

## Standard Paper

# A synopsis of the genus *Arthothelium* (Arthoniales) in Tasmania

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### Abstract

The genus *Arthothelium* A. Massal. in Tasmania comprises ten species. Five of these are described as new: *A. bacidinum* Kantvilas, a saxicolous, littoral species with subglobose apothecia, non-macrocephalic ascospores, 25–40 × 11–19 μm, and containing the pigment Endoaurantiacum-gold which yields a K+ red reaction; *A. insolitum* Kantvilas, lichenicolous in rainforest and characterized by subglobose apothecia, very large, non-macrocephalic ascospores, 50–80 × 22–40 μm, and containing the pigment Interveniens-brown which reacts K+ olive green; *A. macounioides* Kantvilas, corticolous in wet forest and characterized by sessile, convex apothecia, macrocephalic ascospores, 29–42 × 11–18 μm, and containing the pigment Endoaurantiacum-gold; *A. magenteum* Kantvilas, a common wet forest epiphyte with appanate apothecia, non-macrocephalic ascospores, 25–55 × 11–22 μm, and containing a unique maroon-red, K+ pink pigment; and *A. subtectum* Kantvilas, a saxicolous species with convex apothecia, macrocephalic ascospores, 22–36 × 9–14 μm, and containing Endoaurantiacum-gold. The New Zealand species *A. endoaurantiacum* Makhija & Patw. and *A. suffusum* (C. Knight) Müll. Arg., and the Australian *A. velatium* Müll. Arg. are recorded for Tasmania for the first time. The names *A. obtusulum* (Nyl.) Müll. Arg., *A. pellucidum* (C. Knight) Müll. Arg. and *A. polycarpum* Müll. Arg. are considered synonyms of the widespread *A. ampliatum* (C. Knight & Mitten) Müll. Arg. *Arthothelium ferax* Müll. Arg. is a synonym of *A. interveniens* (Nyl.) Zahlbr. and *A. subspectabile* Vězda & Kantvilas is a synonym of *A. suffusum*. The sole record of *A. macrothecum* (Fée) A. Massal. from Tasmania is found to be based on a misidentification. A key to the species is provided. The importance of apothecial pigments, apothecial morphology and ascospore septation is discussed, and three pigments are characterized by their appearance in water and other standard media.

**Key words:** Arthoniaceae, biodiversity, lichenized Ascomycetes, lichens, pigments

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### Introduction

The genus *Arthothelium* A. Massal. encompasses a group of chiefly tropical or subtropical corticolous lichens that is distinguished from the large genus *Arthonia* Ach. by the muriform (rather than transversely septate) ascospores. Other characters that unite these species (and some taxa of *Arthonia* s. lat.) are the ecorticate crustose thallus with a trentepohlioid photobiont, the peculiar apothecioid ascomata with a highly reduced or excluded exciple, frequently yielding a ‘rubbed down’ appearance, the branched and anastomosed paraphyses, and the broadly clavate to subglobose, hemiamyloid, *Arthonia*-type asci (Coppins 2009).

The status of the genus remains unclear. The cladistic study of Tehler (1990) suggested that at least the type species, *A. spectabile* Flot. ex A. Massal., is distinct from *Arthonia* in the broad sense. The relationship between the two genera was also discussed briefly by Sundin & Tehler (1998) and Grube (1998), with the former demonstrating that *Arthonia* and *Arthothelium* are both paraphyletic. Subsequently, using molecular data, Ertz & Tehler (2010) also concluded that *Arthothelium* is paraphyletic, with at

least some species belonging in *Arthonia*; the same conclusion was also reached by Frisch *et al.* (2014). Certainly ascospore septation alone has been found increasingly to be of limited taxonomic value, as seen, for example, in the *Graphidaceae* where the traditional spore-based genera have been almost entirely dismantled (Staiger 2002). Thus the continued application of the name *Arthothelium* as it is currently understood is probably limited in time, and some recent ‘flora’ accounts now treat *Arthothelium* species under *Arthonia* (e.g. Grube 2007; McCune 2017). Nevertheless, *Arthothelium* remains in use with other authors (e.g. Coppins 2009; Gupta & Sinha 2018; Cannon *et al.* 2020) and until its broader phylogenetic position is resolved, the genus will continue to serve as a practical placeholder for a group of unequivocally related species. This approach is retained here.

In the Australasian region, the genus remains largely unstudied. New species have been described by Knight & Mitten (1860), Nylander (1867, 1888), Krempelhuber (1876), Knight (1883), Shirley (1889), Müller (1893, 1895a, b), Kantvilas & Vězda (1992), Makhija & Patwardhan (1995b), Ertz & Fryday (2017) and others; many of these species were described initially in *Arthonia* and only later combined into *Arthothelium* (Müller 1894; Zahlbruckner 1924). Chiefly on the basis of these sources, McCarthy (2020) records 12 species for Australia (five in Tasmania) whereas Galloway (2007) treats nine species for New Zealand. Whilst no systematic revision has been undertaken, the

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accounts by Galloway (1985, 2007) remain extremely useful entry points to the genus in the region. However, because of the widespread nature of many of the species, regional treatments, especially from other temperate areas, can also be highly relevant and useful. These include the Mediterranean (Grube & Giralt 1996), the British Isles (Coppins 2009; Cannon *et al.* 2020), North America (Fink 1935) and western Europe (Clauzade & Roux 1985). Much relevant information is also provided by Willey (1890) although, due to the nature of this pivotal text with its lack of keys, it is not particularly user-friendly. The comprehensive revision of the genus in India by Makhija & Patwardhan (1995a) also includes many general observations of the genus as a whole.

The present account deals with 10 species of the genus in Tasmania, derived from nearly four decades of fieldwork throughout the island. Five of these are new to science, with the remainder having broader, chiefly temperate Australasian distributions.

## Materials and Methods

The study is based chiefly on the author's collections, housed in the Tasmanian Herbarium (HO), and other Australian material held in the Australian National Herbarium (CANB) and the National Herbarium of Victoria (MEL). Type and other historical collections in London's Natural History Museum (BM), the Finnish Museum of Natural History (H) and the Museum of New Zealand Te Papa Tongarewa (WELT) were also studied. Investigations were undertaken on hand-cut sections of the thallus and apothecia, using standard methods, reagents and stains: water, 10% KOH (K), 50% HNO<sub>3</sub> (N), commercial bleach solution (C), lactophenol cotton blue (LCB), Lugol's iodine (I) and concentrated HCl (H). Calcium oxalate was detected by eluting hand-cut sections in 20% H<sub>2</sub>SO<sub>4</sub>.

Measurements of ascospores are based on at least 50 observations of each taxon and are presented in the format 5th percentile–average–95th percentile, with outlying values in brackets and *n* signifying the number of observations. Routine thin-layer chromatographic analysis (TLC) was performed using standard methods, with solvent A as the preferred medium (Orange *et al.* 2010).

## Taxonomic Characters in Tasmanian *Arthothelium*

The major characters underpinning species-level classification in *Arthothelium* are the morphology of the apothecia, apothecial pigments, and ascospore morphology and dimensions. A summary of these features in the species studied is presented in Table 1. The thallus of *Arthothelium* is invariably crustose and ecorticate, and, in the case of the saxicolous species in particular, it may be extremely reduced to the area immediately adjacent to or beneath the apothecia. Whereas Makhija & Patwardhan (1995a) considered thallus colour and texture useful taxonomic characters, these features appear to be of limited application in the Tasmanian species. Variation in colour from whitish to some shade of dingy grey or brown, and whether the thallus is smooth, wrinkled or rimose, are considered to be mainly a function of exposure or substratum texture. The photobiont in all species studied is trentepohlioid, although there are taxa elsewhere where the photobiont is chlorococcoid (e.g. Grube & Giralt 1996) or absent (e.g. Coppins 2009). No Tasmanian species has been found to contain lichen substances, although a wide range of compounds, including xanthonenes, fatty acids, depsides and depsidones, has been detected in taxa from other areas

(Makhija & Patwardhan 1995a; Aptroot & Wirth 2006). Most species are corticolous or lignicolous but saxicolous species are not uncommon in the genus. One of the Tasmanian taxa described below is lichenicolous.

The 'typical' *Arthothelium* apothecium is immarginate with a rather thin, 'rubbed down' appearance, and ranges from applanate to adnate and slightly convex. Such apothecia are seen in the Tasmanian species, although in a small number of taxa, notably *A. insolitum*, *A. bacidinum* and *A. suffusum*, the apothecia are markedly convex to subglobose, and more typical of a species of *Micarea*. Although there are members of the genus with variously coloured apothecia, including whitish, yellowish or reddish, the apothecia of all Tasmanian species are brown-black to black, with the exception of *A. macounioides* where they are dark reddish brown.

The *Arthothelium*-type ascus has been referred to in the literature by numerous authors (e.g. Grube & Giralt 1996; Grube 1998; Sparrius 2009). It is subglobose to broadly obovoid, hemiamyloid, with a thick, non-amyloid wall and a well-developed KI+ blue tholus with a small, darker-staining ring and beak-like ocular chamber (Fig. 1). These features are best observed in younger asci and, as the ascospores mature, the tholus and ring structure become compressed between the ascus wall and the ascoplasm. Eventually they become imperceptible.

The ascospores of Tasmanian species fall into one of two main types (Fig. 2). In the first, the spores are broadly ellipsoid and muriform throughout. The longitudinal and transverse septa may occur at right angles to each other, yielding a neat arrangement of relatively regular, rectangular locules like bricks in a wall. Alternatively, the septation may be relatively haphazard. The second type of ascospore is macrocephalic, with a large, undivided proximal cell and a septate 'tail'; both transverse and longitudinal septa may be frequent, or the latter may be few, with some transverse segments undivided. The ascospores of *A. interveniens* are unusual in that they have a large, undivided central cell.

Apothecial pigments are very useful in lichen taxonomy (Meyer & Printzen 2000) and of critical importance in many crustose groups, such as *Megalania* (Kantvilas 2016), *Micarea* (Kantvilas & Coppins 2019) and *Mycoblastus* (Kantvilas 2009). *Arthothelium* is no exception. Three main pigments were observed in the species studied and are named and characterized here:

Endoaurantiacum-gold: golden yellow in water, or orange-brown to reddish brown when very highly concentrated; brownish orange in polarized light; K+ crimson; C+ pink (fading); unchanged in H and N (Fig. 3A). This pigment is present in high concentrations in four Tasmanian species (*A. bacidinum*, *A. endoaurantiacum*, *A. macounioides* and *A. subtectum*). It also appears to be present in the New Zealand species, *A. spadiceum*, although in lower concentrations. Likewise in the specimen of *A. macounii* seen from the Northern Hemisphere, the pigment is rather dilute, brownish and limited to the upper parts of the apothecia, but its reactions with all the reagents tested is the same.

Magenteum-red: dark maroon-red in water, fluorescing red-pink in polarized light; K+ vivid magenta-pink; C+ orange-brown; N+ orange-brown; H– (Fig. 3B). Found in *A. magenteum*.

Interveniens-brown: brown to red-brown in water, not reacting in polarized light; K+ olive green; C+ olive green; ±intensifying

**Table 1.** Salient features of Tasmanian species of *Arthothelium*.

	Apothecia	Apothecial pigment	Ascospores	Habitat	Geographical distribution
<i>A. ampliatum</i>	±roundish, applanate to slightly convex	Interveniens-brown	macrocephalic, 24–39 × 9–15 µm	corticolous in coastal woodland and wet forest	Tas, Australia, NZ
<i>A. bacidinum</i>	convex to subglobose, adnate or basally constricted	Endoaurantiacum-gold	not macrocephalic, densely muriform, 25–40 × 11–19 µm	saxicolous on littoral rocks	Tas
<i>A. endoaurantiacum</i>	±roundish, plane to convex, adnate	Endoaurantiacum-gold	not macrocephalic, densely muriform, 21–37 × 11–16 µm	corticolous in coastal woodland and scrub	Tas, NZ
<i>A. insolitum</i>	convex to subglobose, adnate to basally constricted	Interveniens-brown	not macrocephalic, densely muriform, 50–80 × 22–40 µm	lichenicolous in rainforest	Tas
<i>A. interveniens</i>	roundish or effigurate, applanate	Interveniens-brown	not macrocephalic, sparingly muriform, 23–36 × 8–12 µm, with central cell(s) undivided	corticolous in wet forest	Tas, Australia, NZ, North America
<i>A. macounioides</i>	roundish, convex, adnate or basally constricted	Endoaurantiacum-gold	macrocephalic, 29–42 × 11–18 µm	corticolous in wet forest	Tas
<i>A. magenteum</i>	±roundish to fleck-like, applanate to convex and adnate	Magenteum red	not macrocephalic, densely muriform, 25–55 × 11–22 µm	corticolous, mainly in rainforest	Tas
<i>A. subtectum</i>	±roundish, convex, adnate or basally constricted	Endoaurantiacum-gold	macrocephalic, 22–36 × 9–14 µm	rocks in highland forest	Tas
<i>A. suffusum</i>	roundish, convex, basally constricted, coarsely whitish pruinose	Interveniens-brown	not macrocephalic, densely muriform, 27–43 × 13.5–24 µm	corticolous in rainforest	Tas, NZ
<i>A. velatium</i>	roundish, fleck-like or effigurate, adnate, plane to slightly convex	Interveniens-brown	not macrocephalic, densely muriform, 26–41 × 11–20 µm	corticolous in wet forest and scrub	Tas, Australia

orange-brown in N and H (Fig. 3C). In Tasmania, it is found in *A. ampliatum*, *A. insolitum*, *A. interveniens* and *A. suffusum*. The same pigment also occurs in species from other regions, for example the tropical *A. macrothecum*. It may well be the

same as Atra-brown of Meyer & Printzen (2000), albeit in consistently low concentrations and therefore never appearing opaque blackish as in many taxa of *Arthoniales*, such as species of *Opegrapha*.

**Key to the *Arthothelium* species**

- 1 Ascospores longer than 50 µm, entirely muriform; apothecia strongly convex to subglobose . . . . . **A. insolitum**  
 Ascospores mostly shorter than 40 µm, entirely muriform or macrocephalic, with an undivided terminal cell; apothecia usually applanate or flattened, and only rarely strongly convex . . . . . 2
- 2(1) Ascospores macrocephalic, with a conspicuously enlarged, undivided proximal cell and a muriform ‘tail’ . . . . . 3  
 Ascospores not macrocephalic, muriform throughout . . . . . 5
- 3(2) Apothecia internally with a brownish, K+ olive pigment . . . . . **A. ampliatum**  
 Apothecia internally golden yellow, K+ crimson . . . . . 4
- 4(3) Ascospores with 4–5 transverse and 0–3 longitudinal septa; on sheltered rocks in inland areas of moderate elevation . . . . .  
 . . . . . **A. subtectum**  
 Ascospores with 6–8 transverse and 2–4 longitudinal septa; corticolous in wet forest . . . . . **A. macounioides**
- 5(2) Apothecia internally with brownish, K+ olive pigment only . . . . . 6  
 Apothecia with golden yellow or reddish pigments yielding crimson or vivid pink reactions in K . . . . . 8
- 6(5) Apothecia markedly convex and basally constricted, coarsely white pruinose at least when young; on the dry, rough bark of mature rainforest trees . . . . . **A. suffusum**  
 Apothecia applanate or plane, adnate, always epruinose; on smooth bark . . . . . 7

- 7(6) Apothecia to 2 mm wide; ascospores sparingly muriform, with 4–8 transverse and 0–1(–2) longitudinal septa, the central, widest cells typically undivided. . . . . **A. interveniens**  
 Apothecia rarely > 0.6 mm wide; ascospores densely muriform throughout, with 6–10 transverse and 2–3 longitudinal septa . . . . . **A. velatum**
- 8(5) Apothecial pigment dark maroon-red, K+ vivid magenta-pink . . . . . **A. magenteum**  
 Apothecial pigment golden yellow, K+ crimson . . . . . 9
- 9(8) Apothecia emergent, plane and adnate; corticolous in coastal scrub and woodland . . . . . **A. endoaurantiacum**  
 Apothecia superficial, subglobose and basally constricted; on littoral rocks . . . . . **A. bacidinum**

**Arthothelium ampliatus** (C. Knight & Mitten) Müll. Arg.

*Bull. Herb. Boissier* 2, App.1, 85 (1894).—*Arthonia ampliata* C. Knight & Mitten, *Trans. Linn. Soc. Lond.* 23, 106 (1860); type: New Zealand, ?Auckland, 1858, C. Knight 276 (lectotype, *vide* Galloway (1995)—BM!; isoelectotype—WELT!).

*Arthothelium obtusulum* (Nyl.) Müll. Arg., *Bull. Herb. Boissier* 2, App.1, 84 (1894).—*Arthonia obtusula* Nyl., *Lich. Nov. Zel.*, 123 (1888); type: New Zealand, *sine loco* [prob. Wellington], 1882, Charles Knight s. n. (lectotype, *vide* Makhija & Patwardan (1995b)—H-NYL 5728!).

*Arthothelium pellucidum* (C. Knight) Müll. Arg., *Bull. Herb. Boissier* 2, App.1, 85 (1894).—*Arthonia pellucida* C. Knight, *Trans. N. Z. Inst.* 15, 352 (1883); type: New Zealand, *sine loco* [prob. Wellington], 22.xi.[18]77, Charles Knight s. n. (holotype—WELT 006972!).

*Arthothelium polycarpum* Müll. Arg., *Bull. Herb. Boissier* 3, 323 (1895); type: Australia, Brisbane, F. M. Bailey 682 (lectotype, *vide* Makhija & Patwardan (1995b)—G).

(Figs 2A & 4A)

*Thallus* very thin and patchy, mottled dingy grey to beige-grey to whitish, in section I+ reddish brown, KI+ blue, usually forming irregular, undelimited patches to c. 25 mm wide amongst other lichens; photobiont trentepohlioid, with cells globose to ellipsoid, 10–20 µm wide, in short chains or scattered in clusters.

*Apothecia* abundant, scattered, 0.3–1(–1.4) mm wide, 100–140 µm thick, black, epruinose, appanate to slightly convex, roundish, ellipsoid or irregularly elongate. *Proper exciple* excluded. *Hypothecium* hyaline to pale brown, K+ olive, barely

differentiated from the hymenium, mostly to 20–50 µm thick. *Hymenium* 50–90 µm thick, hyaline, I+ orange-red, KI+ blue, overlain by a brown, K+ olive epithecium 10–20 µm thick; asci of the *Arthothelium*-type, 50–65 × 32–46 µm, 8-spored; paraphyses branched and anastomosing, 1.5–3 µm wide, brown in the uppermost part, with the apices not expanded. *Ascospores* broadly ellipsoid to oblong, straight or occasionally slightly curved, hyaline at first, becoming brownish grey and rugulose when old, (24–)25–29.8–37(–39) × (9–)10–11.8–14(–15) µm (*n* = 85), macrocephalic with an enlarged, undivided upper cell and muriform ‘tail’ with 5–6 transverse and 0–3 longitudinal septa.

*Conidiomata* not found.

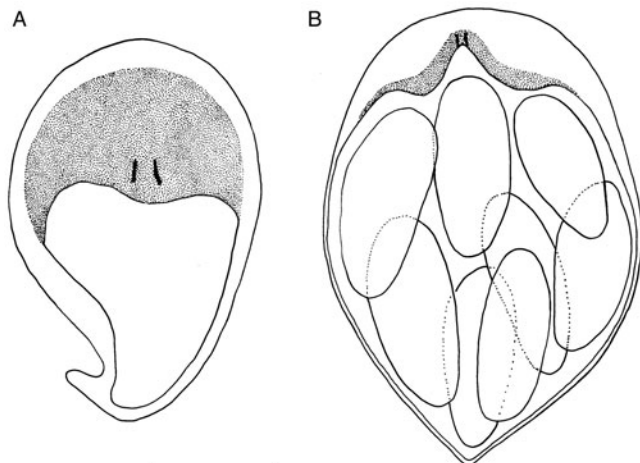
**Chemistry.** No substances detected by TLC.

**Remarks.** This species is readily recognized by the combination of macrocephalic ascospores with an enlarged, undivided, proximal cell and sparsely septate ‘tail’, and the brown, K+ olive apothecial pigment (Interveniens-brown). In the Tasmanian flora, similar macrocephalic ascospores are found in *A. macounioides* and *A. subtectum*, both of which contain golden yellow, K+ crimson, Endoaurantiacum-gold apothecial pigment. Interveniens-brown is widely distributed in the genus worldwide and occurs in several Tasmanian species, but none of these has macrocephalic spores. An exception is *Arthonia ilicina* Taylor, which is ±identical macroscopically, occurs sympatrically, and essentially differs only by having macrocephalic ascospores that lack any longitudinal septa. In that regard, distinguishing these two species should be undertaken with care and be based on multiple observations, since young spores of *A. ampliatus* may lack longitudinal septa and hence be mistaken for *Arthonia ilicina*.

*Arthothelium pellucidum*, based on a New Zealand type that is in very poor condition, is placed here into synonymy with *A. ampliatus*. Galloway (2007) distinguished these species based on *A. pellucidum* having effigurate apothecia and somewhat smaller ascospores ((20–)22–25 × 8–10 µm). An examination of the type specimen of this taxon indicated that the ascospores can be as long as 30 µm, and fall comfortably within the range of those of *A. ampliatus*. The effigurate apothecia are considered to be a function of age and substratum texture.

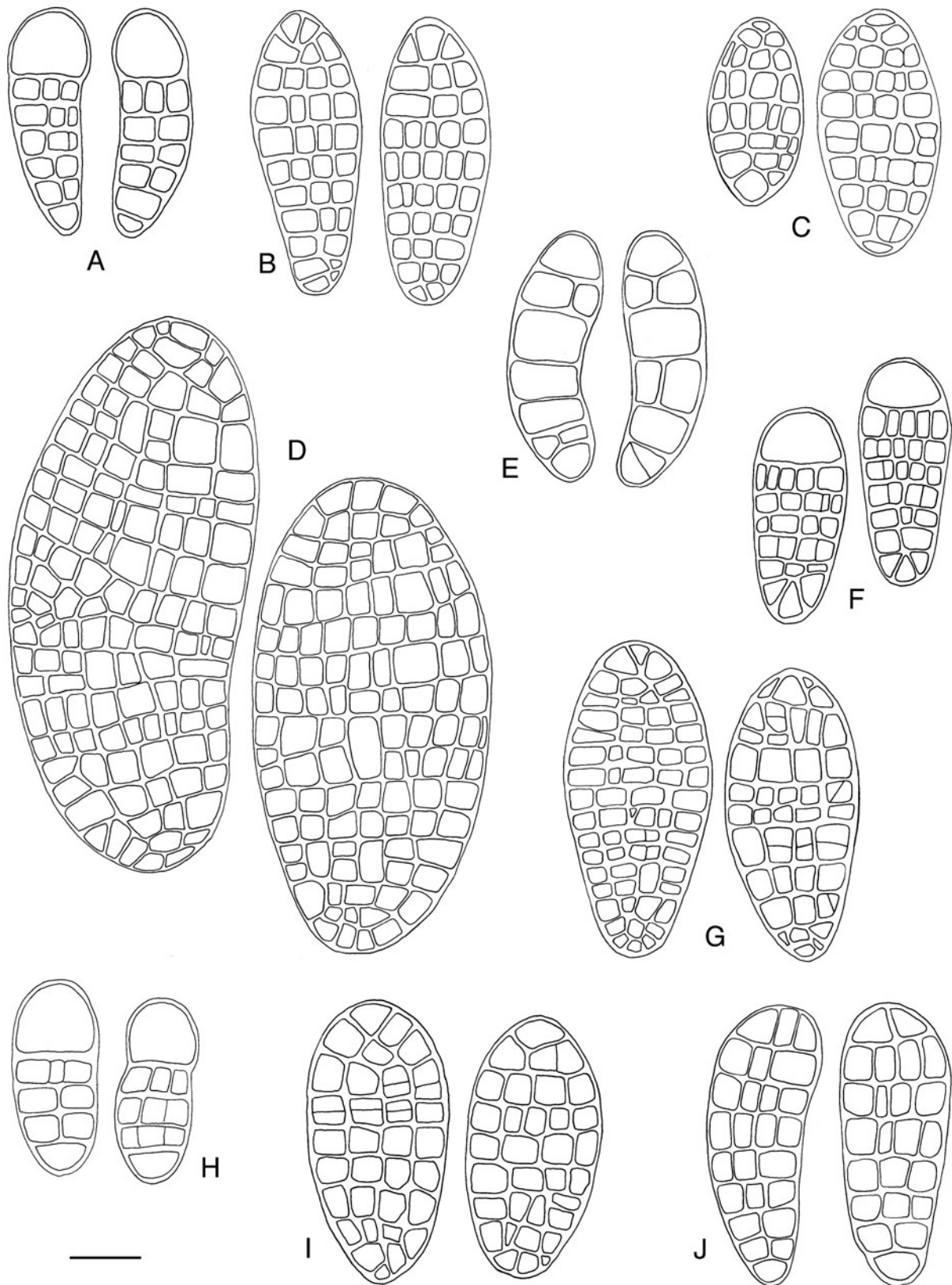
A further new synonym is the New Zealand species *A. obtusulum* (Nyl.) Müll. Arg. According to Makhija & Patwardhan (1995b) and Galloway (2007), this differs from *A. ampliatus* only by having smaller apothecia, 0.3–0.5 mm wide, but these fall within the size range of *A. ampliatus* as understood in the present work. The type specimen of *A. polycarpum* (from Queensland, Australia) was not studied, and this synonymy is derived from Makhija & Patwardhan (1995b).

Given the widespread nature of *A. ampliatus* and its broad ecological amplitude, it is likely to have further, hitherto



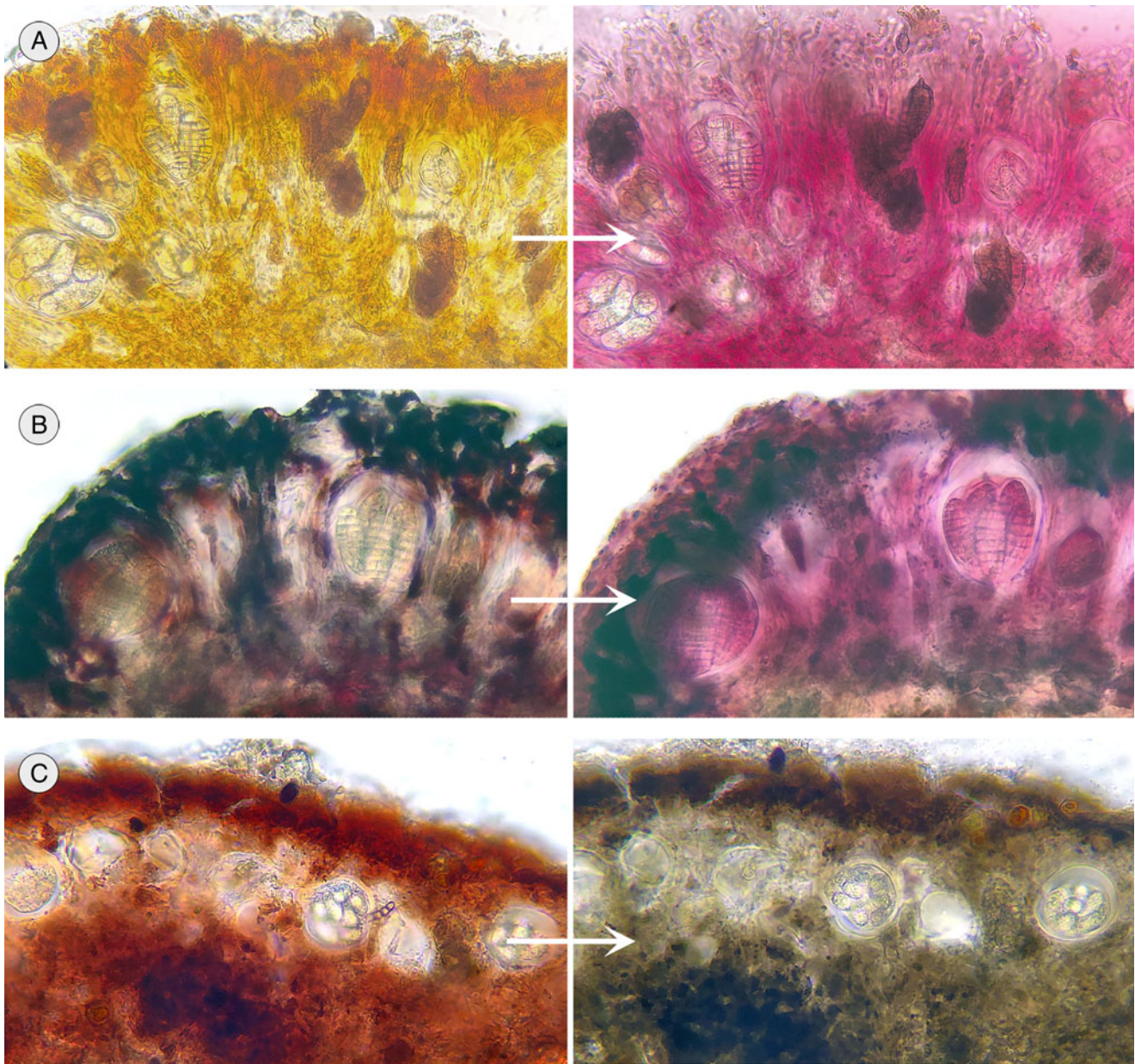
**Fig. 1.** The *Arthothelium*-type ascus as exemplified by *A. magenteum*: young ascus (A), mature ascus (B), with amyloid parts stippled. Scale = 20 µm.





**Fig. 2.** Ascospores of Tasmanian species of *Arthothelium*. A, *A. ampliatum*. B, *A. bacidinum*. C, *A. endoaurantiacum*. D, *A. insolitum*. E, *A. interveniens*. F, *A. macounioides*. G, *A. magenteum*. H, *A. subtectum*. I, *A. suffusum*. J, *A. velatum*. Scale = 10  $\mu$ m.





**Fig. 3.** Apothecial pigments in Tasmanian *Arthothelium* species, in water (left) and 10% KOH (right). A, Endoaurantiacum-gold, illustrated by *A. endoaurantiacum* and also seen in *A. bacidinum*, *A. macounioides* and *A. subtectum*. B, Magenteum-red, illustrated by *A. magenteum*. C, Interveniens-brown, illustrated by *A. interveniens* and also seen in *A. ampliatum*, *A. insolitum*, *A. suffusum* and *A. velatum*.

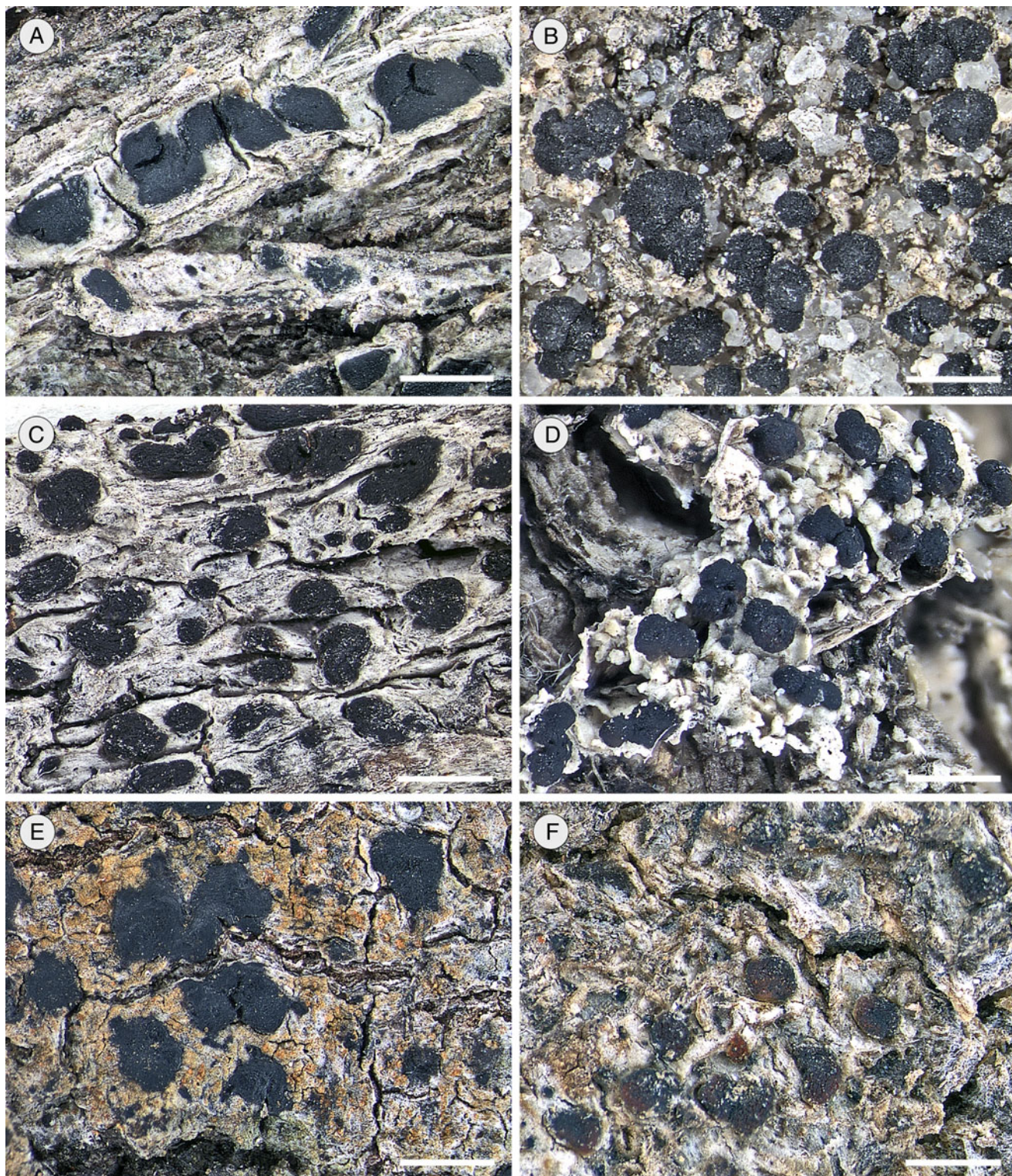
overlooked synonyms. For example, published descriptions of the European species *A. dictysporum* (Coppins & P. James) Coppins (Coppins & James 1979; Coppins 2009; Cannon *et al.* 2020) suggest that this species is very similar to *A. ampliatum*. Closer investigation of the relationships between these taxa is warranted, although *A. ampliatum* is the oldest name.

**Distribution and ecology.** *Arthothelium ampliatum* is frequently collected in Tasmania although it is rarely common and is usually seen as small thalli scattered within diverse assemblages of epiphytic lichens. It has a wide ecological amplitude. Most Tasmanian collections are from coastal woodland, where it grows on shrubs such as *Acacia sophorae* and *Leucopogon parviflorus*. It has also been found in coastal *Melaleuca ericifolia* swamps, either on the papery bark of *Melaleuca* itself or on

subdominant shrubs, and on subdominant trees and shrubs in open eucalypt forests. Less commonly it occurs in wet eucalypt forests where it colonizes smooth-barked hosts such as *Bursaria spinosa*, *Pittosporum bicolor* or *Pomaderris apetala*. It is also known from mainland Australia and New Zealand.

**Selected specimens examined.** **Australia:** **Tasmania:** Strickland Ave, Hobart, 42°55'S, 147°16'E, 180 m, 1906, *W. A. Weymouth* (HO); Deal Island, 39°28'S, 147°19'E, 5 m, 1971, *J. S. Whinray* s. n. (HO, MEL); Maria Island, 1.5 km NW of Mt Maria, 350 m, 1981, *G. Kantvilas* 167/81 (HO); Denium Hill, 40°45'S, 144°53'E, 5 m, 1993, *G. Kantvilas* 130/93 & *J. Elix* (HO); Stumpys Bay, 40°52'S, 148°13'E, 5 m, 1995, *G. Kantvilas* 57/95 (HO); Wielangta Road, 42°43'S, 147°51'E, 260 m, 1996, *G. Kantvilas* s. n. (HO); Flinders Island, Memana Road along Patriarch River, 39°57'S,





**Fig. 4.** Morphology of Tasmanian species of *Arthothelium* I. A, *A. ampliatum*, showing the 'rubbed down' apothecial morphology typical of the genus. B, *A. bacidinum*. C, *A. endoaurantiacum*. D, *A. insolitum*, lichenicolous on the grey, squamulose thallus of an unknown lichen. E, *A. interveniens*. F, *A. macounioides*. Scales = 1 mm. In colour online.

148°10'E, 10 m, 2006, *G. Kantvilas* 67/06 (HO); South Sister, 41°32'S, 148°10'E, 750 m, 2006, *G. Kantvilas* 312/06 (HO); W of Tahune Bridge in the Warra SST, 43°06'S, 146°41'E, 100 m, 2008, *G. Kantvilas* 364/08 (HO); Stony Point, 40°45'S, 144°59'E, 2 m, 2016, *G. Kantvilas* 280/16 (HO); Cape Portland, Musselroe Wind

Farm, Tregaron Lagoons, 40°46'55"S, 147°58'09"E, 2 m, 2018, *G. Kantvilas* 339/18 (HO); Lichen Hill, 43°04'S, 147°56'E, 560 m, 2020, *G. Kantvilas* 336/20 (HO); Stony Head MTA, Ryans Hill, SE of summit, 41°01'05"S, 147°01'43"E, 210 m, 2020, *G. Kantvilas* 215/20 (HO); Pine Creek, N of Marion Bay, 42°45'S, 147°53'E,



30 m, 2021, *G. Kantvilas* 2/21 (HO); Stony Head MTA, Quarry Rd, 41°02'26"S, 146°59'40"E, 50 m, 2021, *G. Kantvilas* 84/21 (HO).

*Also examined. Australia:* Victoria: Lake Tyres, 1888, *F. R. M. Wilson* (MEL 11320). *New South Wales:* Gloucester Tops, 32°04'S, 151°34'E, 1150 m, 1988, *G. Kantvilas* 418/88 (HO, NSW).

### *Arthothelium bacidinum* Kantvilas sp. nov.

Mycobank No.: MB 841467

*Arthothelium endoaurantiaco* simile et item apotheciis pigmentum aurantiacum, in kalio vivide carmesinum continentibus et ascosporis ubique muriformibus, 25–40 µm longis, 11–19 µm latis, sed habitu saxicola et apotheciis convexis vel subglobose, basi constrictis differt.

Typus: Australia, Tasmania, Lime Bay Nature Reserve, c. 1 km N of Plunket Point, 42°59'S, 147°43'E, 2 m, on littoral sandstone boulders, 15 October 2016, *G. Kantvilas* 254/16 (holotypus—HO; isotypi—E, H).

(Figs 2B & 4B)

*Thallus* inapparent, endolithic, at most visible as a dingy grey discoloration of the substratum, or as minute, scurfy, greyish areoles at the base of the apothecia, forming extensive undelimited patches to c. 150 mm wide; subapothecial medulla orange-red; photobiont trentepohlioid, with cells globose to ellipsoid, 10–19 µm wide, in short chains.

*Apothecia* very abundant, 0.3–1(–1.7) mm wide, 200–400 (–500) µm thick, single and scattered or confluent in clusters, black, epruinose, smooth or minutely verruculose, strongly convex to subglobose, adnate or basally constricted, in section infused entirely with a golden yellow pigment, K+ crimson, N–, C+ transient pink; pigment most heavily concentrated in the outer parts of the apothecia and then deep orange-brown to red-brown, in the innermost parts bright golden yellow. *Proper exciple* excluded. *Hypothecium* poorly differentiated from the hymenium, 100–280 µm thick, intensely orange, or becoming massive and orange-red. *Hymenium* 75–120 µm thick, intensely golden yellow, K+ crimson, I+ orange-red, KI+ blue, overlain by a thick, lumpy, red-brown epithecium, 25–50 µm thick; asci of the *Arthothelium*-type, 60–80 × 40–60 µm, 8-spored but often with as many as five spores aborted at maturity; paraphyses branched and anastomosing, 1–1.5 µm wide, with the apices greyish and expanded to 2–4 µm wide. *Ascospores* broadly ellipsoid to oblong, sometimes a little sole-shaped, mostly straight, hyaline at first, very soon becoming brown but remaining smooth-walled, 25–32.3–39(–40) × 11–14.8–18(–19) µm ( $n = 60$ ), muriform throughout with 6–9 transverse and 2–4 longitudinal septa; apices frequently with oblique septa; brown, overmature spores generally somewhat larger, to 45 × 20 µm.

*Conidiomata* not found.

*Chemistry.* No substances detected by TLC.

*Etymology.* The specific epithet alludes to the subglobose or markedly convex apothecia which are more reminiscent of a species of *Bacidia* (especially *B. littoralis* Kantvilas, which occurs in similar habitats) or other member of the *Lecanoromycetes* than of a member of the *Arthoniaceae*.

*Remarks.* This species is well characterized by the combination of the golden yellow, K+ crimson pigmented apothecia (Endoaurantiacum-gold) and the entirely muriform ascospores. The latter readily distinguishes it from the saxicolous *A. subtectum* and the corticolous *A. macounioides*, both of which contain the same pigment but have macrocephalic spores with an undivided proximal cell. Anatomically, the most similar species to *A. bacidinum* is the corticolous *A. endoaurantiacum*, which has entirely muriform ascospores and an identical pigment. Yet the two species look nothing like each other (emergent, generally plane apothecia in the latter, superficial, subglobose apothecia in the former) and although these differences may be a function of habitat, regarding the two taxa as distinct seemed, after careful consideration, justified. In addition to the morphological differences discussed, the two species also have subtly different ascospores, with those of *A. bacidinum* being slightly larger and slightly more muriform, an impression formed when comparing the two in section. The strongly basally constricted apothecia of the new species are suggestive of any number of lichens (such as *Bacidia* s. lat.) rather than an *Arthothelium*. When first collected and sectioned, to discover it was a species of this genus rather than a member of the *Lecanoromycetes* was a genuine surprise, especially given its habitat! The subglobose, basally constricted apothecia contrast starkly with the 'typical' plane, 'rubbed down' appearance of most corticolous species of the genus, although there are some corticolous species, for example *A. insolitum* and *A. suffusum*, that have such apothecia.

Littoral, saxicolous species in the genus are not unusual. For example, there is the subantarctic species, *A. diffluens* (Nyl.) Imshaug & Fryday (Fryday 2002), and Follman (1968) records three further taxa from Chile, but none share any salient characters with *A. bacidinum*.

*Distribution and ecology.* *Arthothelium bacidinum* is known from a single locality, where it was extremely abundant on the sheltered faces of huge sandstone boulders along a sheltered seashore. It formed extensive thalli, and the habitat yielded several other unusual (for Tasmania) lichens, including *Bacidia curvispora* Coppins & Fryday and *Catillaria glaucogrisea* Fryday. Triassic sandstone is a common rock type in south-eastern Tasmania but is infrequent at the coast. Several areas with this geology have been searched for the new species without success.

*Additional specimens examined. Australia: Tasmania:* Lime Bay Nature Reserve, c. 1 km N of Plunket Point, 42°59'S, 147°43'E (type locality), 2 m, 2016, *G. Kantvilas* 240/16, 244/16 (CANB, HO).

### *Arthothelium endoaurantiacum* Makhija & Patw.

*Trop. Bryol.* 10, 208 (1995); type: New Zealand, *sine loco* [prob. Wellington], 25.xi.18[77], *Charles Knight* s.n. (holotype—WELT 006970!).

(Figs 2C, 3A & 4C)

*Thallus* pale grey, rimose, 50–100(–180) µm thick, in section I+ red, KI+ pale blue, or inapparent and perceived as a pale dingy grey to whitish grey discoloration of the substratum, forming irregular patches to 20–40 mm wide, mostly delimited by a thin, black prothallus; photobiont trentepohlioid, with cells



globose to ellipsoid, 7–18 µm wide, in short chains or scattered in clusters.

*Apothecia* scattered, 0.3–1 mm wide, 100–220 µm thick, black, emergent and sometimes retaining an incomplete ‘veil’ of vestigial thalline tissue that becomes abraded and may appear pruina-like, adnate, plane to convex, sometimes markedly so, roundish to irregularly elongate-ellipsoid, in section entirely infused with a golden yellow, K+ crimson, C+ pink (±fleeting), N– pigment, most heavily concentrated in the outer parts of the apothecia and then deep orange-brown to red-brown, in the innermost parts bright golden yellow. *Proper exciple* reduced or excluded, to 10–15 µm thick, deep orange-brown, K+ crimson, sometimes with additional brownish, K+ olive-grey pigment, comprised of anastomosed, entangled hyphae 2–3 µm wide. *Hypothecium* 20–90 µm thick, intensely golden yellow, sometimes also with additional brownish pigment. *Hymenium* 70–100 µm thick, intensely golden yellow, I+ orange-red, KI+ blue, K+ crimson, overlain by a more intensely pigmented epithelial layer to 20 µm thick; asci of the *Arthothelium*-type, 58–80 × 35–52 µm, 8-spored; paraphyses branched and anastomosing, 1–1.5 µm wide in the lower part, to 2–3 µm wide and brownish in the uppermost part, with the apices sometimes slightly expanded. *Ascospores* broadly ellipsoid, mostly straight, hyaline at first, becoming brown but remaining smooth-walled when old, (21–) 25–30.1–36(–37) × 11–13.8–16 µm ( $n = 65$ ), densely muriform throughout, with 5–10 transverse and 1–4 longitudinal septa.

*Conidiomata* not found.

**Chemistry.** No substances detected by TLC.

**Remarks.** This species is very well characterized by the combination of golden yellow, K+ crimson pigment, here termed Endoaurantiacum-gold, and the ascospores, which are muriform throughout and do not have an undivided terminal cell. The type specimen is annotated by the collector, Charles Knight, as ‘*A. ampliatum*’, a completely different and very distinctive taxon (see above). Three other Tasmanian species have this pigment. *Arthothelium macounioides* and *A. subtectum* are easily distinguished by their macrocephalic spores. Separation from *A. bacidium* is more subtle and discussed under that species, which is best recognized by its saxicolous habit and strongly convex to subglobose apothecia. Also containing this pigment is the New Zealand species *A. spadiceum* (C. Knight) Müll. Arg., which has ascospores 33–46 × 13–25 µm, with 4–10 transverse and 1–5 longitudinal septa, and so larger and more septate than those of *A. endoaurantiacum*. In addition, the spores of *A. spadiceum* are rather oblong and the septa and locules are regularly arranged like bricks in a wall. The type specimens of this species (in BM and WELT, both examined) also have pale red-brown to yellow-brown apothecia and the golden yellow pigment is less concentrated when viewed in microscope sections; this is most likely due to environmental factors.

**Distribution and ecology.** This species appears to be uncommon (or overlooked) in Tasmania. It has been collected in the drier northern and eastern parts of the island in coastal scrub, open *Eucalyptus*-dominated woodland and *Melaleuca*-dominated swamp, growing on the twigs and branches of *Acacia verticillata*, *Bursaria spinosa*, *Leucopogon parviflorus*, *Melaleuca ericifolia* and *Pomaderris apetala*. It is also known from New Zealand.

**Additional specimens examined. Australia: Tasmania:** Cape Portland, Musselroe Bay Conservation Area, Abalone Rocks, 40°47′26″S, 148°06′08″E, 2018, G. Kantvilas 387/18 (HO); Cape Portland, northern end of Musselroe Bay, 40°49′36″S, 148°06′41″E, sea level, 2019, G. Kantvilas 236/19 (HO); Stony Head MTA, 250 m W of Black Rock Point, 40°59′18″S, 147°03′19″E, 20 m, 2020, G. Kantvilas 363/20 (HO); Canoe Bay, 43°08′S, 147°58′E, 5 m, 2020, G. Kantvilas 347/20 (HO); Tasman Track, between Canoe Bay and Bivouac Bay, 43°07′S, 147°58′E, 20 m, 2020, G. Kantvilas 350/20 (HO).

***Arthothelium insolitum* Kantvilas sp. nov.**

MycoBank No.: MB 841468

Thallus mox lichenicola, lichenum ignotum corticolum squamulosum incolens, apotheciis 0.2–0.7 mm latis, valde convexis vel subglobois, pigmentum brunneum, in kalio olivaceum infusis, ascosporibus late ellipsoideis vel oblongis, ubique muriformibus, 50–80 µm longis, 22–40 µm longis.

Typus: Australia, Tasmania, Rebecca Creek, 41°13′S, 144°47′E, 120 m, on *Nematolepis squamea* in mature mixed forest, 9 December 1993, G. Kantvilas 323/93 (holotypus—HO; isotypus—E).

(Figs 2D & 4D)

Thallus initially autonomous, very thin, patchy, whitish, to c. 50 µm thick, I+ reddish, KI+ patchily pale bluish, with short chains of subglobose to ellipsoid, trentepohlioid cells 10–19 × 8–13 µm wide clustered beneath the apothecia, soon disappearing and the lichen evident only as apothecia overgrowing an unidentified squamulose lichen with a chlorococcoid photobiont with subglobose cells 8–12 × 6–9 µm.

*Apothecia* scattered, abundant, 0.2–0.7 mm wide, 250–420 µm thick, brown-black to black, epruinose, markedly convex to subglobose, adnate or basally constricted. *Proper exciple* ±excluded, at most seen as a layer of brown, K+ olive pigmented tissue to 30 µm thick at the sides of the apothecia. *Hypothecium* poorly differentiated from adjacent tissues, hyaline to pale yellowish, K–, mostly c. 80–150(–250) µm thick. *Hymenium* 90–180 µm thick, hyaline, I+ red, KI+ blue, interspersed with oil droplets when well developed, overlain by a brown, K+ olive, C+ olive epithecium 5–10 µm thick; asci relatively few and widely dispersed within a network of paraphyses, of the *Arthothelium*-type, 90–150 × 60–110 µm, mostly 8-spored at least when young but with as many as six spores aborted at maturity; paraphyses 1–1.5 µm wide, sometimes with the apices expanded to 3 µm and pigmented when extending into the epithecium. *Ascospores* broadly ellipsoid to oblong, straight or rarely a little curved, hyaline at first, soon becoming yellow-brown and then brown-grey, minutely densely papillate when old, (50–)53–68.6–80 × (22–)23.5–30.6–37(–40) µm ( $n = 45$ ), not macrocephalic, densely muriform throughout, with 9–16 transverse and 4–8 longitudinal septa across the central cells.

*Conidiomata* not found.

**Chemistry.** No substances detected by TLC in the lichen; the host lichen reacts K–, KC+ red, C–, P–, UV+ white and contains 2′-O-methylperlatolic acid.

**Etymology.** The specific epithet alludes to the perplexing and unusual characters of this remarkable lichen.

**Remarks.** This new species is known from a single, rich specimen. It displays very perplexing characters and its biology has been difficult to interpret. The best developed apothecia occur on a relatively common (in rainforest), as yet unnamed, sterile squamulose lichen of unknown taxonomic affinities that has a chlorococcoid photobiont and contains 2'-*O*-methylperlatolic acid. In such cases, no or very few strands or clusters of trentepohlioid algae, the characteristic photobiont of *Arthothelium*, can be observed and then only at the very base of the apothecia. In other parts of the large collection, apothecia occur on an effuse whitish thallus which is interpreted as belonging to the *Arthothelium* because it contains a trentepohlioid photobiont and displays the anticipated reactions in iodine. Although seemingly well-developed apothecia are very abundant, most consist only of a dense network of paraphyses and contain no asci. Asci are rarely seen and are found seemingly by chance, scattered within the network of paraphyses and usually as few as 2–4 per section. Well-formed ascospores are likewise rare; overmature, distorted, brown ascospores a little less so.

The anatomy of this lichen offers no reason to believe it is misplaced in *Arthothelium*, even if the convex apothecia and strange disposition of the asci are unusual. At first sight, it would most likely be considered a species of *Micarea* or *Bryobilimbia*, both of which have representative taxa in such habitats. The lichenicolous biology of the species is unusual for the genus, although Ertz & Fryday (2017) described the remarkable *A. hymeniicola* from the apothecia of a species of *Bacidia*. It is unfortunate that at present the identity of the host of the new lichen cannot be established.

The very large ascospores (the largest of any species in Tasmania), convex apothecia and unique biology mean that it is unlikely to be confused with any other Tasmanian member of the genus. Similarly large, highly septate, non-macrocephalic spores occur in two species that occur on the mainland of Australia, *A. huegelii* (Nyl.) Zahlbr. and *A. macrothecum* (Fée) A. Massal., but both have applanate, adnate apothecia more typical of the genus as a whole.

**Distribution and ecology.** This new species is known from a single collection from the bark of *Nematolepis squamea* (formerly *Phebalium squameum*) in mature mixed forest dominated by *Eucalyptus obliqua*. *Nematolepis* has a smooth aromatic bark favoured by a wide range of macrolichens as well as crustose species. At this site, the new species was associated with *Arthonia ilicina* Taylor, *Pseudocyphellaria bratti* D. J. Galloway & Kantvilas and *Sarrameana albidoplumbea* (Hook. f. & Taylor) Farkas. Since the collection was made, the site has been logged and burned. The area is remote and searching for additional material in the same general vicinity has not been possible.

### *Arthothelium interveniens* (Nyl.) Zahlbr.

*Cat. Lich. Univers.* 2, 127 (1924).—*Arthonia interveniens* Nyl., *Acta Soc. Sci. Fenn.* 7, 482 (1863); type: America septentrionalis ad cortices laeves, Carolina, ex hb. E. Tuckerman (lectotype, *vide* Patwardan & Makhija *ined.*—H-NYL 5470!).

*Arthothelium ferax* Müll. Arg., *J. Linn. Soc., Bot.* 30, 462 (1895); type: Tasmania, Cheshunt, W. Archer (holotype—G!; isotype—BM!).

(Figs 2E, 3C & 4E)

*Thallus* very thin and patchy, pale beige to brownish grey, to 40–100 µm thick, in section I+ reddish brown, KI+ blue, forming irregular patches to c. 40 mm wide, usually delimited by a thin, black prothallus, especially when contiguous with other lichens; photobiont trentepohlioid, with cells globose to ellipsoid, 6–15 µm wide, in short chains or scattered in clusters.

*Apothecia* abundant, scattered, 0.3–2 mm wide, 60–120 µm thick, black, epruinose, applanate, roundish, or irregularly effigurate. *Proper exciple* excluded. *Hypothecium* dark red-brown, K+ olive, 10–50 µm thick. *Hymenium* 50–80 µm thick, hyaline to dilutely yellow-brown or red-brown, K+ olive, I+ orange-red, KI+ blue, overlain by a deep red-brown, K+ olive epithecium 12–20 µm thick; asci of the *Arthothelium*-type, 40–60 × 28–45 µm, 8-spored; paraphyses indistinct. *Ascospores* broadly ellipsoid, straight or slightly curved, hyaline at first, at most pale greyish and minutely rugulose when old, (23–)24–30.8–35(–36) × (8–)8.5–11.1–12 µm (*n* = 60), not macrocephalic, with 4–8 transverse and 0–1(–2) longitudinal septa; central cells mostly undivided; apices rounded.

*Conidiomata* not found.

**Chemistry.** No substances detected by TLC.

**Remarks.** Macroscopically this species is recognized by its relatively large, effigurate, very thin, applanate apothecia, which contrast with the usually slightly convex, roundish and generally smaller fruiting bodies of most other Tasmanian species of the genus. However, examination of its ascospores is essential for unequivocal identification. These are very distinctive, especially in the combination of being non-macrocephalic, with rounded apices, typically one (or at most two) longitudinal septa and, critically, that the central, largest spore locules are usually undivided. This feature is unusual in that in most species of the genus as a whole, it is normal to have the greatest number of longitudinal septa across the widest (and therefore central) cells. Occasional spores will have no longitudinal divisions at all. Similar ascospores are illustrated by Lee & Hur (2019) for the Korean species *A. ulleungdoensis* Lee & Hur, which may well be a later synonym.

The most similar species in the Tasmanian flora is *A. velatium*, which contains the same apothecial pigment but has smaller, more convex apothecia, and which differs most clearly by its ascospores that have more longitudinal septa, including across all the larger, central segments, and have the cells arranged ±regularly like bricks in a wall. There is another similar but as yet unidentified species in the rainforests of New South Wales which differs chiefly by having ascospores with rather more pointed apices (Kantvilas 1990). The brown, K+ olive apothecial pigment, here termed *Interveniens*-brown, occurs commonly in the genera *Arthothelium* and *Arthonia*, and is seen in *A. ampliatum* (which differs by having macrocephalic ascospores) and other species from Tasmania and elsewhere.

**Distribution and ecology.** This species is known from the south-eastern Australian mainland (New South Wales and Victoria), New Zealand and, remarkably, from the eastern United States, the provenance of the type collection. In Tasmania, it is a frequent component of the rich, crustose lichen flora that occurs in the understorey of callidendrous rainforests (nomenclature after Jarman *et al.* (1994)), especially on the smooth bark of *Atherosperma moschatum*, and on the understorey twigs of various other trees and shrubs (*Eucryphia lucida*, *Nothofagus cunninghamii*, *Phyllocladus aspleniifolius*, *Tasmannia lanceolata*). It



can also be found in wet scrub and wet sclerophyll forest communities which are interpreted as seral stages in the development of callidendrous rainforest. This species was particularly common in the extensive callidendrous rainforests of north-west Tasmania, which have since been cleared and the land converted to eucalypt plantations largely devoid of epiphytic lichens.

**Selected specimens examined. Australia:** *Tasmania:* Sumac Road, Spur 2, S of Arthur River, 41°08'S, 145°02'E, 170 m, 1981, *G. Kantvilas* 342/81 (BM, HO); Simons Road, near Ben Nevis, 830 m, 1981, *G. Kantvilas* 1080/81 (BM, HO); Flannel Road, Arthur River, 430 m, 1982, *G. Kantvilas* 16/82 (BM, G, HO); Pieman Road near Huskisson River, 41°44'S, 145°29'E, 180 m, 1989, *G. Kantvilas* 18/89 (HO); Bun Hill, Forestier Peninsula, 42°58'S, 147°56'E, 320 m, 1989, *G. Kantvilas* 372/89 (HO); Anthony Road, 41°47'S, 145°37'E, 390 m, 1990, *G. Kantvilas* 192/90 (HO); Saxons Road, c. 1.5 km NW of Parrawe, 41°17'S, 145°34'E, 560 m, 1992, *G. Kantvilas* 52/92, *B. Fuhrer* & *J. Jarman* (HO); Buckland Military Training Area, S of Bluestone Tier, 42°30'S, 147°48'E, 300 m, 2003, *G. Kantvilas* 331/03 (HO); Savage River Pipeline Road near Rapid River, 41°16'S, 145°20'E, 440 m, 2015, *G. Kantvilas* 223/15 (HO); Rabalga Track, 41°05'S, 145°22'E, 280 m, 2019, *G. Kantvilas* 96/19 (HO); MacGregor Peak, 42°59'S, 147°57'E, 590 m, 2020, *G. Kantvilas* 149/20 (HO); Stony Head MTA, Ryans Hill, SE of summit, 41°01'05"S, 147°01'43"E, 210 m, 2020, *G. Kantvilas* 186/20 (HO).

**Selected comparative material also examined. Australia:** *Victoria:* Errinundra Plateau, Hensleigh Creek Road, 37°16'50"S, 148°58'00"E, 1020 m, 1999, *S. Ford* (MEL); Yarra Ranges NP, The Beeches Rainforest Walk, 37°29'25"S, 145°50'24"E, 800 m, 2008, *V. Stajsic* 4715 (HO, MEL). *New South Wales:* Mt William, Barrington Tops NP, 32°04'30"S, 151°28'00"E, 1400 m, 1988, *G. Kantvilas* 284/88 (HO, NSW); Gloucester Tops, 32°04'S, 151°34'E, 1150 m, 1988, *G. Kantvilas* 417/88 (HO, NSW).—**USA:** *Louisiana:* East Feliciana, Felixville, on parish road 432, c. 8 miles NE of Clinton, 1968, *S. Tucker* 7715 (HO). *South Carolina:* Berkeley Co., Francis Marion National Forest, 33°11'43"N, 79°31'22"W, 21 ft, 2013, *J. C. Lendemmer* 40862 (HO, NY).

#### *Arthothelium macounioides* Kantvilas sp. nov.

Mycobank No.: MB 841469

*Arthothelium macounii* similis et item apotheciis pigmentum in kalio vivide carmesinum infusis et ascosporis macrocephalicis sed ascosporis maioribus, 29–42 µm longis, 11–18 µm latis, et cauda ascosporum septatiis, 6–8-plo transverse et 2–4-plo longitudinaliter, differt.

Typus: Australia, Tasmania, Wielangta Road, 42°43'S, 147°51'E, 260 m, on *Acacia riceana* in *Eucalyptus globulus*-dominated wet forest, 20 March 1996, *G. Kantvilas* s. n. (holotypus—HO).

(Figs 2F & 4F)

*Thallus* very thin, ±inapparent or dull pale greyish, scurfy, discontinuous, forming undelimited patches to c. 30 mm wide, I–, KI+ very patchily bluish; photobiont trentepohlioid, with cells subglobose to oblong-ellipsoid, 10–23 × 6–18 µm wide, forming chains.

*Apothecia* abundant, scattered, roundish, 0.4–0.8 mm wide, 220–400 µm thick, dark reddish brown, epruinose, adnate or basally constricted, markedly convex, in section entirely infused with a golden yellow pigment, K+ crimson, N–, C+ transient pink; pigment most heavily concentrated in the outer parts of the apothecium and then deep orange-brown to red-brown, in the innermost parts bright golden yellow. *Proper exciple* reduced, mostly excluded. *Hypothecium* poorly differentiated from the hymenium, c. 60–120 µm thick. *Hymenium* 90–150 µm thick, golden yellow, K+ crimson, I+ red, KI+ blue; asci of the *Arthothelium*-type, 60–90 × 45–60 µm, 8-spored; paraphyses branched and anastomosed, relatively stout, 1.5–3 µm wide, often greyish in the upper part but with the apices not expanded. *Ascospores* broadly ellipsoid to oblong, straight or slightly curved, hyaline, becoming brown and rugulose when old, (29–)30–34.4–40(–42) × 11–14.0–17(–18) µm (*n* = 55), macrocephalic, with an enlarged, undivided upper cell and muriform 'tail' with 6–8 transverse and 2–4 longitudinal septa.

*Conidiomata* not found.

**Chemistry.** No substances detected by TLC.

**Etymology.** The species epithet refers to the similarity of the new species to *A. macounii*.

**Remarks.** The golden yellow, K+ crimson apothecial pigment (Endoaurantiacum-gold) of this species is shared by three other Tasmanian species (*A. bacidinum*, *A. endoaurantiacum* and *A. subtectum*), but only the saxicolous *A. subtectum* has macrocephalic ascospores similar to *A. macounioides*, although these are shorter and have fewer septa. The new species is superficially very similar to the Northern Hemisphere's *A. macounii* (*G. Merr.*) *W. J. Noble*, which also has macrocephalic spores and contains a K+ red apothecial pigment. However, the ascospores of that species are somewhat smaller (20–38 × 10–14 µm; *Coppins* 2009), with 4–6 transverse and 1–2 longitudinal septa. Furthermore, in *A. macounii* it is not uncommon to have some transverse spore sections with no longitudinal divisions, whereas in *A. macounioides* each transverse segment is always divided, as much as four times. At first glance the pigments of the two species appear different but their profiles in a range of reagents are identical and the perceived differences are possibly due to concentration levels.

**Distribution and ecology.** This distinctive species is known only from the type collection. It grew in deep shade on the bark of the small understorey tree *Acacia riceana*, in wet sclerophyll forest that was logged and regenerated approximately a century ago. This forest type is not known for being a hot spot of lichen diversity or noteworthiness, and hence has been little studied; thus the new species may well be more widespread.

**Comparative material of *A. macounii* examined. Great Britain:** *Scotland:* V.C. 97, West Inverness-shire, Ardnamurchan, hazelwood near Sonachan Hotel, NM 451664, 52 m, *J. R. Douglass* (HO).

#### *Arthothelium magenteum* Kantvilas sp. nov.

Mycobank No.: MB 841470

Species corticola, ascosporis ubique muriformibus, 25–55  $\mu\text{m}$  longis, 11–22  $\mu\text{m}$  latis, pigmento singulari, marronino-rubro, in kalio vivide magento recognita.

Typus: Australia, Tasmania, W of Tahune Bridge in the Warra SST, Coupe 1E, 43°06'S, 146°41'E, 100 m elevation, on *Nematolepis squamea* in *Eucalyptus obliqua* wet forest, 24 February 2004, G. Kantvilas 94/04 (holotypus—HO; isotypus—E).

(Figs 2G, 3B & 5A)

*Thallus* effuse, continuous or patchy, 20–60(–120)  $\mu\text{m}$  thick, dull grey, pale whitish, brownish grey or olive-brown, forming usually unexpanded, irregular patches to c. 60 mm wide, in section ecoricate, I+ brownish red, KI+ pale blue, sometimes overlain with a patchy, dark maroon-red, K+ magenta-pink pigment as in the apothecia; photobiont trentepohlioid, with cells globose to broadly ellipsoid, 10–16  $\times$  9–13  $\mu\text{m}$ , in short chains or clusters.

*Apothecia* abundant, scattered, 0.2–1(–1.5) mm wide, 100–200  $\mu\text{m}$  thick, black to brown-black, epruinose, appanate or slightly to markedly convex, adnate, roundish to ellipsoid or fleck-like when young, when old becoming more irregular, lobate and sometimes confluent. *Proper exciple* lacking or extremely reduced, at most comprised of a hyaline to pale brown layer to c. 20  $\mu\text{m}$  thick of entangled, anastomosing hyphae 1–1.5  $\mu\text{m}$  wide. *Hypothecium* barely differentiated from the hymenium, 10–50  $\mu\text{m}$  thick, hyaline or, more typically, infused with or subtended by dark maroon-red pigment. *Hymenium* 110–180  $\mu\text{m}$  thick, hyaline to pale yellowish brown, I+ orange-red, KI+ mottled orange-red and blue, with the latter reaction confined mainly to the asci, overlain by a thick, lumpy layer of dark maroon-red pigment which suffuses downwards, sometimes through the entire hymenium; pigment in irregular lumps that congeal the hymenium, K+ vivid magenta-pink, C+ orange-brown, N+ orange-brown, H–, fluorescing red-pink in polarized light; asci of the *Arthothelium*-type, 50–90  $\times$  36–60  $\mu\text{m}$ , 8-spored; paraphyses branched and anastomosing, embedded in a gel matrix, 1–1.5(–2)  $\mu\text{m}$  wide, with the apices not expanded. *Ascospores* ellipsoid to ovoid, sometimes a little curved, hyaline at first, becoming brown with age, (25–)33.5–41.4–53.5(–55)  $\times$  (11–)12.5–17.7–22  $\mu\text{m}$  ( $n = 55$ ), not macrocephalic, densely muriform throughout, with 7–15 transverse and 1–5 longitudinal septa.

*Conidiomata* not found; conidia rarely seen within the apothecia, arising from the degeneration of overmature spores, bacilliform, 4.5–6  $\times$  0.8  $\mu\text{m}$ .

**Chemistry.** No substances detected by TLC.

**Etymology.** The specific epithet refers to the colour reaction in K of the apothecial pigment that characterizes this species.

**Remarks.** The unique apothecial pigment, termed here Magenteum-red, characterizes this species. In some specimens, especially those from coastal areas, longer elution in K also produces a diffuse blue coloration. It remains unclear whether an additional pigment is present or whether this effect represents a breakdown of the one pigment.

There are several different pigments in *Arthothelium* that produce a shade of pink or red with K, but none has the same characteristic profile as Magenteum-red in the various standard reagents or in visible or polarized light. In the Tasmanian flora, *A. bacidinum*, *A. endoaurantiacum*, *A. macounioides* and *A. subtectum* all contain Endoaurantiacum-gold, which reacts K+

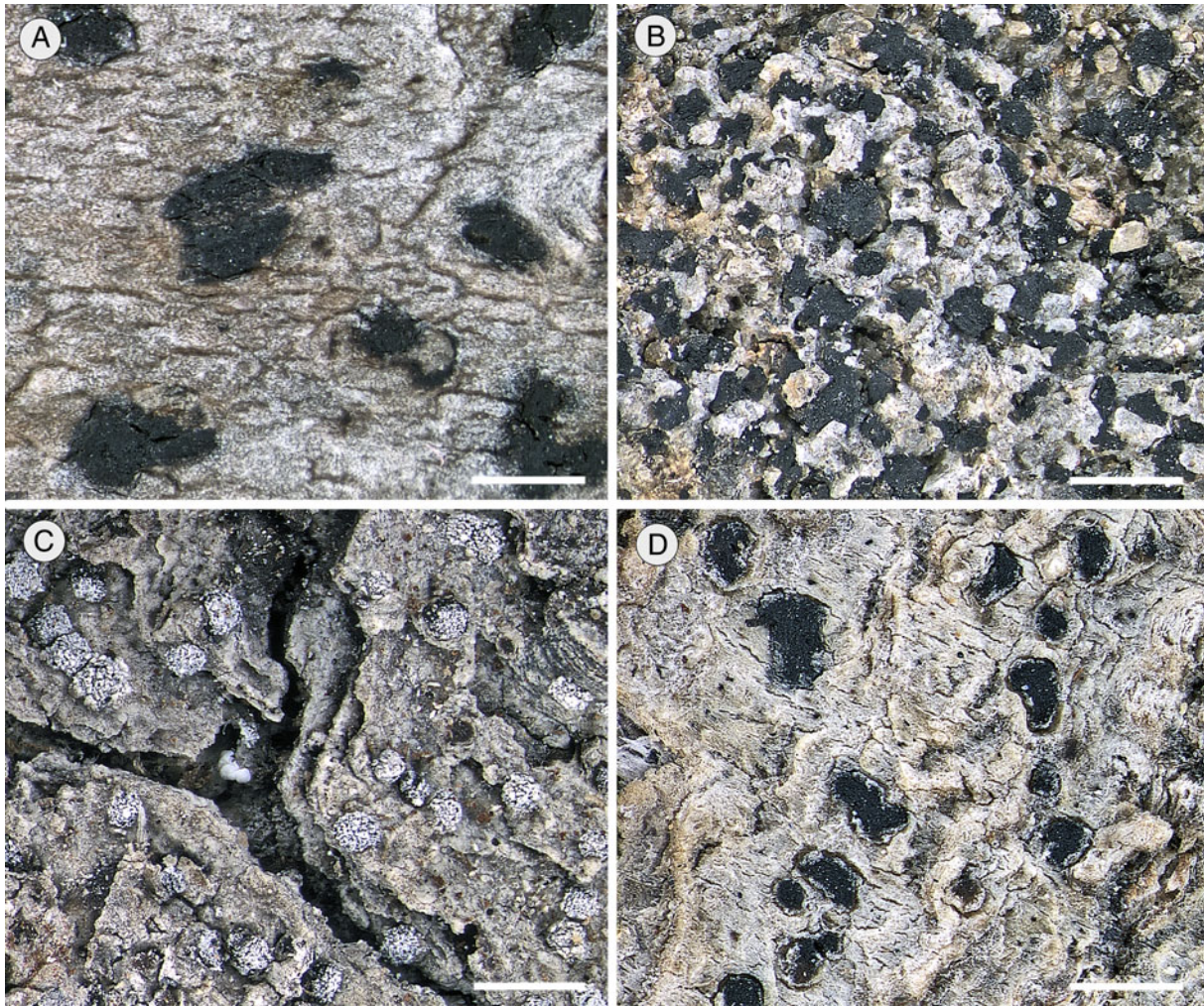
crimson. Brownish, K+ crimson pigments are found in the Northern Hemisphere's *A. macounii* and in the New Zealand species, *A. spadiceum*; these are likely to be Endoaurantiacum-gold as well, albeit in lower concentrations than those seen in the Tasmanian taxa. There is also a brownish, K+ reddish pigment in the Northern Hemisphere's *A. spectabile* which is different again. In addition to apothecial pigments, the ascospores of the species mentioned also differ from those of *A. magenteum*, being either macrocephalic, or muriform throughout but with the septa parallel and the locules  $\pm$  even-sized. In contrast, the ascospores of *A. magenteum* are frequently a little attenuated at one end, sometimes curved, and the septa and locule size are irregular. A further species studied in this context is *A. homoeophanum* (Nyl.) Zahlbr. (type specimen in H examined), described from New Caledonia (Nylander 1863). Here the greyish green pigment is Sedifolia-grey (Meyer & Printzen 2000), reacting K+ violet, C+ violet. Although not known from other species of *Arthothelium*, it is not uncommon in the *Lecanoromycetes*, being found, for example, in species of *Micarea*, *Rimularia* and *Thalloidima*.

The record of *A. macrothecum* (Fée) A. Massal. from Tasmania (Jatta 1911) is based solely on a specimen of *A. magenteum* (held in NAP). This American, essentially tropical species does not occur in Tasmania, and differs starkly from *A. magenteum* in many characters, including its black, appanate apothecia, Interveniens-brown pigmentation, and large ascospores (46–70  $\times$  17–28  $\mu\text{m}$ ) with as many as 17 transverse and 7 longitudinal septa (Fink 1935; this study). Specimens from tropical Queensland, held in CANB, confirm the occurrence of this species in Australia.

**Distribution and ecology.** *Arthothelium magenteum* is known only from Tasmania where it is a common epiphyte on smooth bark, mostly in the wetter, western parts of the island but also in locally wetter, coastal parts of the south-east. It is found mainly in rainforest, especially in communities of the thamnisc type (nomenclature after Jarman *et al.* (1994)), colonizing the bark of hosts such as *Anodopetalum biglandulosum*, *Eucryphia lucida*, *Lagarostrobos franklinii*, young *Nothofagus cunninghamii*, *N. gunnii* and *Pittosporum bicolor*, either in moderately shaded gaps in the understorey, or on young branches within the forest canopy. It is also found in old-growth wet eucalypt forests which represent successional stages towards thamnisc (as distinct from callidendrous) rainforest. In such communities, the bark of mature understorey trees, notably *Nematolepis squamea*, is a preferred habitat. It is found at subalpine to lowland elevations and has also been collected in wet, coastal scrub.

**Selected specimens examined.** **Australia:** *Tasmania:* near Geeveston, 1100 ft [330 m], W. A. *Weymouth* s. n. (NAP); Mueller Road, 500 m, 1981, G. Kantvilas 1036/81 (BM, HO); Weindorfers Forest, 41°38'S, 145°56'E, 1000 m, 1988, G. Kantvilas 10/88 (BM, H, HO); Anthony Road, 41°50'S, 145°38'E, 560 m, 1989, G. Kantvilas 11/89 (HO); Badger Creek, c. 2.5 km S of Greystone Bluff, 43°06'S, 146°02'E, 280 m, 1989, G. Kantvilas 72/89 (HO); 1 km W of Mt Charter, 41°37'S, 145°40'E, 780 m, 1989, G. Kantvilas 160/89 (HO); 4 km N of Precipitous Bluff, 43°25'30"S, 146°36'30"E, 730 m, 1990, G. Kantvilas 111/90 (HO); Olga River at Line 7, 42°51'S, 145°50'E, 70 m, 1990, G. Kantvilas 174/90 (HO); c. 3 km S of Teepookana, 42°13'S, 145°26'E, 220 m, 1990, G. Kantvilas 649/90 (HO); Green Head, 43°06'S, 146°04'E, 750 m, 1991, G. Kantvilas 79/91 (HO); Pelion Plains, 41°50'S, 146°02'E, 900 m, 1992,





**Fig. 5.** Morphology of Tasmanian species of *Arthothelium* II. A, *A. magenteum*. B, *A. subtectum*. C, *A. suffusum*, with basally constricted, subglobose, pruinose apothecia. D, *A. velatum*. Scales = 1 mm. In colour online.

*G. Kantvilas* 220/92 (HO); W of Tahune Bridge in the Warra SST, 43° 06'S, 146°41'E, 90 m, 1997, *G. Kantvilas* 273/97 (CANB, HO); *ibid.*, 200 m, 1998, *G. Kantvilas* s. n. (HO, UPS); Windy Moor, 42°40'S, 146°38'E, 1170 m, 2013, *G. Kantvilas* 8/13 (HO); Crest Range, 43° 17'28''S, 146°30'26''E, 980 m, 2016, *G. Kantvilas* 229/16 (HO); Tasman Track, W of O'Hara Bluff, 43°05'S, 147°57'E, 380 m, 2020, *G. Kantvilas* 273/20 (HO); Bivouac Bay, 43°07'S, 147°58'E, 5 m, 2020, *G. Kantvilas* 345/20 (HO).

**Comparative material of *A. macrothecum* examined.** **Australia:** Queensland: Mossman, Mt Molloy Rd, 16°32'05''S, 145°22'59''E, 390 m, 2006, *J. A. Elix* 36903 (CANB).—**Brazil:** Sao Paulo: Ilha de Santo Amaro, 1978, *K. Kalb* & *G. Plöbst* (*K. Kalb: Lichenes Neotropici* 353) (CANB).

#### *Arthothelium subtectum* Kantvilas sp. nov.

MycoBank No.: MB 841471

Apotheciis pigmento aurantiaco, in kalio vivide carmesino infusis et ascosporis macrocephalicis, 22–36 µm longis, 9–14 µm latis, *Arthothelium macounii* simile sed habitu saxicola et apotheciis

parvioribus, plerumque ad 0.5 mm latis, convexis, sessilibus vel leviter basi constrictis differt.

Typus: Australia, Tasmania, Three Thumbs summit area, 42°36'S, 147°52'E, 540 m elevation, on the undersides of large, inclined dolerite boulders in a damp, sheltered aspect in dry sclerophyll forest, 15 August 2019, *G. Kantvilas* 186/19 (holotypus—HO; isotypus—E).

(Figs 2H & 5B)

*Thallus* inapparent, perceived mainly as a discoloration of the substratum, occasionally unevenly scurfy-verruculose and dull grey or brown, forming extensive undelimited patches to c. 50 mm wide; photobiont trentepohlioid, with cells globose to ellipsoid, 8–22 µm wide, in short chains or scattered in clusters.

*Apothecia* very abundant, scattered, 0.2–0.5(–0.8) mm wide, 160–320 µm thick, black, epruinose, adnate or slightly basally constricted, markedly convex, irregularly roundish or ellipsoid, in section entirely infused with a golden yellow pigment, K+ crimson, N–, C+ transient pink; pigment most heavily concentrated in the outer parts of the apothecia and then deep orange-brown to red-brown, in the innermost parts bright golden yellow. *Proper exciple* generally reduced and reflexed, in younger



apothecia 10–25 µm thick, deep orange-brown, comprised of rather amorphous, anastomosed hyphae *c.* 1 µm wide interspersed with minute granules. *Hypothecium* barely differentiated from the hymenium, mostly to 80–200 µm thick, intense golden yellow. *Hymenium* 70–120 µm thick, intensely golden yellow, K+ crimson, I+ orange-red, KI+ blue, overlain by a thick, lumpy layer of pigment 10–20 µm thick; asci of the *Arthothelium*-type, 55–75 × 20–45 µm, 8-spored; paraphyses branched and anastomosed, 1 µm wide, usually brownish in the uppermost part, with the apices expanded to 4 µm. *Ascospores* broadly ellipsoid to oblong, straight, hyaline at first, soon becoming brown and, when old, minutely rugulose, 22–27.1–33(–36) × 9–11.6–14 µm (*n* = 55), macrocephalic with an enlarged, undivided upper cell and muriform ‘tail’ with 4–5 transverse and 0–3 longitudinal septa.

*Conidiomata* not found.

**Chemistry.** No substances detected by TLC.

**Etymology.** The specific epithet is derived from the Latin *sub*, meaning ‘under’ and *tectum*, meaning ‘roof’, and alludes to the habitat of the new species under rocky overhangs.

**Remarks.** *Arthothelium subtectum* is characterized by the saxicolous habit, the convex, sessile or slightly basally constricted apothecia, heavily infused with Endoaurantiacum-gold pigment, and the macrocephalic ascospores, 22–36 × 9–14 µm. Only one other saxicolous species of *Arthothelium* is known in Tasmania, and whereas both contain the same apothecial pigment, *A. bacidinum* is readily distinguished by its larger, non-macrocephalic ascospores. These two species also have a different habitat ecology, with *A. subtectum* being restricted to upland elevations whereas *A. bacidinum* is coastal. Macrocephalic ascospores, in combination with Endoaurantiacum-gold, are also seen in the corticolous species *A. macounioides*, which differs in having the muriform tail of its ascospores more divided, with up to four longitudinal septa across the widest part (compare Fig. 2F and 2H). Also with macrocephalic ascospores is *A. ampliatum*, but that species is corticolous, has a brownish, K+ olive green apothecial pigment, and the spores are somewhat larger. The most similar taxon to *A. subtectum* is the Northern Hemisphere species *A. macounii* (G. Merr.) W. J. Noble. This lichen has ascospores of very similar dimensions (Coppins & James 1979, as *A. ilicinum* var. *reagens*; Coppins 2009) but is exclusively corticolous on smooth bark and has adnate, applanate apothecia. The record of *A. macounii* from Tasmania by Kantvilas *et al.* (2008) refers to *A. subtectum*. In the field, the strongly convex, black apothecia and the saxicolous habitat of *A. subtectum* are initially more suggestive of a species of *Brianaria* or *Micarea*, all of which have an entirely different apothecial anatomy and ascospore morphology.

**Distribution and ecology.** *Arthothelium subtectum* has a very distinctive and narrow habitat ecology, being restricted to relatively dry, sheltered, deeply shaded underhangs of large dolerite outcrops in wet eucalypt forest and scrub. It is also noteworthy for apparently occurring mainly in the mid-elevation peaks of the eastern half of Tasmania and has not been found on western and central Tasmanian peaks, despite extensive lichen collecting having been undertaken there. This distribution pattern is not unique in Tasmania, and a small number of lichens display a similar, restricted pattern, viz. *Chiodecton montanum* Thor, *Crespona graemeanae* Kantvilas, *Lecanactis scopulicola* Kantvilas, *Lobaria scrobiculata* (Scop.) DC. and *Nephroma rufum* (C.

Bab.) P. James; all, like *Arthothelium subtectum*, are representatives of lichen genera usually associated with old-growth forest vegetation and stable, continuous ecological conditions, and their occurrence on rocks in more dynamic and disturbed vegetation types can be considered unusual.

**Specimens examined. Australia: Tasmania:** Hartz Mtns, 43°13'S, 146°46'E, 1963, P. W. James s. n. (BM, HO); South Sister, 41°32'S, 148°10'E, 750 m, 2004, G. Kantvilas 431/04 (HO); Mt Hobbs summit, 42°30'S, 147°35'E, 820 m, 2018, G. Kantvilas 59/18 (HO); Mt Forestier, 42°55'S, 147°51'E, 315 m, 2020, G. Kantvilas 86/20 (HO); Quoin Mtn, 42°33'S, 147°17'E, 870 m, 2020, G. Kantvilas 130/20 (HO).

### *Arthothelium suffusum* (C. Knight) Müll. Arg.

*Bull. Herb. Boissier* 2, App.1, 84 (1894).—*Arthonia suffusa* C. Knight, *Trans. N. Z. Inst.* 15, 353 (1883); type: New Zealand, *sine loco* [prob. Wellington], 23.xi.[18]77, Charles Knight s. n. (holotype—WELT 006974!; isotype—BM!).

*Arthothelium subspectabile* Vězda & Kantvilas, *Telopea* 4, 665 (1992); type: Australia, Tasmania, 3 km SW of Mt Agnew, 41°55'S, 145°11.5'E, on dry trunk of mature *Nothofagus cunninghamii* in rainforest, 190 m, 6 April 1989, G. Kantvilas 135/89 (holotype—HO!; isotype—PRA-V!).

(Figs 2I & 5C)

*Thallus* very thin, grey-white to dingy olive-grey, continuous, smooth, faintly rimose, I–, KI+ patchily pale bluish, forming irregular, undelimited patches to 100 mm across; photobiont trentepohlioid, with cells subglobose to ellipsoid-oblong, 10–15 µm wide, in short chains or clusters.

*Apothecia* scattered, abundant, roundish, 0.25–0.4(–0.6) mm wide, 180–250 µm thick, black, coarsely granular whitish pruinose with calcium oxalate crystals, epruinose when overmature, initially semi-immersed, soon becoming basally constricted and markedly convex. *Proper exciple* reduced to a layer of red-brown, K+ olive pigmented tissue 10–15 µm thick at the sides of the apothecia and extending continuously in a band beneath the hypothecium. *Hypothecium* poorly differentiated, hyaline to pale yellow-brown to brown, K+ olive, mostly *c.* 30–50 µm thick. *Hymenium* 110–200 µm thick, hyaline in the lower part, red-brown, K+ olive in the upper part, I+ red, KI+ blue, densely interspersed oil droplets and with rhomboidal, hyaline granules to 5–8 µm wide, soluble in K; asci of the *Arthothelium*-type, 60–85 × 40–55 µm, mostly 8-spored; paraphyses 1–1.2 µm wide, rather indistinct, with the apices not expanded. *Ascospores* broadly ellipsoid to ovoid, hyaline, becoming brown and rough-walled when old, (27–)28–33.9–42(–43) × (13.5–)14–17.1–22(–24) µm (*n* = 55), not macrocephalic, with 7–9(–11) transverse and 2–5(–7) longitudinal septa.

*Conidiomata* not found.

**Chemistry.** No substances detected by TLC.

**Remarks.** This species is very well characterized by its coarsely white-pruinose, convex, basally constricted apothecia, with a hymenium heavily interspersed with crystals and oil droplets. The pruina is composed of calcium oxalate, an unusual occurrence in *Arthothelium*, whereas the hymenial crystals are of an



unknown composition. It has no confusing species in the Tasmanian flora, and indeed no other members of the genus with similar characteristics are known. The brown, K+ olive pigment is *Interveniens*-brown, which is found in many other species, both in Tasmania and elsewhere. Illustrations and further data are provided by Kantvilas & Vězda (1992).

**Distribution and ecology.** In Tasmania, *Arthothelium suffusum* has a very distinctive habitat, being confined to the dry, sheltered, deeply shaded faces of the oldest, largest trees in cool temperate rainforest. *Lagarostrobos franklinii* and *Nothofagus cunninghamii* appear to be the preferred hosts, both trees being capable of massive stature and producing flaking, coarse bark when old. This lichen is part of the *Lecanactis abietina*-*L. mollis* association (Kantvilas 1988) and occurs together with calicioid lichens, *Arthonia* spp., *Bactrospora arthonioides* Egea & Torrente, *Chrysothrix candelaris* (L.) J. R. Laundon and other small crustose lichens. It was first described from New Zealand where it appears to have a similar habitat ecology.

**Specimens examined. Australia: Tasmania:** Weldborough, 41°12'S, 147°54'E, 640 m, 1981, G. Kantvilas 1127/81 (BM, HO); Badger Creek, c. 2.5 km S of Greystone Bluff, 43°06'S, 146°02'E, 280 m, 1989, G. Kantvilas 78/89 (HO); c. 3 km S of Teepookana, 42°13'S, 145°26'E, 220 m, 1990, G. Kantvilas 663/90 (HO); Sumac Road, Spur 2, S of Arthur River, 41°08'S, 145°02'E, 170 m, 1993, G. Kantvilas 306/93 (HO); Weldborough Pass, 41°13'S, 147°57'E, 1995, G. Kantvilas 58/95 (HO); Rabalga Track, 41°05'S, 145°23'E, 280 m, 2019, G. Kantvilas 88/19 (HO).

**Also examined. New Zealand: North Island:** Gisborne, Urewera NP, 1.5 km S of Lake Waikareiti, 38°44'S, 177°09'E, 1981, L. Tibell 12993 (MEL, UPS).

### *Arthothelium velatium* Müll. Arg.

*Bull. Herb. Boissier* 1, 60 (1893); type: Victoria, Oakleigh, on *Casuarina*, 8 August 1892, F. R. M. Wilson 1586 (lectotype, *vide* Kantvilas (1990)—G!; isolectotypes—MEL!, NSW!).

(Figs 2J & 5D)

*Thallus* very thin and patchy, pale cream to whitish grey, in section I+ red, KI+ patchily bluish, forming irregular, usually undelimited patches to 10–50 mm wide; photobiont trentepohlioid, with cells globose to ellipsoid, 8–16 µm wide, in short chains or scattered in clusters.

*Apothecia* scattered, 0.3–0.6(–1) mm wide, 60–180(–250) µm thick, black to brown-black, epruinose, adnate or sometimes a little immersed and covered by a thin veil of thalline tissue, plane to a little convex, roundish, fleck-like or irregularly effigurate. *Proper exciple* excluded or reduced to a layer of brown-pigmented tissue c. 10–15 µm thick. *Hypothecium* pale brown to brown, K+ olive or olive-yellow, mostly c. 20–40 µm thick. *Hymenium* 70–80 µm thick, hyaline to dilutely brownish, frequently interspersed with occasional oil droplets, I+ orange-red, KI+ blue, overlain by a deeper brown to red-brown, rather granular, K+ olive-grey to olive-yellow, rarely rather strongly although transiently K+ yellow, N– or intensifying brown, epithecium to 30 µm thick; asci of the *Arthothelium*-type, 40–75 × 30–50 µm, 8-spored; paraphyses 1–1.5 µm wide, sometimes greyish-pigmented and expanded to 2.5 µm in the uppermost part. *Ascospores* broadly ellipsoid,

broader at one end, straight or slightly curved, hyaline at first, becoming brown when old, (26–)30–35.5–41 × (11–)12–14.8–18(–20) µm ( $n = 80$ ), not macrocephalic, with 6–10 transverse and 2–3 longitudinal septa.

*Conidiomata* not found.

**Chemistry.** No substances detected by TLC.

**Nomenclatural note.** Müller (1893) coined the epithet 'velatius' and made reference to the affinities of his new species to 'A. velato Müll. Arg.' which appears to be a *nomen nudum*. The correct inflexion of 'velatius' (indicating affinity to 'velato') should be the neuter 'velatium'.

**Remarks.** This species is distinguished by the combination of its particular ascospore type and the presence of brownish, K+ olive apothecial pigment (*Interveniens*-brown). The same pigment occurs in several other species, notably *A. interveniens* and *A. ampliatum*, although in *A. velatium* it is comparatively dilute and the reactions can be rather weak. In the two coastal specimens seen, the hymenium and hypothecium yield a more yellowish reaction in K which gradually fades to olive; this is presumed to be a function of concentration rather than the result of some additional substance being present. In older specimens, the reaction tends towards a brownish olive colour. Further collections will be required to determine whether these varying colour reactions are correlated with any other taxonomic characters.

The ascospores of *A. velatium* are distinctive in that they tend to be wider at the proximal end, are not macrocephalic, and the cells are ±square or rectangular and arranged neatly like bricks in a wall, at least in the central parts of the spore. In an earlier study, Kantvilas (1990) cited the ascospores as being (16.5–)26–37 × 8–13 µm, with 8–11 transverse and 2–3(–4) longitudinal septa. Examination of further type material suggested that these dimensions were an underestimate, probably based on immature spores; the isolectotype in MEL has ascospores of 32–36 × 10–14 µm, with (7–)9–10 transverse and 3 longitudinal septa. These ascospores are rather more septate and narrower in comparison to the Tasmanian specimens described above, but in general this name offers a 'good fit'.

Also of relevance in this investigation is the Northern Hemisphere taxon *A. norvegicum* Coppins & T. Tønsb. The description of this species by Coppins & Tønsberg (1984) also matches the Tasmanian collections very well, and it is possible that it is closely related if not synonymous with *A. velatium*. Coppins & Tønsberg (1984) also discuss the distinction between *A. norvegicum* and *A. spectabile* Flot. ex A. Massal., noting that the latter has similar but slightly shorter ascospores (26–36 × 12–15 µm) with fewer (5–7) transverse septa, a brown, K+ reddish brown pigment in the hymenium and epithecium, and a thallus that reacts I+ blue in section. An examination of herbarium specimens of *A. spectabile* with an I+ blue thallus, chiefly from North America, revealed ascospores 30–45(–50) × 14–19(–20) µm ( $n = 35$ ) with (5–)6–8(–9) transverse septa and 1–3 longitudinal septa, and a red-brown hymenium that is ±unchanged or reddish in K. A single Tasmanian specimen has these apothecial characters but its thallus is I– and therefore it remains unplaced.

*Arthothelium velatium* is also somewhat similar to the Australian taxon *A. huegelii* (Nyl.) Zahlbr., which has larger and more divided ascospores, 41–60 × 20–27 µm, with 9–14 transverse and 4–7 longitudinal septa (type material in H examined).

**Distribution and ecology.** *Arthothelium velatium* is known from Tasmania, Victoria and New South Wales. In Tasmania, it is never common, the few herbarium collections are fortuitous, and consequently it is difficult to form a picture of its ecological requirements. It has been recorded from the smooth-barked foliage twigs of *Atherosperma moschatum* in the understorey of cool temperate rainforest, on *Beyeria viscosa* in wet eucalypt forest, and on shrubs in wet coastal scrub.

**Specimens examined.** **Australia:** *Tasmania:* Anthony Road, 41°50'S, 145°38'E, 560 m, 1989, G. Kantvilas 12/89 (HO); *ibid.*, 41°49'S, 145°38'E, 480 m, 1992, G. Kantvilas 516/92 (HO); Pelion Plains, c. 1 km SW of Pelion Hut, 41°50'S, 146°02'E, 900 m, 1992, G. Kantvilas 209/92 (HO); Wielangta Road, 42°43'S, 147°51'E, 260 m, 1996, G. Kantvilas s. n. (HO); South Cape Bay, 43°37'S, 146°50'E, 50 m, 2006, G. Kantvilas 354/06 (HO); Bivouac Bay, 43°07'S, 147°58'E, 5 m, 2020, G. Kantvilas 343/20 (HO).

**Comparative material also examined.** *Arthothelium norvegicum.* **Norway:** Nord-Trøndelag, Namdalseid, south of Lake Altvatn, 80–120 m, 1983, T. Tønsberg 8254a (BG, HO).

*Arthothelium spectabile.* **Georgia:** Distr. Soçi, 1982, A. Vězda (A. Vězda: *Lich. Sel. Exsicc.* 1851 (CANB)).—**USA:** *North Carolina:* Haywood County, Great Smoky Mtns NP, Cataloochie Divide Trail, 35°35'02"N, 83°04'39"W, 2011, E. Tripp et al. 2175 (*Lichens of Eastern North America Exsiccati* 464) (CANB, HO). *Massachusetts:* Essex, 1849 (*Reliquiae Tuckermanniae* 7) (CANB). *Iowa:* White Pine Hollow State Forest Preserve, 1965, C. M. Wetmore 13727 (CANB, MEL).

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