A new saxicolous species, a new combination and a new record of *Gyalidea* (lichenized Ascomycota, Asterothyriaceae) from Australia

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Abstract

Gyalidea nambourensis sp. nov. is described from siliceous rock in rainforest near Nambour, south-eastern Queensland. The new combination *Gyalidea halocarpa* (P.M.McCarthy & Elix) P.M.McCarthy is made for the calcicolous, Australian endemic *Gyalideopsis halocarpa*. *Gyalidea psammoica* (Nyl.) Lettau ex Vězda is reported for the first time from Australia (A.C.T. and N.S.W.), and a key is provided to the five species of *Gyalidea* known from the country.

Introduction

Gyalidea Lettau ex Vězda (Asterothyriaceae), a genus of 59 known species, occurs in most tropical and temperate regions. Thirty-two species are obligately saxicolous, mostly on acidic rocks, while most of the remainder are corticolous, apart from a few muscicolous and terricolous representatives. Thalli contain a chlorococcoid photobiont, they lack lichen substances, and the apothecia are mostly biatorine and urceolate, concave or plane, variously coloured (often quite pale) and commonly translucent when wetted. The often substantial proper exciple is a reticulum of radiating and anastomosing hyphae in a matrix dominated by their gelatinous hyphal walls, the hymenium is non-amyloid with mostly simple paraphyses and rather thin-walled asci containing hyaline ascospores that are either transversely septate (13 species) or submuriform to muriform (19 species; Vězda 1966; Clauzade & Roux 1985; Vězda *et al.* 1990; Vězda & Poelt, 1990, 1991; Harada & Vězda 1991, 1996, 1999; Galloway 2007; Gilbert *et al.* 2009; Harada 2016; Harada & Sakata 2016; Kondratyuk *et al.* 2016, 2019).

In this contribution, a new species of *Gyalidea* is reported from siliceous rock in rainforest in south-eastern Queensland, the combination *Gyalidea halocarpa* (P.M.McCarthy & Elix) P.M.McCarthy is proposed for the lichen previously named *Gyalideopsis halocarpa* P.M.McCarthy & Elix, and a second record of that species is documented. In addition, the terricolous *G. psammoica* (Nyl.) Lettau ex Vězda is reported from the Australian Capital Territory and the Southern Tablelands, New South Wales, and a key is provided to the five species known from Australia.

The species

1. Gyalidea halocarpa (P.M.McCarthy & Elix) P.M.McCarthy, comb. nov. Fig. 1
MycoBank No.: **MB834719**

Basionym: *Gyalideopsis halocarpa* P.M.McCarthy & Elix, *Telopea* **16**, 120 (2014) [MB809821]

The type specimen and an additional, recent collection of *Gyalideopsis halocarpa* (see below) have simple to sparingly branched and anastomosing paraphyses that differ markedly from and are sharply discontinuous with the hyphal reticulum and gelatinous matrix of the proper exciple (McCarthy & Elix 2014). By contrast, species of *Gyalideopsis* Vězda (Gomphillaceae) and its segregates have a hamathecium of anastomosing paraphysoids that are scarcely distinguishable from the adjacent excipular hyphae (Kalb & Vězda 1988; Lücking *et al.* 2005, 2006; Lücking 2008). For this reason, *Gyalideopsis halocarpa* is more appropriately included in *Gyalidea*, and that new combination is proposed here.

This species was initially described from an exposed, horizontal slab of mortar on the summit of Mount Canobolas (altitude 1392 m) in central-western New South Wales (McCarthy & Elix 2014). Following a very destructive bushfire in February 2018, there was concern that this apparently highly localized species might have been seriously impacted. However, a return visit to the summit area in October 2019 not only confirmed that the type population had survived the fire, it also revealed numerous other colonies on mortar in and around the summit carpark. Subsequently, the species was collected on concrete rubble in the Southern Tablelands of New South Wales. Clearly, *G. halocarpa*, with its thin, nondescript thallus and minute and more-or-less concolorous apothecia only 0.2–0.35 mm wide, has been overlooked in the past; it is probably common on natural and man-made, calcareous substrata throughout much of south-eastern Australia, and perhaps beyond.

ADDITIONAL SPECIMENS EXAMINED
New South Wales. ● Collector–Gundaroo road, 3 km WSW of Collector, 34°55’12”S, 149°24’19”E, 630 m alt., on calcareous concrete rubble on roadside in dry *Eucalyptus* woodland, *P.M. McCarthy 4913, 4914, 4916*, 27.xi.2019 (CANB).

2. Gyalidea nambourensis P.M.McCarthy, sp. nov. Figs 2 & 3
MycoBank No.: **MB834720**

Thallus epilithic, rimose, off-white to pale grey-green, thin. Apothecia biatorine, adnate to subsessile, medium to dark greenish brown or dull black, (0.28–)0.45(–0.67) mm diam.; disc becoming plane to moderately convex; margin usually persistent. Proper exciple laterally 70–100 µm thick, a radiating reticulum of narrow hyphae in a pale yellow-brown gelatinous matrix. Hypothecium hyaline to pale yellowish, 30–50 µm thick. Hymenium 75–100 µm thick, non-amyloid, with mostly simple paraphyses and thin-walled asci, 70–95 × 16–24 µm. Ascospores hyaline, submuriform, (4–)8 per ascus, 18–30 × 8–13 µm.

Type: Australia. Queensland, Blackall Range, Bold Knob, 18 km SSW of Nambour, 26°46’S, 150°54’E, 150 m alt., on siliceous rock in moist disturbed area of rainforest, *H. Streimann 9414*, 31.viii.1979 (holotype – CANB; ‘duplicates’ in B and M, *n.v.*).

Thallus crustose, epilithic, effuse or forming determinate colonies to 2 or 3 cm wide, continuous to sparingly rimose, not areolate, sometimes peeling from thalline cracks, off-white to very pale greenish grey, dull or with a silvery tint, 40–80(–120) µm thick, smooth to minutely and irregularly rugulose or verruculose, ecorticate, non-amyloid (I–), not containing calcium oxalate (H_2SO_4–). *Algae* globose, chlorococcoid, 8–16 µm diam., rather thick-walled; interstitial hyphae short-celled, 1–2 µm thick. *Medulla* not delimited, much of the lower thallus packed with rock fragments and crystals. *Prothallus* not apparent. *Apothecia* moderately numerous, usually solitary and scattered, occasionally in proliferating clusters, adnate to subsessile and slightly constricted at the base, biatorine, (0.28–)0.45(–0.67) mm diam. [*n* = 87], rounded or somewhat irregular in outline, in section subtended by a continuous algal layer; disc at first shallowly concave or plane, later remaining plane or becoming slightly to moderately convex, smooth, epruinose, medium to dark greenish brown or dull black, the colour ± unchanged when wetted, but moist apothecia becoming rather translucent; margin concolorous with the disc, swollen and a little paler when wetted, *c.* 40–60 µm thick, entire to faintly undulate or irregularly crenulate, usually slightly prominent and persistent or becoming excluded in more convex, mature apothecia, without thallus remnants. *Proper exciple* annular, laterally 70–100 µm thick, 40–60(–80) µm thick at the base; anatomically a radiating reticulum of hyphae in a predominantly pale yellow-brown gelatinous matrix (i.e. the swollen hyphal walls), the upper, outer area of the exciple usually medium to dark brown, K–, N–, I–; hyphal lumina (1–)1.5(–2) µm wide. *Hypothecium* hyaline to pale yellowish, 30–50 µm thick, K–, N–, patchily KI+ pale violet (this colour takes up to 30 minutes to develop and is best seen in squash preparations); hyphae short-celled, rather thick-walled, periclinal, 3–5 µm long. *Hymenium* 75–100 µm thick, not inspersed with oil droplets, granules or crystals, non-amyloid, K–, N–. *Subhymenium* hyaline or very pale yellowish, 25–30 µm thick, K–, N–, KI–; hyphae variously orientated, 1–2 µm wide. *Epihymenium* 15–25 µm thick, a diffuse, pale to medium brown, extracellularly pigmented zone, K– or becoming darker, N– or becoming darker. *Paraphyses* rather conglutinate in water, loosening in KOH, mostly simple throughout their length, rarely with sparse branches and anastomoses, mainly distally, 0.7–1 (–1.2) µm thick, long-celled, not constricted at the septa; apices not or only very slightly swollen (to 1.5 µm

wide), not pigmented. *Asci* narrowly clavate or clavate-cylindrical, rarely more broadly clavate, (4–)8-spored, 70–95 × 16–24 µm [*n* = 25], with a gradually tapering stalk; wall and contents non-amyloid; ascoplasm KI+ orange-brown; apex rounded at maturity, with a thin tholus lacking an ocular chamber and apical apparatus; immature asci with a comparatively thicker tholus and, occasionally, a broad, rounded ocular chamber. *Ascospores* colourless, submuriform, with (3–)4–6(–7) transverse septa and (0–)1–3(–4) longitudinal or diagonal septa [6–10(–12) cells in optical section], the end cells rounded, oblong-ellipsoid to almost fusiform-ellipsoid, less commonly broadly ellipsoid or clavate to rather irregular in shape, straight or slightly bent, irregularly biseriate or overlapping-uniseriate in the ascus, thin-walled, usually lacking a perispore even when immature, (18–)25(–30) × (8–)10(–13) µm [*n* = 70]; cells contents usually clear, the external spore wall markedly constricted at the septa. *Pycnidia* not seen.
Chemistry: no substances detected by TLC (Elix 2014).

Etymology: The epithet *nambourensis* refers to the locality of the type specimen.

Remarks
The new species is characterized by its rather pale and nondescript thallus, uniformly brown to blackish and moderately large, subsessile apothecia, by the size and septation of its ascospores, along with a thick and annular proper exciple, a deep hymenium and a comparatively thick hypothecium.

Several taxa with submuriform or muriform ascospores are variously similar to *G. nambourensis* in apothecial morphology or other anatomical attributes, but all are readily distinguishable. Thus, *G. fritzei* (Stein) Vězda, from Europe, has persistently and deeply concave apothecial discs, each with a dark brown exciple, while the hymenium is up to 160 µm thick, and the fully muriform ascospores are 18–43 10–21 µm (Vězda 1966; Gilbert *et al*. 2009). *Gyalidea saxicola* (Groenh.) Hafellner & Vězda, from Indonesia, has rather similar brown-black apothecia, but the smaller ascospores (16–20 6–7 µm) are more sparingly septate, the outer excipulum is considerably darker in section and the hypothecium is thinner (Vězda & Poelt 1991). *Gyalidea luzonensis* (Kalb & Vězda) Aptroot & Lücking, from the Philippines and Papua New Guinea, also has smaller and less septate, submuriform ascospores (15–23 × 9–10 µm; Vězda & Poelt 1991; Aptroot & Lücking 2003), while the Japanese *G. pacifica* (H.Harada) Vězda has a thallus of goniocysts and smaller ascospores, 10–24 × 5–7 µm (Harada & Vězda 1996, 1999). Finally, the recently described *G poeltii* S.Y.Kondr., L.Lökös, J.P.Halda & Hur, from Korea, has a similarly thick but uniformly dark brown proper exciple, apothecia to 1 mm wide and halonate ascospores (Kondratyuk *et al*. 2019).

Gyalidea nambourensis is known only from the type locality in disturbed rainforest in south-eastern Queensland, Australia. Supposed duplicates of the holotype, sent in exchange from CANB to B and M, have not been examined.

3. Gyalidea psammoica (Nyl.) Lettau ex Vězda, *Folia Geobot. Phytotax. Praha* **1**, 329 (1966) Figs 4 & 5

Lecidea psammoica Nyl., *Flora* **51**, 343 (1868)

Thallus crustose, on friable soil, forming determinate colonies to *c.* 5 cm wide, richly rimose to obscurely areolate, dull, pale to medium greyish green, 60–80(–100) µm thick [to 100 (–150) µm thick beneath apothecia], heavily impregnated with soil material; areoles 0.2–0.6 (–0.8) mm wide, minutely and irregularly uneven, ecorticate, non-amyloid (I–), not containing calcium oxalate (H_2SO_4–). *Algae* globose, chlorococcoid, (8–)10–20(–23) µm diam.; interstitial hyphae 1–2 µm thick; medulla not delimited. *Prothallus* not apparent. *Apothecia* very numerous, usually solitary, occasionally in proliferating clusters or short rows, adnate to subsessile, biatorine, (0.23–)0.37(–0.55) mm diam. [*n* = 50], rounded or somewhat irregular or angular in outline (due to mutual pressure), in section subtended by a continuous algal layer to 100 µm thick; disc at first urceolate, becoming shallowly concave to plane, smooth, epruinose, dull greenish black to jet-black, the colour ± unchanged when wetted; margin concolorous with the disc or slightly to considerably paler, swollen and occasionally a little darker than the disc when wetted, 50–70(–80) µm thick, entire or irregularly fissured, slightly prominent and persistent to maturity, sometimes with sparse thallus remnants or with embedded soil particles. *Proper exciple* cupulate; laterally 35–55 µm thick, a radiating reticulum of hyphae in a hyaline to pale brown gelatinous matrix, the upper and outer 10–20(–25) µm of the lateral exciple medium to dark brown or brown-black, K–, N–, I–; outermost cells rounded, thick-walled, 4–6 µm wide; exciple base 8–12 µm thick, hyaline, of tightly arranged periclinal hyphae 1.5–2 µm wide. *Hypothecium* hyaline, 8–15(–20) µm thick, K–, N–; hyphae short-celled, variously orientated, 2–3 µm wide. *Hymenium* 55–72 µm thick, not inspersed with oil droplets or granules, non-amyloid, K–, N–. *Subhymenium* not distinguishable from the hypothecium. *Epihymenium* 10–20 µm thick, a diffuse, pale to medium brown pigmented zone, K– or becoming slightly darker, N– or becoming slightly darker. *Paraphyses* conglutinate in water, scarcely loosening in KOH, mostly simple throughout their length, with very sparse branches and even rarer anastomoses, 1–1.5(–2) µm thick, long-celled, not constricted at the septa; apices not or only very slightly swollen, not or very faintly and diffusely pigmented. *Asci* mostly narrowly clavate or clavate-cylindrical, 8-spored, 50–62 × 10–15 µm; wall non-amyloid, KI–; ascoplasm KI+ orange-brown; apex rounded, with a thin tholus lacking an ocular chamber and apical apparatus; immature asci with a thicker tholus and, occasionally, a broad, rounded ocular chamber. *Ascospores* colourless, submuriform, with (5–)6–8(–9) cells in optical section, the end cells rounded, narrowly to broadly ellipsoid to oblong-ellipsoid or broadly clavate to rather irregular in shape, irregularly biseriate or overlapping-uniseriate in the ascus, thin-walled, usually lacking a perispore even when immature, (10–)14.5(–18) × (6–)7.5(–9.5) µm [*n* = 25]; cell contents usually clear, the external spore wall markedly constricted at the septa. *Pycnidia* not seen.
Chemistry: no substances detected by TLC (Elix 2014).

Remarks
One of a handful of terricolous species in *Gyalidea*, *G. psammoica* was known with certainty only from Poland, where it was first collected from moist sandy soil (Vězda 1966). However, the diagnostic combination of a thin, grey-green thallus, medium-sized but thin, dark apothecia with a persistent margin and a concave to plane disc, as well as apothecial anatomy and exceptionally small, submuriform ascospores in the Australian material, confirms its identity, however unexpected that might seem. One anatomical anomaly: Vězda (1966) cited algal cells 6–12 µm wide, considerably smaller than those of the Australian specimens, *viz.* (8–)10–20(–23) µm.

SPECIMENS EXAMINED
Australian Capital Territory. ● start of Mount McDonald Summit Track, Cotter Avenue, 35°18’48”S, 148°56’50”E, 595 m alt., on friable, siliceous soil bank on roadside, *P.M. McCarthy 4919*, 12.ii.2020 (CANB); ● Cook, between Bindubi Street and the horse paddocks, *c.* 5 km W of Canberra, 35°16’08”S, 149°04’29”E, 630 m alt., on consolidated soil bank in dry *Eucalyptus* woodland, *P.M. McCarthy 4935*, 8.v.2020 (CANB).
New South Wales. ● Southern Tablelands, Murrumbateman–Gundaroo road, *c.* 2 km W of Sutton Rd intersection, *c.* 4 km SW of Gundaroo, 35°03’19”S, 149°14’08”E, 590 m alt., siliceous soil bank on roadside adjacent to pasture, *J.A. Elix 46956*, 17.iii.2020 (CANB); ● Southern Tablelands, Wallaroo District, Brooklands Road, *c.* 2 km W of Southwell Road, *c.* 7 km W of Hall, 35°09′49”S, 148°59′37”E, 605 m alt., on soil bank on roadside adjacent to pasture, *P.M. McCarthy 4932*, 23.iii.2020 (CANB).

Key to the Australian species of *Gyalidea*

1 Ascospores 3-septate, 15–24 × 5–6.5 µm; apothecia 0.8–1.2 mm diam., pinkish brown, with a paler proper margin ..... ***G. hyalinescens*** (Nyl.) Vězda
1: Ascospores submuriform to muriform; apothecia to 0.7 mm diam 2

2 Thallus growing on soil; ascospores 10–18 × 6–9.5 µm ..... ***G. psammoica***
2: Thallus growing on mortar or on rock; ascospores in the range 17–30 × 8–16 µm 3

3 Thallus calcicolous, growing on mortar; apothecia 0.15–0.35 mm diam., with a blackish disc; thallus remnants visible as a pale, discontinuous ring on the proper exciple..... ..... ***G. halocarpa***
3: Thallus silicolous; apothecial margin lacking thallus remnants; if the disc is blackish then the apothecia 0.28–0.67 mm diam 4

4 Apothecia pale yellow-brown; lateral exciple 40–60 µm thick; hymenium 65–75 µm thick; thallus rimose-areolate ..... ***G. henssenia*e** Hafellner, Poelt & Vězda
4: Apothecia medium to dark greenish brown or dull black; lateral exciple 70–100 µm thick; hymenium 75–100 µm thick; thallus continuous to sparingly rimose..... ***G. nambourensis***

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Figure 1. *Gyalidea halocarpa* (*P.M. McCarthy 4914*). Scales: 1 mm.

Figure 2. *Gyalidea nambourensis* (holotype). Scales: 1 mm.

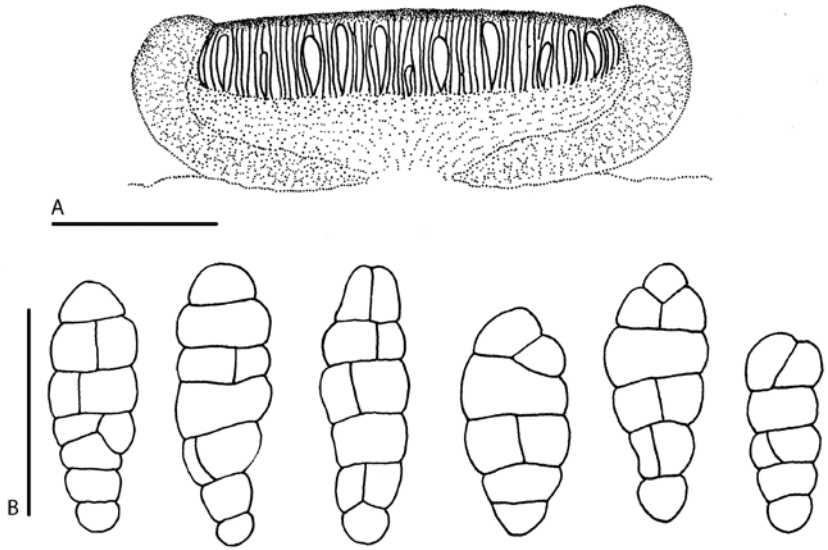

Figure 3. *Gyalidea nambourensis* (holotype). A, Section of apothecium (semi-schematic). B, Ascospores. Scales: A = 0.2 mm; B = 20 µm.

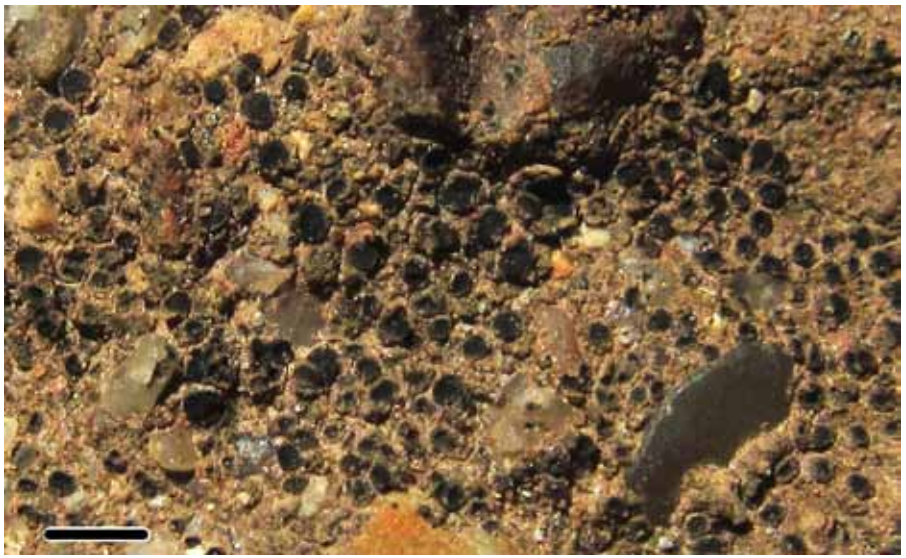

Figure 4. *Gyalidea psammoica* (*P.M. McCarthy 4919*). Scale: 1 mm.

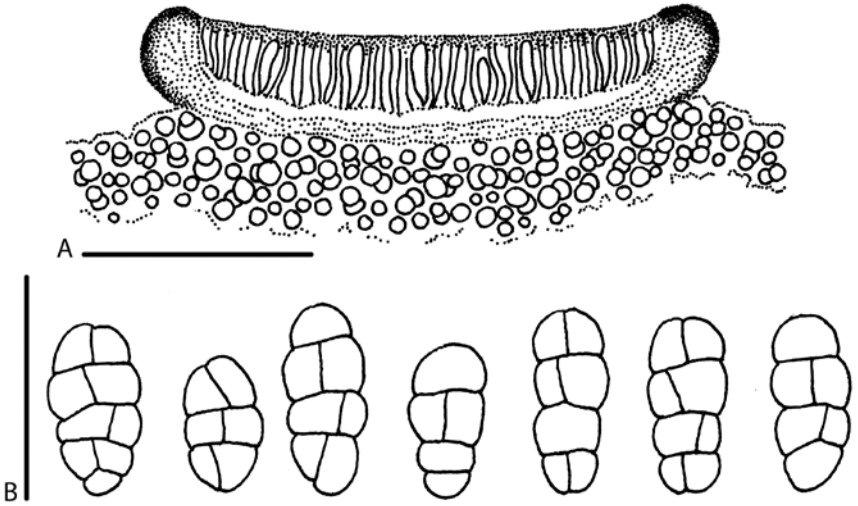

Figure 5. *Gyalidea psammoica* (*P.M. McCarthy 4919*). A, Section of apothecium and adjacent thallus (semi-schematic). B, Ascospores. Scales: A = 0.2 mm; B = 20 µm.