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Five new lichen species (Ascomycota) from south-eastern Australia

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Abstract

Five lichens (Ascomycota) are described as new from south-eastern Australia: *Enterographa cretacea* P.M.McCarthy & Elix (Roccellaceae; southern New South Wales), *Eugeniella farinosa* P.M.McCarthy & Elix (Pilocarpaceae; Tasmania), *E. usnica* P.M.McCarthy & Elix (southern New South Wales and eastern Victoria), *Megalaria montana* P.M.McCarthy & Elix (Ramalinaceae; central-western New South Wales) and *Micarea eucalypti* P.M.McCarthy & Elix (Pilocarpaceae; Australian Capital Territory). *Megalaria orokonuiana* Fryday & A.Knight is reported for the first time from Australia (New South Wales and Victoria).

Introduction

Field studies and laboratory investigations continue to expand our understanding of Australian lichen diversity. In early 2016 the number of species and infra-specific taxa in the six states and two mainland territories stood at 3578, including 1269 endemic taxa (McCarthy 2016).

In this contribution, five new lichen species are documented from south-eastern Australia, representing the genera *Enterographa* Fée (Roccellaceae), *Eugeniella* Lücking, Sérus. & Kalb and *Micarea* Fr. (Pilocarpaceae) and *Megalaria* Hafellner (Ramalinaceae). *Megalaria orokonuiana* Fryday & A.Knight, is reported for the first time from Australia, while *Rimularia campestris* Kantvilas & Elix (Trapeliaceae) is a new record for New South Wales.

Methods

Observations and measurements of photobiont cells, thalline and apothecial anatomy, asci, ascospores, pycnidial anatomy and conidia were made on hand-cut sections mounted in water and treated with 10% potassium hydroxide (K), 50% nitric acid (N) and 10% hydrochloric acid (H). Calcium oxalate was detected by treatment of apothecial margins and medullary tissue with a 10% aqueous solution of sulfuric acid. It forms colourless, needle-shaped crystals that are readily observed under the stereomicroscope. Asci were also observed in Lugol's Iodine (I), with and without pre-treatment in K. Chemical constituents were identified by thin-layer chromatography (Elix 2014) and comparison with authentic samples.

New Species

1. *Enterographa cretacea* P.M.McCarthy & Elix, **sp. nov.**

MycoBank No.: MB 817592

Characterized by a chalky white, ecorticate, saxicolous thallus containing dehydroconstipatic acid (major), scattered, markedly convex to subglobose-bullate, fertile areoles of (0.8–)1–1.8(–2.5) mm, immersed, black-punctate ascomata that merge into lirelliform aggregations 0.3–1.2 × 0.1–0.3 mm, but do not form pseudostromata, a thin, brown, divergent proper excipulum, a non-amyloid hymenium, 7-septate ascospores of 18–30 × 4–5.5 µm, and pycnidia that are solitary, black, punctate, immersed and produce simple, filiform conidia of 10–16(–20) × 0.5 µm.

Type: Australia. New South Wales: South Coast (Jacobs and Pickard 1981): 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 4475*, 10 Feb 2016; holotype: CANB.

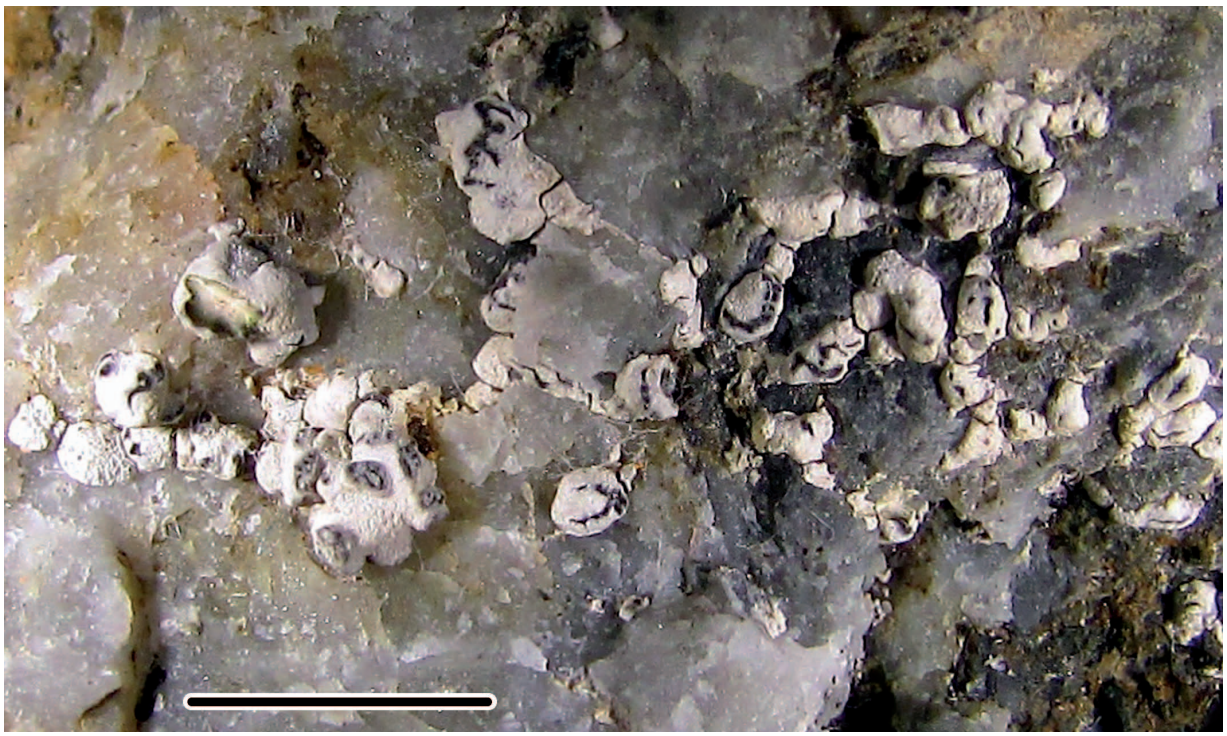

Fig. 1. *Enterographa cretacea* (holotype). Scale bar = 5 mm.

Thallus epilithic, crustose, diffuse, dull chalky white, scarcely forming continuous colonies to 1 cm wide, areolate, the areoles at first solitary, usually in small scattered clusters, or in rows following microfissures in the rock surface, or developing and maturing around other irregularities in the substratum, not water-repellent, with an uneven, 30–50 µm thick frosting of white pruina (just visible under a hand lens). *Areoles* initially plane to slightly convex, rounded, angular or irregular, increasing in size and thickness; mature fertile areoles (0.8–)1–1.8(–2.5) mm in maximum extent, to 0.7 mm thick, strongly convex or forming large irregular verrucae or subglobose-bullate; persistently sterile areoles plane to strongly convex, 0.2–0.8 mm wide, 0.08–0.4 mm thick. *Cortex* absent. *Algae Trentepohlia*, occupying a layer 80–150 µm thick in larger and fertile areoles, commonly scattered vertically throughout immature areoles; cells 10–21 × 8–14 µm, solitary or in filaments of up to 6 cells; interstitial hyphae 3–4 µm thick. *Medulla* white, densely packed with small to large calcium oxalate crystals (as is the algal layer); hyphae 2–4 µm thick, inconspicuous. *Prothallus* not apparent. *Ascomata* numerous, immersed, initially black-punctate and 0.08–0.12(–0.16) mm wide, merging to form lirelliform aggregations 0.3–1.2 mm long and 0.1–0.3 mm wide [n = 40, solitary and aggregated ascomata], the 'lirellae' simple or with 1 or 2 branches, straight or curved to arcuate, occasionally sigmoid, not in pseudostromata. *Thalline excipulum* absent. *Proper excipulum* visible only in thin section, divergent; in solitary ascomata medium to dark olive-brown above and 15–20 µm thick, pale brown or hyaline laterally and below, 10–15 µm thick; in aggregated ascomata the basal excipulum becoming obscured or possibly excluded; disc open, plane, smooth, dull, occasionally hyaline to dark pinkish grey, but usually blackish, epruinose or

patchily white-pruinose. *Hypothecium* hyaline, poorly defined, c. 25–40 µm thick, with oily inclusions, K–, I–, often becoming indistinguishable from the base of the proper excipulum. *Hymenium* 55–70 µm thick, not inspersed with granules or oil globules, non-amyloid, K–, I+ orange-red or wine-red. *Epihymenium* bilayered, K–, I–, 10–15 µm thick and hyaline above, 15–20 µm thick below and medium grey-brown to dark brown. *Paraphysoids* moderately conglutinate, not separating in K, branched and anastomosing above, simple or sparingly branched below, rather long-celled, 0.8–1.5 µm thick; apical cells to 2 µm thick, not pigmented. *Asci* structurally *Opegrapha*-type, but completely non-amyloid, broadly cylindrical or cylindroclavate, laterally thin-walled, 8-spored, 52–65 × 11–14 µm; apex rounded, with a 2–3 µm thick tholus and a minute ocular chamber at maturity. *Ascospores* colourless, irregularly massed in the ascus, 7-septate at maturity, narrowly oblong to fusiform, usually straight, occasionally slightly curved, faintly constricted at the septa or not, (18–)25(–30) × (4–)5(–5.5) µm excluding the perispore [n = 25]; cells of ± equal size throughout spore ontogeny (i.e. microcephalic); perispore to 1(–1.5) µm thick around immature and submature spores; apices rounded or subacute; contents clear or granular-guttulate. *Pycnidia* moderately numerous, immersed, solitary, 80–120 µm wide; apex black, punctate, plane, rounded, epruinose; internal wall medium to dark brown (thin section), with a simple conidiogenous layer; conidiogenous hyphae 10–15 µm long. *Conidia* hyaline, simple, filiform, usually curved, arcuate or sigmoid, 10–16(–20) × 0.5 µm. **Figs 1, 2.**

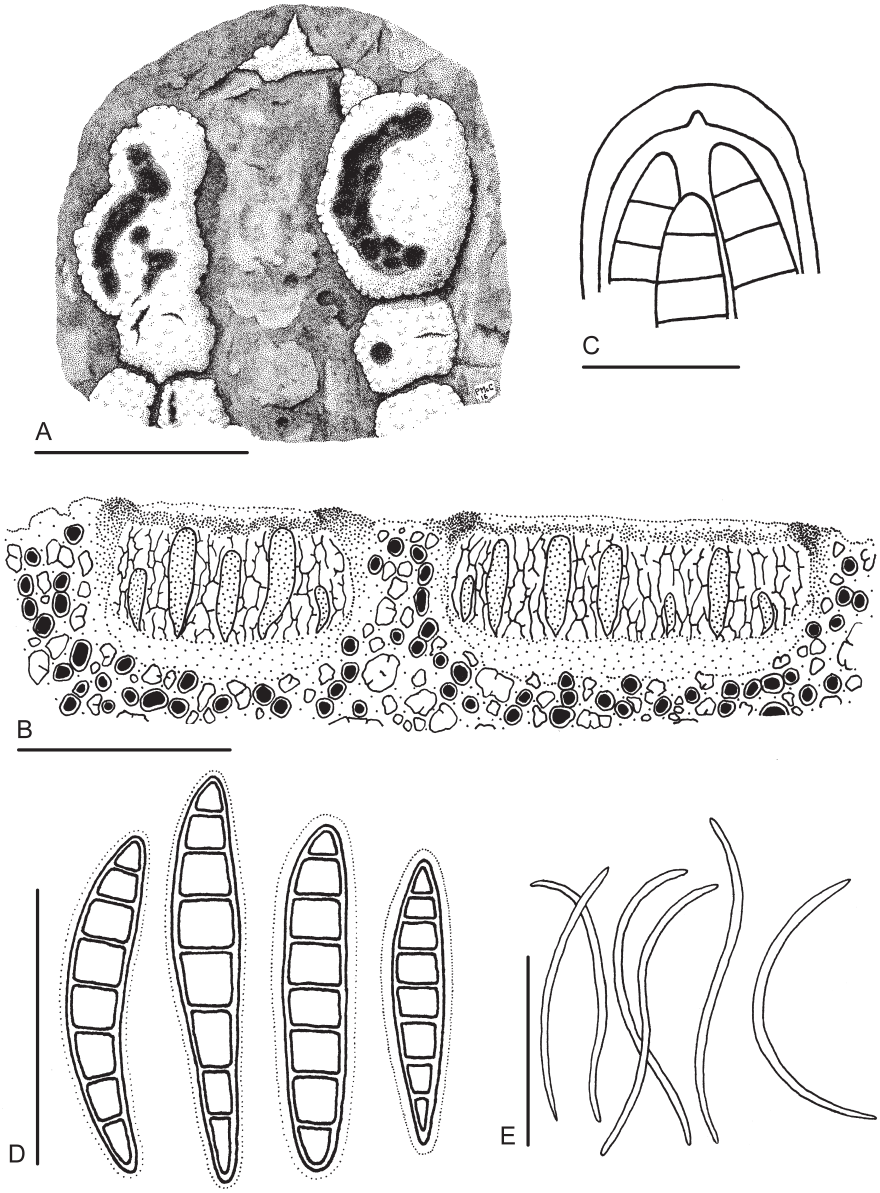

Fig. 2. *Enterographa cretacea* (holotype). A, habit of thallus and ascomata; B, sectioned ascomata (semi-schematic); C, ascus apex; D, ascospores; E, conidia. Scale bars: A = 1 mm; B = 0.1 mm; C, E = 10 µm; D = 20 µm.

Chemistry: Thallus K–, C–, KC–, PD–, UV–; dehydroconstipatic acid (major) by TLC. Medulla and algal layer H_2SO_4+, containing calcium oxalate.

Relationships: The genus *Enterographa* Fée (Roccellaceae) includes 56 species that grow on bark, rock or leaves, or as parasites of other lichens, mainly in tropical and subtropical latitudes, but with a significant minority found in temperate regions of both hemispheres (Sparrius 2004, Seavey and Seavey 2014). Ten species are known from Australia and its oceanic island territories (McCarthy 2016) where most are corticolous or foliicolous, except for *E. subgelatinosa* (Stirt.) Redinger which occurs on coastal rock in the south-west of Western Australia and in a similar habitat at the type locality in northern New Zealand.

The diagnostic characters of *E. cretacea* (see above), especially those of thalline habit and chemistry, ascomatal anatomy and the absence of pseudostromatic tissues, the non-amyloid hymenium, ascospore size and septation and pycnidial attributes, set it apart from all other species (Sparrius 2004; Seavey and Seavey 2014). For example, while the Australasian *E. subgelatinosa* has similar ascospores and conidia, its thallus forms 2–5 cm wide, cream-coloured, rimose-areolate colonies with a PD+ yellow colour reaction ["probably psoromic acid" *fide* Sparrius (2004)], and the pycnidia are orange-brown. The corticolous, Neotropical *E. sipmanii* Sparrius has similar ascomatal anatomy and ascospores, but the thallus lacks lichen substances, and the conidia are short-bacilliform and 3–5 × 1 µm (Sparrius 2004). The northern-temperate *E. hutchinsiae* (Leight.) A.Massal. also grows on rock and has an ascomatal anatomy similar to that of *E. cretacea*, but the olive-grey to dark brown thallus contains confluentic acid, and the bacilliform conidia are 5–6 × 1.2–1.5 µm (Coppins and James 1979; Sparrius 2004).

Etymology: The epithet *cretacea* (chalky) refers to the white thallus of the new species.

Distribution and habitat: This species is known only from the type locality, an exposed rocky seashore on the south coast of New South Wales, Australia. It grows on the moderately shaded, landward side of a quartzitic sandstone pinnacle among lichens that include *Buellia halonia* (Ach.) Tuck., *Caloplaca* spp., *Diploicia canescens* subsp. *australasica* Elix & Lumbsch, *Opegrapha* sp. and *Porina guentheri* (Flot.) Zahlbr.

2. *Eugeniella farinosa* P.M.McCarthy & Elix, **sp. nov.**

MycoBank No.: MB 817593

Characterized by the predominantly farinose, pale grey-green, epiphloeodal thallus containing usnic acid, adnate or basally constricted, biatorine apothecia 0.25–0.60 mm diam., with an epruinose, greenish brown disc, a thin but usually persistent and off-white proper margin of moniliform hyphae encrusted with crystals of calcium oxalate, the proper excipulum partially subtending the medium to dark reddish brown hypothecium, an inconspicuous epihymenium, simple to sparingly branched paraphyses and *Byssoloma*-type asci containing 3-septate ascospores of 10–15 × 2.5–4 µm.

Type: Australia. Tasmania: 1 km SE of Wiltshire along Bass Highway, 40°50'S, 145°17'E, alt. 5 m, on bark of *Melaleuca ericifolia* in a swamp, *G. Kantvilas 272/99*, 28 Jun 1999; holotype: HO 445376.

Thallus crustose, epiphloeodal, continuous and farinose (the granules 30–60 µm wide), or rimose to indistinctly areolate and smooth to minutely rugulose-verruculose, pale grey-green, to 0.1(–0.2) mm thick, ecorticate, forming colonies to 4 cm wide. *Algal cells* green, globose, chlorococcoid, 8–18 µm diam., thick-walled. *Medulla* not delimited, a loose hyphal reticulum; hyphae long-celled, 2–3(–4) µm wide. *Prothallus* absent. *Apothecia* numerous, adnate or basally constricted, solitary and rounded or shallowly to deeply lobate, often subdividing into rounded clusters or short rows of apothecia, their shape distorted by mutual pressure; individual apothecia (0.25–)0.46(–0.60) mm diam. [*n* = 60]; disc medium greenish brown, smooth, epruinose, at first ± plane, becoming moderately to strongly convex; proper margin biatorine, off-white, thin but distinct, usually persistent, initially 25–40 µm thick in surface view, entire and even to delicately flexuose. *Proper excipulum* partially subtending the hypothecium and up to 60 µm thick, heavily impregnated with rounded, squarrose or irregularly shaped crystals of calcium oxalate which are interspersed with radiating moniliform hyphae; cells ellipsoid to subglobose, constricted at the septa, 4–6 µm long and 3–4 µm wide. *Hypothecium* medium to dark reddish brown, 50–80 µm thick, not inspersed with granules or oil droplets, non-amyloid, K–; subhypothecial tissue hyaline to pale brown, lacking an "apothecial base" *sensu* Lücking (2008) and Breuss and Lücking (2015). *Hymenium* 50–70 µm thick, not inspersed, I+ dark blue, K–, occasionally with a faint brownish tint. *Epihymenium* 10–15 µm thick, inconspicuous, pale grey-green to pale greenish brown, often scarcely distinguishable from the hymenium. *Paraphyses* simple to sparingly branched, long-celled, conglutinate, 0.8–1.5 µm thick; apical cells not swollen and not pigmented. *Asci* narrowly to broadly clavate or clavate-cylindrical, 8-spored, 36–47 × 10–13 µm [*n* = 20], *Byssoloma*-type (Hafellner 1984), with or without a thin amyloid outer coat; tholus well-developed, uniformly amyloid, but with a very inconspicuous *masse axiale* bordered by a more intensely amyloid zone; ocular chamber conical or not apparent. *Ascospores* colourless,

3-septate at maturity, narrowly ellipsoid to oblong or fusiform, irregularly biseriate or obliquely massed in the upper half of the ascus, straight or slightly bent, with rounded or subacute apices, not or only very slightly constricted at the septa, (10–)13(–15) × (2.5–)3.5(–4) µm [*n* = 50], thin-walled; perispore lacking. *Pycnidia* not seen. **Figs 3A, 4.**

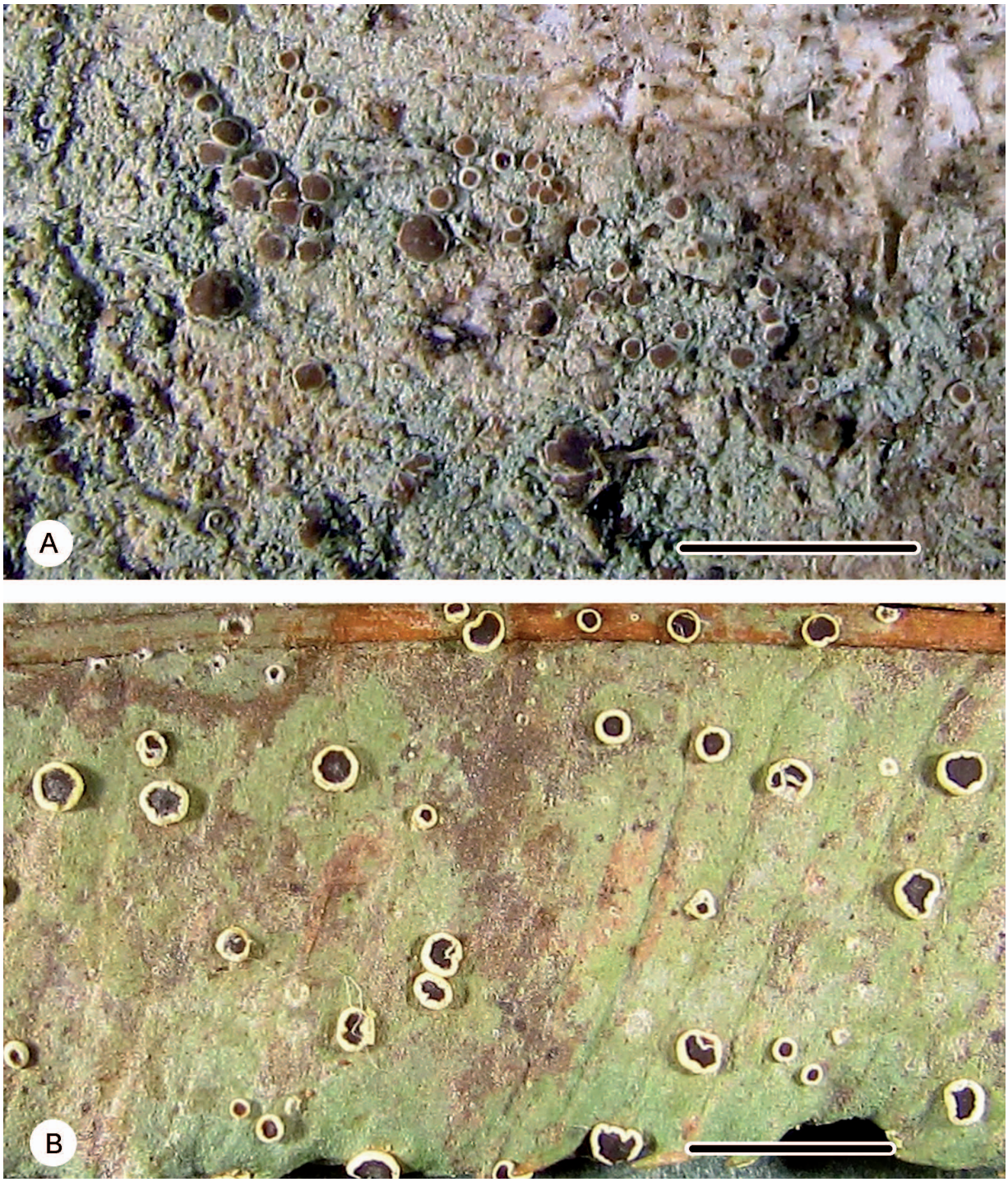

Fig. 3. *Eugeniella* species. A, *E. farinosa* (holotype); B, *E. usnica* (holotype). Scale bars = 2 mm.

Chemistry: Thallus K–, C–, KC–, PD–, UV–; usnic acid [major] by TLC; H_2SO_4+, thallus and apothecial margin containing calcium oxalate.

Relationships: *Eugeniella* was first described to accommodate several species previously included in *Bacidia sens. lat.* and *Byssoloma* Trevis. (Lücking 2008). Its circumscription emphasises an excipular anatomy of moniliform hyphae heavily encrusted with calcium oxalate crystals in conjunction with mostly unbranched

paraphyses, *Byssoloma*-type asci and transversely septate to muriform ascospores (Breuss and Lücking 2015). The genus includes nine species, most of which are foliicolous and exclusively Neotropical (Lücking 2008, Breuss and Lücking 2015), with one pantropical taxon, *E. micrommata* (Kremp.) Lücking, Sérus. & Kalb, which has previously been reported from north-eastern New South Wales (Lücking et al. 2001).

Eugeniella farinosa and *E. palleola* Breuss & Lücking are the only two obligately corticolous species in the genus (see couplet 2 of the key, below). The new species is characterized by a pale grey-green, mainly farinose thallus containing usnic acid, adnate or basally constricted apothecia with an epruinose, greenish brown disc, a thin but usually persistent and off-white proper margin that, in section, partially subtends the medium to dark reddish brown hypothecium and small, 3-septate ascospores. A key to the eight species of *Eugeniella* with 3-septate ascospores is provided below.

Etymology: The epithet *farinosa* refers to the powdery thallus of the new species.

Distribution and habitat: *Eugeniella farinosa* is currently represented only by the type collection from the bark of *Melaleuca ericifolia* in a coastal swamp in north-eastern Tasmania.

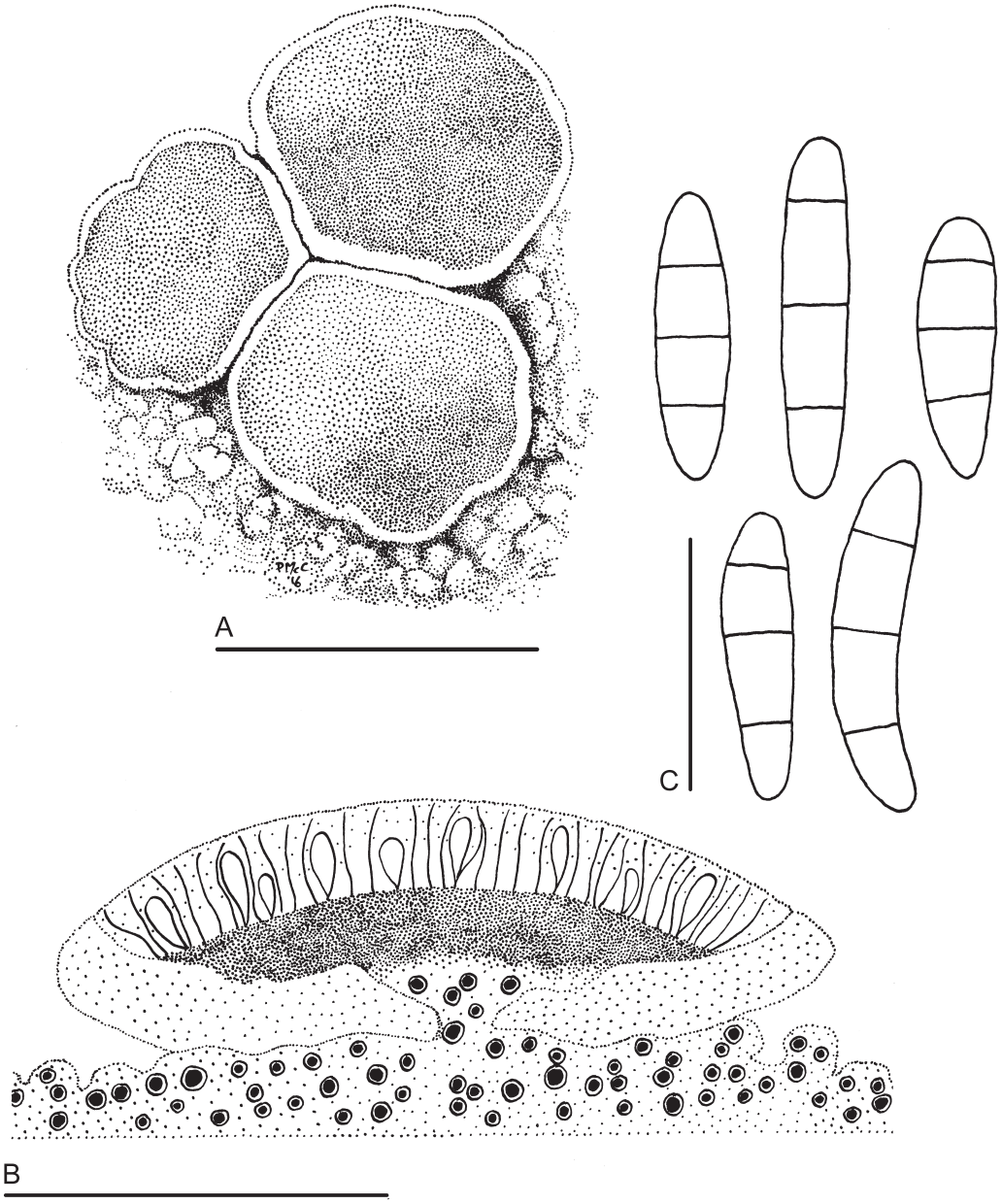

Fig. 4. *Eugeniella farinosa* (holotype). A, habit of thallus and apothecia; B, sectioned apothecium (semi-schematic); C, ascospores. Scale bars: A = 0.5 mm; B = 0.2 mm; C = 10 µm.

3. *Eugeniella usnica* P.M.McCarthy & Elix, **sp. nov.**

MycoBank No.: MB 817594

Characterized by a very thin, often smooth, pale to medium green or pale greyish green, epicuticular thallus on herb and tree leaves and on fern pinnae, highly conspicuous, sessile, biatorine apothecia 0.24–0.62 mm diam. with a plane, epruinose, dark olive-brown to blackish disc, a persistent, white to pale yellowish proper margin of moniliform hyphae encrusted with crystals of calcium oxalate and containing usnic acid (major), the excipulum cupulate or partially subtending the medium to dark reddish brown hypothecium, a hyaline to pale greenish brown epihymenium, simple paraphyses and *Byssoloma*-type asci containing 3-septate ascospores of 11–16 × 3.5–5 µm.

Type: Australia. New South Wales: South Coast: Box Cutting Rainforest Walk, off Kianga Forest Drive, Bodalla State Forest, near Narooma, 36°10'57"S, 150°04'05"E, alt. 140 m, on pinnae of *Blechnum* sp. in a wet forest gulley, *P.M. McCarthy 4477*, 10 Feb 2016; holotype: CANB.

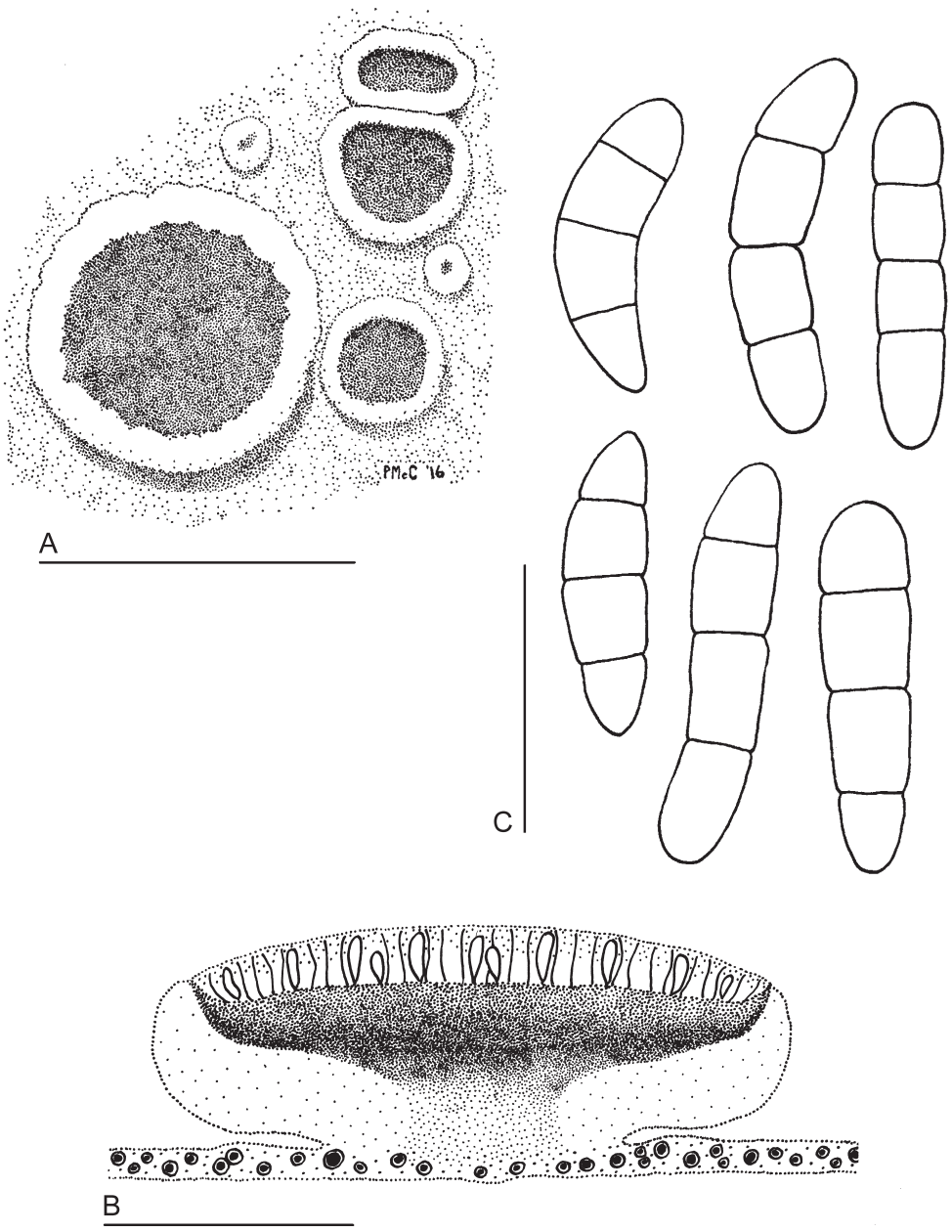

Fig. 5. *Eugeniella usnica* (holotype). A, habit of thallus and apothecia; B, sectioned apothecium (semi-schematic); C, ascospores. Scale bars: A = 0.5 mm; B = 0.2 mm; C = 10 µm.

Thallus crustose, epicuticular on the upper surfaces of fern pinnae, the leaves of wet forest trees and a perennial herb (*Lomandra* sp.), diffuse or continuous, not areolate, smooth to minutely and irregularly uneven, 18–30 µm thick, pale to medium green or pale greyish green, ecorticate, forming colonies to 5–10(–15) mm wide. *Algal cells* green, globose, chlorococcoid, 8–15 µm diam., thick-walled; interstitial hyphae long-celled, 1.5–2 µm wide. *Prothallus* pale grey and effuse, or not apparent. *Apothecia* usually numerous, sessile, solitary and rounded or shallowly to deeply and irregularly lobate, or paired, or in small clusters, the apothecial shape then usually distorted by mutual pressure, (0.24–)0.45(–0.62) mm diam. [*n* = 100], often leaving a round, 0.2–0.35 mm wide scar when detached from the thallus; disc plane, smooth, epruinose, dark olive-brown to blackish; thalline margin absent; proper margin 40–80(–100) µm thick, biatorine, entire, white to pale yellowish, persistent, often translucent when wet. *Proper excipulum* partially subtending or continuous beneath the hypothecium, heavily encrusted with hyaline, squarrose or irregular crystals that largely obscure the moniliform hyphae; cells 3–5 µm long and 2–3(–4) µm wide; excipulum base 90–130 µm thick, subtending the hypothecium with a loose reticulum of 2–3 µm thick hyphae, I+ pale yellowish brown, K–. *Hypothecium* medium to dark reddish brown, 40–65 µm thick, not inspersed with granules or oily inclusions, I–, K+ dark olive-brown; subhypothecial tissue [the "apothecial base" *sensu* Lücking (2008), Breuss and Lücking (2015)] hyaline to pale brown, 40–60 µm thick, I–, K–. *Hymenium* 50–60 µm thick, not inspersed, I+ dark blue, K–. *Epihymenium* 10–15 µm thick, this layer and adjacent parts of hymenium hyaline to pale greenish brown, K–. *Paraphyses* simple, long-celled, conglutinate, 0.8–1.5 µm thick; apical cells not or slightly swollen (2–3 µm thick), not pigmented. *Asci* narrowly clavate to cylindrical, 8-spored, 40–55 × 9–12 µm [*n* = 15], *Byssoloma*-type, with or without a thin amyloid outer coat; tholus well-developed, uniformly amyloid, but with an inconspicuous *masse axiale* bordered by a more intensely amyloid zone; ocular chamber not apparent. *Ascospores* colourless, 3-septate at maturity, narrowly ellipsoid to oblong, irregularly biseriate in the ascus, straight or bent, occasionally faintly sigmoidal, with rounded apices, or the proximal apex more pointed, slightly constricted at the septa, especially the primary septum, (11–)14(–16) × (3.5–)4(–5) µm [*n* = 100], thin-walled; perispore lacking or up to 1 µm thick. *Pycnidia* not seen. **Figs 3B, 5.**

Chemistry: Thallus K–, C–, KC–, PD–, UV–; usnic acid (major), atranorin (minor or trace), chloroatranorin (minor or trace) by TLC; H_2SO_4+, apothecial margin containing calcium oxalate.

Relationships: *Eugeniella usnica* is a very distinctive lichen, even at a distance in the field, and its dark olive-brown to blackish apothecial discs and white to pale yellowish margins are particularly noticeable. Its habit, the presence of usnic acid in the proper margin of the apothecium and 3-septate ascospores of 11–16 × 3.5–5 µm set it apart from all other species. Thus, the Neotropical *E. atrichoides* (Malme) Lücking, Sérus. & Kalb has a pale grey to brownish grey apothecial margin and ascospores that are only 2.5–3.5 µm wide (Lücking 2008), while the more widely distributed *E. leucocheila* (Tuck.) Lücking, Sérus. & Kalb has dark brown to brownish black hypothecial and subhypothecial tissues, a white to pale brown apothecial margin (Lücking 2008) and a thallus that can contain perlatolic acid, stenosporic acid and glomelliferic acid.

Etymology: The epithet *usnica* refers to usnic acid, the dominant lichen substance in this species.

Distribution and habitat: *Eugeniella usnica* is locally abundant on the upper surfaces of fern pinnae, the leaves of wet forest trees and a perennial herb (*Lomandra* sp.) at two localities in rainforest and warm-temperate forest in south-eastern New South Wales and far-eastern Victoria. Associated lichens at the type locality included many of the foliicolous species typical of wet, coastal forest in south-eastern New South Wales, *viz. Arthonia trilocularis* Müll.Arg., *Aulaxina dictyospora* R.Sant., *Byssoloma leucoblepharum* (Nyl.) Vain., *B. subdiscorda*ns (Nyl.) P.James, *Fellhanera bouteillei* (Desm.) Vězda, *Gyalectidium microcarpum* (Vězda) Lücking, Sérus. & Vězda, *Mazosia phyllosema* (Nyl.) Zahlbr., *Sporopodium flavescens* (R.Sant.) Vězda, *Strigula nitidula* Mont., *S. smaragdula* Fr.: Fr., *Tapellaria phyllophila* (Stirt.) R.Sant. and *Trichothelium alboatrum* Vain.

Additional specimens examined: NEW SOUTH WALES: type locality, *P.M. McCarthy 2809*, 10 Apr 2009 (CANB). **VICTORIA:** East Gippsland (Foreman and Walsh 1993): 10 km E of Cann River, Drummer Rainforest Walk, 37°34'05"S, 149°16'26"E, alt. 80 m, on leaves of trees at margin of warm-temperate forest, *J.A. Elix 39368*, 11 Nov 2008 (CANB); *loc. id.*, on leaves of *Lomandra*, *J.A. Elix 39367*, 11 Nov 2008 (CANB).

Key to the species of *Eugeniella* with 3-septate ascospores

[Based on Lücking (2008), Breuss & Lücking (2015) and the two newly described species]

1 Apothecial disc pale brown to grey or medium greenish brown; growing on bark **2**

1: Apothecial disc dark brownish grey, dark olive-brown or blackish; usually growing on leaves, bark or wood **3**

2 Thallus farinose; apothecial margin containing usnic acid; hypothecium medium to dark reddish brown, not subtended by a pigmented "apothecial base"; ascospores 10–15 µm long ..... ***E. farinosa***

2: Thallus minutely uneven but not farinose; apothecial margin containing norstictic acid; hypothecium brown-black, subtended by a concolorous "apothecial base"; ascospores 13–17(–20) µm long [Central America] ..... ***E. palleola***

3 Thallus distinctly verrucose **4**

3: Thallus lacking verrucae **5**

4 Thallus greenish; verrucae white, 0.07–0.15 mm wide; paraphyses unbranched [Neotropics] ..... ***E. psychotriae***

4: Thallus bluish grey or white; verrucae concolorous, 0.1–0.2 mm wide; paraphyses branched and anastomosing [pantropical] ..... ***E. micrommata***

5 Apothecial margin evanescent; tubular pycnidia usually present [Neotropics] ..... ***E. corallifera***

5: Apothecial margin well-defined and persistent; pycnidia absent **6**

6 Apothecial margin pale grey to brownish grey; ascospores 2.5–3.5 µm wide [Neotropics ..... ***E. atrichoides***

6: Apothecial margin white, pale yellowish white or pale brown; ascospores 3–5 µm wide **7**

7 Hypothecium and subhypothecial tissues dark brown to brownish black; apothecial margin white to pale brown; chemistry: perlatolic acid (major), stenosporic acid (minor), glomelliferic acid (minor) (J.A.Elix, unpublished) [Neotropics, SE United States and tropical Africa] ..... ***E. leucocheila***

7: Hypothecium medium to dark reddish brown; subhypothecial tissue hyaline to pale brown; apothecial margin white to yellowish; chemistry: usnic acid (major), atranorin (minor or trace), chloroatranorin (minor or trace) ..... ***E. usnica***

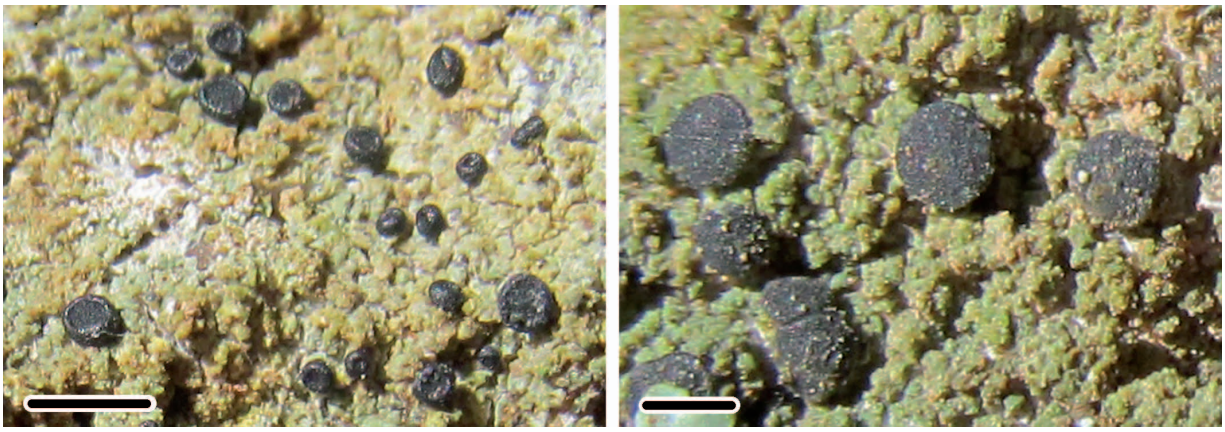

Fig. 6. *Megalaria montana* (holotype). Thalli with immature (left) and mature apothecia. Scale bars = 1 mm.

4. *Megalaria montana* P.M.McCarthy & Elix, **sp. nov.**

MycoBank No.: MB 817595

Characterized by a thick, green, granulose-isidiate to coralloid-isidiate thallus growing on rock and lacking lichen substances, apothecia that are adnate to sessile, black, 0.5–1.5 mm diam., with a persistent margin, a thick, laterally violet-grey to bluish black proper excipulum (N+ violet or purple) that is cupulate and paler at the base, a pale, bilayered hypothecium (N+ pale pink above), a blackish epihymenium, simple to sparingly branched paraphyses with occasional anastomoses mainly towards their base, mostly 8-spored, ± *Biatora*-type asci of 88–110 × 11–30 µm and narrowly ellipsoid to oblong-ellipsoid, 1-septate ascospores 19–40 × 8–13 µm.

Type: Australia. New South Wales: Central Tablelands: Mount Canobolas State Conservation Area, W face of Mt Canobolas, c. 12 km SW of Orange, 33°20'13"S, 148°58'51"E, alt. c. 1115 m, on weathered trachytic rhyolite in heath with scattered *Eucalyptus* and *Acacia*, *P.M. McCarthy 4480*, 6 Apr 2016; holotype: CANB.

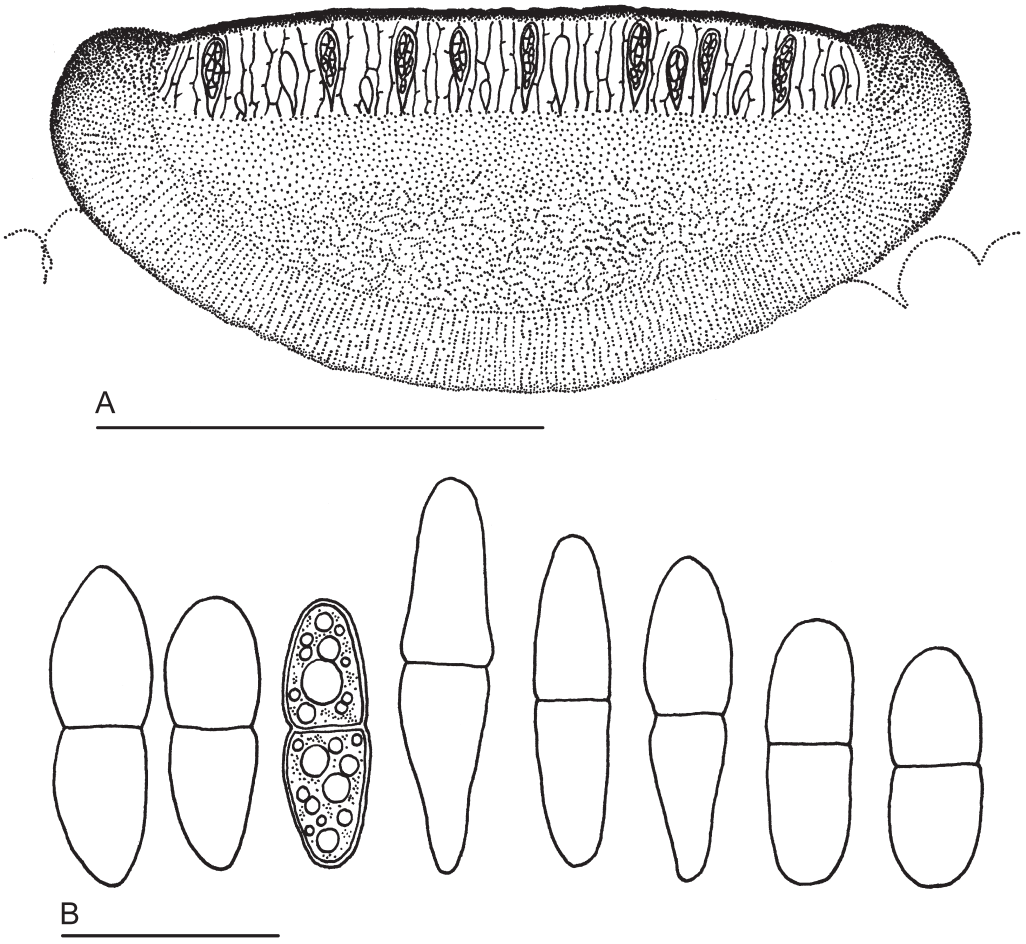

Fig. 7. *Megalaria montana* (holotype). A, sectioned apothecium (semi-schematic); B, ascospores. Scales bars: A = 0.5 mm; B = 20 μm.

Thallus crustose, epilithic, pale to medium green or greyish green, 0.2–1.5(–2) mm thick, forming colonies to 5 cm wide, granulose-isidiate to coralloid-isidiate, in places verruculose and with coralloid lobules, patchily and thinly corticate on granules to distinctly corticate on coralloid outgrowths, then the cortex hyaline, prosoplectenchymatous or subparaplectenchymatous and 10–15 μm thick; granulose isidia globose or somewhat irregular, 0.1–0.3(–0.4) mm wide; lobules and coralloid isidia ±terete, or plane to convex, erect, spreading or contorted, simple to irregularly and short-branched, 0.1–0.3 mm wide, forming pulvinate, areole-like clumps up to 2 mm wide; thallus friable when dry, readily crumbling, becoming detached from the substratum and exposing the white prothallus. *Photobiont* chlorococcoid, forming a subcortical layer 40–80(–100) μm thick; cells mostly globose, 8–14(–18) μm wide, thin- or thick-walled. *Medulla* loose, almost byssoid in places; hyphae variously orientated, long-celled, 3–5(–6) μm wide. *Prothallus* thin, white, discontinuous and byssoid under the thallus, up to 1.5 mm wide at the thallus margin where the inner part is white and minutely radially rimose, the outer zone silvery grey and fimbriate. *Apothecia* rounded or slightly irregular in outline, or more contorted when immature and wedged between 'areoles', (0.5–)0.9(–1.5) mm diam. [$n = 44$], usually solitary and scattered, adnate or basally constricted; margin at first glossy black, smooth, entire, later dull black, persistent, 80–120 μm thick, occasionally a little paler than the disc; disc initially slightly concave or plane, becoming moderately convex, matt black, smooth, epruinose, roughened or pock-marked in post-mature apothecia and internally becoming uniformly blackish and anatomically amorphous, the hymenium disappearing. *Proper excipulum* cupulate in section, 75–125(–150) μm thick laterally, 70–120 μm thick at the base, laterally uniformly medium violet-grey to bluish black, or pigmented towards the outside and hyaline within, suprabasal and basal excipulum uniformly hyaline or with a thin, external violet-grey zone; pigmented parts K– or K+ greenish blue, H+ bluish, I–, N+ violet or purple; excipular hyphae radiating

outwards laterally and downwards basally, anastomosing, tightly coherent, 6–11 µm wide, very thick-walled (the lumina c. 1 µm thick), the outermost/lowermost cells not swollen. *Hypothecium* bilayered, not inspersed with oil droplets or granules, or with sparse granules distally; upper layer paraplectenchymatous, hyaline to pale straw-coloured or pale greenish brown, 60–130 µm thick, K–, H–, I+ pale yellowish, N+ pale pink, the uppermost 10–20 µm (adjacent to the hymenium) occasionally very pale bluish green; lower layer 90–160 µm thick, a well-defined, hyaline zone of prosoplectenchymatous or very loose and randomly orientated hyphae 3–5 µm wide, K–, H–, I–, N–. *Hymenium* 90–150 µm thick, not inspersed with granules or oil globules, hyaline, K–, H–, I+ blue, N–. *Epihymenium* inky black, blue-black or dark bluish green, 15–20(–25) µm thick, K+ greenish, H+ deep cobalt blue, I–, N+ violet or purple. *Paraphyses* simple to sparingly branched, with occasional anastomoses especially towards the base of the hymenium, 1–1.5(–2) µm thick, separating in K but conglutinate at the epihymenium; apices swollen, 3.5–4 µm wide, with or without a cap of blue-black pigment and a diffuse, internal blue-green pigment; short paraphyses occasionally intermixed, only c. half the height of the hymenium, with numerous short branches. *Asci* narrowly clavate to clavate-cylindrical, mostly 8-spored, occasionally with 2 or 3 spores aborted, the spores biseriate, irregularly arranged, or massed in the distal half of the ascus, 88–110 × 11–30 µm [n = 25], ± *Biatora*-type; tholus well-developed, weakly amyloid, penetrated almost to the ascus wall by a conical *masse axiale*, this bordered by a narrow, more deeply amyloid zone; ocular chamber stunted-convex or not apparent; ascoplasma non-amyloid. *Ascospores* narrowly ellipsoid or oblong-ellipsoid, hyaline, 1-septate, slightly constricted at the septum or not, straight, (19–)31(–40) × (8–)11(–13) µm [n = 100]; apices rounded or subacute; wall 1–1.5 µm thick, lacking all traces of an epispore; contents usually guttulate, frequently also minutely granular. *Pycnidia* not seen. **Figs 6, 7.**

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

Relationships: With a circumscription that has varied considerably over the last 30 years, *Megalaria* (including *Catillochroma* Kalb and *Lopezaria* Kalb & Hafellner) is recognised by its usually pale and variously crustose thallus with a unicellular green photobiont, large, mainly black apothecia lacking a thalline margin but with a thick proper excipulum of anticlinal hyphae, an amyloid hymenium with *Biatora*- or *Bacidia*-type asci or a variant of the *Lecanora*-type (*sensu* Hafellner 1984), simple, sparingly branched or somewhat anastomosing paraphyses, the apices with or without dark, pigmented caps, and 1-septate ascospores (Hafellner 1984; Ekman and Tønsberg 1996; Kantvilas 2008, 2016; Sanderson 2009; Fryday and Lendemer 2010; Fryday 2016). This almost cosmopolitan genus includes at least 35 species, and while most are corticolous, several are facultatively or exclusively saxicolous (Lendemer 2007; Kantvilas 2008; Sanderson 2009; Fryday 2016).

Megalaria montana has a thick, green, corticate and mainly granulose- or coralloid-isidiate thallus, large black apothecia with a blackish epihymenium, a hyaline or very pale hypothecium, a partly violet-grey to blue-black and partly hyaline, cupulate excipulum and moderately large 1-septate ascospores. Six other species, all known only from bark or epiphytic on bryophytes, have a granulose- or coralloid-isidiate thallus. *Megalaria brodoana* S.Ekman & Tønsberg, from north-western North America, has a bluish green thallus, a red-brown hypothecium and inner excipulum and broadly ellipsoid to almost subglobose ascospores of c. 17–21 × 9–11 µm (Ekman and Tønsberg 1996), while *M. bryophila* (Müll.Arg.) Elix from south-eastern Australia (Elix 2012), *M. bengalensis* Jagadeesh, Aptroot, G.P.Sinha & Kr.P.Singh from India (Jagadeesh Ram et al. 2007) and *M. spodophana* (Nyl.) D.J.Galloway from New Zealand (Galloway 2007) all have ascospores less than 20 µm long. The possibly pantropical *M. isidiza* (Makhija & Nagarkar) Fryday & Lendemer has considerably larger ascospores in 1- or 2-spored asci (Sipman 1983; Fryday and Lendemer 2010).

The recently described *M. orokonuiana* Fryday & A.Knight, from southern New Zealand, is rather similar to *M. montana* in outward appearance and in the dimensions of its ascospores. However, it has a very different pattern of apothecial pigmentation (Fryday and Knight 2012); the epihymenium is dark grey to blue-black and N+ red or violet, the upper hypothecial zone is reddish brown to dark chestnut-brown and N+ orange-brown or red-brown, while the cupulate excipulum has a hyaline, outer, basal zone and is bluish black within. It is reported here for the first time from Australia (see below).

Etymology: The epithet *montana* refers to the discovery of the new species on the upper slopes of Mount Canobolas, New South Wales.

Distribution and habitat: *Megalaria montana* is known only from weathered outcrops of hard trachytic rhyolite in montane heath with scattered *Eucalyptus* and *Acacia* below the summit of Mount Canobolas in central-western New South Wales. This habitat supports a diverse and distinctive saxicolous lichen flora including the recently described *Sarcogyne sekikaica* P.M.McCarthy & Elix (McCarthy and Elix 2014), along with *Acarospora fuscata* (Nyl.) Arnold, *A. veronensis* A.Massal., *Aspicilia* spp., *Buellia homophylia* (C.Knight) Zahlbr., several *Caloplaca* spp., *Candelariella vitellina* (Hoffm.) Müll.Arg., *Ingvariella bispora* (Bagl.) Guderley & Lumbsch, *Lecidea capensis* Zahlbr., numerous Parmeliaceae, *Pertusaria* spp., *Paraporpidia leptocarpa* (C.Bab. & Mitt.) Rambold & Hertel, *Ramboldia petraeoides* (Nyl. ex C.Bab. & Mitt.) Kantvilas & Elix, *R. plicatula* (Müll.

Arg.) Kantvilas & Elix, several species of *Rhizocarpon*, *Rimularia campestris* Kantvilas & Elix (reported here for the first time outside of Tasmania; *P.M. McCarthy 4482*, CANB), *Rinodina oxydata* (A.Massal.) A.Massal. and *Tephromela atra* (Huds.) Hafellner.

Additional specimen examined: c. 100 m from the type specimen, on weathered trachytic rhyolite in heath with scattered *Eucalyptus* and *Acacia*, *P.M. McCarthy 4481*, 6 Apr 2016 (CANB).

5. *Micarea eucalypti* P.M.McCarthy & Elix, **sp. nov.**

MycoBank No.: MB 817596

Characterized by a moderately thick, greenish, granular, corticolous thallus that lacks lichen substances, black, convex apothecia 0.21–0.42 mm diam. with a K– and C– hymenium, a hyaline hypothecium and 3-septate ascospores of 16–28 × 2.5–4 µm. Pycnidia produce either short-acicular microconidia 4–7 × c. 0.5 µm or elongate-filiform, (1–)3-septate macroconidia 12–22 × 0.5–1 µm.

Type: Australia. Australian Capital Territory: Namadgi National Park, Mt Scabby, summit, 35°45'08"S, 148°54'35"E, alt. 1809 m, on twigs of *Eucalyptus pauciflora*, *P.M. McCarthy 4200*, 9 Dec 2013; holotype: CANB.

Thallus crustose, epiphloeodal, diffuse or forming a continuous colony to 16 mm wide in microfissures in the twig surface, 80–140 µm thick, dull medium greenish grey to darker grey-green, granular and forming irregular and poorly defined areoles; granules 50–100(–130) µm wide, ±globose to tuberculate, ecorticate. *Algae* scattered or well-delimited and occupying a layer 50–80 µm thick; cells micareoid, yellowish green to grey-green, globose to subangular (when tightly aggregated), 5–8 µm wide. *Medulla* poorly defined; hyphae 2–3 µm wide, thin-walled. *Prothallus* absent. *Apothecia* dull black, adnate, rounded to irregular, solitary or in groups of 2–4, (0.21–)0.29(–0.42) mm diam. [n = 20]; disc smooth, moderately to strongly convex, epruinose; proper margin initially 15–25 µm thick, but scarcely visible in surface view, entire, concolorous with the disc, soon becoming excluded. *Proper excipulum* dark brown in section, 10–12(–15) µm thick laterally, 15–25 µm thick and paler brown at the base, partially subtending the hypothecium. *Hypothecium* hyaline, 60–90 µm thick, paraplectenchymatous, with cells 3–5 µm wide, not inspersed with granules or oil globules, K–, I+ blue. *Hymenium* 40–50 µm thick, not inspersed, I+ dark blue, K–, C–; upper parts greenish black, the pigmentation continuous with the epihymenium. *Epihymenium* dark olive-green to greenish black, 10–20 µm thick, K–, N–. *Paraphyses* loosely to tightly conglutinate, sparingly branched and anastomosed, long-celled, 0.8–1.2(–1.5) µm thick; apical cells not swollen. *Asci* narrowly to more broadly clavate, 40–58 × 9–13 µm, 8-spored, with an amyloid outer coat; tholus well-developed, predominantly amyloid, with a short, conical, ocular chamber subtending a non-amyloid, apical cushion that broadens distally. *Ascospores* colourless, irregularly massed in the ascus, 3-septate at maturity, narrowly oblong to oblong-fusiform or bacilliform, usually slightly or strongly curved, occasionally straight or faintly sigmoid, not constricted at the septa, (16–)21(–28) × (2.5–)3.2(–4) µm [n = 40], thin-walled, lacking a perispore; apices rounded to subacute. *Pycnidia* moderately numerous, semi-immersed and hemispherical to superficial and tuberculate, dark greenish grey to black, 40–80 µm diam.; conidiogenous layer simple or convoluted. *Conidia* of 2 types: microconidia short-acicular, simple, 4–7 × c. 0.5 µm, with pointed apices; macroconidia elongate-filiform, curved, arcuate, uncinate, sigmoid or otherwise contorted, (1–)3-septate, 12–22 × 0.5–1 µm, with rounded or subacute ends; mesoconidia not seen. **Fig. 8.**

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

Relationships: The crustose lichen genus *Micarea* Fr. (Pilocarpaceae) is mainly northern-temperate in its distribution, with approximately 100 species growing on bark, rock and soil. Twenty-three taxa are known from Australia (McCarthy 2016), mostly at southern latitudes, but this diversity is likely to increase substantially as unresolved herbarium specimens are clarified and further collections become available.

Micarea eucalypti is a diminutive, but highly distinctive species. Ascomatal anatomy, pigmentation and lack of chemistry confirm its place in the *M. lignaria–M. ternaria* species group (Coppins 1983, 2009; McCarthy and Elix 2016) where it aligns with *M. lignaria* (Ach.) Hedl. var. *lignaria* by virtue of its narrowly elongate ascospores. However, the latter has longer ascospores with up to 7 septa, and the thallus contains argopsin. Ascospores of a rather similar shape and septation occur in *M. globulosella* (Nyl.) Coppins and *M. synotheoides* (Nyl.) Coppins, corticolous species with a very scattered Northern Hemisphere distribution (Coppins 1983, 2009). In contrast to *M. eucalypti*, both have a K+ violet upper hymenium, *M. globulosella* also has a C+ red upper hymenium (presumably due to the presence of gyrophoric acid), and the microconidia of both species are shorter and broader (Coppins 1983, 2009).

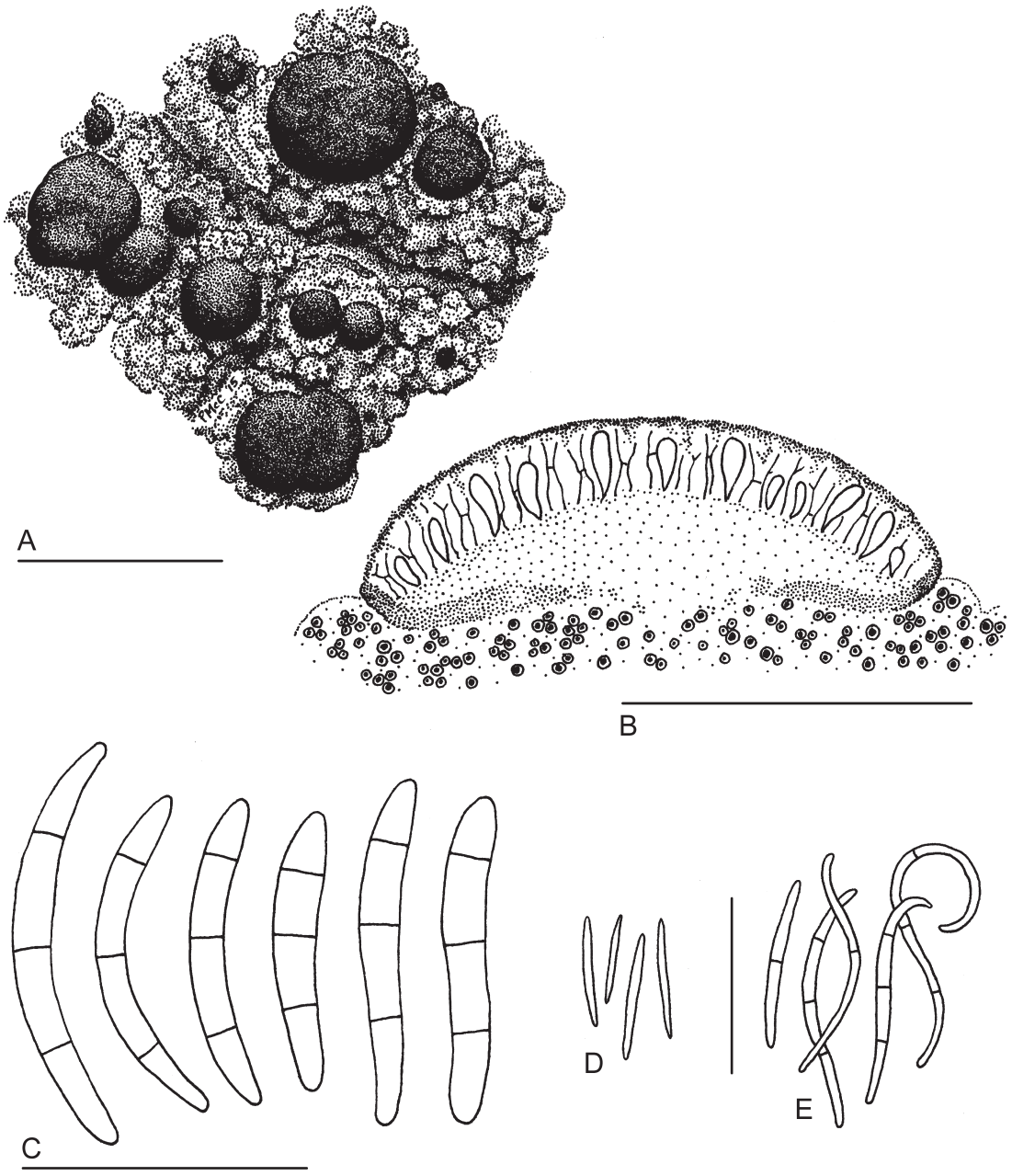

Fig. 8. *Micarea eucalypti* (holotype). A, habit of thallus, apothecia and pycnidia; B, sectioned apothecium (semi-schematic); C, ascospores; D, microconidia; E, macroconidia. Scale bars: A = 0.5 mm; B = 0.2 mm; C–E = 10 µm.

Etymology: The epithet *eucalypti* refers to the host tree of the new species, *Eucalyptus pauciflora*.

Distribution and habitat: *Micarea eucalypti* is currently represented only by the small type specimen that grew on a centimetre-wide twig of snowgum (*Eucalyptus pauciflora*) on the summit of Mount Scabby near the southern border of the Australian Capital Territory. These twigs support a surprisingly diverse community of lichens in an environment not ideally suited to corticolous species or their hosts (McCarthy 2015). Species on twigs of the same and nearby trees at the type locality include *Caloplaca wilsonii* S.Y.Kondr. & Kärnefelt, *Candelariella xanthostigma* (Ach.) Lettau, *Lecidella destituta* Kantvilas & Elix, *L. xylogena* (Müll.Arg.) Kantvilas & Elix, *Ramboldia laeta* (Stirt.) Kalb, Lumbsch & Elix and *R. stuartii* (Hampe) Kantvilas & Elix. A careful examination of hundreds of snowgum twigs from the summit areas of Mount Scabby, Mount Murray, Mount Ginini, Mount Bimberi and Sentry Box Mountain in the southern A.C.T., and among the subalpine vegetation on Mount Canobolas in the Central Tablelands of N.S.W. failed to yield further collections of *M. eucalypti*.

New Record for Australia

Megalaria orokonuiana Fryday & A.Knight, *Australasian Lichenology* 70: 27 (2012)

Type: New Zealand. South Island: Otago: Dunedin, Orokonui Ecosanctuary, 45°46'S, 170°36'E, alt. 236 m, on bark at base of trunk in kanuka grove, *A. Knight s.n.*, 12 Jul 2010; holotype: OTA 60695 *n.v.*; isotypes: CANB!, MSC *n.v.*

Thallus crustose, epiphloeodal, olivaceous, grey-brown or pale greyish green, (0.05–)0.2–0.5(–1) mm thick, granulose-isidiate to coralloid-isidiate. *Photobiont* chlorococcoid; cells mostly globose, 5–10(–12) µm wide. *Medulla* loose, almost byssoid in places; hyphae variously orientated, long-celled, 4–6 µm wide. *Prothallus* thin and white, or not apparent. *Apothecia* sparse to numerous, rounded or slightly irregular in outline, adnate or basally constricted, uniformly dull black, rarely with slightly paler patches, (0.5–)1.5(–2.7) mm diam. [*n* = 50], usually solitary and scattered, occasionally clustered; proper margin often prominent, entire or flexuose, persistent or becoming excluded around the most convex apothecia; disc initially slightly concave or plane, becoming slightly to moderately convex, smooth, epruinose. *Proper excipulum* cupulate in section, 50–150 µm thick laterally, 100–180 µm thick at the base, laterally uniformly dark violet-grey to blue-black, or pigmented internally and with hyaline outer layer 10–25 µm thick; basal excipulum bilayered, internally blue-black and 50–80 µm thick, externally hyaline and 20–50 (–70) µm thick; hyphae radiating outwards laterally and downwards basally, anastomosing, tightly coherent, very thick-walled; pigmented parts K+ greenish blue or green, H+ bluish, N+ violet or purple. *Hypothecium* bilayered, not inspersed with oil globules or granules; upper layer of compacted hyphae, dark reddish brown or chestnut-brown, 50–100(–150) µm thick, K+ slightly darker or purple-brown, N+ red or deep red-brown; lower layer of loose, randomly orientated hyphae, hyaline to pale brown, 80–160 µm thick. *Hymenium* 120–180 µm thick, not inspersed. *Epihymenium* dark olive-grey to blue-black, 10–20(–25) µm thick, K+ blue-green or blue-grey, H+ deep blue, I–, N+ violet or red. *Paraphyses* simple, 1–1.5(–2) µm thick, separating in K but conglutinate at the epihymenium; apices not or only slightly swollen, with a cap of dark olive-grey to blue-black pigment. *Asci* narrowly clavate to clavate-cylindrical, ± *Biatora*-type, mostly 8-spored, occasionally with 2–4 spores aborted, 100–125 × 27–35 µm. *Ascospores* narrowly ellipsoid or oblong-ellipsoid, rarely more broadly ellipsoid, 1-septate, hyaline, straight or slightly curved, (20–)31(–41) × (9–)14(–17) µm [*n* = 115]; apices rounded or subacute; wall 1–2(–3) µm thick. *Pycnidia* not seen.

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

Relationships: For a comparison with other isidiate species of *Megalaria*, see the discussion of *M. montana* (above).

Distribution and habitat: Previously known only from bark at the type locality in southern New Zealand (Fryday and Knight 2012), *Megalaria orokonuiana* is reported here from forest trees in the Northern and Southern Tablelands of New South Wales and from the Gippsland Plain and East Gippsland, Victoria.

Additional specimens examined: NEW SOUTH WALES: Northern Tablelands: Barrington Tops Forest Road, Barrington Tops State Forest, 42 km WNW of Gloucester, 31°55'S, 151°30'E, alt. 1340 m, on bark of Proteaceae species in disturbed *Nothofagus* forest bordering *Eucalyptus* forest, *J.A. Elix 24874*, 26 Apr 1990 (CANB); Southern Tablelands: along the Mongarlowe River, 3.5 km S of Monga, 35°37'S, 149°55'E, alt. 665 m, on bark of *Leptospermum* sp. in wet-sclerophyll forest, *J.A. Elix 30247*, 19 Sep 1993 (CANB). **VICTORIA:** East Gippsland: Spring Creek, 1 km W of Buchan, 37°30'S, 148°10'E, alt. 250 m, on stem of *Telopea* sp. in disturbed wet-sclerophyll forest in valley, *J.A. Elix 39755*, 2 Oct 1988 (CANB); Gippsland Plain: Fosters Gully Nature Walk, Morwell National Park, c. 16 km S of Morwell, on bark in wet-sclerophyll forest, *I.M. Chang 4*, 2016 (CANB).

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