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Two new species of *Sarcogyne* (lichenised Ascomycota: Acarosporaceae) from central and southern Australia

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Abstract

Two new lichens, *Sarcogyne iridana* P.M.McCarthy & Kantvilas and *S. meridionalis* P.M.McCarthy & Kantvilas (Acarosporaceae), are described and illustrated from sandstone in central Australia and from limestone, mainly in coastal habitats, in southern Australia, respectively. The widespread *S. regularis* Körb. is reported from Tasmania for the first time. *Sarcogyne calcifraga* (Müll.Arg.) H.Magn., based on collections from Egypt, is lectotypified, but it is excluded from the Australian lichen flora.

Key words: biodiversity, lichen, new species, taxonomy.

Introduction

The lichen genus *Sarcogyne* Flot. (Acarosporaceae) is characterised by a crustose and usually inconspicuous thallus that is often immersed in the substratum, reddish brown to black apothecia with a lecideine exciple, a non-carbonised epihymenium, simple to sparingly branched (but not anastomosing) paraphyses, and asci that contain (50–) 100–200 minute simple ascospores (Magnusson 1935a, b, 1937; Golubkova 1977, 1988; Clauzade & Roux 1985; Knudsen & Standley 2007; Fletcher & Hawksworth 2009). Currently with c. 34 accepted species, it grows on calcareous and siliceous rocks, and less commonly on soil. However, while variability in some of the most common species has prompted the description of numerous infraspecific taxa, several have been inadequately collected and documented and remain poorly understood. Recent research by Knudsen and co-workers, especially in North America, has seen a re-examination of type specimens, a thorough analysis of many old and often misapplied names, and the description of new taxa, all building towards a revision of the genus based on molecular and morphological methods which aims to clarify the circumscription and affinities of *Sarcogyne* and its species (Knudsen & Standley 2007; Knudsen & Kocourcová 2011).

Sarcogyne is most diverse in temperate and semi-arid regions (especially in Europe, North Africa and North America), but is less so in the subtropics and wet-tropics and at subpolar latitudes. The genus is poorly known in the Southern Hemisphere, with very few records from South America, Antarctica, New Zealand and the South Pacific. Four species have been reported from Australia, viz. *S. clavus* (DC.) Kremp. and *S. privigna* (Ach.) A.Massal. from the south-west of Western Australia (Richardson & Richardson 1982), *S. regularis*

Körb. from all southern mainland States (McCarthy 2013), and *S. calcifraga* Müll.Arg. from south-western Victoria (Müller 1893). Here we describe *S. iridana* from sandstone outcrops in arid central Australia and *S. meridionalis* from limestone in south-eastern South Australia and Flinders Island, Tasmania. We also report *S. regularis* from Tasmania and discuss the identity of the Australian specimen attributed to *S. calcifraga*.

Methods

Observations and measurements of photobiont cells, thallus and apothecium anatomy, asci and ascospores were made on hand-cut sections mounted in water and dilute KOH (K). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K.

Taxonomy

Sarcogyne iridana P.M.McCarthy & Kantvilas, *sp. nov.*

Thallus epilithicus, diffusus, albidus, 15–25 µm crassus. *Apothecia* superficiales, atra, plana vel valde convexa aut subglobosa, (0.33–) 0.60 (–1.14) mm diametro, plerumque epruinosa. *Excipulum proprium* pallidiore vel disco concoloratum, tenue persistensque aut excludens, 20–40 (–60) µm crassum, non carbonaceum, annulatum. *Hypothecium* 80–140 µm crassum, incoloratum. *Hymenium* 65–85 (–100) µm crassum, amyloideum, non inspersionem. *Paraphyses* simplices, 1–2 µm crassae. *Asci* clavati vel cylindriclavati, c. 150–180-spori, 60–88 µm longi, 13–22 µm lati. *Ascosporae* simplices, (3–) 5 (–7) µm longae, (1.5–) 2 (–2.5) µm latae.

Mycobank No.: MB804752.

Typus: AUSTRALIA, NORTHERN TERRITORY, c. 75 km S of Alice Springs, ESE of Rainbow Valley, 24°20'33"S, 133°39'22"E, on sandstone outcrop in dry scrub, 22 Oct. 2005, G. Kantvilas 283/05 (holo.: HO 533881).

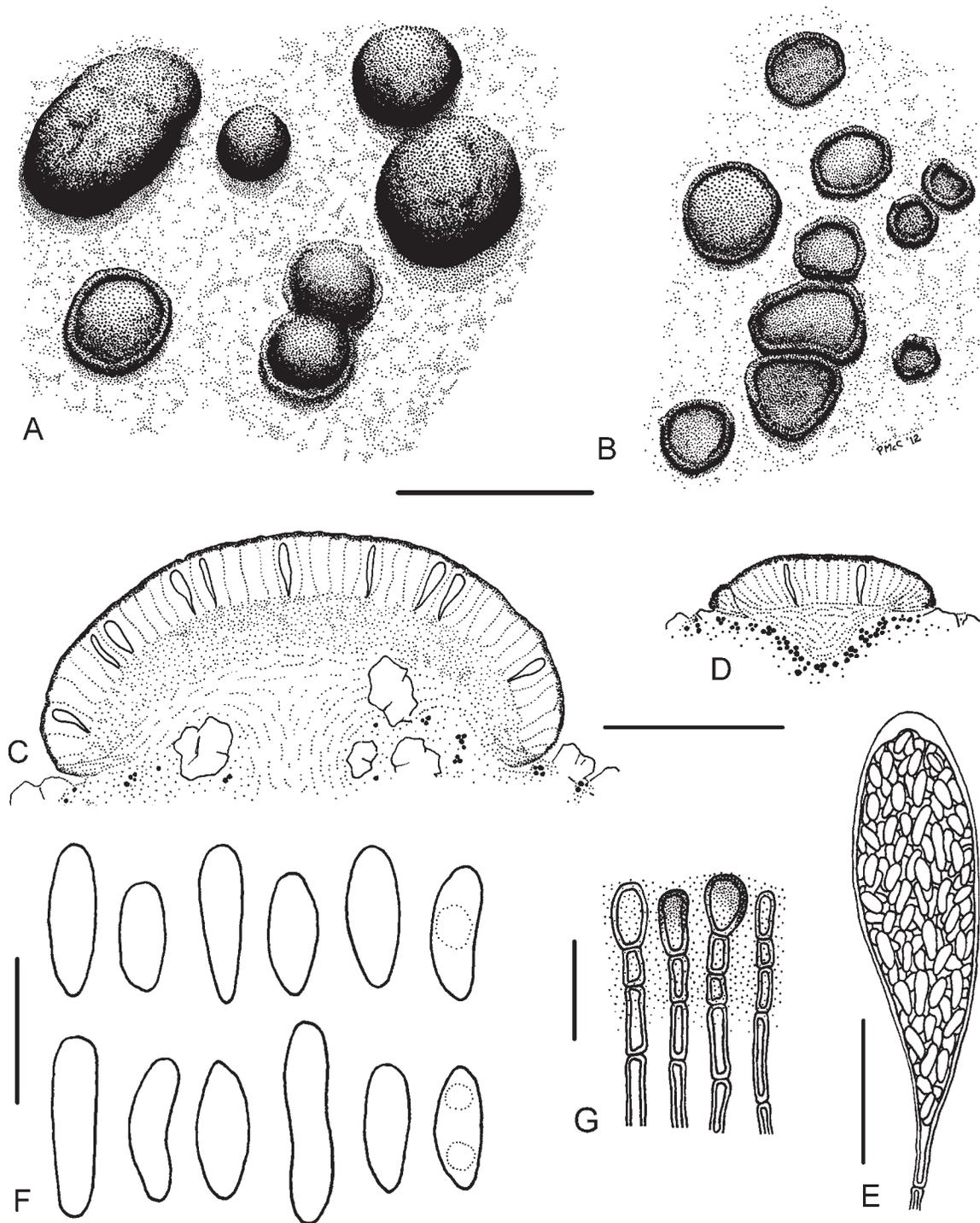


Fig. 1. *Sarcogyne iridana*. A–B habit of thalli and apothecia; C–D sectioned apothecia and adjacent thallus (semi-schematic); E mature asci; F ascospores; G epiphytenium. Scale bars: A–B 1 mm; C–D 0.2 mm; E 20 μm; F 5 μm; G 10 μm. — A, C, E–G holotype; B, D *Kantvilas 290/05*.

Thallus crustose, epilithic, diffuse, occupying minute depressions in the substratum or following micro-crevices around rock crystals, whitish, 15–25 μm thick, forming colonies to c. 5 cm wide; cortex absent; mycobiont hyphae short-celled, 2–2.5 μm wide; photobiont cells chlorococcoid, 8–16 μm diam., scattered or in small clusters, not forming a distinct layer except, occasionally, beneath apothecia; prothallus not apparent.

Apothecia numerous, solitary, paired, in clusters of 3 or 4, or in short rows, superficial, lecideine, (0.33–) 0.60 (–1.14) mm diam. [*n* = 110]; disc dull black, the colour unchanged when wetted, occasionally plane, usually moderately to markedly convex or subglobose and then strongly constricted at the base (often appearing almost substipitate), rarely faintly grey-pruinose, the surface smooth to irregularly uneven or minutely and

shallowly rimulose; proper exciple concolorous with the disc or a little paler, usually epruinose, the outer edge occasionally faintly grey-pruinose, persistent and uniformly very thin or becoming excluded (especially in strongly convex to subglobose apothecia), smooth, even or undulate; in section the exciple non-carbonised, 20–40 (–60) μm thick, annular, not continuous beneath the hypothecium, the outer edge dark brown, internally hyaline to pale brown, the cells compacted, thick-walled, $3\text{--}4 \times 2\text{--}3 \mu\text{m}$. *Hypothecium* hyaline, 80–140 μm thick, interspersed with granules, merging below with a discrete or poorly defined thalline layer, I– (with or without pretreatment in K). *Hymenium* 65–85 (–100) μm thick, the cut surface of a sectioned apothecium often appearing pale orange-brown; thin section not interspersed with oil droplets, granules or crystals, I+ persistently deep blue (after pretreatment in K), subtending a diffusely medium brownish, 10–20 μm thick epihymenium. *Paraphyses* unbranched, long-celled, 1–2 μm wide, separating readily in water and K; apices usually strongly capitate, 4–5 (–6) μm wide, the apical cell with a partially brown-pigmented wall. *Asci* clavate to clavate-cylindrical, containing c. 150–180 ascospores, $60\text{--}88 \times 13\text{--}22 \mu\text{m}$ [$n=20$], with a tapering stalk; apex rounded to somewhat truncate; submature asci with a thick uniformly amyloid tholus and a distinct ocular chamber. *Ascospores* colourless, simple, ellipsoid to elongate-ellipsoid or bacilliform, lacking a distinct perispore, often 1–2-guttulate, $(3\text{--}) 5 (7) \times (1.5\text{--}) 2 (2.5) \mu\text{m}$ [$n=75$]. *Pycnidia* not seen. **Fig. 1.**

Etymology. The specific epithet is based on the Latin *iridis* (of a rainbow) and the suffix *-ana*, in reference to the type locality, Rainbow Valley.

Remarks. The principal diagnostic characters of the new species are the very thin, diffuse, whitish thallus growing on siliceous rock, moderately large, black, epruinose apothecia that become immarginate and markedly convex to subglobose and basally constricted, a non-carbonised exciple, simple capitate paraphyses, polysporous asci and comparatively elongate, simple ascospores. *Sarcogyne regularis*, the most common and widely distributed species of the genus in Australia and globally, almost invariably grows on limestone, but it has larger, plane to only slightly convex apothecia that are persistently marginate and have a white-to bluish grey-pruinose disc (Knudsen & Standley 2007; Fletcher & Hawksworth 2009). Although the widespread *S. privigna* occurs on both siliceous and calcareous rocks, its epruinose apothecia have a plane, dark reddish disc and a persistent, often jointed and variably carbonised exciple up to 0.3 mm thick (Knudsen & Standley 2007; Fletcher & Hawksworth 2009; Knudsen & Kocourcová 2011). *Sarcogyne clavus*, an exclusively silicolous species with a distribution that also includes south-western Australia, has much larger apothecia (commonly to 3 mm wide) with a thicker, crenulate and carbonised exciple and a dark

brown hypothecium (Magnusson 1935b; Knudsen & Standley 2007; Fletcher & Hawksworth 2009). Finally, the predominantly silicolous *S. similis* H.Magn., known from the U.S.A., Greece (Poelt & Vězda 1974) and Zimbabwe (Becker, 2002), has larger and sometimes clustered apothecia, often with a thicker exciple, and paraphyses with apical cells that are not or scarcely expanded (Magnusson 1935a; Knudsen & Standley 2007).

Distribution & habitat. *Sarcogyne iridana* is known only from sandstone outcrops in dry scrub at the type locality in the far south of the Northern Territory. The abundantly fertile type specimen grows near thalli of *Peltula aff. placodizans* (Zahlbr.) Wetmore and *Lecanora pseudistera* Nyl. Also present on rocks nearby were *Xanthoparmelia colensooides* Elix, *X. filarszkyana* (Gyeln.) Hale, *X. isidiosa* (Müll.Arg.) Elix & J.Johnst. and an unidentified species of *Pyrenopsis*.

Additional specimen examined

NORTHERN TERRITORY. Type locality, 22 Oct. 2005, G. Kantvilas 290/05 (HO 533888).

***Sarcogyne meridionalis* P.M.McCarthy & Kantvilas, sp. nov.**

Thallus endolithic vel subepilithicus, 30–70 μm crassus. *Apothecia* immersa, atra, plana vel concava, (0.17–) 0.27 (–0.40) mm diametro, plerumque epruinosa. *Excipulum* proprium tenue, persistens aut excludens, 25–50 μm crassum, non carbonaceum, annulatum vel continuum. *Hypothecium* 30–60 (–80) μm crassum, incoloratum. *Hymenium* 60–90 (–110) μm crassum, amyloideum, non inspersum. *Paraphyses* simplices, 1.5–2 (–3) μm crassae. *Asci* clavati vel cylindricoclavati aut ellipsoidei, c. 150–200-spori, 60–75 μm longi, 14–32 μm lati. *Ascosporae* simplices, (3–) 4.5 (–6) μm longae, (1.5–) 2 (–2.5) μm latae.

Mycobank No.: MB804753.

Typus: SOUTH AUSTRALIA. **Kangaroo Island:** Pelican Lagoon, 35°48'S, 137°48'E, alt. 20 m, on limestone rocks in rough paddock, 27 Sep. 2012, G. Kantvilas 413/12 & B. de Villiers (holo.: HO 567046).

Thallus crustose, endolithic and inconspicuous or subepilithic and continuous to sparingly rimose, off-white to pale grey and up to 30–70 μm thick; cortex absent; mycobiont hyphae short-celled, 3–5 μm wide; photobiont cells chlorococcoid, 8–16 μm diam., scattered or in rather large clusters (in subepilithic thalli), not forming a distinct layer; prothallus not apparent. *Apothecia* numerous, lecideine, solitary, paired, in clusters of 3–6 or in irregular rows of up to 10, rounded or broadly ellipsoid, although the shape commonly distorted and angular due to mutual pressure, immersed in the substratum and leaving shallow pits after their decay, (0.17–) 0.27 (–0.40) mm diam. [$n=100$]; post-mature apothecia often becoming greenish white as the exciple and epihymenium lose their pigmentation and the hymenium disintegrates; disc jet-black when dry, dark reddish brown to dull black when wetted and becoming slightly pulpy and translucent, plane to deeply concave,

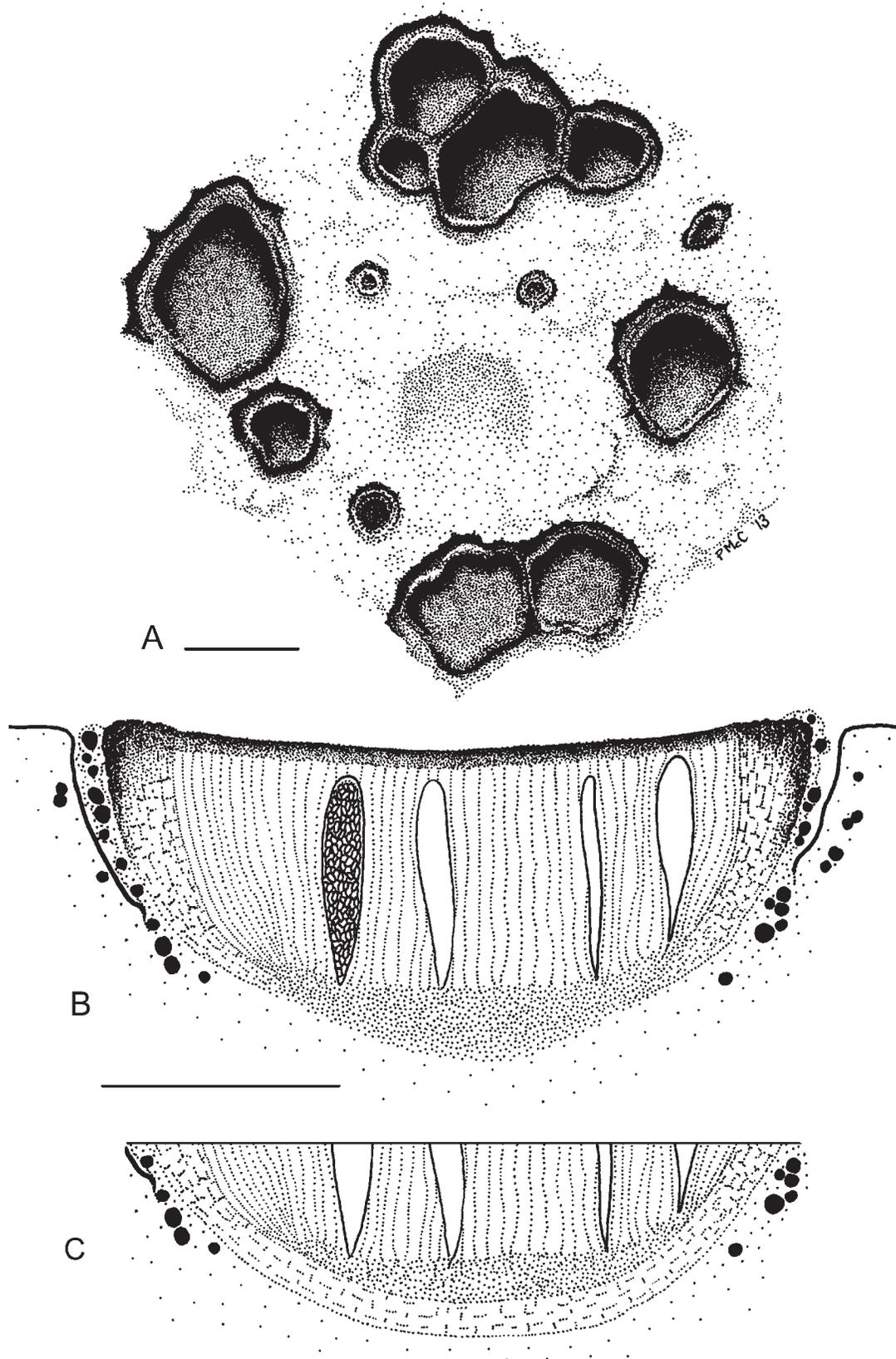


Fig. 2. *Sarcogyne meridionalis*. A apothecia on an endolithic thallus; B sectioned apothecium with an annular exciple (semi-schematic); C part of a sectioned apothecium with the exciple continuous beneath the hypothecium (semi-schematic). Scale bars: A 0.2 mm; B-C 0.1 mm. — A-B holotype; C Kantvilas 443/12.

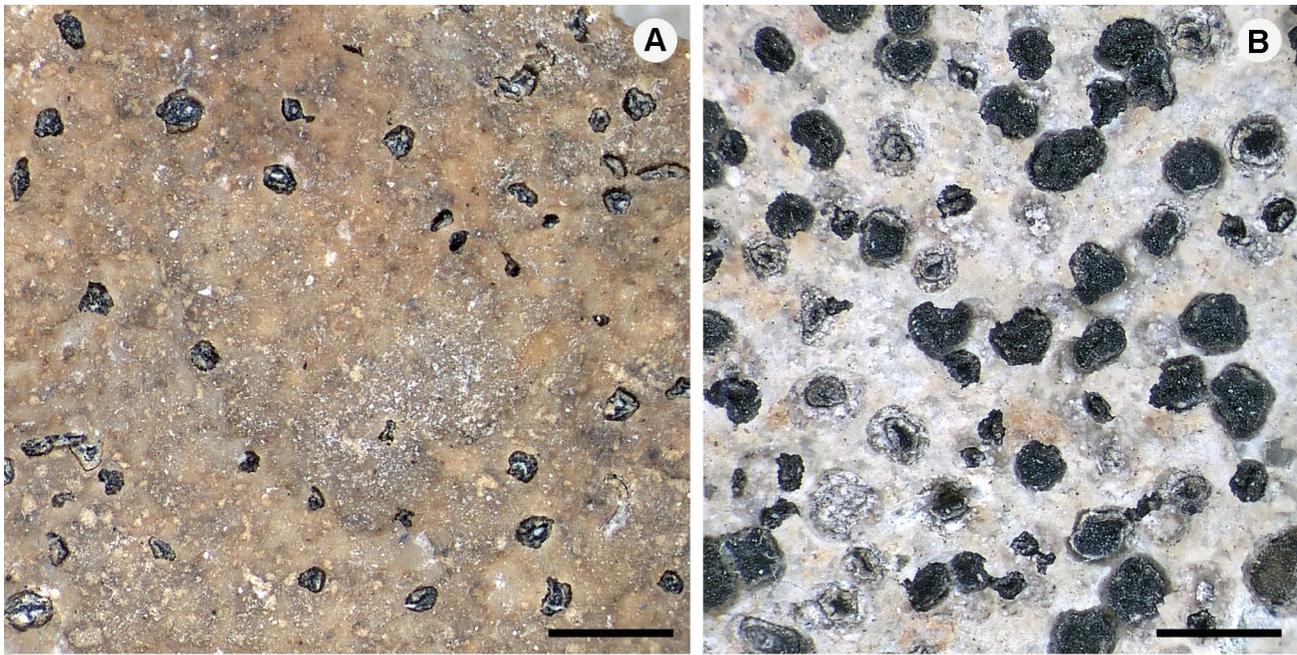


Fig. 3. A *Sarcogyne calcifraga* (lectotype), habit, showing minute apothecia immersed in pits. B *Sarcogyne* sp. (Wilson 817), with relatively broad apothecia with a well-developed exciple. Scale bars: 1 mm.

smooth, occasionally faintly grey-pruinose; proper exciple dark brown to jet-black, persistent and moderately thick or inconspicuous, or becoming excluded, usually epruinose, but the exciple of immature apothecia often with a very thin, uneven, whitish encrustation of thallus; in section the exciple non-carbonised, 25–50 μm thick, either annular or continuous beneath the hypothecium, outer edge dark brown, internally hyaline to pale brown, the cells compacted, rather thick-walled, 8–12 \times 2–3 μm , K–. *Hypothecium* hyaline, 30–60 (–80) μm thick, occasionally interspersed with granules, I– (with or without pretreatment in K). *Hymenium* 60–90 (–110) μm thick, not interspersed with oil droplets, granules or crystals, I+ persistently blue-violet (after pretreatment in K), I+ pale blue-violet, rapidly changing to reddish orange (without pretreatment), subtending a medium brownish, 10–15 μm thick epihymenium, itself topped by a 2–4 μm thick, hyaline amorphous coat. *Paraphyses* unbranched, long-celled, 1.5–2 (–3) μm wide, the cytoplasm granulose and minutely guttulate, separating readily in water and K (although the apical cells often remaining tightly coherent); apices usually strongly capitate, 3–4 (–5) μm wide, the apical cell with a partially brown-pigmented wall. *Asci* clavate to clavate-cylindrical or ellipsoid, containing 150–200 ascospores, 60–75 \times 14–32 μm [$n = 20$], with a tapering stalk; apex rounded; submature asci with a thick uniformly amyloid tholus and a distinct ocular chamber. *Ascospores* simple, colourless, ellipsoid to elongate-ellipsoid or somewhat panduriform, lacking a distinct perispore, (3–) 4.5 (–6) \times (1.5–) 2 (–2.5) μm [$n = 100$]. *Pycnidia* not seen. **Fig. 2.**

Etymology. The specific epithet, the Latin *meridionalis* (southern), refers to the known Australian and global distributions of the new lichen.

Remarks. This highly distinctive *Sarcogyne* is characterised by its endolithic to thinly subepilithic thallus, and very small, immersed apothecia that are solitary, paired, clustered or form rows, each having a dull black and deeply concave, epruinose disc and a usually thin, non-carbonised exciple that in section can form a partial ring or a continuous layer beneath the hypothecium.

The apothecia of the new species are very much smaller and more thinly marginate than those of *S. regularis*, the epruinose disc being plane to deeply concave rather than plane to convex and distinctively bluish- or white-pruinose. Furthermore, the larger apothecia and the thicker and carbonised exciple of *S. privigna* are certainly sufficient to distinguish it from *S. meridionalis*, while *S. algoviae* H.Magn., known from central Europe and Scandinavia, has immersed apothecia 0.3–0.5 mm diam. with a very thin hymenium (50–60 μm) and a fissured and carbonised exciple (Magnusson 1935b; Clauzade & Roux 1985; Knudsen & Kocourcová 2008).

Sarcogyne calcifraga (Müll.Arg.) H.Magn., based on two specimens from Egypt¹, also superficially resembles *S. meridionalis*, particularly with respect

¹ *Sarcogyne calcifraga* (Müll.Arg.) H.Magn., Meddel. Göteborgs Träd. 12: 101 (1938); *Lecidea simplex* var. *calcifraga* Müll.Arg., Revue Mycol. 2: 79 (1880). — **Type citation:** “Habitat calcicola in deserto Wadi Cherese et in Wadi Na-umieh: Schweinf.” **Lectotype (here designated):** in deserto aegypt. [Egypt], Wadi Cherese, 1877, G.A. Schweinfurth (G!). **Residual syntype:** in deserto aegypt. [Egypt], Wadi Na-umieh, 1879, G.A. Schweinfurth (G!). — The two specimens cited by Müller (1879) were located in his herbarium in Geneva. The one from Wadi Na-umieh is a minute fragment of rock with about 16 apothecia. The second specimen is considerably larger and is here selected as the lectotype. We are not aware of any duplicates of Schweinfurth’s specimens in other herbaria.

to the limestone habitat, endolithic thallus and sunken epruinose apothecia (Fig. 3A). However, this species differs in the following characters: the apothecia are smaller, 0.12–0.25 mm wide, and the degree of dark pigmentation is even less than in *S. meridionalis*, so that when moistened, they turn reddish brown. When dry, the disc is deeply concave, and the exciple is pulled away from the walls of the pit in the rock and inflexed, partly covering the disc. Chiefly because of adhering specks of substratum, this inflexed exciple looks rather pale, as noted by Magnusson (1937), although his allusion to *Arthonia* is incomprehensible. In section, the exciple is extremely reduced (at most 5–10 µm thick) and reddish brown at the upper edge. The paraphyses are more slender than in *S. meridionalis*, being only 1.5–2 µm wide. Moreover, the ascospores of the Egyptian species are ellipsoid and broader than those of the Australian lichen (5–7 × 2.5–4 µm vs 3–6 × 1.5–2.5 µm).

Distribution & habitat. *Sarcogyne meridionalis* occurs in a broad range of microhabitats on weathered and more recently exposed limestone outcrops and boulders in remnant mallee scrub, paddocks and roadsides in Yorke Peninsula, Kangaroo Island and the Murray River Region of south-eastern South Australia and on Flinders Island, Bass Strait, Tasmania. Associated lichens in South Australia include *Aspicilia contorta* (Hoffm.) Kremp., *Buellia albula* (Nyl.) Müll.Arg., *Caloplaca mereschkowskiana* S.Y.Kondr. & Kärnefelt, *Caloplaca* spp., *Lecania turicensis* (Hepp) Müll.Arg., *Lecanora dispersa* (Pers.) Sommerf., *L. sphaerospora* Müll.Arg., *Rinodina bischoffii* (Hepp) A.Massal., *Verrucaria calciseda* DC., *V. compacta* (A.Massal.) Jatta, *V. minor* Breuss, *V. muralis* Ach. and *V. nigrescens* Pers.

Additional specimens examined

SOUTH AUSTRALIA. Kangaroo Island: slopes above Red House Bay, 35°49'S, 138°07'E, alt. 50 m, on limestone outcrops in paddock, 17 Sep. 2012, G. Kantvilas 443/12 (AD, HO 567206); Flour Cask Bay, on coastal limestone, 6 Jan. 2013, A. Wells s.n. (CANB). **Yorke Peninsula:** Stansbury–Yorketown road, 4 km S of Stansbury, 34°56'06"S, 137°45'09", alt. 25 m, on limestone rubble in mallee scrub remnant, 11 Apr. 2013, P.M. McCarthy 4036 (AD); Yorketown–Warooka road, 11 km E of Warooka, 35°01'13"S, 137°30'23", alt. 38 m, on limestone among scattered *Melaleuca*, 10 Apr. 2013, P.M. McCarthy 4006 (AD). **Murray River Region:** Brookfield Conservation Park, 12 km NW of Blanchtown, 34°22'59"S, 139°29'43", alt. 85 m, on limestone rubble and outcrops in mallee scrub remnant, 13 Apr. 2013, P.M. McCarthy 4038, 4039 (AD, CANB); Chaunceys Line Road, 18 km E of Hartley, 35°15'28"S, 139°10'19", alt. 15 m, on limestone rubble and outcrops in mallee scrub remnant, 14 Apr. 2013, P.M. McCarthy 4035 (AD, CANB); Boundary Road, c. 10 km N of Tailem Bend, 35°10'16"S, 139°27'55", alt. 55 m, on limestone rubble and outcrops in mallee scrub remnant, 14 Apr. 2013, P.M. McCarthy 4025, 4026 (AD, CANB).

TASMANIA. Flinders Island: c. 0.5 km SE of Mt Killiecrankie, 39°49'S, 147°51'E, alt. 120 m, on fragment of calcified rock in blown out sand-hollow, 22 Jan. 2006, G. Kantvilas 38/06 & B. de Villiers (HO 536675).

Sarcogyne calcifraga not in Australia

The Victorian specimen (Wilson 817; Fig. 3B), labelled as *Lecidea simplex* var. *calcifraga* Müll. Arg. and reported by Müller (1893), is conspecific with neither *S. calcifraga* nor *S. meridionalis*. It has an endolithic thallus in a limestone substratum and epruinose apothecia 0.3–0.6 mm wide, immersed in pits, black when dry and dark brown when wetted. The exciple is thin, non-carbonised in section, c. 60 µm thick and reddish brown at the upper edge, while the robust paraphyses are 2–3 µm wide and the ascospores are comparatively narrow (1.5–2.5 µm). Consequently, *S. calcifraga* can be removed from the Australian lichen census (McCarthy 2013).

Several other specimens of *Sarcogyne* studied, from the south-west of Western Australia and South Australia (Kangaroo Island, Yorke Peninsula and the Murray River Region), are conspecific with or closely related to Wilson's specimen and likewise cannot be accommodated in *S. meridionalis* or related taxa (e.g. *S. privigna* and *S. regularis*). These endolithic to subepilithic specimens also tend to have predominantly immersed, occasionally very thinly grey- or bluish-pruinose apothecia, 0.3–0.55 (–0.65) mm diam. that often form clusters or rows and can be angular or otherwise distorted due to mutual pressure, with a comparatively thick apothecial exciple that is smooth and entire and a plane or slightly concave disc. In contrast, in terms of apothecial anatomy, there is little to characterise them. These problematic collections require further field study and careful comparison with extra-Australian taxa.

Specimens examined

SOUTH AUSTRALIA. Kangaroo Island: West Bay, Flinders Chase National Park, 15 km SSW of Cape Borda, 35°53'S, 136°33'E, alt. 40 m, on sloping limestone platform with scattered shrubs, 29 Sep. 1994, H. Streimann 55024 (CANB). **Yorke Peninsula:** Stansbury–Yorketown road, 4 km S of Stansbury, 34°56'06"S, 137°45'09", alt. 25 m, on limestone rubble in mallee scrub remnant, 11 Apr. 2013, P.M. McCarthy 4037 (AD); Brookfield Conservation Park, 12 km NW of Blanchtown, 34°22'59"S, 139°29'43", alt. 85 m, on limestone rubble and outcrops in mallee scrub remnant, 13 Apr. 2013, P.M. McCarthy 4040–4044 (AD, CANB);

VICTORIA. near Warrnambool, on calcareous rock, 1892, F.R.M. Wilson 817 (G).

WESTERN AUSTRALIA. Hamelin Bay, 34°13'S, 115°02'E, alt. 12 m, on soft, coarse coastal limestone, 12 Nov. 2011, G. Kantvilas 428/11 (HO 563409, PERTH).

Sarcogyne regularis Körb.

This species is characterised by (0.3–) 0.4–1.5 (–2) mm wide immersed or sessile apothecia with a red-brown to black, typically thickly whitish- to bluish grey-pruinose disc, a black, often thickly pruinose proper exciple and ellipsoid ascospores, 3–5 (–6) × 1.5–2 µm (Fletcher & Hawksworth 2009). It appears to be rather common on calcareous rocks, mortar, cement and (rarely) on soil in natural and urban habitats in temperate Australia, having been reported from Western Australia, South Australia, Victoria, New South Wales

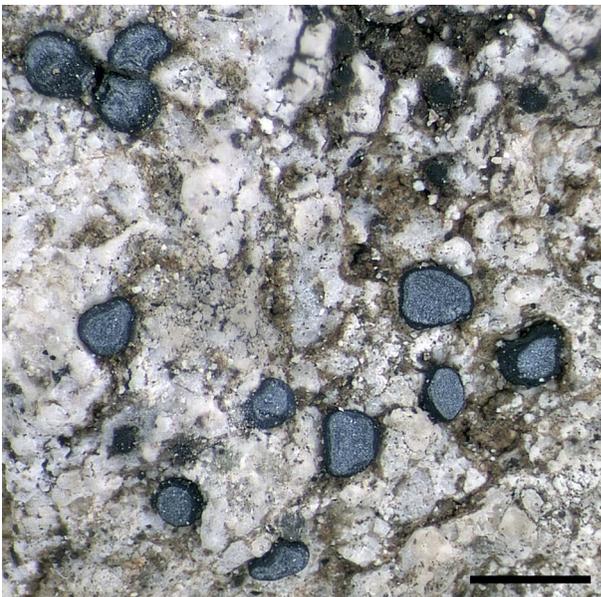


Fig. 4. *Sarcogyne regularis*, habit. Scale bar: 1 mm. — *Kantvilas* 172/98.

and the Australian Capital Territory (McCarthy 2013). The following specimen citations are the first to be published for Tasmania (Fig. 4).

Specimens examined

TASMANIA. near Lienna Road and Mersey Forest Road junction, 41°34'S, 146°15'E, 350 m alt., on limestone outcrops in pasture, 19 Feb. 1984, *G. Kantvilas* 366/84C & *P. James* (BM, HO); Tunbridge, Midland Hwy near northern exit from township, 42°09'S, 147°25'E, 200 m alt., on lumps of calcrete on basalt-derived soil along roadside, 9 Sep. 1998, *G. Kantvilas* 172/98 (HO); Cascades, Hobart, 42°54'S, 147°17'E, 130 m alt., on old concrete in suburban garden, 6 Sep. 1998, *G. Kantvilas* 165/98 (HO).

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