

New species of *Megalaria* (lichenized Ascomycota, Ramalinaceae) from Queensland, Lord Howe Island and Norfolk Island, Australia

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### Abstract

Four species of *Megalaria* Hafellner are described as new from tropical and subtropical Australia: *M. australiensis* from eastern Queensland and Lord Howe Island (corticolous and containing atranorin; excipulum bilayered, internally pale with variously orientated hyphae; epihymenium N+ maroon or blood-red; hymenium 70–100 µm thick; ascospores 12–23 × 4–7.5 µm); *M. crystallifera* from Lord Howe Island (corticolous and containing atranorin; excipulum internally pale, with tightly packed, radiating hyphae, the oblong to moniliform cells containing K-soluble crystals; epihymenium N+ purple; hymenium 55–90 µm thick; ascospores 10–17 × 4.5–7 µm); *M. norfolkensis* from Norfolk Island (corticolous and containing atranorin; excipulum bilayered, internally pale with variously orientated hyphae; epihymenium N+ deep maroon; hymenium 100–160 µm thick; ascospores 13–24 × 6–11 µm); and *M. stratosa* from north-eastern Queensland and Lord Howe Island (saxicolous and lacking lichen substances; excipulum multilayered, internally dense and very dark; epihymenium N+ violet or purple-violet; hymenium 60–100 µm thick; ascospores 9.5–18 × 4–7 µm).

### Introduction

*Megalaria* Hafellner (Ramalinaceae) is an almost cosmopolitan genus of *c.* 45 mainly corticolous, crustose species. The thallus is often wide-spreading and robust, usually pale, smooth, granular or verruculose, occasionally isidiate, rarely sorediate, completely lacking lichen substances or with a very limited suite of depsides, depsidones and terpenoids, and it contains a unicellular green photobiont. Apothecia are comparatively large, usually sessile and mainly or completely black, lacking a thalline margin but with a usually thick and persistent, sometimes comparatively pale proper margin that is internally a cupulate proper excipulum, an amyloid hymenium with *Biatora*- or *Bacidia*-type asci or a variant of the *Lecanora*-type, simple, sparingly branched or somewhat anastomosing paraphyses, and small to moderately large, colourless, 1-septate ascospores (Hafellner 1984; Coppins 1992; Ekman & Tønberg 1996; Fryday 2004, 2007; Galloway 2007; Jagadeesh Ram *et al.* 2007; Kalb 2007; Fryday & Lendemer 2010; Fryday & Knight 2012; Lendemer *et al.* 2016; McMullin & Lendemer 2016; Su & Ren 2017; Wang *et al.* 2019; Aptroot *et al.* 2021; Cannon *et al.* 2021; Nimis & Martellos 2021).

Sixteen species of *Megalaria* are known from mainland Australia and its oceanic islands (McCarthy 2020). Recent contributions have included detailed accounts of the genus in Tasmania (Kantvilas 2008, 2016), as well as new taxa and new records from temperate, subtropical and wet-tropical localities (McCarthy & Elix 2016a, b; Elix & McCarthy 2018). In this paper four species are described as new from eastern Queensland and the Australian territories of Lord Howe Island and Norfolk Island in the south-western Pacific Ocean. All have a superficial, off-whitish to pale grey-green thallus that is sparingly rimose to areolate, smooth to minutely granulate or verruculose and lacks soralia and isidia, and all, apart from *M. stratosa* (the only saxicolous species), contain atranorin in major concentrations. The jet-black apothecia are sessile, usually persistently marginate, mostly 0.5–1(–1.4) mm in diameter, they have a deep red to medium or dark red-brown hypothecium (the colour usually intensifying in N), an indigo to blue-black epihymenium and comparatively small ascospores.

### 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; apothecial sections were also treated with 10% potassium hydroxide (K) and 50% nitric acid (N). Calcium oxalate was detected by treatment of thallus fragments with a 10% aqueous solution of sulfuric acid (H<sub>2</sub>SO<sub>4</sub>); it forms colourless, needle-shaped crystals. Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K. Chemical constituents were identified by thin-layer chromatography (Elix 2020) and comparison with authentic samples.

### The species

#### 1. *Megalaria australiensis* P.M. McCarthy & Elix Mycobank No.: MB 841085

Figs 1, 5B, 6A

Characterized by an epiphloeodal thallus containing atranorin (major), uniformly black apothecia 0.33–0.98 mm wide, each with a pale, inner excipulum of loose and variously orientated hyphae, usually lacking crystals, and a thin outer layer of mainly blue-black, thick-walled, radiating hyphae, a blue-black epihymenium (N+ maroon or blood-red), a deep red to medium or deep red-brown or dark brown hypothecium (N+ intensifying or blood-red to crimson), asci that are 58–75 × 11–17 µm in a hymenium 70–100 µm thick, and rather elongate, 1-septate ascospores (12–23 × 4–7.5 µm).

*Type:* Australia, Queensland, Newell, 6 km NE of Mossman, 16°25'S, 145°24'E, 1 m alt., on *Bruguiera* stem in mangrove vegetation beside creek estuary, *H. Streimann 31064*, 6.vii.1984 (holotype – CANB).

*Thallus* crustose, epiphloeodal, off-white to pale creamy grey or pale to medium greenish grey or pale greyish green, continuous to sparingly or richly rimose, less commonly areolate (the areoles 0.2–1 mm wide), dull, smooth or irregularly and minutely granulate or verruculose, (40–)90–150(–200) µm thick, not containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub>–), I–; soredia and isidia absent. *Cortex* absent, but the thallus often with a hyaline, amorphous alga-free layer to 10–15 µm thick. *Algal layer* poorly delimited, to *c.* 100 µm thick; cells green, chlorococcoid, 6–11 (–13) µm diam.; interstitial hyphae short-celled, thin-walled, *c.* 2.5–3.5 µm wide. *Medulla* indistinct. *Prothallus* blackish and sharply defined, or diffuse, broad and bluish black, or not apparent. *Apothecia* usually very numerous, solitary, paired or forming clusters of 3–6 proliferating from a single apothecium, (0.33–)0.61(–0.98) mm wide [*n* = 238; clusters to 1.7 mm wide], becoming sessile; margin usually glossy black, entire, often flexuose, not very prominent, 50–90 µm thick, persistent to maturity but then thin, fissured or ragged, becoming excluded; disc at first slightly concave to plane, later undulate or weakly to moderately convex, dull jet-black, occasionally piebald or dark pinkish brown, smooth to minutely uneven, epruinose. *Proper excipulum* cupulate, 60–90(–120) µm thick laterally and at the base, of 2 well-defined layers (see Fig. 5B): i) inner layer adjacent to the hypothecium ± pale brownish grey, 40–70(–100) µm thick, of comparatively loose, variously orientated hyphae 2–3 µm wide, often with lacunae and scattered or clustered crystals to *c.* 20 µm wide (K–, N–, H<sub>2</sub>SO<sub>4</sub>–); ii), outer layer of radiating hyphae (prosoplectenchymatous), 20–30(–40) µm thick, the hyphae directed outwards laterally and downwards basally, tightly coherent, 1.5–2.5 µm wide, with a thick coat 5–8(–10) µm wide; in the lateral excipulum this layer uniformly blue-black, or with hints of red-brown, K+ deep purple-brown to reddish black in part, N+ maroon to deep maroon; in the basal excipulum with the outermost *c.* 10–15 µm hyaline to pale blue, the innermost half of this zone blue-black. *Hypothecium* 70–130(–150) µm thick, not interspersed with granules or oil globules, deep red to medium or deep red-brown or dark brown (darkest in the centre, paler towards the hymenium and the excipulum base), N+ intensifying or blood-red to crimson, K+ intensifying or maroon to red-black; hyphae variously orientated, 2.5–4 µm wide. *Hymenium* 70–100 µm thick, not interspersed, uniformly hyaline, or diffuse brownish

adjacent to the hypothecium, KI+ deep blue, N-, K-. *Epihymenium* usually well-delimited, medium grey-brown to blue-black, 10–20(–25) µm thick, N+ maroon or blood-red, K- or K+ bluish green. *Paraphyses* usually simple for most of their length, with sparse branches and anastomoses mainly in the epihymenium, tightly conglutinate in water, 1–1.5(–2) µm thick; apical cells usually swollen and rounded, 2–3(–4) µm wide, thick-walled, these and the subtending hyphal cell blue-black. *Asci* narrowly to broadly clavate or clavate-cylindrical, almost exclusively 8-spored, 58–75 × 11–17 µm [*n* = 25]; tholus with a narrow, tube-like, moderately to deeply amyloid zone. *Ascospores* narrowly ellipsoid or oblong-ellipsoid to somewhat fusiform, hyaline, 1-septate, overlapping-uniseriate to irregularly biseriolate in the ascus, not or only slightly constricted at the septum, straight or slightly bent, (12–)17(–23) × (4–)5.5(–7.5) µm [*n* = 388; 179 ascospores (*c.* 46%) 17 µm long or longer; cf. *M. crystallifera* and *M. stratosa*, below]; apices rounded or subacute; wall smooth, 0.8–1.2 µm thick; epispore not apparent. *Pycnidia* not seen.

*Chemistry*: Thallus containing atranorin (major) by TLC.

*Etymology*: The epithet *australiensis* refers to this being an Australian species.

### Remarks

The corticolous *M. australiensis* has ascospores that are longer than those of *M. crystallifera* and the saxicolous and TLC-negative *M. stratosa* (12–23 µm long vs 9.5–18 µm; Fig. 6), the blue-black epihymenium reacts maroon or blood-red in N and the bilayered excipulum is pale with variously orientated hyphae internally but radiating-prosoplectenchymatous and bluish black near the surface. While excipular anatomy is closer to that of *M. norfolkensis* than the multilayered *M. stratosa*, the more-or-less uniformly pigmented hypothecium of *M. australiensis* differs from that of the Norfolk Island species which is distinctly bilayered (darker below and paler above), while the ascospores are narrower ((4–)5.5(–7.5) µm vs (6–)8(–11) µm; Fig. 6).

The similarly small-spored *M. laureri* (Th.Fr.) Hafellner, a predominantly temperate species across the Northern Hemisphere, has also been reported from tropical and temperate Australia (South Australia, Queensland, New South Wales and Tasmania; McCarthy 2020), although not always with unambiguous certainty (*vide* Kantvilas 2008). A corticolous species with little or no atranorin in its thallus, and an apothecial margin that is often paler than the blackish disc (Coppins 1992; Cannon *et al.* 2021; Nimis & Martellos 2021), apothecial sections have a dominant, pink or purple-pink pigment that intensifies pinkish in K and reacts N+ orange (Kantvilas 2008, 2019; Cannon *et al.* 2021; Nimis & Martellos 2021). The corticolous *M. hafellneriana* Kantvilas, another small-spored species known only from southern New South Wales, Victoria and Tasmania, is characterized by its granular thallus that lacks lichen substances and apothecial sections dominated by blue-green, N+ crimson pigments (Kantvilas 2016).

Two endemic species in New Zealand, *M. maculosa* (Stirt.) D.J.Galloway and *M. sublvensis* (Nyl.) D.J.Galloway, also produce small 1-septate ascospores, but both have a pale hypothecium (Galloway 1985, 2007). The saxicolous *M. obhudens* (Nyl.) Fryday & Lendemer (syn. *M. imshaugii* Fryday), from Chile and Campbell Island, New Zealand, has a much thicker, areolate thallus lacking lichen substances, as well as a thicker hymenium and longer asci (Fryday 2004; Fryday & Lendemer 2010). Finally, *M. columbiana* (G.Merr.) S.Ekman, a rather common corticolous lichen on the west coast of North America, has small ascospores similar to those of *M. australiensis*, but also a red to red-black excipulum, a brown to red-brown epihymenium and a bright blue-green hypothecium (Noble 1980, as *Catillaria*; Ekman & Tønsberg 1996).

*Megalaria australiensis* grows on the twigs, branches and trunks of rainforest trees and those in strand and mangrove vegetation in the wet-tropics and subtropics of eastern Queensland; it is also known from a palm trunk in moist forest in Lord Howe Island in the south-western Pacific Ocean. Associated species include *Astrothelium meristosporum* (Mont. & Bosch.) Aptroot & Lücking, *Brigantaea tricolor* (Mont.) Trevis., *Coccocarpia palmicola* (Spreng.) Arv. & D.J.Galloway, *Heterodermia appendiculata* (Kurok.) Swinscow & Krog, *Lecanora dissoluta* Nyl., *Letrouitia domingensis* (Pers.) Hafellner & Bellem., *Parmeliella*

*mariana* (Fr.) P.M.Jørg. & D.J.Galloway, *Pyxine fallax* (Zahlbr.) Kalb, *Relicinopsis malacensis* (Nyl.) Elix & Verdon and *Trypethelium eluteriae* Spreng.

### ADDITIONAL SPECIMENS EXAMINED

*Queensland*: ● Annan River, Grass Tree Pocket Road, 37 km S of Cooktown, 15°48'S, 145°14'E, 240 m alt., on tree trunk in monsoon forest on gentle ridge, *H. Streimann 46387*, 11.xii.1990 (CANB); ● Lookout over Barron Falls, Atherton Tableland, 16°50'S, 145°39'E, on bark in rainforest, *W.H. Ewers 8561*, 29.ix.1991 (CANB); ● Tinaroo Dam, 2 km past dam wall, Atherton Tableland, 17°10'S, 145°33'E, on twig in rainforest, *W.H. Ewers 8118*, 25.ix.1991 (CANB); ● Tully Gorge, 49 km NW of Tully, 17°45'20"S, 145°37'39"E, 145 m alt., on fallen tree trunk at margin of rainforest, *J.A. Elix 36967, 37004*, 28.vii.2006 (CANB); ● Garners Beach, 23 km NE of Tully, 17°49'S, 146°06'E, 1 m alt., on dead *Bruguiera* in strand vegetation, *H. Streimann 45502*, 1.xii.1990 (CANB); ● Stony Creek, Bowen State Forest, 25 km NNW of Yeppoon, 22°55'S, 150°39'E, 100 m alt., on shrub in remnant monsoon forest in head of gully, *J.A. Elix 34568*, 24.viii.1993 (CANB); ● Coochiemudlo Island, near Brisbane, 23°34'S, 153°20'E, 1–5 m alt., on bark in mixed mangrove vegetation, *C.H. Miller 128*, 30.viii.1984 (CANB).

*New South Wales, Lord Howe Island*: ● track to Goathouse Cave, at base of escarpment of Mt Lidgbird, 31°33'48"S, 159°05'11"E, 380 m alt., on base of palm in moist semi-tropical forest, *J.A. Elix 42085*, 7.ii.1995 (CANB).

**2. *Megalaria crystallifera*** P.M.McCarthy & Elix  
Mycobank No.: **MB 841086**

Figs 2, 5C, 6B

Characterized by an epiphloeodal thallus containing atranorin (major), uniformly black apothecia 0.35–0.83 mm wide, each with a comparatively pale, inner excipulum of tightly packed, radiating hyphae with oblong to moniliform cells containing K-soluble crystals and 10–16 × 5–10 µm, a blue-black epihymenium (N+ purple), a deep red to deep red-brown hypothecium (N+ intensifying or blood-red), asci that are 40–61 × 10–16 µm in a hymenium 55–90 µm thick, and small, 1-septate ascospores (10–17 × 4.5–7 µm).

*Type*: Australia, New South Wales, Lord Howe Island, track to Goathouse Cave, at base of escarpment of Mt Lidgbird, 31°33'48"S, 159°05'11"E, 380 m alt., on tree trunk in moist semi-tropical forest, *J.A. Elix 42077*, 7.ii.1995 (holotype – CANB).

*Thallus* crustose, epiphloeodal, greenish white to pale creamy grey, continuous to sparingly to richly and intricately rimose, or areolate (the areoles 0.3–0.8 mm wide), dull, smooth or irregularly and minutely uneven, (40–)60–100(–120) µm thick, with or without crystal-like inclusions of calcium oxalate (H<sub>2</sub>SO<sub>4</sub>+ or H<sub>2</sub>SO<sub>4</sub>-), I-; soredia and isidia absent. *Cortex* absent, but the thallus usually with an uppermost hyaline, amorphous alga-free layer to 20–35 µm thick. *Algal layer* poorly defined and discontinuous, to *c.* 70 µm thick; cells green, chlorococcoid, 6–12 µm diam.; interstitial hyphae short-celled, thin-walled, *c.* 2–3.5 µm wide. *Medulla* indistinct. *Prothallus* marginal, blackish and sharply defined, or patchy or not apparent. *Apothecia* usually very numerous, solitary, paired or forming clusters of 3 or 4 proliferating from a single apothecium, (0.35–)0.61(–0.83) mm wide [*n* = 111], becoming sessile; margin usually glossy black, entire, not very prominent, 40–70 µm thick, soon becoming excluded; disc plane to slightly convex, dull, jet-black, smooth to minutely uneven, epruinose. *Proper excipulum* cupulate, 55–100(–130) µm thick laterally and at the base, of 2 or 3 well-delimited layers (see Fig. 5C): i) inner layer appearing whitish in the cut surface of a vertically sectioned apothecium, ± pale brownish grey in thin section, 40–90(–120) µm thick, lacking lacunae and large crystals, of tightly packed downwardly and outwardly radiating hyphae; cells 10–16 × 5–10 µm, oblong or moniliform, thick-walled, packed with elongate crystals (1.5–2.5 µm long) most of which dissolve in K; ii) outer layer of radiating hyphae (prosoplectenchymatous), 12–25 µm thick, the hyphae tightly coherent, with a thick coat 7–11 µm wide; in the lateral excipulum this layer uniformly blue-black, K+ indigo, N+

deep maroon; in the basal excipulum the hyphae with blue-black caps; iii) outermost, amorphous, hyaline layer 5–10 µm thick (not always present). *Hypothecium* 70–110(–130) µm thick, not interspersed with granules or oil globules, deep red to deep red-brown, with a sharply defined border with the excipulum base, N+ intensifying or blood-red, K+ intensifying or maroon. *Hymenium* 55–80 µm thick, not interspersed, uniformly hyaline or diffusely pale brownish adjacent to the hypothecium, KI+ deep blue, N–, K–. *Epihymenium* well-delimited and blue-black or patchily pigmented, 10–20(–25) µm thick, N+ purple, K– or K+ bluish green. *Paraphyses* usually simple for most of their length, with sparse branches and anastomoses mainly in the epihymenium, tightly conglutinate in water, 1–1.5(–2) µm thick; apices deeply pigmented, slightly swollen and often rounded, 1.5–2.5(–3) µm wide. *Asci* narrowly to broadly clavate, 8-spored, 40–61 × 10–16 µm [*n* = 25]; tholus with a narrow, tube-like, moderately to deeply amyloid zone. *Ascospores* narrowly ellipsoid or oblong-ellipsoid to somewhat fusiform, hyaline, 1-septate, overlapping-uniseriate to irregularly biseriolate or distally massed in the ascus, not or only slightly constricted at the septum, straight, curved or bent, (10–)14(–17) × (4.5–)5.5(–7) µm [*n* = 150; with 1 ascospore 17 µm long]; apices rounded or subacute; wall smooth, 0.8–1.2 µm thick; epispore not apparent. *Pycnidia* not seen. *Chemistry*: Thallus containing atranorin (major) by TLC.

*Etymology*: The epithet *crystallifera* refers to the K-soluble crystals of the massively impregnated excipulum.

### Remarks

While the thallus of *M. crystallifera* contains abundant atranorin, and thus matches the three other corticolous species described here, its small ascospore dimensions, the thickness of the hymenium and the similarly pigmented and N-reactive epihymenium agree instead with the saxicolous *M. stratosa*. However, the excipulum is bilayered, not multilayered as in the latter taxon, with a comparatively pale, inner excipulum of radiating prosoplectenchymatous or moniliform hyphae, the cells containing massed K-soluble crystals, while in the basal outer excipulum the hyphal tips have distinctive, blue-black caps. Indeed, the faintly powdery appearance of the crystalliferous tissues of the excipulum is usually visible even on the cut surface of a vertically sectioned apothecium.

This lichen grows on the branches and trunks of trees in lowland, subtropical forest in Lord Howe Island in the south-western Pacific Ocean. Associated species include *Menegazzia lordhowensis* Elix, *Parmotrema crinitum* (Ach.) M.Choisy, *Parmotrema reticulatum* (Taylor) M.Choisy, *Phyllopsora foliata* (Stirt.) Zahlbr., *Phycia soredata* Nyl., *Porina eminentior* (Nyl.) P.M.McCarthy and *Pyrenula anomala* (Ach.) Vain.

### ADDITIONAL SPECIMENS EXAMINED

*New South Wales, Lord Howe Island*: ● Intermediate Hill via track to North Hummock, 31°32'45"S, 159°04'55"E, 120 m alt., on *Cryptocarya* in poor lowland forest with dense shrub cover on steep slope, *J.A. Elix 42028*, 5.ii.1995 (CANB); ● track from Smoking Tree Ridge to Rocky Run, 31°33'35"S, 159°05'09"E, 170 m alt., on tree in lowland forest on moderate slope, *J.A. Elix 42433, 42444*, 10.ii.1995 (CANB).

**3. *Megalaria norfolkensis*** P.M.McCarthy & Elix  
Mycobank No.: **MB 841087**

Figs 3, 5D, 6C

Characterized by an epiphloeodal thallus containing atranorin (major), uniformly black apothecia 0.45–1.48 mm wide, each with a comparatively pale, inner excipulum of loose and variously orientated hyphae, usually lacking crystals, and a thin outer layer of mainly blue-black, thick-walled, radiating hyphae, a blue-black epihymenium (N+ deep maroon), a bilayered hypothecium (pale to medium red-brown above, dark red-brown below; N+ intensifying), 4–8-spored asci (75–90 × 14–20 µm) in a hymenium 100–160 µm thick, and moderately large, 1-septate ascospores (13–24 × 6–11 µm).

*Type*: Australia, Norfolk Island, Mount Pitt National Park, track between Mt Pitt and Mt Bates, 29°00'05"S, 167°56'05"E, 270 m alt., on *Nestigia* in disturbed forest, *J.A. Elix 27391*, 15.vi.1992 (holotype – CANB).

*Thallus* crustose, epiphloeodal, whitish to pale greenish grey, continuous to sparingly rimose, not forming areoles, dull, mainly smooth but partly minutely and irregularly granulose-verruculose, 40–100 µm thick, not containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub>–), I–; soredia and isidia absent. *Cortex* absent, but the thallus with a patchy, hyaline, amorphous alga-free layer 10–20 µm thick. *Algal layer* poorly delimited, 30–60 µm thick; cells green, chlorococcoid, 6–10 (–12) µm diam.; interstitial hyphae short-celled, thin-walled, *c.* 2.5–3.5 µm wide. *Medulla* indistinct. *Prothallus* blackish, discontinuous. *Apothecia* sparse, solitary, (0.45–)0.82(–1.48) mm wide [*n* = 45], becoming sessile; margin glossy black, entire to crenulate and often flexuous, not very prominent, 40–80 µm thick, usually persisting to maturity; disc plane to slightly convex, dull jet-black, smooth, epruinose. *Proper excipulum* cupulate, 50–90 µm thick laterally, 90–150 µm thick at the base, of 2 distinct layers (see Fig. 5D): i) inner layer adjacent to the hypothecium ± pale brownish grey, 70–110 µm thick, of comparatively loose, variously orientated hyphae 2–3 µm wide, often with lacunae and scattered or clustered crystals to *c.* 30 µm wide (these largely dissolving in N); ii), outer layer of radiating hyphae (prosoplectenchymatous), 25–35(–45) µm thick, the hyphae directed outwards laterally and downwards basally, tightly coherent, *c.* 1 µm wide, with a thick coat 4–6 µm wide; in the lateral excipulum this layer uniformly blue-black, K+ indigo, N+ violet; in the basal excipulum with the outermost *c.* 10–15 µm hyaline to pale blue, the innermost half of this zone blue-black. *Hypothecium* 100–150 µm thick, not interspersed with granules or oil globules, ± bilayered, pale to medium red-brown above, dark red-brown below, N+ intensifying, K+ deep maroon below. *Hymenium* 100–140(–160) µm thick, not interspersed, uniformly hyaline, KI+ deep blue, N–, K–. *Epihymenium* blue-black, 15–25 µm thick, N+ deep maroon, K– or K+ blue. *Paraphyses* simple for most of their length, with sparse branches and anastomoses mainly in the epihymenium, tightly conglutinate in water, 1–1.5 µm thick; apical cells deeply pigmented, swollen and often rounded, 2–4 µm wide. *Asci* narrowly to broadly clavate, 4-spored (with 4 others minute or aborted) or 8-spored, 75–90 × 14–20 µm [*n* = 10]; tholus with a narrow, tube-like, moderately to deeply amyloid zone. *Ascospores* narrowly to broadly ellipsoid, hyaline, 1-septate, overlapping-uniseriate to irregularly biseriolate in the ascus, not or only very slightly constricted at the septum, mostly straight, (13–)18(–24) × (6–)8(–11) µm [*n* = 130]; apices rounded or subacute; wall smooth, *c.* 1 µm thick; epispore not apparent. *Pycnidia* not seen.

*Chemistry*: Thallus containing atranorin (major) by TLC.

*Etymology*: The epithet refers to the occurrence of this species in Norfolk Island.

### Remarks

Currently the rarest of the four newly described taxa, *M. norfolkensis* has an excipular anatomy almost identical to that of *M. australiensis* (Fig. 5), while its corticolous thallus also contains atranorin, and the epihymenium is N+ deep maroon. However, the hymenium is thicker (100–160 µm vs 70–100 µm), the ascospores are broader (6–11 µm wide vs 4–7.5 µm; Fig. 6), and the deep red to brown hypothecium is distinctly bilayered (darker below and paler above) rather than more-or-less uniformly pigmented as in *M. australiensis*. Apothecial pigmentation and reactions further distinguish *M. norfolkensis* from *M. laureri* and *M. hafellneriana* (see above), while the thinner and uniformly paler hypothecia of the small-spored corticolous New Zealand endemics *M. maculosa* and *M. sublivens* are also distinctive and diagnostic.

This lichen is known only from the type locality in Norfolk Island in the south-western Pacific Ocean, where it grows on a trunk of *Nestigia* in disturbed forest and in association with *Dirinaria applanata* (Fée) D.D.Awasthi, *Heterodermia subcomosa* (Nyl.) Elix, *Parmotrema reticulatum* (Taylor) M.Choisy, *Phyllopsora buettneri* (Müll.Arg.) Zahlbr., *Pyrenula cruenta* (Mont.) Vain., *Pyxine cocoes* (Sw.) Nyl. and *Ramalina stevensiae* Elix.

Characterized by an epilithic thallus lacking lichen substances, uniformly black apothecia 0.32–1.46 mm wide, each with a multilayered and comparatively dark excipulum lacking crystals, and with only the outermost hyphae radiating, with a blue-black epihymenium (N+ violet or purple-violet), a deep red or maroon to deep red-brown or brown-black hypothecium (N+ deep red, blood-red or crimson), asci that are 43–65 × 10–15 µm in a hymenium 60–80 (–100) µm thick, and small, 1-septate ascospores (9.5–18 × 4–7 µm).

*Type:* Australia, Queensland, 30 km SSE of Cooktown, Wallaby Creek, Home Rule Falls, 15°44'S, 145°18'E, 240 m alt., on semi-shaded, siliceous rock in gorge beside permanent creek, in *Tristaniopsis*-dominated forest, *H. Streimann* 57533, 23.x.1995 (holotype – CANB; according to the label, duplicate in B, *n.v.*).

*Thallus* crustose, epilithic, off-white to pale grey, pale greenish grey or pale to medium yellowish grey, continuous to sparingly or richly rimose, or areolate (areoles 0.2–1(–1.5) mm wide), dull, smooth or irregularly and minutely granulose or verruculose, (50–)100–250(–500) µm thick, not containing calcium oxalate (H<sub>2</sub>SO<sub>4</sub>–), I–; soredia and isidia absent. *Cortex* 10–15(–25) µm thick, of poorly defined periclinal hyphae 2–2.5 µm wide or thick-walled paraplectenchymatous cells, or apparently ecorticate, but the thallus often with only a hyaline, amorphous alga-free layer to 10–15(–20) µm thick. *Algal layer* poorly delimited or forming a continuous layer to 70–120(–180) µm thick; cells green, chlorococcoid, (5–)6–12(–14) µm diam.; interstitial hyphae short-celled, thin-walled, *c.* 2–2.5 µm wide. *Medulla* indistinct, the lower levels of the thallus dominated by substratum material. *Prothallus* dark grey to blackish and sharply defined between adjacent thalli, or not apparent. *Apothecia* usually numerous, solitary, paired or forming clusters proliferating from a single apothecium, (0.32–)0.75(–1.46) mm wide [*n* = 310], becoming sessile; margin usually glossy black, entire or minutely uneven and fissured or crenulate, often flexuous, prominent or not, 50–80(–100) µm thick, persistent to maturity or becoming excluded; disc at first slightly concave to plane, later undulate or moderately convex, dull greyish black to jet-black, smooth, epruinose. *Proper excipulum* cupulate, 55–90(–130) µm thick laterally, 90–150(–180) µm thick at the base, predominantly blue-black, N+ deep violet, K+ paler blue-black or greyish black infused purple, of 3 or 4 well-delimited layers (see Fig. 5A): i) innermost layer adjacent to the hypothecium dense and very dark, 50–80 µm thick, ± parenchymatous; ii), this subtended by a looser, anatomically similar and slightly paler zone (50–80(–100) µm thick) often with minute lacunae and small scattered crystals (K–, N–, H<sub>2</sub>SO<sub>4</sub>–); iii) a radiating hyphal layer 10–25 µm thick, the hyphae directed outwards laterally and downwards basally, tightly coherent, *c.* 2–3 µm wide, with a thick coat 6–10 µm wide; iv) outermost, amorphous, hyaline layer 5–10(–15) µm thick (not always present). *Hypothecium* 50–80(–120) µm thick, not interspersed with granules or oil globules, red or maroon to deep red-brown or brown-black, N+ deep red, blood-red or crimson, K– or K+ purple or maroon. *Hymenium* 60–80(–100) µm thick, not interspersed, uniformly hyaline or patchily brownish and reduced in post-mature apothecia, KI+ deep blue, N–, K–. *Epihymenium* usually well-delimited, indigo to blue-black, 8–15(–20) µm thick, N+ violet or purple-violet, K–. *Paraphyses* simple to sparingly branched, with sparse anastomoses, tightly conglutinate in water, 1–1.5(–1.8) µm thick; apices deeply pigmented, slightly to strongly swollen and rounded (2.5–3.5(–4) µm). *Asci* narrowly to broadly clavate or clavate-cylindrical, (4–)8-spored, 43–65 × 10–15 µm [*n* = 25]; tholus penetrated almost to the apex by a broad apical cushion that is bordered by a narrow, moderately to deeply amyloid zone; ocular chamber low-convex to hemispherical. *Ascospores* narrowly to broadly ellipsoid or oblong-ellipsoid to somewhat fusiform, hyaline, 1-septate, overlapping-uniseriate to irregularly biseriolate in the ascus, not or only slightly constricted at the septum, straight or slightly bent, occasionally ± fabiform, (9.5–)14.5(–18) × (4–)5(–7) µm [*n* = 366; 10 ascospores (*c.* 3%) 17 µm long or longer]; apices rounded or subacute; wall smooth, 0.8–1.2 µm thick; epispore not apparent. *Pycnidia* absent, or present and numerous (seen in two of the eight specimens

examined), semi-immersed to almost completely immersed in the thallus, 50–90 µm wide, obpyriform to subglobose; apex dark brown to blackish and 15–25 µm thick, hyaline below; conidiophores simple, 15–25 µm long and *c.* 0.8 µm wide. *Conidia* narrowly ellipsoid or fusiform to bacilliform, 2–3(–3.5) × 0.5–0.8 µm.  
*Chemistry:* No substances detected by TLC.

*Etymology:* The epithet *stratosata* (layered) refers to the anatomy of the excipulum in thin section.

#### Remarks

*Megalaria stratosata*, the only exclusively saxicolous lichen among the new species, has a thallus that lacks lichen substances, comparatively short and narrow ascospores, and the epihymenium reacts violet or purple-violet in N. Most distinctively, it has a multilayered excipulum, with or without a hyaline, amorphous external layer (Fig. 5). Like two of the three other new taxa (but not *M. norfolkensis*), it has a thin hymenium less than 100 µm deep. Another small-spored saxicolous species, *M. oblundens* (Nyl.) Fryday & Lendemer (syn. *M. imshaugii* Fryday), from Chile and Campbell Island, New Zealand, has an anatomically far less intricate excipulum, a thicker hymenium, a thin, dark blue hypothecium and asci 80–85 µm long (Fryday 2004).

This lichen grows on various siliceous rock types in rainforest and scrub and in lowland, subtropical forest in north-eastern Queensland and Lord Howe Island in the south-western Pacific Ocean. Associated species include *Buellia dimbulahensis* Elix, *Cratiria vioexanthina* (Elix) Kalb & Elix, *Dirinara flava* (Mull. Arg.) C.W. Dodge, *Letrouitia bifera* (Nyl.) Hafellner, *Parmotrema crinitum* (Ach.) M. Choisy, *Pyxine pungens* Zahlbr., *Pyxine subcinerea* Stirt. and *Xanthoparmelia amplexula* (Stirt.) Elix & J. Johnst.

#### ADDITIONAL SPECIMENS EXAMINED

*Queensland:* ● type locality, *H. Streimann* 57532, 57536, 57538, 23.x.1995 (CANB; according to the labels, duplicates in B, *n.v.*); ● 32 km SSE of Cooktown, Slaty Creek, Home Rule, 15°45'S, 145°17'E, 230 m alt., on semi-exposed, siliceous rock, in forest on moderate slope, *H. Streimann* 64530, 29.viii.1999 (CANB; according to the label, duplicate in B, *n.v.*); ● 18 km NNE of Proserpine, Charleys Creek, 20°15'S, 148°38'E, 50 m alt., on basalt in poor, scrubby forest on rocky hillside, *J.A. Elix* 21004 & *H. Streimann*, 30.vi.1986 (CANB).  
*New South Wales, Lord Howe Island:* ● Max Nicholls Track, 31°31'08"S, 159°03'03"E, 50 m alt., on basalt in dry, lowland forest, *J.A. Elix* 32730, 20.vi.1992 (CANB); ● Goathouse Cave, at base of escarpment of Mt Lidgbird, 31°33'50"S, 159°05'15"E, 420 m alt., on semi-shaded basalt rockface in moist forest, *H. Streimann* 55842, 7.ii.1995 (CANB; according to the label, duplicate in B, *n.v.*); ● Boat Harbour, 31°33'40"S, 159°05'50"E, 3 m alt., on basalt rocks along foreshore in disturbed lowland vegetation with palms, *J.A. Elix* 42474, 10.ii.1995 (CANB; according to the label, duplicates in B, H, NY, *n.v.*).

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Figure 1. *Megalaria australiensis* (holotype in CANB). Scale = 1 mm.



Figure 2. *Megalaria crystallifera* (holotype in CANB). Scales = 2 mm.



Figure 3. *Megalaria norfolkensis* (holotype in CANB). Scale = 2 mm.



Figure 4. *Megalaria stratosa*. A, *H. Streimann* 57533 (holotype in CANB); B, *H. Streimann* 55842 (CANB). Scales = 2 mm.

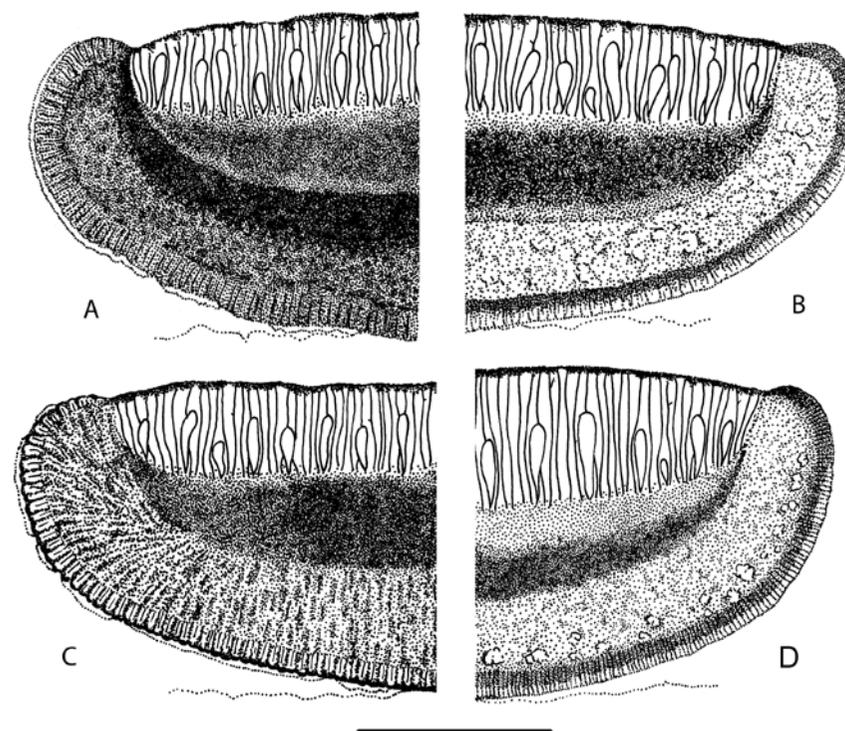


Figure 5. Sectioned apothecia of the new *Megalaria* species. (semi-schematic). A, *M. stratos*; B, *M. australiensis*; C, *M. crystallifera*; D, *M. norfolkensis*. Scale = 0.2 mm.

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**Abstract**

Three species are reported from Antarctica: *A. gremmenii* Øvstedal sp. nov., *A. narssaquensis* (Lynge) Thomson, which is new to the Southern Hemisphere, and *Oxneriaria virginea* (Hue) S.Y.Kondr. & L.Lökös, which is already known from the region.

**Introduction**

Few species of *Aspicilia* A.Massal. and *Oxneriaria* S.Y.Kondr. & L.Lökös have been reported from Antarctica, viz. *O. virginea* (Hue) S.Y.Kondr. & L.Lökös (Halici *et al.* 2018, as *Aspicilia virginea*) and *Aspicilia* cf. *aquatica* Körb. (Øvstedal & Lewis Smith 2001). In addition, two other entities, presumed to represent *Aspicilia*, were recognized but not named by Øvstedal & Lewis Smith (2001, 2004). Neighbouring regions also have few species; for example Argentina has six species (Calvelo & Liberatore 2002), the Falkland Islands one (Fryday *et al.* 2021) and New Zealand seven (Galloway 2007). By contrast, the vast and well-studied landmasses of the Northern Hemisphere support substantial floras, with 97 species known from North America (Esslinger 2019), 40 from Svalbard (Øvstedal *et al.* 2009) and 104 from Russia (Urbanavichus 2010).

*Aspicilia* has recently been divided into four segregate genera: *Aspicilia* s. str., *Circinaria* Link and *Sagedia* Ach., both resurrected on the basis of molecular evidence (Nordin *et al.* 2011), and the newly described and mainly molecular-based *Oxneriaria* S.Y.Kondr. & L. Lökös (Moniri *et al.* 2019). Since the material examined here is too old for molecular analyses, the present species, apart from *O. virginea*, cannot be placed in that system.

**Material and methods**

All material is deposited in AAS. The specimens were investigated using a Zeiss Stemo 2000C microscope and a Zeiss Axiolab compound microscope. Microscopic details were obtained by examining hand-cut sections. The sections were mounted in dilute lactophenol cotton blue or water. Measurements were made on sections mounted in 10% KOH. Chemical constituents were identified by thin-layer chromatography (Elix 2014).

**The species**

***Aspicilia gremmenii* Øvstedal sp. nov.**  
Mycobank No.: MB 842490

Fig. 1

Thallus of small rosettes, lead grey, with radiating lobes at the margin. Apothecia urceolate, to 0.4 mm in diam. Ascospores 16–20 × 12–17 µm. Paraphyses not moniliform. No chemical products.

*Type:* Antarctica, Signy Island, Moraine Valley, 60°43'S, 45°37'W, on exposed moraine boulders. *T.N. Hooker 639*, 1.ii.1974, (holotype—AAS).

*Thallus* as small rosettes, up to 9 mm wide, subeffigurate, lead grey, partly with a yellowish tinge. Inner part of thallus weakly rimose, in centre with elevated, adpressed fertile areolae 0.4–0.7 mm wide. Radiating at the margin, closely adpressed, minute lobes, darkened at end. No prothallus. Cortex pseudoparenchymatous, 25–35 µm high, the uppermost cells brownish. Photobiont trebouxoid, c. 10 µm in diam. Medulla with numerous colourless oxalate crystals. Apothecia urceolate, round to irregular, 1–4 per areolae, 0.1–0.4 mm in diam. Thalline margin not seen. Proper margin thin, 20–30 µm in upper part, narrowing

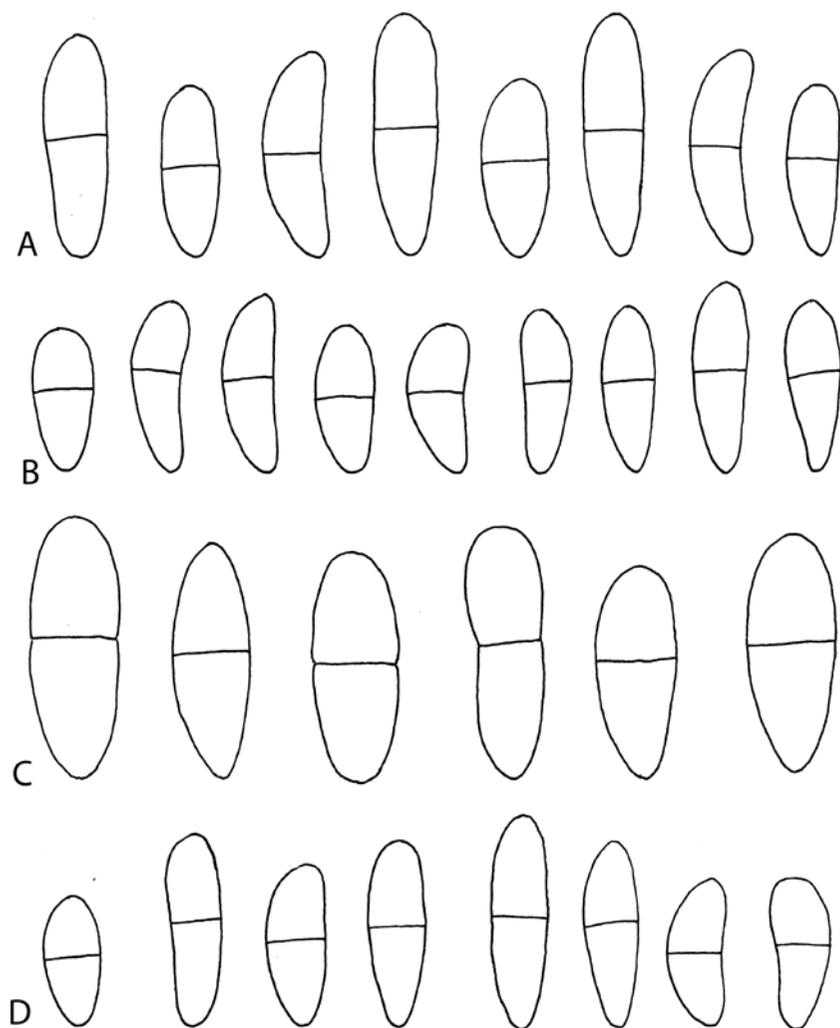


Figure 6. Ascospores of the new *Megalaria* species. A, *M. australiensis*; B, *M. crystallifera*; C, *M. norfolkensis*; D, *M. stratosa*. Scale = 20 µm.