

Three new lichen species from Christmas Island, Indian Ocean

Patrick M. McCarthy

64 Broadsmith St, Scullin, A.C.T. 2614, Australia

e-mail: pmcc2614@hotmail.com

Abstract

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

Introduction

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

The species

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

Fig. 1A–D

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

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

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

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

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

Remarks

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

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

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

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

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

ADDITIONAL SPECIMEN EXAMINED

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

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

Figs 2, 3

Mycobank No.: MB 839436

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

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

Thallus crustose, epilithic, forming determinate colonies to 45 mm wide, continuous to sparingly rimose or abundantly and faintly rimose but not areolate, smooth to minutely uneven, dull off-white to very pale greenish, 50–80(–120) µm thick, ecarticate, but with an amorphous, alga-free, necral layer 10–17 µm thick, the thallus non-amyloid in section (I–), not containing calcium oxalate (H₂SO₄–). **Algal layer** poorly delimited, c. 40–60 µm thick; cells globose, chlorococcoid, 6–12(–14) µm diam., rather thick-walled; interstitial hyphae obscure, short-celled, 1–2 µm thick. **Medulla** not delimited, much of the lower thallus packed with rock fragments and crystals. **Prothallus** not apparent. **Apothecia** very numerous, usually solitary, adnate to sessile and slightly constricted at the base, mostly rounded, biatorine, (0.24–) 0.37(–0.49) mm diam. [$n = 70$]; disc at first deeply and narrowly urceolate (often appearing plane) and perithecioid, or almost stellate, at maturity broad and slightly concave to plane, smooth, epruinose, pale cream-coloured to pale creamy yellow, when wetted

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

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

Remarks

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

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

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

ADDITIONAL SPECIMENS EXAMINED

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

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

MycoBank No.: **MB 839437**

Figs 4, 5

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

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

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

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

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

Remarks

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

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

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

ADDITIONAL SPECIMENS EXAMINED

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

References

Aptroot, A; Seaward, MRD (1999): Annotated checklist of Hongkong lichens. *Tropical Bryology* **17**, 57–101.
Aptroot, A; Diederich, P; Sérusiaux, E; Sipman, HJM (1995): Lichens and lichenicolous fungi of Laing Island (Papua New Guinea). *Bibliotheca Lichenologica* **57**, 19–48.
Aptroot, A; Diederich, P; Sérusiaux, E; Sipman, HJM (1997): Lichens and lichenicolous fungi from New Guinea. *Bibliotheca Lichenologica* **64**, 1–220.
Archer, AW (2003): Additional lichen records from Australia 50. Graphidaceae from Christmas Island. *Australasian Lichenology* **52**, 14–15.

Clauzade, G; Roux, C (1985): Likenoj de Okcidenta Eŭropo. Ilustrita Determinlibro. *Bulletin de la Société Botanique du Centre-Ouest*, Nouvelle Série, Numéro Spécial **7**, 1–893.
Elix, JA (2020): *A Catalogue of Standardized Chromatographic Data and Biosynthetic Relationships for Lichen Substances*, 5th edn. Published by the author, Canberra.
Galloway, DJ (1985): *Flora of New Zealand Lichens*. P.D. Hasselberg, Government Printer, Wellington.
Galloway, DJ (2007): *Flora of New Zealand Lichens*. Revised second edition. Manaaki Whenua Press, Lincoln.
Gilbert, OL; James, PW; Woods, RG (2009): *Gyalidea* Lettau (1937). Pp. 421–423 in Smith, CW; Aptroot, A; Coppins, BJ; Fletcher, A; Gilbert, OL; James, PW; Wolseley, PA (eds), *The Lichens of Great Britain and Ireland*. British Lichen Society, London.
Gueidan, C; Van Do, T; Lu, NT (2014): Phylogeny and taxonomy of *Staurothele* (Verrucariaceae, lichenized ascomycetes) from the karst of northern Vietnam. *Lichenologist* **46**, 515–533.
Harada, H (2013): The lichen genus *Thelidium* (Verrucariaceae) in Japan. *Lichenology* **11**, 53–66.
Harada, H (2016): *Gyalidea izuensis* sp. nov. (lichenized Ascomycota, Solorinellaceae), a semi-aquatic freshwater species from Shizuoka-ken, central Japan. *Lichenology* **15**, 85–90.
Harada, H; Sakata, A (2016): *Gyalidea oosumiensis* sp. nov. (lichenized Ascomycota, Solorinellaceae) from Kagoshima-ken, Kyushu, southwestern Japan. *Lichenology* **15**, 1–5.
Harada, H; Vězda, A (1991): Two new species of gyalectoid lichens from East Asia. *Natural History Research* **1**, 13–17.
Harada, H; Vězda, A (1996): *Gyalidea pacifica* (lichenized Ascomycotina, Solorinellaceae), a new gyalectoid lichen from Japan. *Bryologist* **99**, 193–195.
Harada, H; Vězda, A (1999): *Gyalidea kawanae* (lichenized Ascomycota, Solorinellaceae) sp. nov. from Chiba-ken, central Japan, with notes on *Gyalidea pacifica*. *Natural History Research* **5**, 57–62.
Harris, RC (1975): *A Taxonomic Revision of the Genus Arthopyrenia Massal. s. lat. (Ascomycetes) in North America*. Ph.D. dissertation, University of Michigan, Ann Arbor.
Harris, RC (1990): *Some Florida Lichens*. Privately published, New York.
Harris, RC (1995): *More Florida Lichens including the 10¢ Tour of the Pyrenolichens*. Privately published, New York.
Kantvilas, G; Elix, JA (1992): A new species and new records from the Tasmanian lichen flora. *Muelleria* **7**, 507–517.
Kondratyuk, S[Y]; Lököš, L; Tschabanenko, S; Moniri, MH; Farkas, E; Wang, X; Oh, S-O; Hur, J-S (2016): New and noteworthy lichen-forming and lichenicolous fungi: 5. *Acta Botanica Hungarica* **58**, 319–396.
Kondratyuk, SY; Halda, JP; Lököš, L; Yamamoto, Y; Popova, LP; Hur, J-S (2019): New and noteworthy lichen-forming and lichenicolous fungi 8. *Acta Botanica Hungarica* **61**, 101–135.
Kopachevskaya, EG; Makarevicz, MF; Oxner, AN (1977): *Opredelidetel' lishainikov SSSR*. Volume 4. Verrucariaceae-Pilocarpaceae. Nauka, Leningrad.
McCarthy, PM (1993): New saxicolous species of *Ditremis* Clements (lichenized Ascomycotina, Monoblastiaceae) from New Zealand and Hawaii. *Muelleria* **8**, 1–4.
McCarthy, PM (1995): Notes on Australian Verrucariaceae (lichenised Ascomycotina). 5. *Staurothele pallidopora* sp. nov. from south-eastern Queensland. *Muelleria* **8**, 275–277.
McCarthy, PM (2000): The lichens of Rarotonga, Cook Islands, South Pacific Ocean I: pyrenocarpous taxa. *Lichenologist* **32**, 15–47.
McCarthy, PM (2001a): The lichen genus *Strigula* in Christmas Island, Indian Ocean. *Bibliotheca Lichenologica* **78**, 275–287.
McCarthy, PM (2001b): The genus *Lithothelium* (Pyrenulaceae) in Christmas Island, Indian Ocean. *Australasian Lichenology* **49**, 7–9.
McCarthy, PM (2001c): The *Trichotheliaceae* of Christmas Island, Indian Ocean. *Lichenologist* **33**, 393–401.
McCarthy, PM (2001d): *Thelidium*. *Flora of Australia* **58A**, 174–175.

- McCarthy, PM (2008): Additional lichen records from Australia 68. Tropical pyrenolichens. *Australasian Lichenology* **63**, 10–16.
- McCarthy, PM (2014): Additional lichen records from Australia 77. Verrucariaceae. *Australasian Lichenology* **75**, 3–5.
- McCarthy, PM (2020): A new saxicolous species, a new combination and a new record of *Gyalidea* (lichenized Ascomycota, Asterothyriaceae) from Australia. *Australasian Lichenology* **87**, 30–39.
- McCarthy, PM; Elix, JA (2002): Additional lichen records from Australia 48. Miscellaneous taxa in Christmas Island. *Australasian Lichenology* **50**, 10–22.
- McCarthy, PM; Johnson, PN (1995): New and interesting lichens from New Zealand. *Nova Hedwigia* **61**, 497–508.
- McCarthy, PM; Kantvilas, G (2016): *Thelidium robustum* sp. nov. (lichenized Ascomycota, Verrucariaceae) from Kangaroo Island, South Australia. *Journal of the Adelaide Botanic Garden* **29**, 37–40.
- McCarthy, PM; Kantvilas, G (2018): *Anisomeridium disjunctum* (Monoblastiaceae), a new lichen species from Tasmania, with a key to the genus in Australia. *Australasian Lichenology* **83**, 54–60.
- McCarthy, PM; Kantvilas, G (2020): *Thelidium carbonaceum* (Verrucariaceae) a new saxicolous lichen from Tasmania. *Australasian Lichenology* **86**, 109–113.
- Orange, A (1991): *Thelidium phuvium* (Verrucariaceae), a new lichenized species from north-west Europe. *Lichenologist* **23**, 99–106.
- Orange, A (2013): *British and other Pyrenocarpous Lichens*. Version 2. National Museum of Wales, Cardiff [Orange-A-2013-British-and-other-pyrenocarpous-lichens.pdf]
- Servit, M (1954): *Československé lišejníky čeledi Verrucariaceae*. Akademie Věd, Prague.
- Thüs, H; Nascimbene, J (2008): Contributions toward a new taxonomy of Central European freshwater species of the lichen genus *Thelidium* (Verrucariales, Ascomycota). *Lichenologist* **40**, 499–521.
- Thüs, H; Schultz, M (2009): *Süßwasserflora von Mitteleuropa/Freshwater Flora of Central Europe*, Vol. **21**(1): Fungi; Lichens. Springer Spektrum Akademischer Verlag, Heidelberg.
- Upreti, DK; Nayaka, S (2006): *Anisomeridium calcicolum* sp. nov. and further new records of pyrenocarpous lichens from India. *Lichenologist* **38**, 231–233.
- Vězda, A (1966): Flechtensystematische Studien IV. Die Gattung *Gyalidea* Lett. *Folia Geobotanica et Phytotaxonomica [Praha]* **1**, 311–340.
- Vězda, A; Poelt, J (1990): Solorinellaceae, eine neue Familie der lichenisierten Ascomyceten. *Phyton [Horn]* **30**, 47–55.
- Vězda, A; Poelt, J (1991): Die Flechtengattung *Gyalidea* Lett. ex Vězda (Solorinellaceae). Eine Übersicht mit Bestimmungsschlüssel. *Nova Hedwigia* **53**, 99–113.
- Vězda, A; Lumbsch, HT; Øvstedal, DO (1990): Zwei neue Arten der Gattung *Gyalidea* aus der Südhemisphäre (Ostropales; Solorinellaceae). *Nova Hedwigia* **50**, 523–528.
- Zhang, C; Aptroot, A; Liu, H-J; Jiang, S-H (2020): Two new species of *Anisomeridium* (lichenized Dothideomycetes, Ascomycota) from China. *Phytotaxa* **458**, 167–172.
- Zschacke, H (1933): Epigloeaceae, Verrucariaceae und Dermatocarpaceae. *Dr. L. Rabenhorst's Kryptogamen-Flora von Deutschland, Österreich und der Schweiz* **9**, 1(1), 44–695.

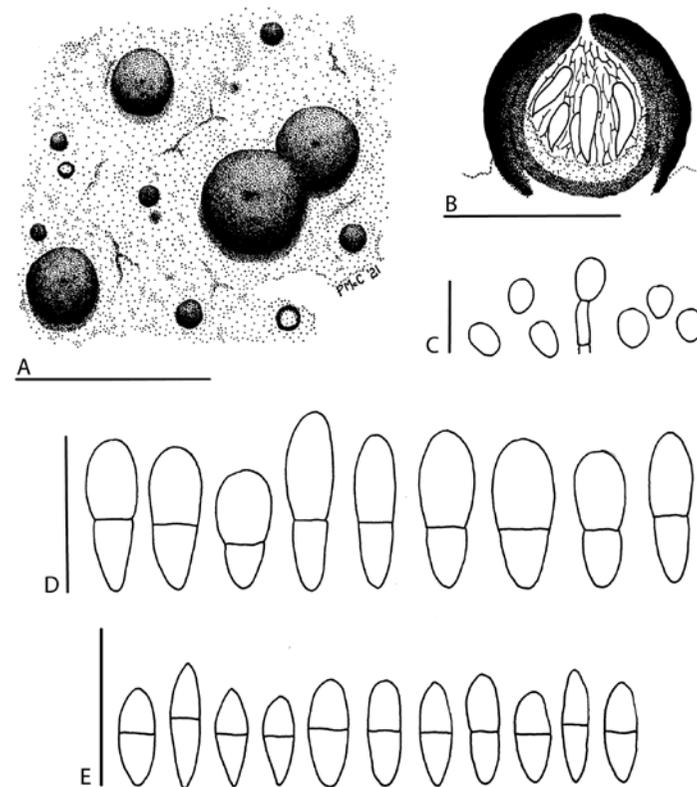


Fig. 1. *Anisomeridium* spp. A–D, *A. calcivorum* (holotype). Habit of thallus, ascomata and microconidia. B, Section of ascoma (semi-schematic). C, Microconidia and part of a conidiophore. D, Ascospores. E, Ascospores of *Anisomeridium* sp. (PMMcC 1441). Scales: A = 0.5 mm; B = 0.2 mm; C = 5 μm; D,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



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

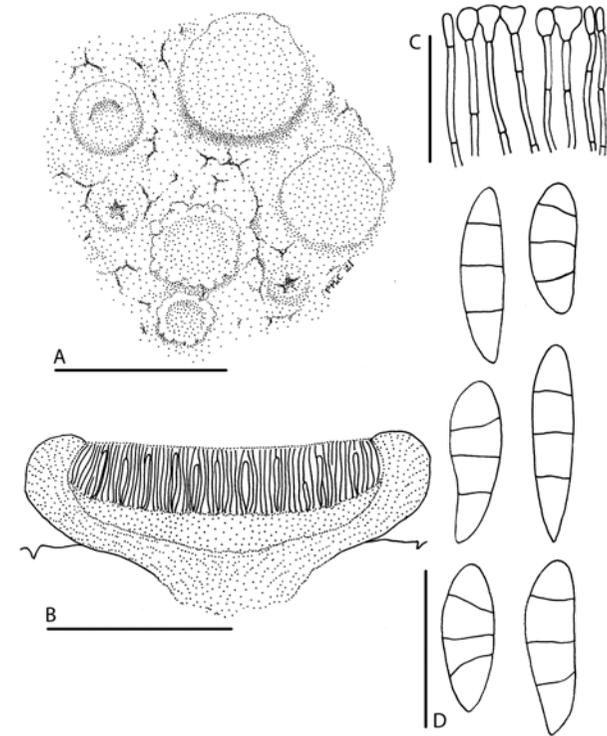


Fig. 3. *Gyalidea incolorata* (holotype). A, Habit of thallus and apothecia. B, Section of apothecium (semi-schematic). C, Apices of paraphyses. D, Ascospores. Scales: A = 0.5 mm; B = 0.2 mm; C, D = 10 μ m.



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

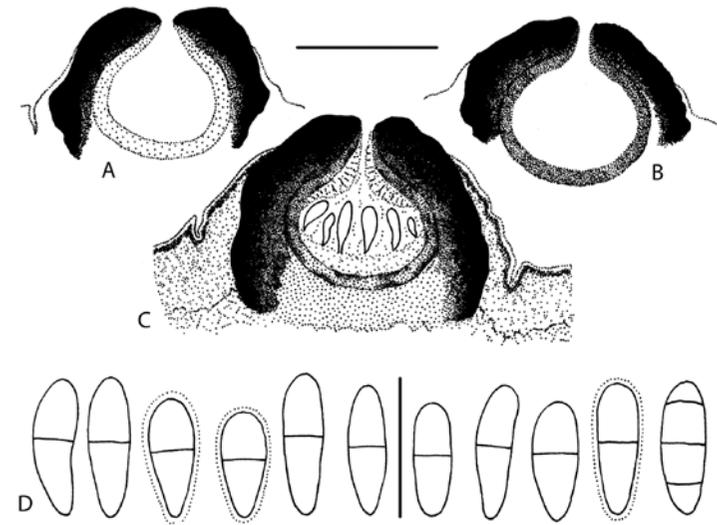


Fig. 5. *Thelidium insulare*. A–C, Sectioned perithecia (semi-schematic). D, Ascospores. Scales: A–C = 0.2 mm; D = 20 μ m.