negative; chlorobiont layer present below; *asci* clavate, 8-spored, 80–100 × 15 µm, without internal IKI+ apical structures; *paraphyses* simple, septate, 1.5–2 µm wide, without swollen apices. *Ascospores* hyaline, non-septate, ellipsoid to ovate, more rarely citriform, 13–18 × 7–11 µm; *perispores* of the same shape, 15–22 × 8–12 µm, regularly verruculose, verruculae 1–1.5 µm wide, and with distinct pulvinate apical extensions, up to 2–2.5 µm wide and 2 µm tall. *Pycnidia* common, marginal, partly laminal, black, immersed, with a thin fissure-like ostiole; spermatia/conidia bacilliform, weakly thickened at the apices, 2.5–3 × 0.5 µm.

Chemistry: (by TLC) vicanicin (major), leprolomin (major to minor), scabrosin acetate hexanoate (trace to major), another scabrosin ester (nil or minor), unidentified terpenoids (minor).

Etymology: Named after the eminent Tasmanian lichenologist Gintaras Kantvilas, who collected the first studied specimens, including the holotype.

Remarks

This species was first detected among Tasmanian specimens that are clearly phyllidiate, but more abundantly fertile than most species producing vegetative propagules. As indicated by the diagnosis, both lobes and perispores differ from those of *P. leproloma*, and *P. kantvilasii* should therefore be considered closely related to *P. leproloma*, but not as its phyllidiate counterpart. A total of four additional specimens have been determined from New Zealand. When fertile, *P. kantvilasii* is different from all the other species dealt with here. However, sterile specimens are difficult to tell apart from *P. wrightiorum* with its similar phyllidia and chemistry.

ADDITIONAL SPECIMENS EXAMINED

Australia. *Tasmania*: ● Savage River, Pipeline Road, by 14.5 km peg, 41°16'S, 145°19'E, alt. 480 m, on *Cassinia aculeata* at edge of rainforest, *G. Kantvilas 262/93*, 8.xii.1993 (HO 312611); ● near Goderick Plains, alt. 640 m, occasional on *Cassinia aculeata* (*Compositae*) at edge of rainforest, *G. Kantvilas 6/82*, 12.i.1982 (BM 000760159).

New Zealand. *Tasman*: ● Nelson Lake District, Lakehead Track, map S33 630225, alt. 2000 ft, on beech, *B. Rietveld 86-18*, i.1986 (AK 290153); *Wellington*: ● Wainuiomata Water Reserve, 41°15'30″S, 175°02'45″E, alt. 730 m, branch of fallen *Nothofagus menziesii* in temperate rainforest, *A. Knight*, 17.vii.2011 (TROM L-42425; OTA 61718); *Otago*: ● Eglington [Eglinton] Valley, W. Otago, *W. Martin*, 27.ii.1972 (CHR 604736); *Stewart Island*: ● Ocean Beach Forest, on trees, *W. Martin 58*, 11.ii.1947 (CHR 588113).

Pannaria microphyllizans (Nyl.) P.M.Jørg., *Biblioth. Lichenol.* **78**, 121 (2001) Figs 7, 8 and 12B

Basionym: *Psoroma sphinctrina* var. *microphyllizans* Nyl., *Syn. Meth. Lich*. **2**, 25 (1863) ≡ *Psoroma microphyllizans* (Nyl.) D.J.Galloway, *New Zealand J. Bot.* **21**, 196 (1983).

Type: Nova Zelandia, sine loco, *J.S.C. Dumont d'Urville* ex Herb. Buchinger (H-NYL 30782! – lectotype).

Thallus corticolous, foliose, closely attached, ± free at the margins, forming rosettes 5–12 cm wide. *Lobes* 1–2 mm wide, 0.15–0.25 mm thick, weakly concave to flat, subdichotomously branched, elongating peripherally. *Upper surface* smooth, weakly glossy to glossy, green in the field when moist, pale greenish grey when dry; herbarium specimens becoming ochraceous. *Phyllidia* marginal, 0.2–0.7 mm wide, 0.1–0.15 mm thick, horizontally arranged or weakly ascending, weakly decumbent, initially isodiametric and constricted at the base, later weakly branched. *Upper cortex* 40–50 µm thick, paraplectenchymatous, with the lowermost lumina elongate and arranged perpendicular to the surface. *Chlorobiont layer* 20–30 µm thick, of *Trebouxia* cells, globose to irregularly short-ellipsoid, 5–15 µm; chloroplasts angular. *Medulla* 70–150 µm thick. *Lower surface* ecorticate, whitish to ochraceous, partly covered with rhizinomorphs, pale centrally, black near margins, either poorly developed or forming a dense

hypothallus that sometimes extends into a 1–4 mm wide prothallus, where the rhizinomorphs are partly orientated horizontally along the substratum, partly vertically, in both cases with frequent lichenizations forming tiny thallus granules, squamules and occasionally lobe systems. *Cephalodia* common, laminal on the upper surface, occasionally also on the lower surface or directly on the prothallus, mostly small, *c.* 0.5 mm wide and irregularly pulvinate, more rarely up to 2 mm and placodioid to coarsely corallioid. *Cyanobiont Nostoc*, with cells greyish blue, globose to irregularly subglobose, 3–6 µm in diam., arranged within indistinct glomeruli and without visible chain structures. *Apothecia* common, laminal, substipitate, 1–3 mm in diam.; disc rufous brown, plane to weakly concave or convex; *thalline margin* crenulate-striate, 0.1–0.3 mm wide; *epithecium* pale brown, 10–20 µm tall; *hymenium* colourless, intensely IKI+ blue, *c.* 60–80 µm thick; *hypothecium* pale brown, 60–80 µm, IKI negative, chlorobiont layer present below; *asci* clavate, 8-spored, 80–100 × 15–20 µm, without internal IKI+ apical structures; *paraphyses* simple, septate, 1.5–2.5 µm wide, without swollen apices. *Ascospores* hyaline, non-septate, regularly ellipsoid, 13–20 × 8–12 µm; *perispores* 23–42 × 12–17 µm, gibbose laterally, single gibbae 2–5 µm wide, 2–3 µm tall, irregularly arranged, apical extensions 7–15 µm long, forming a filiform apex, abruptly narrowing from a 5–10 µm wide, swollen base. *Pycnidia* not seen.

Chemistry: (by TLC) two unidentified terpenoids found near vicanicin and leprolomin positions in both solvents A and C, the upper one violet, the lower brownish.

Remarks

Pannaria microphyllizans was, for a long time, considered to be a phyllidiate species in the *P. sphinctrina* complex. Specimens determined as *P. microphyllizans* in most recent taxonomic treatments and phylogenies represent *P. pulverulacea* Elvebakk or *P. minutiphylla* Elvebakk before those species were described (Elvebakk 2013), and in Australia possibly also *Pannaria phyllidiata* Elvebakk (Lumbsch *et al*. 2011). It could be added that P.W. James synonymized *P. microphyllizans* with *P. athroophylla* in an unpublished annotation tag added to the lectotype in 1965. The latter is indeed a more closely related species, although the interpretation is not evident because the lectotype of *Psoroma sphinctrinum* var. *microphyllizans* is sterile. Its chemistry is therefore critical to understanding this species. Absence of TLC-detectable secondary compounds is very rare in tripartite *Pannaria* species, and when additional specimens with that chemosyndrome were detected and studied, it was shown that the perispores of *P. athroophylla* and *P. microphyllizans* were similar, having long-tailed apical extensions. Laterally, the perispores are gibbose and not verrucose or verruculose. However, the perispore structures are not identical in those two species. Instead, the spores of *P. microphyllizans*, based on 150 drawings from 21 samples, are very similar to those of *P. cassa*.

Pannaria microphyllizans is known from eight collections from the Auckland Islands, two from volcanic areas of the North Island, and eight from the South Island, five of those from the West Coast. The morphology of phyllidia is distinctive in *P. microphyllizans*. Thus they are laminal, rather small, often horizontal or partly ascending, and decumbent. Furthermore, the ascospores are homogeneous in all of the specimens cited. Two terpenoids have been detected as minor compounds in four specimens from the Auckland Islands, although not in the lectotype.

The specimens cited share all those characters, but specimens from the Auckland Islands differ from those further north. Most Auckland Island specimens have rather narrow lobes and develop a distinct prothallus that recruits lichenized granules. Northern specimens are less glossy and lack such prothallus formation, and some are more broad-lobed. Their habitats are quite different. However, there is a possibility that the smooth bark of small trees of *Metrosideros umbellata* initiate prothallus formation and lobe ramification in southern specimens, thus appearing as a habitat modification as compared with more northern populations.

During his last expedition in 1837–1840, D'Urville collected on the Auckland Islands as well as on the peninsulas east of Dunedin and Christchurch and in the northern Bay of Islands (Galloway 1985). From what is known of the distribution of *Pannaria* species today, the Auckland Islands appear to be the most likely collection site of the lectotype.

ADDITIONAL SPECIMENS EXAMINED

New Zealand. *Taranaki*: ● Egmont National Park, North Egmont, along Veronica Walk, 39°175'S, 174°05'E, alt. 1000 m, in subalpine *Weinmannia racemosa-Podocarpus hallii* forest, on tree trunk, *L. Tibell 18753*, 21.xii.1989 (UPS L-17835); *Manawatū-Wanganui*: ● Central Volcanic Plateau NE, Tree Trunk Gorge, *c.* 10 km S of Rangipo, 39°10.24'S, 175°48.15'E, alt. *c.* 700 m, over *Hymenophyllum* stems on trunk, near the path in a shaded *Nothofagus* forest, *A. Elvebakk 02:367*, 30.xi.2002 (TROM, L-43888); *Tasman*: ● NW Nelson Ecological Region, old track from Flora Saddle to Mount Arthur Hut, 41°12'S, 172°44'E, alt. 1050 m, on bark of *Nothofagus solandri* var. *cliffortioides* in 8 metre tall beech forest; with a prominent black hypothallus*, B.W. Hayward & A.E. Wright 11211*, 13.iv.1991 (AK 204407); *Canterbury*: ● Banks Peninsula, 1 km SW of Mt Bossi, in remnant podocarp forest, on *Podocarpus totara*, alt. 640 m, *J.A. Elix 18978 & J. Johnston*, 3.iii.1985 (B 60 6119592, CANB not seen); *West Coast*: ● *c.* 15 km S of Jackson Bay, Cascade Forest, along Cascade Road, 1 km before farm at the end of the road, 44°06.01'S, 188°31.64'E, alt. 25 m, on *Nothofagus menziesii*, at the edge of grazed meadows, *A. Elvebakk 02:506*, 7.xii.2002 (TROM, L-43889*)*; ● *loc. id.*, *A. Elvebakk 02:504* (TROM); ● *loc. id.*, *A. Elvebakk 02:507* (TROM); *West Coast*: ● North Westland, Mount Glasgow, lower slopes in dense bush, 41°28'S, 172°03'E, *J.K. Bartlett 24516,* undated (AK 203557); *Southland*: ● Lake Hauroko, overlying vegetation on beech trees, *W. Martin*, 24.iii.1967 (CHR 578156); *Auckland Islands*: ● Auckland Island, Sealers Creek Cove, mouth of Laurie Harbour, littoral zone and adjacent scrub, *H.A. Imshaug 57667*, 9.i.1973 (MSC 156177); ● N Auckland Island, Cove of German Expedition (1874), on *Coprosma* on large peat tussocks, *H.A. Imshaug 56744*, 23.xii.1972 (MSC 146171); ● *loc. id.*, *H.A. Imshaug 57674* (MSC 146178); ● head of Tandy Inlet, *H.A. Imshaug 57599*, 8.i.1973 (MSC 146151) ● Auckland Island, WNW of Chambres Inlet, mature *Metrosideros* forest with tree ferns on north-facing slope, on *Metrosideros*, *H.A. Imshaug 56262A*, 12.xii.1972 (MSC 146167); ● Auckland Island N, Lookout Point, NW of Ranui Cove, on *Metrosideros*, *H.A. Imshaug 56791*, 24.xii.1972 (MSC 146172); ● S side of Granger Inlet, *Metrosideros* forest with tree ferns, *H.A. Imshaug 57634*, 8.i.1973 (MSC 146156): ● Terror Cove, along shore on *Dracophyllum*, *H.A. Imshaug 56723*, 23.xii.1972 (MSC 146170); ● Ewing Island, southeast part of island, on *Coprosma* in *Metrosideros* forest, *H.A. Imshaug 56444A*, 13.xii.1972 (MSC 146169).

Pannaria wrightiorum Elvebakk, sp. nov. Figs 9, 10 and 11B

Mycobank No.: **MB 844590**

Similar to *Pannaria microphyllizans*, but with a chemistry of vicanicin, leprolomin and scabrosin acetate hexanoate; ascospores longer and weakly lenticular in outline; and perispores with much lower and more regular lateral gibbae and apical extensions with less swollen bases.

Type: New Zealand. *Marlborough*: Sounds-Wellington Ecological Region, Sounds Ecological District, Queen Charlotte Sound, west up ridge from saddle between Resolution Bay and Ship Cove, 41°06'S, 174°13'E, alt. 550 m, on bark of *Weinmannia racemosa*, *A.E Wright 11791*, 2.i.1992 (AK 204976–holotype).

Thallus usually corticolous, occasionally saxicolous, foliose, closely attached, ± free at the margins, forming rosettes 3–12 cm wide. *Lobes* 0.5–2 mm wide, 0.15–0.25 mm thick, weakly concave to flat, subdichotomously branched. *Upper surface* smooth, glossy, weakly tomentose along a narrow marginal zone, green in the field when moist, pale greenish grey when dry; herbarium specimens becoming ochraceous. *Phyllidia* marginal, ovoid/obovoid to spathulate, entire to weakly branched, 0.2–0.5 mm wide, 0.2–0.8 mm long, 0.05–0.15 mm thick, decumbent, arranged horizontally or weakly ascending. *Upper cortex* 40–60 µm thick, paraplectenchymatous with lumina up to 10 × 15 µm, irregularly ellipsoid, and arranged perpendicular to the surface with walls 3–5 µm thick, the surface weakly sclerenchymatic. *Chlorobiont layer* 20–40 µm thick, of *Trebouxia* cells, globose to irregularly short-ellipsoid, 6–12 µm, the chloroplasts angular and papillose. *Medulla* 70–150 µm thick. *Lower surface* ecorticate, ochraceous, white along the margins, with patches of bluish black to black

rhizinomorphs, *c.* 0.5 mm long, mostly pencil-shaped but rarely squarrose, pale centrally, on smooth substrata often extending as a 2–6 mm wide prothallus, where the rhizinomorphs are partly orientated horizontally along the substratum, and partly vertically, in both cases with frequent lichenizations forming tiny thallus granules, squamules and occasionally lobe systems. *Cephalodia* scattered, laminal on the upper surface, occasionally also on the lower surface or directly on the prothallus, *c.* 0.5–1.5 mm wide and irregularly pulvinate when young, later placodioid. *Cyanobiont Nostoc*, with cells greyish blue, globose to irregularly subglobose, 3–8 µm in diam., arranged within indistinct glomeruli and without visible chain structures. *Apothecia* common, laminal, substipitate, 0.5–2 mm in diam.; disc chestnut-brown, plane to weakly concave; thalline margin crenate-striate, 0.2–0.4 mm wide; *epithecium* brown, 10–20 µm tall; *hymenium* colourless, intensely IKI+ blue, *c.* 80–90 µm thick; *hypothecium* pale brown, 60–80 µm, IKI negative; chlorobiont layer present below; *asci* clavate, 8-spored, 80–100 × 15–20 µm, without internal IKI+ apical structures; *paraphyses* simple, septate, 2–3 µm wide, with swollen apices, *c.* 5 µm wide. *Ascospores* hyaline, non-septate, weakly lenticular to ovoid, 13–21 × 8–11 µm; *perispores* 21–40 × 11–15 µm, gibbose laterally, single gibbae rather small, 2–2.5 µm wide, 1–2 µm tall, rarely 4 × 3 µm, sometimes confluent, mostly regular like large verrucae, apical extensions 5–16 µm long, forming a filiform apex, abruptly narrowing from a moderately swollen base to about 5 µm wide. *Pycnidia* not seen.
Chemistry: (by TLC) vicanicin, leprolomin, scabrosin acetate hexanoate, and unidentified terpenoids.

Etymology: During my first visit to AK in 2002, I noticed the numerous interesting Pannariaceae specimens from New Zealand collected by Anthony Wright, previously a curator there, and also how beautifully the specimens had been mounted. According to Ewen Cameron, the current curator, the mounting was done by Anthony's mother, Meryl M.G. Wright, who was a volunteer there. The holotype of the new species *Pannaria wrightiorum* was collected by Anthony and curated by Meryl (1931–2019). The species is named in honour of both (hence the epithet is plural).

Remarks

This species has small phyllidia and is typically very different from *P. athroophylla*. Moreover, the ascospores are clearly different in being weakly but distinctly lenticular to ovoid, whereas those of *P. athroophylla* are very regularly ellipsoid. *Pannaria wrightiorum* is morphologically much closer to *P. microphyllizans*. The former is conspicuously more abundantly fertile than most of the species producing vegetative propagules. In the absence of information on secondary chemistry, *P. wrightiorum* can be recognized by its ascospore morphology. A total of 123 spore sketches were made from 20 collections, and the weakly lenticular outline of relatively large ascospores is characteristic. In addition, the relatively small and regular lateral gibbae are diagnostic, whereas the apical extensions extend from the moderately wide and swollen base. In *P. microphyllizans*, the lateral gibbae are much less regular, and single gibbae are larger and taller, whereas the basal part of the apical extensions is also more swollen.

Thallus chemistry is also distinctive. About 15 of the specimens cited have been studied by TLC. They all contain vicanicin, which is similar to the isovicanicin found in *P. athroophylla*. Both species also contain leprolomin. About 90% of the *P. wrightiorum* specimens contain the ester scabrosin acetate hexanoate.

Pannaria wrightiorum, a New Zealand endemic, is now known from three localities in the North Island. Two of them are Colenso collections. Spores from only one of them were studied. Eight collections are known from the South Island, the type specimen from the northernmost part and the other five from Otago. A single specimen is known from the Auckland Islands. However, 34 collections from Campbell Island were determined among the MSC collections made there in 1969 and 1970 by H.A. Imshaug and R.C. Harris. The species most commonly grew on *Dracophyllum* (*D. longifolium* and *D. scoparium* dominate on the island), but also on rock outcrops. It must be one of the most common *Pannaria* species on Campbell Island.

SELECTED SPECIMENS EXAMINED

New Zealand. *Manawatū-Wanganui*: ● NW of Taihape, Mataroa, Paengaroa Scenic Reserve. 39°38'S, 175°43'E, on *Prumnopitys taxifolia* bordering bush and grassy patch, *B. Polly*, 4.iii.1997 (WELT L5629); ● banks of Makakahi River, dense forest, *W. Colenso 2802* (WELT L1001); ● Dannevirke, on bark of living trees, *W. Colenso 1748*, 22.v.1854 (WELT L1562); *Marlborough*: ● D'Urville Island, SE ridge to Attempt Hill, 40°51'S, 173°52'E, alt. 400–500 m, on beech forest, *B.W. Hayward*, 6.i.1988 (AK 181652); ● *c.* 10–15 km SW of Haast, 4 km from main road along Turnbull Road, 43°56.23'S, 168°55.32'E, alt. 10 m, on *Prumnopitys taxifolia*, *A. Elvebakk 02*:*526*, 7.xii.2002 (TROM, L-44552); *Otago*: ● Otago Land District, Swampy Hill, Pipeline Track, Leith Saddle*, Melicytus* bark, *D.J. Galloway*, 25.v.1995 (CHR 627983); ● Catlins, Table Hill. 46°30'S, 169°28' , on *Nothofagus menziesii* in *N. menziesii* forest. 500 m, *B. Polly*, 23.xi.1998 (WELT L6104); ● Central Otago, Remarkables, Wye Valley, 45°08'S, 168°46'E. On rock in black beech forest, SE aspect, alt. 2800 ft, *C.J. West*, 30.xii.1991 (WELT L4001). *Campbell Island / Motu Ihupuku*: ● *Dracophyllum* scrub north of Beeman Station, on *Dracophyllum scoparium*, *R.C. Harris 5039*, 3.i.1970 (MSC 112793, sterile in admixture with *Pannaria gallowayi* Elvebakk & Elix); ● S side Perseverance Harbour, 1 mile W of South Point, tall *Dracophyllum* scrub, *R.C. Harris 5292*, 13.i.1970 (MSC 104985); ● S side of Perseverance Harbour, 1 mile W of South Point, tall *Dracophyllum* scrub, *R.C. Harris 5305*, 13.i.1970 (MSC 104986); ● *loc. id.*, *R.C. Harris 5306* (MSC 104987); ● *loc. id.*, *R.C. Harris 5452B* (separated from MSC 110691).

Conclusions

A previous subdivision of the genus *Pannaria* into three subgenera as proposed by Jørgensen (1994) was abandoned by Ekman *et al.* (2014), who demonstrated good support for the *Pannaria lurida* group as a distinct subgeneric clade within *Pannaria*. Thus far, other potential groups have only moderate support due to the low number of sequences and a limited number of thorough studies of accompanying characters. Four of the species dealt with here have long-tailed and gibbose perispores, strongly deviating from other tripartite groups in *Pannaria*. The South American species *P. patagonica* can be added to the group which is dealt with here as the *P. athroophylla* group, from its first described taxon. The three phyllidiate species develop a distinct prothallus, as described from the squamulose species *P. byssoidea* (Passo & Calvelo 2011). However, a prothallus has not been observed for the two primarily fertile species *P. cassa* and *P. patagonica*. So far, the single sequence of *P. athroophylla* from Argentina first published by Passo *et al.* (2008) is the only one available for the group.

Within the group, the four species dealt with here are easy to identify, even without knowing their chemistry. *Pannaria microphyllizans* and *P. wrightiorum* have rather similar thalli and shapes of phyllidia. However, their spores are distinctive, and the specimens are usually fertile. The fourth phyllidiate species dealt with here, *P. kantvilasii*, with very different spores, belongs to the *P. leproloma* group. It is also usually fertile, which makes identification easy. However, sterile samples can be challenging, because the species is also chemically identical to *P. wrightiorum*.

Pycnidia have not been seen in the four species from the *P. athroophylla* group, although they are frequently heavily infected by what appears to be an unidentified pyrenomycetous fungus. *Pannaria kantvilasii*, on the other hand, is abundantly pycnidiate, with pycnidia of the same type as those in other members of the *P. leproloma* group.

In New Zealand there are now six known phyllidiate, tripartite *Pannaria* species, including also *P. aotearoana* Elvebakk & Elix and *P. minutiphylla* Elvebakk. The latter is the most widespread of them (Elvebakk 2013). It contains vicanicin but lacks leprolomin, and has indistinct perispores which are finely verruculose, with modest or absent apical extensions. *Pannaria aotearoana* and *P. kantvilasii* also have ellipsoid spores (short-ellipsoid in the former), and the latter has distinct apical perispore extensions. The former contains pannarin and a series of associated substances (Elvebakk & Elix 2017), and like most pannarin species it has a glaucous green colour when moist, as opposed to a salad-green colour in most other

species. In *P. aotearoana* the phyllidia are quite swollen and mostly decumbent, whereas in *P. minutiphylla* they are mostly small, but can overlap in size with those of *P. kantvilasii*, in which case they can be separated using spore morphology or chemistry.

At present, I refrain from writing an identification key, because one additional and distinct phyllidiate species still remains to be described.

Acknowledgements

Curators of the cited herbaria kindly made material available for study, and the New Zealand Department of Conservation kindly gave permission to collect. Mari Karlstad of the Arctic University Museum of Norway photographed several of the specimens, and Anthony E. Wright, Canterbury Museum, supplied information needed for the naming of one of the new species.

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Fig. 1. *Pannaria athroophylla* (isolectotype at WELT); scale bar = 1 cm.

Fig. 2. *Pannaria athroophylla* (*Elvebakk 16:161*). Specimen from Taranaki showing prothalli with thallus fragments; scale bar = 1 cm.

Fig. 3. *Pannaria cassa* (holotype); scale bar = 1 cm.

Fig. 4. *Pannaria cassa* (*Tibell 18886* UPS); scale bar = 1 cm.

Fig. 5. *Pannaria kantvilasii* (holotype); scale bar = 1 cm.

Fig. 6. *Pannaria kantvilasii* (part of holotype); scale bar = 5 mm.

Fig. 7. *Pannaria microphyllizans* (lectotype); scale bar = 1 cm.

Fig. 8. *Pannaria microphyllizans* (*Tibell 18753*, UPS); scale bar = 5 mm.

Fig. 9. *Pannaria wrightiorum* (holotype); scale bar = 1 cm.

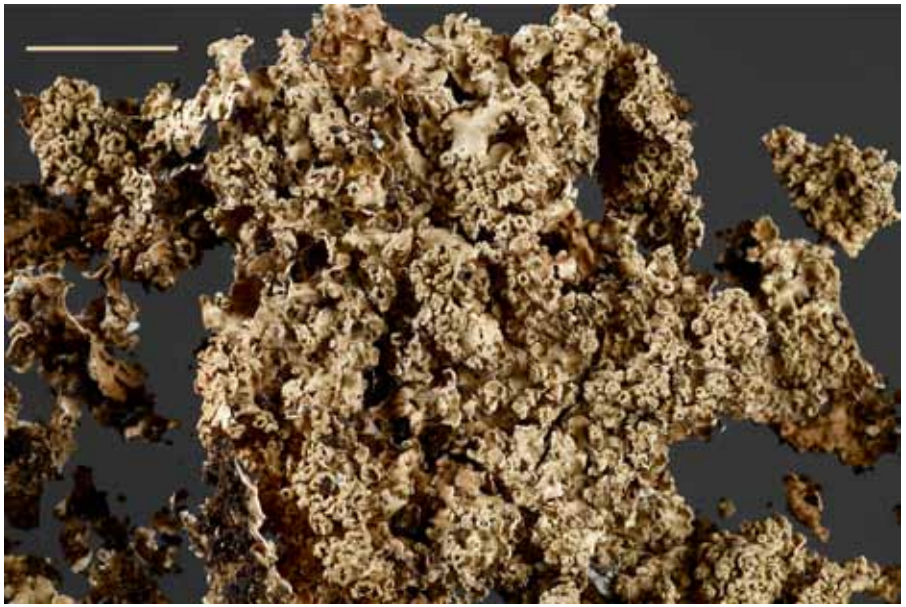

Fig. 10. *P. wrightiorum* (*Polly*, WELT L5629); scale bar = 1 cm.

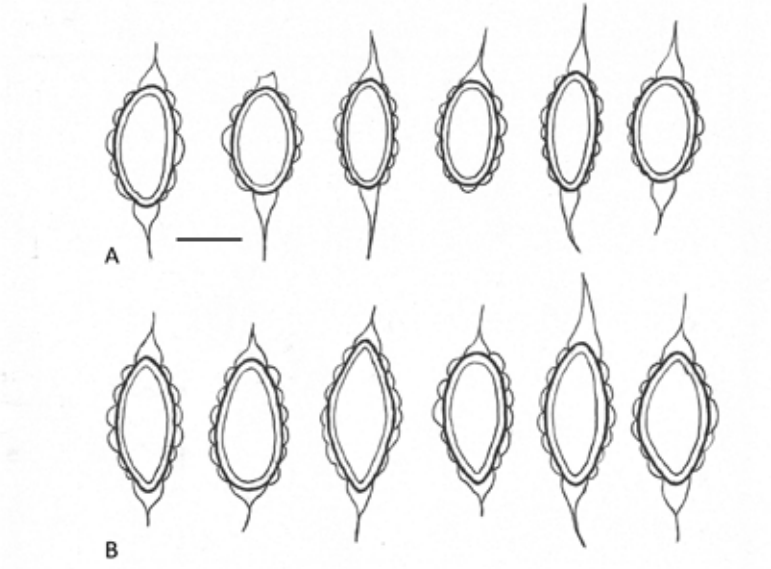

Fig. 11. Ascospores of *Pannaria athroophylla* (A) and *P. wrightiorum* (B); scale bar = 10 µm.

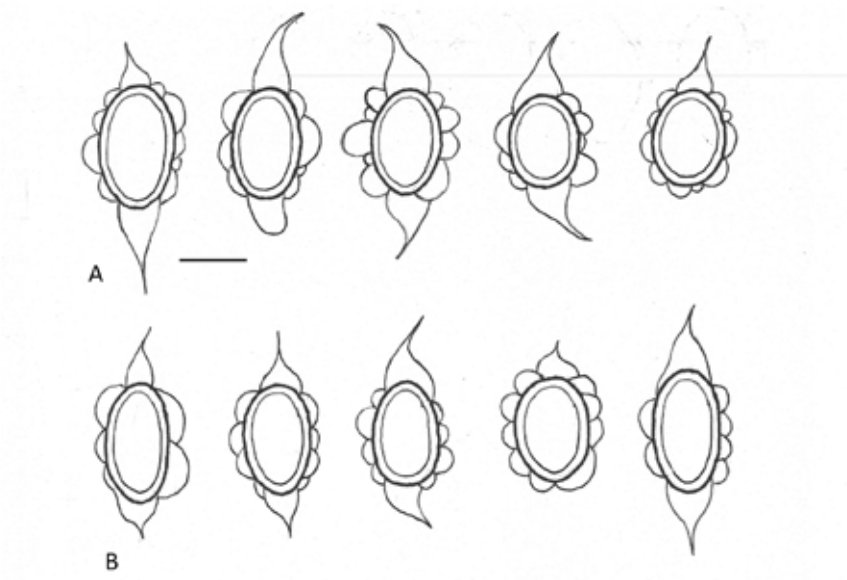

Fig. 12. Ascospores of *Pannaria cassa* (A) and *P. microphyllizans* (B); scale bar = 10 µm.

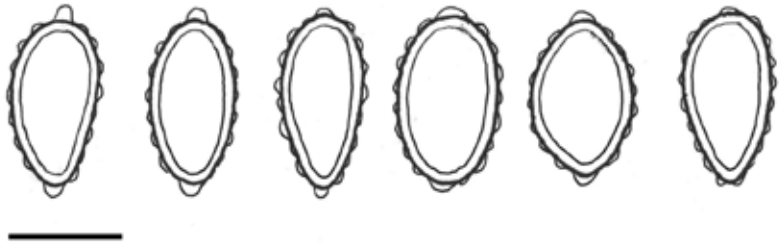

Fig. 13. Ascospores of *Pannaria kantvilasii*; scale bar = 10 µm.

Gyrographa fecunda (Roccellaceae), a new saxicolous lichen from New South Wales, Australia

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Abstract

Gyrographa fecunda sp. nov. (Roccellaceae) is described from rhyolite in eastern New South Wales. It has a pale to medium greyish brown, minutely areolate thallus containing gyrophoric acid, very small adnate to subsessile ascomata with a lirelliform to contorted-gyrose disc, a blackish lateral excipulum, a dark hypothecium and 3-septate ascospores.

Introduction

Gyrographa Ertz & Tehler was described for two species previously included in *Opegrapha* (Opegraphaceae), but found by Ertz *et al.* (2014) to be strongly supported within the Roccellaceae, although separated from the rest of that family. *Gyrographa gyrocarpa* (Flotow) Ertz & Tehler and *G. saxigena* (Taylor) Ertz & Tehler occur on siliceous rocks in western Europe and Macaronesia; the former also in North America, while the latter is known from Turkey. Both have a greyish or pale to dark brown thallus, gyrose-contorted to lirelliform ascomata with a lateral proper excipulum bordering a thick, blackish hypothecium, and ascospores lacking a perispore (Ertz *et al.* 2014; Cannon *et al.* 2021). A third species, *G. nigrofusca* Jagad.Ram, was subsequently described from India (Jagadeesh Ram 2016).

Here, a new saxicolous species from eastern New South Wales is confidently attributed to *Gyrographa* based on chemistry and morphology.

Gyrographa fecunda P.M.McCarthy sp. nov. Figs 1 & 2
MycoBank No.: **MB 843188**

Characterized by the pale to medium greyish brown, minutely areolate thallus containing gyrophoric acid, bounded and dissected by blackish prothalline lines; ascomata very numerous, small, adnate to subsessile, 0.22–0.58 mm in maximum extent, with a slit-like to contorted-gyrose disc and a blackish, lateral excipulum; hypothecium thick, dark brown to brown-black; hymenium hyaline, 60–80 µm thick; epihymenium medium to dark brown; asci (4–)8-spored, 48–67 × 13–18 µm, with a small, conical to tuberculate ocular chamber within a KI+ medium blue ring; ascospores 3-septate, 14–27 × 4.5–7 µm, lacking a perispore; and pycnidia minute and blackish above, with bacilliform to filiform conidia 6–9 × 0.5–0.8 µm.

Type: Australia, New South Wales, Mid-North Coast, Bulahdelah, Mt Alum, 32°25'S, 152°12'E, 100 m alt., on large rhyolite rock face in dry sclerophyll forest, *H. Streimann 44173*, 24.iv.1990 (holotype – CANB; according to the herbarium label a duplicate in B, *n.v.*).

Thallus crustose, epilithic, pale to medium greyish brown, well-delimited and forming colonies up to at least 50 mm wide, to 100(–150) µm thick, minutely areolate; areoles angular or irregular and often slightly rounded, 0.1–0.2(–0.25) mm wide, separated by pale, very delicate and shallow cracks, thallus not containing calcium oxalate (H_2SO_4–), I–; cortex lacking, but the thallus with an amorphous, uppermost layer that is brownish orange and 12–20 µm thick, the pigment dissolving in K. *Algae Trentepohlia*, solitary or in short filaments; cells narrowly to broadly ellipsoid or subglobose to globose, (10–)15–25(–28) × 10–18(–20) µm; interstitial hyphae long-celled, 2–3.5 µm thick, ± vertically orientated between columns/erect filaments of algal cells. *Prothallus* blackish, broad and marginal, or much narrower and forming a reticulum within the colony which delimits individuals in a mosaic of small thalli. *Ascomata* very numerous, adnate to subsessile, mostly solitary, or in small, non-overlapping clusters of up to 4, dull black, epruinose, ± isodiametric to slightly elongate, (0.22–)0.42 (–0.58) mm in maximum extent [*n* = 75], unbranched, initially lirelliform, with blunt ends and a slit-like disc, the surface soon becoming grossly distorted or gyrose; margin irregularly fissured, or raised around an uneven, concave disc, not or scarcely overgrown by the thallus. *Proper excipulum* lateral only, not closed below the hymenium, brown-black, K+ greenish black, 35–60 µm thick, the apices convergent (with slit-like discs) or erect (with open discs). *Hypothecium* 60–120 µm thick, patchily dark brown to brown-black, not inspersed, K–, KI–. *Hymenium* 60–80 µm thick, hyaline, not inspersed with granules or oil globules, KI+ uniformly pale to medium blue (colour soon fading), I+ brownish orange or reddish. *Epihymenium* 10–20 µm thick, medium to dark brown, K+ blackish brown. *Paraphysoids* tightly conglutinate in water, loosening in K, richly branched and anastomosing throughout, short-celled to moderately long-celled, 1–1.5(–2) µm thick; apical cells often swollen, to 2.5 µm wide. *Asci* mostly 8-spored, rarely 4-spored, fissitunicate, narrowly clavate, cylindroclavate or cylindrical, laterally thin-walled, 48–67 × 13–18 µm [*n* = 15]; apex rounded, with a tholus 2–3 µm thick; ocular chamber usually small but distinct, conical to tuberculate, within a KI+ medium blue ring (the only amyloid part of the ascus wall); ascoplasma KI+ orange-brown. *Ascospores* 3-septate, irregularly biseriate or more massed in the distal half of the ascus, persistently colourless, narrowly ellipsoid to fusiform or slightly clavate, occasionally oblong-fusiform, with rounded or subacute apices, straight or slightly bent, rarely constricted at the middle septum, (14–)19(–27) × (4.5–)5.5(–7) µm [*n* = 54]; perispore absent at maturity; cells of ± equal size; contents clear. *Pycnidia* numerous, semi-immersed to almost completely immersed in the thallus, blackish above, 50–70(–80) µm wide. *Conidia* hyaline, simple, straight, bacilliform to almost filiform, 6–9 × 0.5–0.8 µm.
Chemistry: thallus containing gyrophoric acid (major, by TLC, *fide* K.Kalb).

Etymology: The epithet "*fecunda*" refers to the abundantly fertile holotype, in marked contrast to what is probably the most closely related species, the predominantly soraliate *G. gyrocarpa*.

Remarks

The new lichen can be readily distinguished from previously recognized species of *Gyrographa*. Thus, *G. gyrocarpa*, in some ways the most similar species, has a continuous to rimose-areolate, pale to dark brown thallus that also contains gyrophoric acid but is dominated by scattered to confluent, yellowish or orange-brown soralia 0.4–1.5(–2.5) mm wide. Uncommon ascomata are larger than those of the Australian species, 0.7–1.6(–2) mm long, with a hymenium 80–120 µm tall (60–80 µm in *G. fecunda*) and 3-septate ascospores 12–30 × 3–6 µm (Cannon *et al.* 2021). *Gyrographa saxigena* has a thin, continuous, dark, smooth or partially rimose-areolate thallus without lichen substances. Ascomata are 0.5–1.2(–1.4) long, (0.15–)0.2–0.35(–0.45) mm wide, the hymenium is 80–120 µm tall, and the 3-septate ascospores are 15–22 × 4–6 µm (Cannon *et al.* 2021). Lastly, *G. nigrofusca* has elongate, simple to substellate, lirelliform ascomata, 7-septate ascospores, and it lacks lichen substances (Jagadeesh Ram 2016).

This lichen and the type specimens of *Catillaria laevigata* P.M.McCarthy & Elix and *Porina aluniticola* P.M.McCarthy were collected from rhyolite rock faces, outcrops and boulders at Mount Alum following the Ninth Australasian Lichenological Meeting based at Booral, New South Wales, in April 1990. Associated species include *Canoparmelia texana* (Tuck.) Elix & Hale, *Chrysothrix xanthina* (Vain.) Kalb, *Diplotomma venustum* Körb., *Dirinaria flava* (Mull. Arg.) C.W.Dodge, *Heterodermia reagens* (Kurok.) Elix, *Lepra subventosa* (Malme) I.Schmitt & Lumbsch, *Notoparmelia erumpens* (Kurok.) A.Crespo, Ferencova & Divakar, *Parmelinopsis neodamaziana* (Elix & J.Johnst.) Elix & Hale, *Pertusaria xanthoplaca* Mull.Arg., *Relicina sydneyensis* (Gyeln.) Hale, *Tephromela atra* (Huds.) Hafellner, *Xanthoparmelia mongaensis* (Elix) Elix and *X. mougeotina* (Nyl.) D.J.Galloway.

Acknowledgements

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Figure 1. *Gyrographa fecunda* (holotype). Scales: 1 mm.

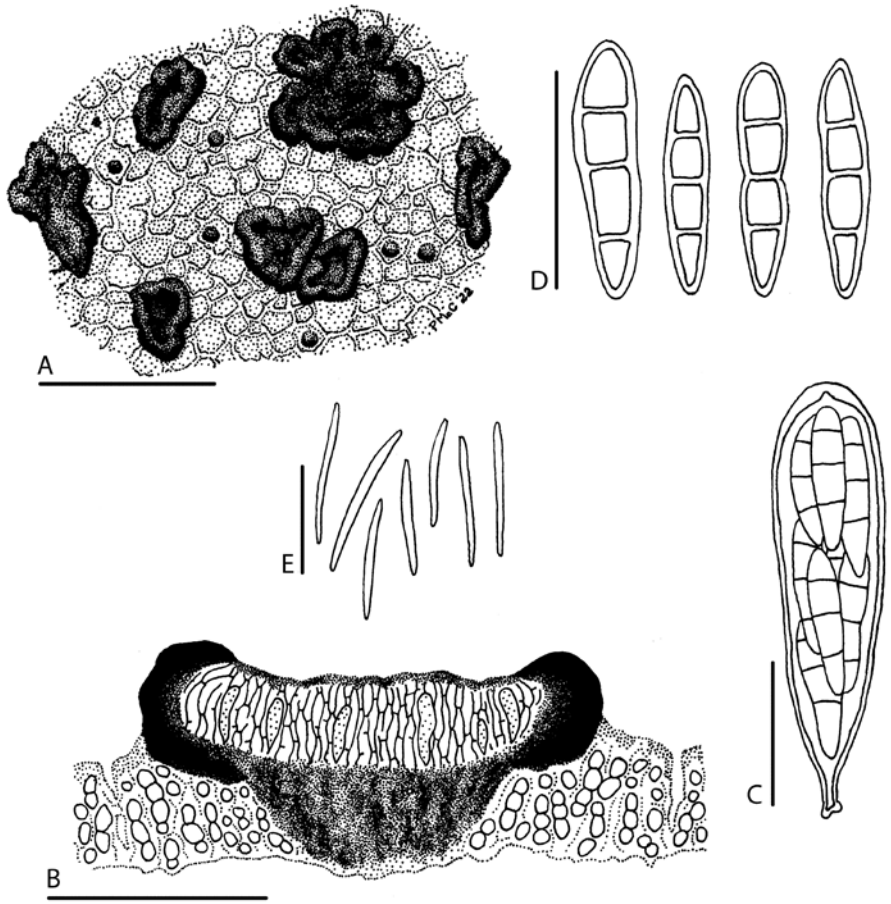

Figure 2. *Gyrographa fecunda* (holotype). A, Habit of ascomata, pycnidia and thallus; B, Vertical section of an ascoma and adjacent thallus (semi-schematic); C, Mature ascus; D, Ascospores; E, Conidia. Scales: A = 0.5 mm; B = 0.2 mm; C, D = 20 µm; E = 5 µm.

A new lichenicolous species of *Cratiria* (Caliciaceae, Ascomycota) from north Queensland, Australia

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Abstract
Cratiria cinnamomea Elix, a lichenicolous species with 1-septate *Cratiria*-type ascospores, bacilliform conidia and containing norstictic and cinnamomeic acids, is described as new to science.

Introduction
This paper is a continuation of my investigations into *Buellia*-like lichens in the Southern Hemisphere (Elix 2019a, b, 2020, 2022 and references therein). The genus *Cratiria* Marbach includes species that are characterized by relatively large, submuriform or 1-septate ascospores, 15–28 × 7–13 µm, with apical wall-thickenings, short, bacilliform conidia 4–6 µm long, a hymenium that can be inspersed with oil droplets or not and an excipulum containing lichen substances (Marbach 2000; Elix 2014; Elix & Mayrhofer 2020). In this paper I describe a new, lichenicolous species of *Cratiria* from north Queensland, Australia. Methods are as described in previous papers cited above.

Cratiria cinnamomea Elix, sp. nov. Fig. 1
MycoBank No.: **MB 843272**

Thallus lichenicolous on *Lecanora* cf. *pangarangoensis* Zahlbr., with broadly adnate to sessile apothecia 0.2–0.7 mm wide, an inspersed hymenium, a pigmented (K+ crimson) excipulum, 1-septate, *Cratiria*-type ascospores, 13–21 × 5–8 µm, and containing atranorin, norstictic acid and cinnamomeic acid C.

Type: Australia, Queensland, Zillie Falls, 12 km by road NE of Millaa Millaa, 17°28’29”S, 145°39’22”E, alt. 705 m, over *Lecanora* cf. *pangarangoensis* on fallen tree in remnant rainforest, *J.A. Elix 39505*, 29.viii.2006 (CANB – holotype).

Thallus lichenicolous, to 15 mm wide and 50 µm thick, developed over the surface of the host (*Lecanora* cf. *pangerangoensis*), the infected area surrounded by a brownish black ring; crustose, rimose, warted; upper surface yellow-brown, matt; prothallus brownish black and marginal; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 7–16 µm diam. *Apothecia* 0.2–0.7 mm wide, lecideine, broadly adnate to sessile and constricted at the base, dispersed, rounded; disc black, epruinose, weakly concave to flat. *Excipulum* thick, persistent, raised above the disc, in section 40–80 µm thick, dark brown to brown-black, K+ crimson solution (no crystals), N–; inner zone pale brown. *Epihymenium* 8–10 µm thick, red-brown, inspersed with crystals, K+ yellow then red, with needle-like crystals, N–. *Hypothecium* 70–125 µm thick, K+ forming red, needle-like crystals. *Hymenium* 70–110 µm thick, colourless, densely inspersed with oil droplets; subhymenium 10–15 µm thick, pale brown, inspersed. *Paraphyses* 1.5–2 µm wide, sparsely branched, with apices 3–3.5 µm wide and pale brown caps. *Asci Bacidia*-type, 8-spored. *Ascospores* 1-septate, *Cratiria*-type, brown, ellipsoid, 13–[*16.3*]–21 × 5–[*6.7*]–8 µm, ± curved, becoming constricted at the septum, with moderate apical wall-thickenings; outer spore-wall weakly ornamented. *Pycnidia* not seen.
Chemistry: Thallus K+ yellow then red, C–, P+ yellow-orange; excipulum K+ crimson; containing atranorin (minor), norstictic acid (major), connorstictic acid (minor), cinnamomeic acid C (minor) and unknown (minor).

Etymology: The species is named after the red pigment, cinnamomeic acid C, present in the excipulum.

Remarks
Cratiria cinnomomea is characterized by initially being lichenicolous and then developing its own independent thick, yellow-brown, rimose, warted thallus, with broadly adnate to sessile, lecideine apothecia, an inspersed hymenium, a pigmented (K+ crimson) excipulum, 1-septate, *Cratiria*-type ascospores, 13–21 × 5–8 µm, and by the presence of atranorin, norstictic acid and cinnamomeic acid C. Cinnamomeic acid C was previously reported from *Rinodina cinnamomea* (Th.Fr.) Räsänen as ‘*cinnamomea* unknown’ (Resl *et al*. 2016) and from *Rinodina herteliana* Kaschik (Elix 2021). *Cratiria chloraceus* Marbach has similar-sized, *Cratiria*-type ascospores and a pigmented K+ red to violet excipulum, but that species differs in being corticolous and in containing arthothelin and thuringione (Marbach 2000). The primary *Lecanora* species contains atranorin (minor), chloroatranorin (minor), 2′-*O*-methylperlatolic acid (major), 3-chloro-2′-*O*-methylhyperanziaic acid (minor), 3,5-dichloro-2′-*O*-methylanziaic acid (minor) and thiophanic acid (minor).
Cratiria cinnamomea is known only from the type collection. Associated species include *Graphis vittata* Müll.Arg., *Lepidocollema brisbanense* (C.Knight) P.M.Jørg., *Letrouitia vulpina* (Tuck.) Hafellner & Bellem., *Lobaria discolor* (Delise) Hue, *Pertusaria albopunctata* (A.W.Archer & Elix) A.W.Archer & Elix, *Pseudocyphellaria brattii* D.J.Galloway & Kantvilas and *Sarcographa verrucosa* (Mont. & Bosch) Zahlbr.

Acknowledgements
I thank Dr Chris Cargill and Ms Judith Curnow of CANB for their kind cooperation in providing me with ready access to key collections.

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Figure 1. *Cratiria cinnamomea* (holotype in CANB). Scale = 2 mm.

A new *Cratiria* (Caliciaceae, Ascomycota) with triseptate ascospores from Papua New Guinea

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Abstract
The saxicolous *Cratiria buloloensis* Elix, from Papua New Guinea, is described as new to science.

Introduction

This paper continues my investigation of *Buellia*-like lichens in the Pacific islands; for recent additions see Elix (2016, 2019) and Elix & Mayrhofer (2019). The genus *Cratiria* Marbach includes species that are characterized by relatively large, submuriform, 1- or 3-septate ascospores, 15–28 × 7–13 µm, with apical wall-thickenings, short, bacilliform conidia 4–6 µm long, a hymenium that can be inspersed with oil droplets or not and an excipulum containing lichen substances (Marbach 2000; Elix 2014; Elix & Mayrhofer 2020). In this paper, I describe a new saxicolous species of *Cratiria* with 3-septate ascospores from Papua New Guinea. Methods are as described in the previous papers cited above.

Cratiria buloloensis Elix, sp. nov. Fig. 1
MycoBank No.: **MB 843459**

Similar to *Cratiria lauricassiae* (Fée) Marbach, but differs in having a saxicolous thallus and in containing atranorin and diploicin rather than norstictic acid.

Type: Papua New Guinea, Morobe Province, Road 4, 4.6 km SW of Bulolo, 07°14'S, 146°36'E, 1500 m alt., on boulder in regrowth forest at margin of *Araucaria* plantation, *H. Streimann 33480A*, 16.i.1983 (holotype – CANB).

Thallus crustose, to 20 mm wide and 0.2 mm thick, continuous, verrucose-areolate; individual areoles irregular, convex, 0.2–0.5 mm wide; upper surface grey-white, smooth; prothallus not apparent; medulla white, lacking calcium oxalate (H_2SO_4–), I–; photobiont cells 8–13 µm in diam. *Apothecia* 0.4–0.9 mm wide, lecideine, adnate to sessile, dispersed, round or distorted with age; disc black, epruinose, plane then markedly convex. *Excipulum* thin, excluded in older, convex apothecia, in section 40–55 µm thick, outer zone dark brown, K+ pale yellow, N–, inner zone brown. *Epihymenium* 8–10 µm thick, brown, K–, N–. *Hypothecium* 75–80 µm thick, extending to 150–200 µm thick in the central stipe, brown-black, K–, N–. *Hymenium* 50–75 µm thick, colourless, not or only sparingly inspersed; subhymenium 15–20 µm thick, colourless to pale brown. *Paraphyses* 1.5–2 µm wide, moderately branched, capitate, with apices 3–4.5 µm wide and brown caps. *Asci Bacidia*-type, 8-spored. *Ascospores* initially 2-septate but soon 3-septate, brown, elongate-ellipsoid, 14–[*18.2*]–22 × 6.5–[*7.7*]–9.5 µm; outer spore-wall weakly ornamented. *Pycnidia* not seen.
Chemistry: Thallus K+ yellow, P+ pale yellow, C–, UV–; containing atranorin (major), diploicin (minor).

Etymology: The species is named after the type locality.

Remarks

Cratiria buloloensis is characterized by the verrucose-areolate, pale grey crustose thallus, with a non-amyloid medulla that lacks calcium oxalate, the adnate to sessile, lecideine apothecia with epruinose discs, a non-inspersed or sparingly inspersed hymenium, 3-septate ascospores, 14–22 × 6.5–9.5 µm, and the presence of atranorin and diploicin. The pantropical

C. lauricassiae has similar-sized, usually 3-septate ascospores, but it differs in being invariably corticolous, in containing norstictic acid and in the ascospores occasionally having 1 or 2 additional transverse septa (Nordin 2000; Elix 2011). *Cratiria lauricassiaeoides* (Aptroot) Elix from Papua New Guinea also has mainly 3-septate ascospores and chemistry that is identical to *B. buloloensis*, but it differs in having larger ascospores, 21–[*23.2*]–26 × 8–[*8.9*]–10 µm, which sometimes become 4-septate, as well as being corticolous (Aptroot *et al*. 1997; Nordin 2000).

At present *Cratiria buloloensis* is known only from the type locality. Associated species include *Cladonia ramulosa* (With.) J.R.Laundon, *Dirinaria aegialita* (Ach.) Moore, *Heterodermia galactophylla* (Tuck.) Trevis., *Leucodermia leucomelos* (L.) Kalb, *Parmotrema cristiferum* (Taylor) Hale, *P. subrugatum* (Kremp.) Hale, *P. tinctorum* (Despr. ex Nyl.) Hale, *Physcia atrostriata* Moberg and *Rinodina xanthomelana* Mull.Arg.

Acknowledgement

I thank Dr Christine Cargill and Ms Judith Curnow for their kind cooperation in providing access to key collections in CANB.

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Figure 1. *Cratiria buloloensis* (holotype in CANB). Scale = 2 mm.

Additional lichen records from New Zealand 52. *Xanthoparmelia dayiana* (Elix & P.M.Armstr.) Elix & J.Johnst. (Parmeliaceae)

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Abstract
Xanthoparmelia dayiana, previously known only from Australia and Réunion Island, is reported from Banks Peninsula, Canterbury, New Zealand.

Among fresh collections of Parmeliaceae made on Banks Peninsula (Canterbury, New Zealand), we found a *Xanthoparmelia* that did not key out in Galloway (2007), distinguished from species treated there by the following features: the thallus is isidiate and the medulla is K– and Pd+ orange-red.

The morphology is very similar to *Xanthoparmelia exillima* (Elix) Elix & J.Johnst., in that the upper surface is pale yellow-green, the thallus is closely attached to the substratum, the lobes are narrow (*c.* 0.5 mm wide) and the upper surface is erumpent-isidiate. However, the medulla gives a Pd+ orange-red reaction, whereas the medulla of *X. exillima* is Pd–. In addition, the medulla is KC–, whereas the medulla of *X. exillima* is KC+ rose-pink due to the presence of norlobaridone. We easily identified the specimen as *Xanthoparmelia dayiana* in the treatment of that genus in the *Flora of Australia* (Elix, 1994), because the thallus is tightly adnate to the substratum, it has isidia that become erumpent, the lower surface is brown rather than black, the medulla is K–, the lobes are narrow, and the medulla is white and reacts Pd+ orange-red (from the presence of fumarprotocetraric acid).

Xanthoparmelia dayiana is known from 32 Australian collections: 30 from Western Australia, one from the Northern Territory (Liddle Hills east of Uluru), and one from South Australia (Coober Pedy) (Elix 1994; Atlas of Living Australia, searched on 5 March 2022). It is also known from Réunion Island (J.A. Elix pers. comm.). All features of the Banks Peninsula lichen are in accord with the description in Elix (1994).

SPECIMEN EXAMINED
New Zealand. *Canterbury*: ● Banks Peninsula, Port Hills, bluffs near Watlings Track above Governors Bay, 172.63486°E, 43.62318°S, alt. 420 m, on *Grimmia pulvinata* and soil on vertical basalt bluff, *Pseudopanax arboreus–Melicytus ramiflorus* forest near to but below the bluff, with *Notoparmelia signifera* and *Stereocaulon ramulosum*, *D. Glenny 15219*, 3.iii.2022 (CHR 674511).

Acknowledgement
We thank Jack Elix for commenting on a draft of the manuscript.

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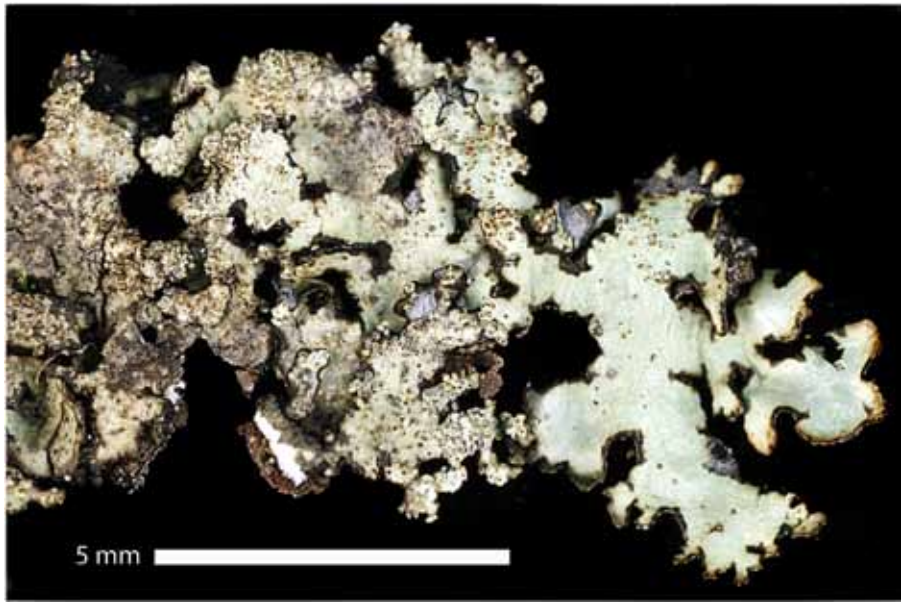

Figure 1. *Xanthoparmelia dayiana*, dorsal view of thallus. CHR 674511.


Figure 2. *Xanthoparmelia dayiana*, ventral view of thallus. CHR 674511.

Additional lichen records from Australia 89.
***Acanthothecis consocians* (Nyl.) Staiger & Kalb**

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Abstract
Acanthothecis consocians (Graphidaceae) is reported for the first time from Australia. Previously known from tree bark elsewhere in the eastern Palaeotropics, the species was collected on the twig of a rainforest tree in Christmas Island, an Australian territory in the north-eastern Indian Ocean.

Introduction
Acanthothecis Clem. (Graphidaceae) is a genus of about 40 mostly corticolous species found mainly in the subtropics and tropics, and characterized by pale lirellae lacking carbonization, with spiny or warty periphyses, paraphyses with spiny apices, and oblong, thin-walled ascospores with cylindrical locules (Staiger & Kalb 1999, 2004; Archer 2009; Muskavitch & Lendemer 2016). Eight species are known from Australia, most occurring in the subtropics and wet-tropics (Archer 2009; Archer & Elix 2009; Kantvilas 2010). In this contribution, the eastern Palaeotropical *A. consocians* (Nyl.) Staiger & Kalb is reported from Christmas Island.

Acanthothecis consocians (Nyl.) Staiger & Kalb, *Mycotaxon* **73**, 97 (1999)
Graphis consocians Nyl., *Bulletin Société Linnéenne de Normandie*, sér. 2, **2**, 116 (1868)

Thallus pale greyish brown to pale olive-brown, smooth to patchily convex-verruculose, non-rimose, dull to slightly glossy, to 60(–100) µm thick, thinly corticate, containing calcium oxalate (H_2SO_4+). *Algae Trentepohlia*; cells rounded to ± ellipsoid, 7–16 µm in maximum extent. *Prothallus* not apparent. *Apothecia* lirelliform, scattered or contiguous, sometimes clustered but not overlapping, adnate to subsessile, mostly elongate, straight, curved or sinuous, simple to sparingly branched, with blunt or pointed ends, (0.6–)1.3(–2.2) mm long, (0.15–)0.3(–0.45) mm wide [*n* = 25]; disc slit-like or more open, pale pinkish brown, smooth, concave, epruinose. *Thalline margin* initially concolorous with the thallus and smooth, finally white and with a minutely roughened surface, 80–120 µm thick, containing abundant calcium oxalate (H_2SO_4+). *Proper excipulum* cupulate, pale yellowish brown, paraplectenchymatous, 25–35 µm thick laterally, with periphyses directed from the inner edge upwards and into the hymenium, these 12–17(–20) µm long, 2.5–3.5(–4.5) µm wide, hyaline, abundantly short-spinose and tuberculate, the apices slightly swollen; excipulum base pale yellowish brown, 10–15(–20) µm thick. *Epihymenium* hyaline and not apparent, or pale brown. *Hymenium* 50–70 µm thick, hyaline, non-amyloid, not inspersed with granules or oil globules, although the paraphyses can have granular inclusions. *Hypothecium* pale yellowish brown, 10–15 µm thick, not inspersed, I–. *Paraphyses* simple, strongly conglutinate in water, loosening in K, 0.8–1(–1.2) µm thick; apices slightly swollen, hyaline to brownish and with minute spines or tubercles. *Asci* narrowly clavate to clavate-cylindrical, 8-spored, 44–58 × 8–11 µm [*n* = 8], *Graphis*-type; apex broadly rounded; wall KI–. *Ascospores* (4–)6(–8)-locular, hyaline, oblong to oblong-fusiform, fusiform or oblong-cylindrical, usually straight, with rounded or subacute ends, I–, KI–, (12–)14.5(–17) × (3–)4(–5) µm [excluding the epispore; *n* = 38]; epispore smooth, *c.* 1–2 µm thick at maturity (spores viewed outside the asci); locules cylindrical; post-mature ascospores remaining hyaline. *Pycnidia* not seen. [Figs 1 & 2]
Chemistry: No substances detected in the thallus or lirellae by TLC (Elix 2020).

Acanthothecis consocians is characterized by its delicate, white lirellae, a yellowish brown, cupulate proper excipulum, a non-inspersed hymenium, and small, narrow 4–8-locular ascospores. It was previously known from tree bark at the type locality in New Caledonia (Staiger & Kalb 1999; photograph by A.W. Archer in A. Aptroot, *Pictures of Tropical Lichens*, https://www.tropicallichens.net/specieslist.aspx), as well as the Solomon Islands (Archer 2007), Papua New Guinea (Staiger & Kalb 1999), Thailand (Kalb & Kalb 2017) and India (Makhija & Adawadkar 2007). While the Australian specimen matches previous accounts of the species in terms of ascomatal morphology and anatomy, including the thalline margin and proper excipulum, periphyses and hymenial structures, Staiger & Kalb (1999) reported the thalli of the type and Papua New Guinean specimens to be considerably paler (white to yellowish), while Makhija & Adawadkar (2007) stated that collections from India had pale white thalli. In a further complication, published accounts of thalline and ascomatal chemistry also point to some variability in this species. Thus, the ascomata of the holotype were said to contain trace amounts of psoromic acid (Staiger & Kalb 1999) or to lack lichen substances (the type specimen annotated by M. Nakanishi, *fide* Staiger & Kalb 1999), to have ascomata with major con-centrations of psoromic acid (in Thailand, *fide* Kalb & Kalb 2017) or, as in the Australian material, to completely lack lichen substances (also in India, *fide* Makhija & Adawadkar 2007).

SPECIMEN EXAMINED
Christmas Island: ● *c.* 700 m N of Grants Well, 10°28.52’S, 105°39.14’E, alt. 260 m, on bark of centimetre-wide twig in moderately dense primary forest [associated with *Hemithecium implicatum* (Fée) Staiger, *Porina tetracerae* (Ach.) Müll.Arg. and *Pyrenula nitidula* (Bres.) R.C.Harris], *P.M. McCarthy 1457 pr. p.*, 28.vii.2000 (CANB).

Acknowledgement
I thank Jack Elix for chemical analysis (TLC) of the specimen.

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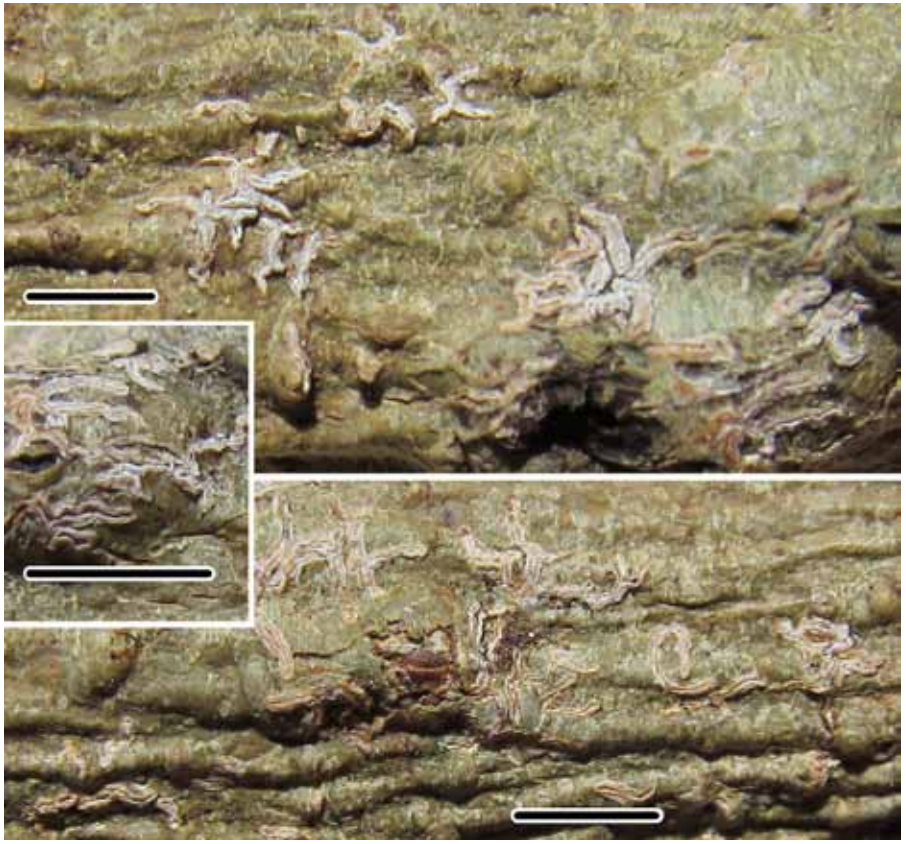

Figure 1. *Acanthothecis consocians* (*P.M. McCarthy 1457 pr. p.*). Scales: 2 mm.

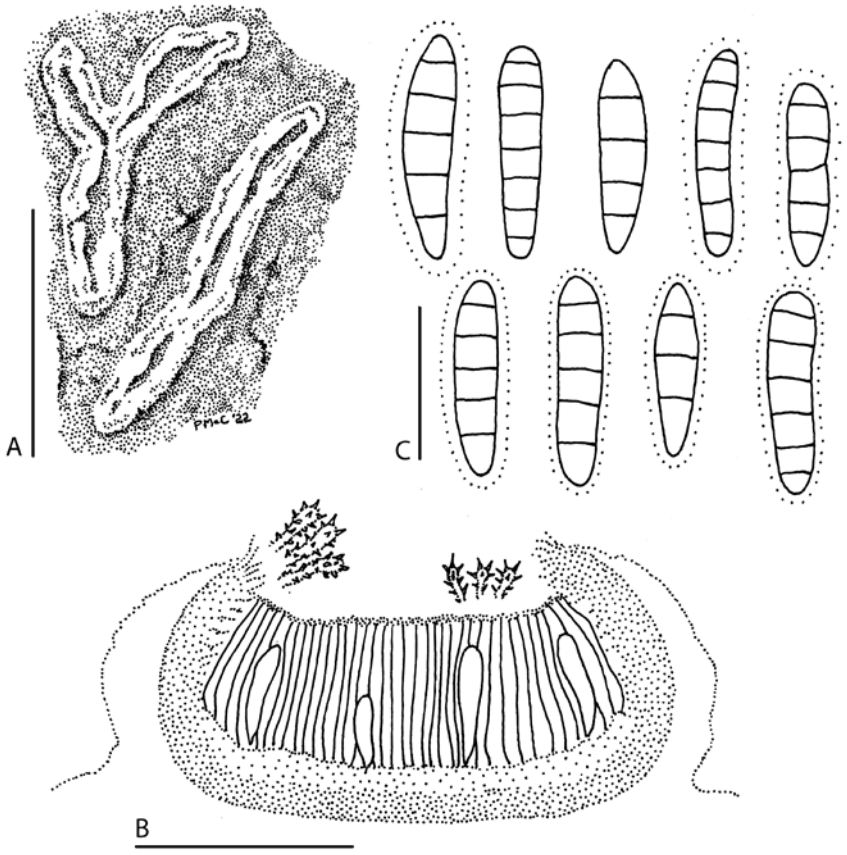

Figure 2. *Acanthothecis consocians* (*P.M. McCarthy 1457 pr. p.*). A, Habit of lirellae and adjacent thallus; B, Vertical section of an ascoma (semi-schematic), with close-ups of spiny periphyses and paraphysis tips; C, Mature ascospores. Scales: A = 1 mm; B = 0.1 mm; C = 10 µm.

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