

## ADDITIONS TO THE TASMANIAN LICHEN FLORA FROM *ATHROTAXIS CUPRESSOIDES*-DOMINATED ALPINE VEGETATION

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(with two figures, seven plates and one table)

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Tasmania's *Athrotaxis*-dominated woodlands represent a distinctive habitat for lichens and support numerous remarkable species, many of which are endemic to Tasmania and confined to this host tree. In this paper, four further species known only from Tasmania are described as new to science: *Amandinea athrotaxiphila* Elix & Kantvilas, *Catinaria macrospora* Kantvilas, *Pertusaria comminuta* Kantvilas and *Pertusaria tasmanica* Kantvilas. A fifth species, *Xerotrema megalosporum* Sherwood & Coppins, hitherto known only from the cool temperate Northern Hemisphere, is recorded for Tasmania (and the Southern Hemisphere) for the first time. The presence of *Caloplaca ferruginea* (Huds.) Th.Fr. in Tasmania, previously based on a doubtful, historical record, is confirmed. All species are described in full and illustrated, and salient features of their ecology, distribution and related species are discussed.

**Key Words:** *Amandinea*, *Caloplaca*, *Catinaria*, conifers, new lichen species, *Pertusaria*, Tasmania, *Xerotrema*.

### INTRODUCTION

Alpine Tasmania represents a highly biodiverse region, not least for its remarkable lichens. Studies on Tasmania's alpine lichens over previous decades have gradually brought to light a truly noteworthy flora, which includes many taxa endemic to Tasmania (e.g., Kantvilas 1999, Kantvilas & Vězda 2000, Kantvilas & Lumbsch 2009, Fryday & Kantvilas 2012, Kantvilas 2012, Kantvilas & Jarman 2012, Kantvilas & Söchting 2013, Kantvilas 2014a, b, McCarthy & Kantvilas 2023), taxa that underline Tasmania's ancient Gondwana connections (e.g., Kantvilas 1990, Kantvilas *et al.* 2005), and bipolar taxa that illustrate the floristic similarities between Tasmania and other cold regions of the world (e.g., Kantvilas & Louwhoff 2007, Kantvilas & Gueidan 2018, Kantvilas 2023).

The composition of the lichen biota is shaped by several critical ecological factors, with rock-type being of particular importance, as it essentially divides Tasmania into two provenances: the central and eastern provenance, dominated by Jurassic dolerite, and the western provenance, dominated chiefly by Precambrian metamorphosed sediments (Kantvilas & Jarman 1991, Kantvilas 1995). Fire history and elevation are also important determinants of alpine species distribution (Kantvilas 2022). In this paper, we document six noteworthy additions to the Tasmanian lichen flora. All represent epiphytes of the endemic conifer, *Athrotaxis cupressoides* D. Don (pencil pine), a conspicuous, highly fire-sensitive tree species that occurs in small stands, copses or as isolated trees, mainly in central Tasmania.

### METHODS

The work is based on the collections of the first author, accumulated over many years of exploring and collecting lichens in Tasmania's high country, and housed in the Tasmanian Herbarium (HO). Anatomical observations and measurements are based on thin, hand-cut sections of the thallus, apothecia and pycnidia, mounted in water, 10% KOH (K), Lugol's Iodine (I), ammoniacal erythrosin and/or Lactophenol Cotton Blue (LCB). Ascospore measurements are presented in the format '5th percentile–average–95th percentile', with outlying values in brackets and *n* signifying the number of observations. Measurements were made from sections mounted in water, except for *Caloplaca ferruginea* where sections were mounted in LCB. Routine chemical analyses were undertaken by thin-layer chromatography (TLC) using standard methods (Orange *et al.* 2010); solvent A was the preferred medium. Liquid chromatography-mass spectroscopy (LCMS) was also undertaken on extracts of *Amandinea athrotaxiphila* and *Pertusaria comminuta* by Dr Ernest Lacy, Microbial Screening Technologies, Sydney.

The species descriptions and accompanying discussions include reference to their general context with respect to related taxa. However, full identification keys are not given here, but will be published in the *Tasmanian Lichen Flora* (<https://flora.tmag.tas.gov.au/about/lichens/>) when the names are formally validated





PLATE 1 — Scattered copses of *Athrotaxis cupressoides* (Turrana Heights, Central Plateau).



PLATE 2 — Fire-scarred and surviving trees of *Athrotaxis cupressoides* fringing a tarn (Mt Ophel, Central Plateau).



PLATE 3 — Mature trunks of *Athrotaxis cupressoides*, showing the furrowed, fibrous bark seemingly devoid of epiphytes (Long Tarns, Central Plateau).



## ATHROTAXIS AS A LICHEN HOST

*Athrotaxis cupressoides* (pencil pine) is a tree of ecological significance, being highly fire-sensitive and restricted to alpine elevations, mainly in Tasmania's central highlands. Individuals are estimated to be more than 1,000 years old. Pencil pine-dominated woodlands are classified as 'open montane rainforest' by Jarman *et al.* (1994), or as '*A. cupressoides* open woodland or *A. cupressoides* rainforest' in Harris and Kitchener (2005). Although they were once relatively extensive, fires, especially since European colonisation and particularly since the 1960s, have severely reduced their occurrence, although significant remnants still occur, for example, in the Walls of Jerusalem National Park, Mt Field National Park and elsewhere on the Central Plateau. The tree species frequently also occurs as small

copses or scattered or single trees in fire-protected sites, such as at the fringes of tarns (pls 1–3). These survivors can also be observed in the wider alpine landscape, usually surrounded by dead stags of fire-killed trees that indicate the historic extent of pencil pine woodlands. In more recent times, an added threat to *A. cupressoides* has emerged from a warming climate, with associated drought, susceptibility to fungal pathogens such as *Phytophthora* and increased fire risk. Small stands that have presumably died of drought in the past few years have been observed, for example, in the King William Range, and could well be considered at risk in the future, even though at present, neither the species nor the woodlands are classified formally as threatened.

*Athrotaxis cupressoides* is an unusual host for lichens. A mature tree typically presents fibrous, relatively unstable bark, smooth, bleached, decorticated wood, a bryophyte-

TABLE 1 — Noteworthy epiphytes of *Athrotaxis cupressoides* woodlands

Species	World distribution	Found mainly in <i>Athrotaxis</i> woodlands	Found exclusively in <i>Athrotaxis</i> woodlands	Widely distributed in other Tasmanian vegetation types
<i>Amadinea athrotaxiphila</i> Elix & Kantvilas	Tas endemic		x	
<i>Caloplaca ferruginea</i> (Huds.) Th.Fr.	Pan-temperate (?)		x	
<i>Catinaria macrospora</i> Kantvilas	Tas endemic		x	
<i>Chrysothrix palaeophila</i> Kantvilas & Elix	Tas endemic			x
<i>Japewia subaurifera</i> Muhr & Tønsberg	Tas, cool temperate Northern Hemisphere	x		
<i>Lambiella hepaticicola</i> (Coppins & Kantvilas) Resl. & T.Sprib.	Southern Hemisphere			x
<i>Menegazzia athrotaxidis</i> Kantvilas	Tas endemic		x	
<i>Meridianelia macCarthyana</i> Kantvilas & Lumbsch	Tas endemic	x		
<i>Mycoblastus kalioruber</i> Kantvilas	Australia inc. Tas, NZ			x
<i>Parmeliopsis hyperopta</i> (Ach.) Arnold	Tas, widespread in temperate areas		x	
<i>Pertusaria comminuta</i> Kantvilas	Tas endemic		x	
<i>Pertusaria tasmanica</i> Kantvilas	Tas endemic		x	
<i>Pseudoramonia riccheae</i> Kantvilas & Vězda	Tas, NZ			x
<i>Roccellinastrum flavescens</i> Kantvilas	Tas, NZ		x	
<i>Thelotrema</i> sp. <sup>1</sup>	Tas endemic		x	
<i>Topeliopsis fatiscens</i> Kantvilas	Tas endemic		x	
<i>Topeliopsis kantvilasii</i> Mangold & Lumbsch	Tas endemic	x		
<i>Topeliopsis</i> sp. <sup>1</sup>	Tas endemic			
<i>Xerotrema megalosporum</i> Sherwood & Coppins	Tas, cool temperate Northern Hemisphere		x	

<sup>1</sup> Species new to science to be described in a separate study.

dominated buttress, and hard, relatively long-lived leaves. Whereas lichens can colonise all these habitats, many trees can be effectively devoid of lichens or dominated by just a few species. Thus, in general, epiphytic lichen diversity can be poor relative to that seen on other trees such as, for example, *Nothofagus cunninghamii* (Kantvilas 1988), even if the biomass of lichens can be relatively high. It is not unusual to find a single lichen species dominating one small stand or copse, whereas another might dominate a nearby copse. *Athrotaxis* woodlands also tend to be sparse and open, and do not produce shaded, permanently moist and sheltered microhabitats that *Nothofagus*- or *Atherosperma*-dominated forests produce. Although some of the lichens found on *A. cupressoides* occur widely in other forest types in high rainfall areas in Tasmania, others are restricted to this vegetation or almost so (table 1).

## THE SPECIES

### *Amandinea athrotaxiphila* Elix & Kantvilas sp. nov.

MycoBank No.: MB 885784

Similar to *Amandinea occidentalis* Elix & Kantvilas, but differing in containing atranorin and norstictic acid, and in having ascospores  $16\text{--}29 \times 8\text{--}11 \mu\text{m}$ , sometimes with one or two endosepta.

Type: Australia, Tasmania, W side of Middle Lake,  $41^{\circ}44'S$ ,  $146^{\circ}23'E$ , 1230 m, on lone *Athrotaxis cupressoides* in alpine heathland, 1 January 2023, *G Kantvilas 5/23* (holotype—HO; isotype—CANB).

Thallus crustose, continuous, irregularly rimose, to 30 mm wide and 0.3 mm thick, white to grey-white, dull, verruculose, sorediate; soralia 0.4–1 mm wide, excavate to plane or convex, frequently with a distinct rim; soredia white, becoming discoloured or darkening with age; prothallus marginal, dark brown or black, or inapparent; photobiont cells  $8\text{--}18 \mu\text{m}$  wide; medulla white, lacking calcium oxalate ( $\text{H}_2\text{SO}_4$ ), I–. Apothecia 0.2–0.5 mm wide, lecideine, discrete, roundish, broadly adnate to sessile; disc black, epruinose, weakly concave to plane or becoming weakly convex; proper exciple persistent, elevated above the disc in younger apothecia, in section  $35\text{--}75 \mu\text{m}$  thick, dark olive-brown to brown-black, K–, N– in the outer part, paler brown within. Hypothecium  $40\text{--}50 \mu\text{m}$  thick, brown to dark brown; subhypothecium brown-black,  $120\text{--}200 \mu\text{m}$  thick; subhymenium  $15\text{--}20 \mu\text{m}$  thick, pale brown. Hymenium  $50\text{--}70 \mu\text{m}$  thick, hyaline, generally not interspersed but with a few, scattered oil droplets, overlain by a dark brown to brown-black, K–, N– epithelial layer  $12\text{--}15 \mu\text{m}$  thick; paraphyses  $2\text{--}3 \mu\text{m}$  wide, simple to sparsely branched, with apices dark brown,  $3.5\text{--}5 \mu\text{m}$  wide; asci of the *Bacidia*-type, 8-spored. Ascospores initially of the *Callispora*-type, then of the *Buellia*-type, 1-septate, brown, ellipsoid to broadly fusiform,  $16\text{--}23.5\text{--}29 \times 8\text{--}9.1\text{--}11 \mu\text{m}$

( $n = 30$ ), becoming constricted at the septum, often curved; immature spores sometimes with one or two endosepta; outer spore-wall minutely rugulate. Pycnidia rare, black, immersed; conidia curved, filiform,  $30\text{--}45 \times 0.7\text{--}1 \mu\text{m}$ . (pl. 4, fig. 1)

**Chemistry:** atranorin and norstictic acid (minor); soralia K+ pale yellow, KC–, C+ fleeting orange, P–, UV–. The chemical composition was confirmed by both TLC and LCMS, despite the enigmatic (but consistent) spot test results that failed to yield the expected K+ yellow→red reaction that typically signifies the presence of norstictic acid. Similarly, there was no development of red, needle-like crystals (also indicative of norstictic acid) when microscope squashes of the thallus and apothecia were eluted with K. These observations are attributed to low concentrations of this metabolite in the lichen.

**Etymology:** The specific epithet refers to the host of the new species, the conifer *Athrotaxis cupressoides*.

### Ecology and distribution

*Amandinea athrotaxiphila* is known only from the region colloquially referred to as ‘the land of a thousand lakes’ on Tasmania’s Central Plateau, where it grows on the wood and bark of isolated trees of *Athrotaxis cupressoides*. However, because most thalli are small and sterile, it may well have been overlooked elsewhere. Associated species include *Austroparmelina labrosa* (Zahlbr.) A.Crespo *et al.*, *A. pseudorelicina* (Jatta) A.Crespo *et al.*, *Lecidella* sp., *Meridianelia maccarthyana* Kantvilas & Lumbsch, *Micarea peliocarpa* (Anzi) Coppins & R.Sant., *Ochrolechia xanthostoma* (Sommerf.) K.Schmitz & Lumbsch, *Ramboldia stuartii* (Hampe) Kantvilas & Elix and *Usnea oncodes* Stirt.

### Discussion

The genus *Amandinea* is one of the largest groups of buellioid lichens in Tasmania, a group that has seen a steady stream of discoveries of species previously unrecorded for the island or of species new to science (see Elix & Kantvilas 2016a, b, 2020 for the more recent additions). The group is characterised by a crustose to small-squamulose thallus containing a green unicellular photobiont, 8-spored, *Bacidia*-type asci, and brown, usually 1-septate ascospores. *Amandinea* is further characterised chiefly by its filiform conidia.

In some respects, this new species resembles the Australian endemic *A. occidentalis* Elix & Kantvilas, insofar as both are corticolous, sorediate, and have relatively large, 1-septate, ellipsoid to broadly fusiform ascospores ( $22\text{--}30 \times 9\text{--}14 \mu\text{m}$  in the latter, Elix & Kantvilas 2013a) that become constricted at the septum, and curved, filiform conidia. However, in *A. occidentalis* the soredia are diffuse and granular rather than occurring in discrete soralia, and lichen substances are absent. Although conidia have not been observed in *Buellia yilliminngensis* Elix & Kantvilas, this species is also sorediate and has similar-sized ascospores to *A. athrotaxiphila*. However, it differs in containing gyrophoric and thiophanic acids and in lacking atranorin (Elix & Kantvilas 2013b).



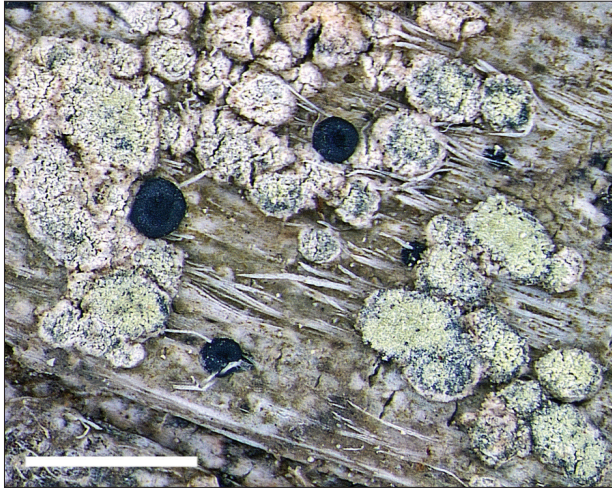


PLATE 4 — *Amandinea athrotaxiphila* with black apothecia and round soralia. Scale = 1 mm. (Photo: J Jarman)

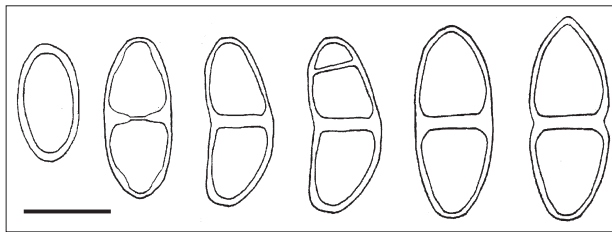


FIGURE 1 — Ascospore ontogeny in *Amandinea athrotaxiphila*. Scale = 10  $\mu$ m.

#### Additional specimens examined

TASMANIA: type locality, 2024, *G Kantvilas* 39/24 (HO); Turanna Heights, northwestern slopes, 41°45'S 146°22'E, 1270 m, 2024, *G Kantvilas* 4/24 (HO).

#### *Caloplaca ferruginea* (Huds.) Th.Fr.

*Nova Acta Regiae Soc. Sci. Upsal.*, ser. 3, 3: 223 (1861); — *Lichen ferrugineus* Huds., *Fl. Angl.*: 444 (1762); *Blastenia ferruginea* (Huds.) A.Massal., *Atti Reale Ist. Veneto Sci. Lett., ed Arti*, ser. 2, 3 (App. 3): 102 (1852).

Thallus effuse, very thin, mainly endophloeodal and best distinguished by a whitish discoloration of the bark substratum. Apothecia biatorine, sessile, basally constricted, 0.3–1.3 mm diam.; disc rusty orange, slightly pruinose, persistently plane; proper exciple  $\pm$  concolorous with the disc, persistent throughout development, in section 50–60(–90)  $\mu$ m thick, hyaline within, at the outer edge with a granular, golden-orange layer that reacts K<sup>+</sup> crimson and mostly dissolves. Hypothecium hyaline to pale yellow-brown, 60–70  $\mu$ m thick, generally not inspersed, rarely with occasional oil droplets. Hymenium 90–100  $\mu$ m thick, not inspersed, hyaline, in the upper part with a granular, golden-orange layer *c.* 10  $\mu$ m thick as in the exciple; paraphyses simple to sparingly branched, divided mainly in the uppermost part, 2–3  $\mu$ m thick, with the apices slightly expanded to 3–4  $\mu$ m wide and often

with occasional oil vacuoles to 4–5  $\mu$ m wide; asci of the *Teloschistes*-type, 8-spored, 70–90  $\times$  13–20  $\mu$ m. Ascospores polaribilocular, hyaline, broadly ellipsoid, (10–)11–13.2–15  $\times$  (5.5–)6–8.0–10  $\mu$ m (*n* = 70); septum prominent and occupying *c.* half of the spore length, 5–7(–8)  $\mu$ m thick. Conidiomata not seen. (pl. 5A)

#### Distribution and ecology

This species was first recorded for Tasmania by Crombie (1880), based on a collection made by Robert Brown in 1804 from the 'Derwent River'. The identification has never been confirmed, and the species was not recognised for Australia by Kondratyuk *et al.* (2012) but the name has persisted in various checklists up until the present day (McCarthy 2023). The recent Tasmanian collections cited here are from the twigs of *Athrotaxis cupressoides*, occurring as small clusters of apothecia within a rich assemblage of other lichens, including *Catinaria macrospora* Kantvilas, *Hypogymnia lugubris* (Pers.) Krog, *Menegazzia athrotaxidis* Kantvilas, *Ochrolechia xanthostoma*, *Pertusaria pertractata* Stirt., *Tasmidella subfuscens* (Hellb.) Kantvilas, *Tephromela soorediata* Kalb, *Thelotrema lepadinum* (Ach.) Ach. and *Usnea* spp.

#### Discussion

*Caloplaca* is one of the largest genera of crustose lichens in Tasmania, and it is particularly prominent in coastal areas where it causes the bright orange, red or yellow coloration of littoral rocks. The genus is less species diverse or conspicuous in higher rainfall areas, although a small number of uncommon (and mostly still unidentified) taxa have been recorded. The taxonomy and identification of most species of the genus is generally acknowledged as difficult, and particularly so in Australasia where there is a pressing need to resolve the plethora of names based on Australian (including Tasmanian) types with the many Northern Hemisphere names that have also been applied. *Caloplaca ferruginea* is widely recorded in the Northern Hemisphere (e.g., Fletcher & Laundon 2009, McCune 2017). The name is applied here with some caution, although the Tasmanian material compares favourably to these published sources and displays the salient features of biatorine, rusty orange apothecia, a mostly non-inspersed hymenium and hypothecium, paraphyses with few (or no) oil vacuoles, and ascospores where the septum occupies almost half of the spore-length.

Contemporary classification of the large, heterogeneous 'form' genus *Caloplaca* based on DNA-sequence data (e.g. see Arup *et al.* 2013) places this taxon in the genus *Blastenia*, together with another alpine Tasmania taxon, *C. wilsonii* (= *Blastenia circumpolaris* Søchting *et al.*). However, this new approach has not been without controversy and has not been adopted in Australia (McCarthy 2023), where all species are retained in *Caloplaca*.

#### Specimens examined

TASMANIA: Lake Ball, 41°51'S 146°18'E, 1150 m, 2002, *G Kantvilas* 108/02 (HO); George Howes Lake, southern end, 41°47'S 146°17'E, 1150 m, 2022, *G Kantvilas* 57/22 (HO);



Mt Field National Park, Twisted Tarn, 42°40'S 146°34'E, 1120 m, 2024, *G Kantvilas 127/24* (HO).

*Catinaria macrospora* Kantvilas sp. nov.

Mycobank No. MB 855785

Similar to *C. atropurpurea* (Schaer.) Vězda & Poelt, but with larger apothecia, 0.5–1.3 mm diam., and larger ascospores, 15–28 × 6–10 µm.

Type: Australia, Tasmania, c. 2 km S of Turrana Bluff, 41°47'S 146°21'E, 1280 m, on *Athrotaxis cupressoides* in a small copse in alpine heathland, 16 February 2012, *G Kantvilas 35/12* (holotype—HO).

Thallus effuse, endophloeodal, barely discernible as a dull discoloration of the bark substratum; photobiont green, unicellular (*Dictyochloropsis*), with globose cells 6–12 µm wide. Apothecia biatorine, sessile, basally constricted, 0.5–1.3 mm diam.; disc dark reddish brown, epruinose, mostly persistently plane, becoming undulate to weakly convex at maturity; proper exciple ± concolorous with

the disc or somewhat darker and a little glossy, persistent throughout development, in section 60–90 µm thick laterally, deep reddish brown, K± dull brown at the outer edge, becoming increasingly patchily and dilutely pigmented within, composed of radiating, conglutinated, branched and anastomosed hyphae with thread-like lumina. Hypothecium hyaline to pale yellow-brown, 40–50(–90) µm thick, inspersed with oil droplets to 6 µm diam. Hymenium 70–100 µm thick, not inspersed, hyaline, overlain by a reddish brown, K± dull brown epithecial layer c. 10 µm thick; paraphyses simple to sparingly branched, 1–1.5 µm thick, with apices reddish brown, to 3–4 µm wide; asci of the *Catillaria*-type, 8-spored, 70–80 × 16–20 µm. Ascospores 1-septate, very rarely with an additional septum towards one end of the spore, straight or slightly curved, frequently a little apiculate at the apices and slightly constricted at the septum, (15–)17.5–21.2–25(–28) × 6–7.4–8.5(–10) µm ( $n = 80$ ); wall distinct, 0.5–1 µm thick; perispore often incomplete, c. 0.5–1 µm thick. Conidiomata not seen. (pl. 5B)

*Chemistry*: nil.

*Etymology*: The specific epithet alludes to the relatively large ascospores of the new species.

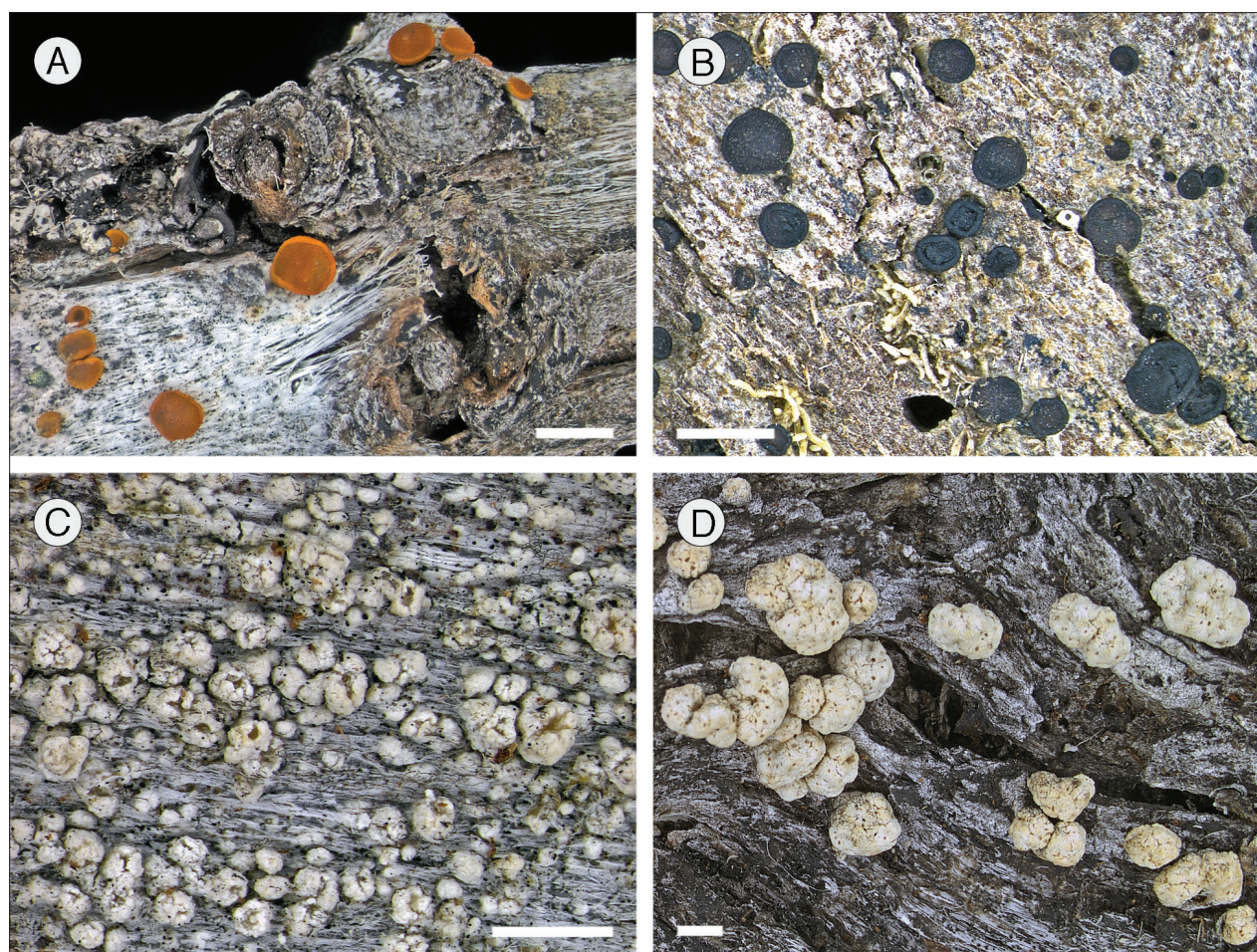


PLATE 5 — Species studied. **A** *Caloplaca ferruginea*; **B** *Catinaria macrospora*; **C** *Pertusaria comminuta*; **D** *Pertusaria tasmanica*. Scales = 1 mm. (Photos: J Jarman)



### Ecology and distribution

*Catinaria macrospora* has been collected from the bark of old *Athrotaxis cupressoides* growing in small, isolated copses. There it grew on trunks seemingly devoid of other lichens, although occurring on one of the pieces of bark are the scattered, orange soralia of *Caloplaca wilsonii* S.Y.Kondr. & Kärnefelt. It has also been collected from the twigs of *A. cupressoides* fringing a lake shore, and there it is associated with a rather diverse epiphytic community that includes *Caloplaca ferruginea*, *Thelotrema lepadinum*, *Menegazzia athrotaxidis* and *Pertusaria flavoexpansa* Kantvilas & Elix.

### Discussion

*Catinaria* is a small genus of about six species, found mostly in the Northern Hemisphere and the Americas. It is characterised by an ecorticate, crustose thallus containing a green, unicellular photobiont, biatorine apothecia, a cupulate proper exciple, *Catillaria*-type, 8–16-spored asci with a well-developed, uniformly amyloid tholus lacking any internal differentiation, simple to sparsely branched paraphyses with capitate, pigmented apices, and 1(–3)-septate, hyaline, ellipsoid ascospores with a thin, compact, gelatinous perispore. The recent classification of Jaklitsch *et al.* (2016) includes *Catinaria* in the Ramalinaceae, together with *Bacidia*, *Jarmania* and many other crustose genera. However, the distinctive ascus structure and halonate ascospores would appear to align it more readily to *Halecania*, which differs chiefly by having lecanorine apothecia, whereas the 1-septate ascospores and general appearance of the apothecia are similar to those of *Megalania*, which differs by having *Bacidia*-, *Biatora*- or *Lecanora*-type asci and non-halonate ascospores. One species, the cosmopolitan *C. atropurpurea*, is widely distributed in temperate Australia and is locally abundant in Tasmania on the bark of mature shrubs and small trees in coastal scrub.

The new species is very distinctive and its larger apothecia and incrementally larger ascospores readily distinguish it from 'typical' *C. atropurpurea* as illustrated by numerous Australian and Tasmanian specimens studied, and as described in the literature (e.g., Hafellner & Ryan 2004, Gilbert 2009, Stenroos *et al.* 2016). When well-developed it also forms extensive, 'pure' patches up to c. 15 cm across. In contrast, *C. atropurpurea* has apothecia 0.2–0.8 mm diam. and ascospores 10–15 × 5–7 µm, and usually occurs as tiny thalli just a few centimetres across; furthermore, its ascospores have consistently rounded (rather than apiculate) apices, and the septum is frequently eccentric. However, despite these clear differences between the coastal *C. atropurpurea* with small ascospores and the alpine *C. macrospora* with large ascospores, two Tasmanian specimens remain undetermined. Both are from inland, wet forest habitats and have intermediate-sized ascospores, 13–20 × 5–8 µm; further collections may establish that these represent a further taxon in the genus.

### Additional specimens examined

TASMANIA: Fisher Bluff, c. 700 m E of summit, 41°43'S 146°20'E, 1340 m, 2022, *G Kantvilas* 393/22 (HO); George Howes Lake, southern end, 41°47'S 146°17'E, 1150 m, 2022, *G Kantvilas* 58/22 (HO).

### Other selected specimens examined

**Undetermined taxon.** TASMANIA: southern slope of South Sister, 41°32'S 148°10'E, 640 m, 20024, *G Kantvilas* 377/04A (HO); Florentine Bridge at 'Duke of Edinburgh' picnic area, 42°30'S 146°27'E, 360 m, 2005, *G Kantvilas* 315/09 (HO).

***Catinaria atropurpurea*.** TASMANIA: Flinders Island, Yellow Beaches, 40°13'S 148°15'E, 2 m, 1978, *JS Whinray* 1231 p.p. (HO); Cape Deslacs, 42°59'S 147°33'E, 1980, *G Kantvilas* 231/80 (BM, HO); Little Musselroe River estuary, 40°46'S 148°03'E, 5 m, 2018, *G Kantvilas* 181/18 (HO); St Helens Point, 41°17'S 148°21'E, 10 m, 2020, *G Kantvilas* 99/20 (HO); Stony Head, 40°59'S 147°01'E, 50 m, 2020, *G Kantvilas* 244/20 (HO, NY). SOUTH AUSTRALIA, KANGAROO ISLAND: Billy Goat Falls, 35°42'S 136°55'E, 200 m, *G Kantvilas* 781/12 (HO); Grassdale Lagoon, 36°00'S 136°53'E, 20 m, 2015, *G Kantvilas* 342/15 (HO). AUSTRIA: Mt Ebenberg, 47°19'N 12°47'E, 1200 m, 1990, *R. Türk* (*H Hertel: Lecideaceae Exsicc.* 261) (HO).

### *Pertusaria comminuta* Kantvilas sp. nov.

Mycobank No. MB 885786

Type: Australia, Tasmania, Blue Peaks, southern slope overlooking Middle Lake, 41°44'S 146°23'E, 1240 m, on *Athrotaxis cupressoides* in a stand of open montane forest, 2 January 2023, *G Kantvilas* 13/23 (holotype—HO).

Characterised by a thallus containing malonprotocetraric acid, irregularly deformed, verruciform apothecia, 4–8-spored asci, and ellipsoid ascospores, 52–85 × 29–44 µm.

Thallus crustose, effuse, cream-white, very thin, beset with coarse, irregular, highly fissured and sculptured, sessile or basally constricted, scattered or contiguous thalline granules and warts 0.2–0.8 mm wide containing the apothecia, sometimes fused together in irregular clumps to c. 1.5 mm wide; photobiont a unicellular green alga with globose cells 8–14(–18) µm diam. Apothecia mostly single per thalline wart; ostioles pale yellowish brown, c. 0.1 mm wide and a little sunken, with the margins irregular, ragged and dentate, becoming gaping, roundish, excavate and to 0.2 mm wide post-maturity. Proper exciple hyaline, 15–30 µm thick. Hymenium to c. 220–300 µm thick, hyaline, not interspersed, with the hymenial gel non-amyloid and the I+ blue reaction confined to the asci; paraphyses densely anastomosed, 1.5–2 µm thick, not capitate; asci 180–240 × 50–75(–80) µm (very few intact asci observed), (4–)8-spored, of the *Pertusaria*-type, with a weakly amyloid wall, a well-developed tholus with an intensely amyloid

cap, and a narrow ocular chamber when young. Ascospores biseriate or uniseriate in the ascus, simple, hyaline, ellipsoid,  $52\text{--}64.1\text{--}78(-85) \times (29\text{--})30\text{--}36.0\text{--}43(-44) \mu\text{m}$  ( $n = 70$ ); wall  $5\text{--}8 \mu\text{m}$  thick, 2-layered, smooth on the inner surface. Pycnidia not seen. (pl. 5C, fig. 2D)

**Chemistry:** malonprotocetraric acid (major), protocetraric acid ( $\pm$  minor), fumarprotocetraric acid ( $\pm$  minor); thallus and apothecia K $\pm$  gradually reddish brown, KC-, C-, P+ orange-red, UV-.

**Etymology:** The specific epithet means 'crumbling' in Latin and refers to the crumbly, rather abraded appearance of the thallus and apothecia.

#### Distribution and ecology

Most collections of this species are from the trunks of *Athrotaxis cupressoides* in alpine woodland, where it occurs on fibrous, otherwise seemingly bare bark largely devoid of other lichens. However, some are from the fibrous bark of *Eucalyptus delegatensis* subsp. *tasmaniensis* Boland in open heathy woodland, suggesting that with further fieldwork, it may prove to be more widespread.

#### Discussion

This is a generally rather nondescript and inconspicuous species and is therefore easily overlooked. The thallus is dominated by crumbly, sculptured verrucae, which commence development as scattered granules that usually fuse together to produce an uneven, irregular mass. Thus, unlike 'typical' *Pertusaria* species where the verrucae are  $\pm$  roundish or hemispherical, with the ostioles visible as neatly rounded specks, depressions or holes, in *P. comminuta*, the apothecial verrucae resemble thallus granules, and the ostiole is a ragged opening where sometimes a pale yellowish-brown disc is partially visible. Post-mature verrucae can be excavate and appear as round, concave depressions.

Superficially, this species is similar to *P. tasmanica* (described below) when the latter is in a poor or juvenile state, insofar as both species have a creamy thallus, their asci are  $\pm$  identical, and their ascospores are of similar size and shape. It was mainly the chemical difference that inspired further study, especially in the field where the morphological differences are stark: *P. tasmanica* with large, neatly globose apothecial verrucae, and *P. comminuta* with deformed, fissured and sculptured verrucae.

#### Additional specimens examined

TASMANIA: near Tom Thumb Plain,  $42^{\circ}53'S$   $147^{\circ}11'E$ , 1965, *GC Bratt 2298* & *JA Cashin* (HO); Hartz Mountains National Park, Lake Osborne Track,  $43^{\circ}13'S$   $146^{\circ}45'E$ , 850 m, 1981, *G Kantvilas 492/81* & *P James* (BM, HO); Doherty's Cradle Mountain Hotel grounds,  $41^{\circ}34'S$   $145^{\circ}56'E$ , 830 m, 2003, *G Kantvilas 450/03* (HO); Mt Field National Park, track to Lake Nicholls,  $42^{\circ}40'S$   $146^{\circ}39'E$ , 985 m, 2008, *G Kantvilas 350/08* (HO); Mt Field National Park, Twisted Tarn,  $42^{\circ}40'S$   $146^{\circ}34'E$ , 1120 m, 2024, *G Kantvilas 124/24* (HO).

#### *Pertusaria tasmanica* Kantvilas sp. nov.

Mycobank No. MB 855787

Type: Australia, Tasmania, Traveller Range, c. 3.5 km NNW of The Gatepost,  $41^{\circ}56'S$   $146^{\circ}06'E$ , 1230 m, on *Athrotaxis cupressoides* in open coniferous woodland, 12 March 2011, *G Kantvilas 146/11* (holotype—HO; isotype—E).

Characterised by a thallus containing norstictic acid, globose, verruciform apothecia, 0.8–2 mm diam., 6–8-spored asci, ellipsoid ascospores,  $46\text{--}100 \times 20\text{--}50 \mu\text{m}$ , and fusiform conidia,  $10\text{--}15 \times 1 \mu\text{m}$ , with a central bulge.

Thallus crustose, effuse, cream- to grey-white, very thin and discontinuous, dominated by verruciform apothecia; photobiont a unicellular green alga with globose cells  $8\text{--}13 \mu\text{m}$  diam. Apothecia immersed in thalline verrucae with a usually wrinkled or cracked surface, globose, superficial, strongly basally constricted, cream-white, 0.8–2 mm diam., single or more commonly comprised of several apothecia fused together; ostioles 1–3 per simple verruca, to c. 10 in compound, fused verrucae, at first pale pinkish brown, c. 0.1 mm wide and a little sunken, gaping post-maturity. Thalline exciple  $80\text{--}140 \mu\text{m}$  thick. Proper exciple hyaline,  $20\text{--}30 \mu\text{m}$  thick. Hymenium to c.  $400\text{--}450 \mu\text{m}$  thick, hyaline, interspersed with large oil droplets,  $6\text{--}30 \mu\text{m}$  diam., with the hymenial gel non-amyloid and the I+ blue reaction confined to the asci; paraphyses densely anastomosed,

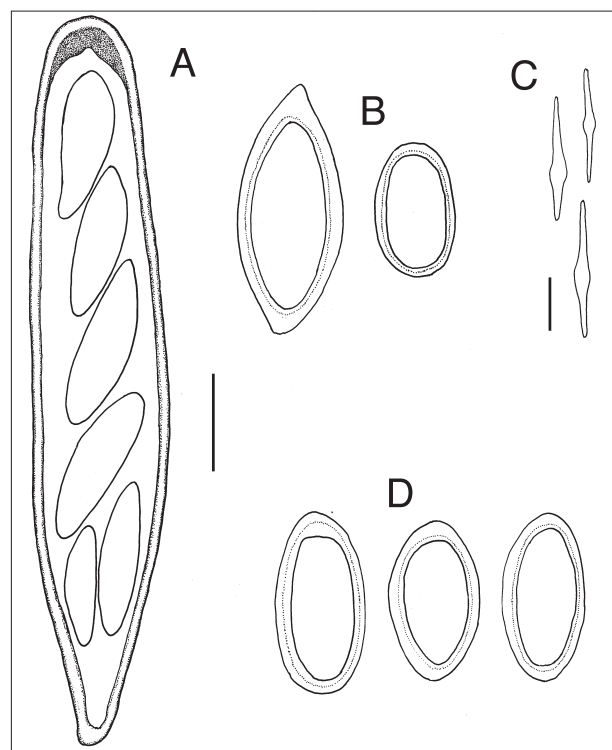


FIGURE 2 — Anatomy of *Pertusaria*. **A** The *Pertusaria*-type ascus, as seen in *P. tasmanica*, with amyloid parts stippled; **B** Ascospores of *P. tasmanica* (note the double wall); **C** Conidia of *P. tasmanica*; **D** Ascospores of *P. comminuta*. Scales: A, B, D =  $40 \mu\text{m}$ ; C =  $5 \mu\text{m}$ .



1.5–2 µm thick, not capitate; asci 200–300 × 26–35(–50) µm (few intact asci observed), 6–8-spored but often with as many as 4 spores aborted by maturity, of the *Pertusaria*-type, with a weakly amyloid wall, a well-developed tholus with an intensely amyloid cap, and, when young, with a short, blunt ocular chamber. Ascospores uniseriate in the ascus, simple, hyaline, ellipsoid, (46–)50–65.9–80(–100) × (20–)22.5–32.1–44(–50) µm ( $n = 60$ ); wall (2–)4–7 µm thick and inconspicuously 2-layered, swelling to 10 µm thick in K, smooth on the inner surface. Pycnidia immersed; conidia 10–15 × 1 µm, fusiform-acicular with a central bulge. (pl. 5D, figs 2A–C)

**Chemistry:** norstictic and connorstictic acids; thallus and thalline apothecial margin yielding red, needle-like crystals when sections are eluted with K.

**Etymology:** The specific epithet is based on the Tasmanian provenance of this taxon.

#### Distribution and ecology

*Pertusaria tasmanica* is an uncommon species that has been collected rather fortuitously in widely separated alpine localities. Whereas most collections are from the bark of *Athrotaxis cupressoides*, one is from *Diselma archeri* Hook.f. (cheshunt pine), a conifer that offers a bark of similar form and texture, and which frequently co-occurs with *Athrotaxis* in alpine woodlands and heathlands. As with the preceding species, *P. comminuta*, this new species occurs on fibrous bark essentially devoid of other lichens.

#### Discussion

The new species is very conspicuous due to its prominent, large, lumpy, thalline verrucae which contrast markedly with the dull grey-brown bark substratum, especially in cases where the thallus is rather poorly developed. However, also occurring in identical habitat is *Pertusaria comminuta*, which differs principally by its different chemical composition (protocetraric acid) and in having smaller, rather scurfy and abraded apothecial verrucae. Thus, care is required in identifying the new species and a simple chemical test with K is recommended.

Within the Tasmanian lichen flora, *P. tasmanica* is distinguished chiefly by the combination of its effuse to absent thallus, relatively large, globose apothecia, and large ascospores. The only other norstictic-acid containing species is *P. norstictica* A.W.Archer, which occurs in low rainfall, lowland areas and differs clearly by having a thick, continuous, pale olive-grey thallus, and hemispherical, apically flattened, mostly simple apothecial verrucae with black ostioles. The ascospore sizes of the two taxa are very similar. Also possibly related is *P. patagonica* Müll.Arg., described from Argentina and also recorded from New Zealand, but that species likewise differs by having a well-developed thallus as well as larger ascospores, 80–135 × 36–68 µm, with a rough inner wall (Messuti & Vobis 2002).

The current delimitation of genera within the Pertusariales (Cannon *et al.* 2021) has developed over many iterations and involved analysis of a range of characters that include the ascus, ascospores and thallus chemistry (e.g., Schmitz *et al.* 1994, Lumbsch *et al.* 1995) and, more

recently, molecular data (e.g., Lumbsch & Schmitt 2002, Schmitt *et al.* 2006, Wei *et al.* 2017). Generic placement of the new species was, of necessity, based solely on a comparison of morphological and anatomical characters of herbarium specimens, chemical data and survey of the literature. Several genera were considered and compared during this study, with the classification of the new species determined by a combination of apothecial morphology, ascus type (fig. 2A) and the structure of the ascospore wall (fig. 2B). With this last character, it must be noted that the thick, gelatinous outer spore wall layer can become stripped away in preparing microscope mounts, and then the spores appear to be thin walled (GK pers. obs.). *Ochrolechia* was dismissed chiefly on account of it having an amyloid hymenium (as distinct from having the amyloid reaction confined to the asci), a particular ascus type where the outer wall is intensely amyloid and yields a 'fuzzy' appearance in light microscopy, ascospores with a thin, unlayered wall, and a thallus chemistry that comprises gyrophoric acid or its metabolic relatives, 5-*O*-methylhiasic acid or alectoronic acid. In the genus *Lepra*, the amyloid reaction is similar to that of the new species, in that it is confined to the asci, the asci themselves approximate the *Pertusaria*-type and there are species that contain depsidones such as norstictic acid, but it also has a particular apothecial form where the hymenium develops beneath a sorediate 'plug' and the ascospores have a single-layered wall; this genus too was dismissed. Also considered was the monotypic genus *Thamnochrolechia*, which has shortly stipitate apothecia, a non-amyloid hymenium, amyloid asci of the *Pertusaria*-type, and ascospores with a thin, single-layered wall. It is this last character that best distinguishes it from *Pertusaria sens. str.*, and hence this genus too was not considered.

#### Additional specimens examined

TASMANIA: Mt Field National Park, Clemes Tarn, 42°40'S 146°32'E, 1210 m, 2016, *G Kantvilas* 6/16(HO); plateau of Snowy South, 42°56'E 146°40'E, 1220 m, 2020, *G Kantvilas* 39/20(HO); Mt Field National Park, Twisted Tarn, 42°40'S 146°34'E, 1120 m, 2024, *G Kantvilas* 123/24 (HO).

#### *Xerotrema megalosporum* Sherwood & Coppins

*Notes Roy. Bot. Gard. Edinburgh* 38: 368 (1980).

Thallus effuse and pale greyish to absent or endophloeodal, forming extensive, diffuse patches, doubtfully lichenised but with various, scattered algal cells often present. Apothecia perithecioid, 0.2–0.3 mm wide, black, initially immersed, soon erumpent and frequently overlain in part by vestigial, whitish thallus fragments; proper exciple ± carbonised, strongly incurved when young, typically radially split and ridged, with a central, ostiole-like opening, later gaping, bearing periphyses 15–20 µm long, 2 µm thick in the upper part, in section annular, 30–50 µm thick, brown or olive-brown with a greenish tinge at the outer edge, becoming more dilutely pigmented to hyaline within, I+



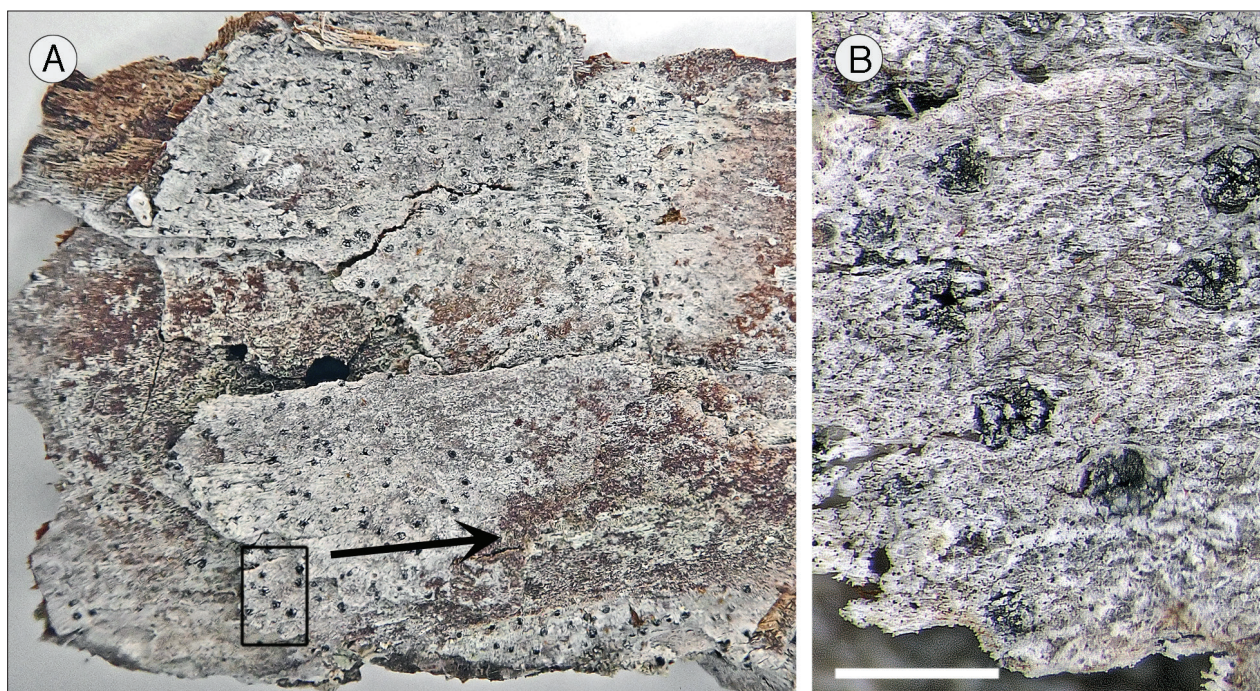


PLATE 6 — *Xerotrema megalosporum*. **A** Habit, showing black, speck-like apothecia; **B** Detail of apothecia. Scale = 500  $\mu$ m. (Photos: J Jarman)

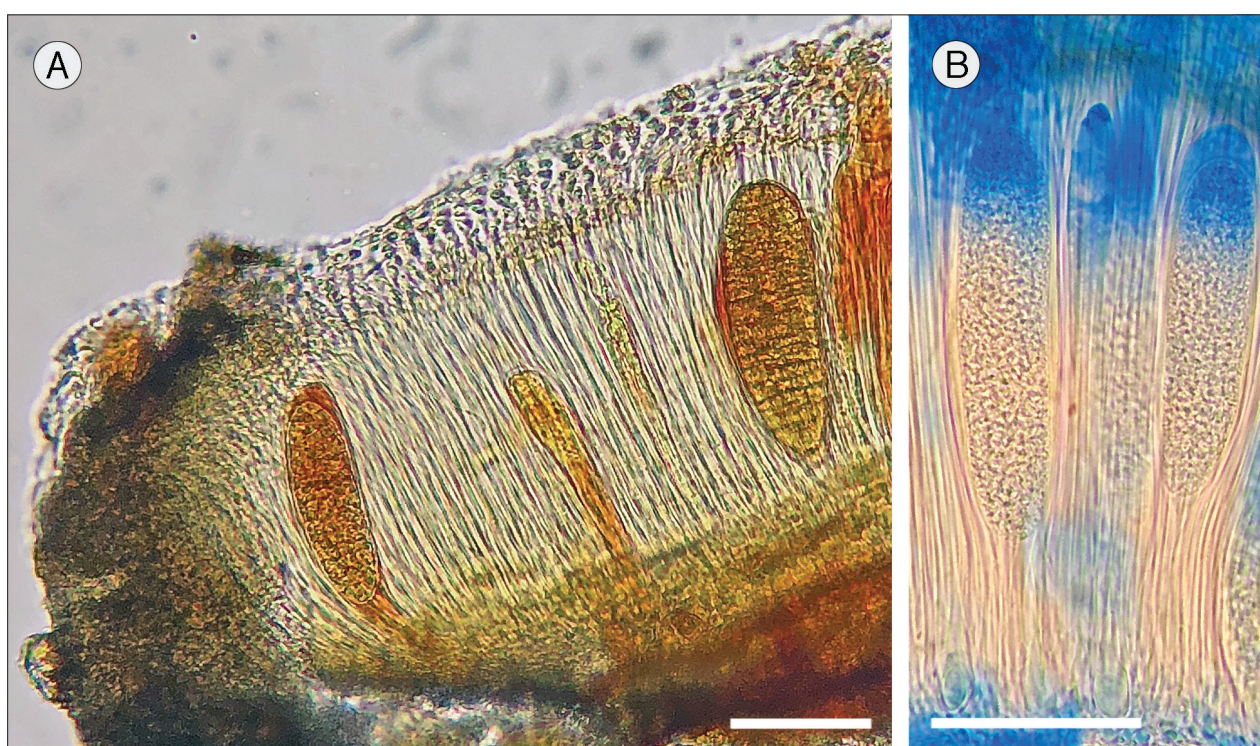


PLATE 7 — *Xerotrema megalosporum* anatomy. **A** Section through apothecium (in Iodine) showing asci with a single, muriform ascospore; **B** Portion of hymenium (in LCB) showing asci with contents disintegrated into conidia. Scales = 50  $\mu$ m. (Photos: M Baker)



patchily mauve in the lowermost part (colour developing very slowly); disc plane to concave, generally obscured. Hypothecium hyaline, poorly differentiated, 10–20 µm thick. Hymenium hyaline, non-amyloid, 100–160 µm thick, overlain by a brown epithelial layer 5–8 µm thick; paraphyses slender, ± straight and parallel, mostly simple, or sparsely branched and anastomosed in the upper part, c. 1 µm thick, with apices not swollen; asci 130–150 × 20–40 µm, cylindrical to elongate-clavate, 1-spored, non-amyloid, with a ± uniformly thick wall when young but lacking a tholus. Ascospores highly muriform, (70–)73–91.4–124(–130) × (16–)18.5–26.7–35.5(–40) µm, hyaline, broadly ellipsoid to oblong, non-amyloid, thin-walled, non-halonate; locules c. 3–5 µm wide, irregularly rhomboid, sometimes breaking down into ellipsoid conidia 3–3.5 × 1 µm. (pls 6–7)

#### Distribution and ecology

This species is locally common at alpine elevations on the Central Plateau where it forms inconspicuous, extensive thalli, frequently many tens of centimetres in extent, on the old trunks of *Athrotaxis cupressoides* in small, isolated copses of open montane rainforest. It is also known from montane areas of Britain, Scandinavia and the Pacific northwest of North America, where it likewise grows on conifer wood.

#### Discussion

*Xerotrema* is a genus of two, highly inconspicuous crustose species, mostly occurring on wood in cool temperate areas of the Northern Hemisphere (Sherwood & Coppins 1980, Holien & Diederich 2010, Brodo 2020, Cannon *et al.* 2024). It is characterised by an ecorticate, inconspicuous thallus that is loosely associated with algal cells and doubtfully lichenised, perithecioid fruiting bodies (when young) that open by a roundish pore with an entire or dentate margin, an annular proper exciple, a non-amyloid hymenium, mostly simple or sparsely branched and anastomosed paraphyses, 1-spored, non-amyloid asci, and large, muriform ascospores. In some respects, it resembles some species of *Topeliopsis*, which differ by having a clearly lichenised thallus containing *Trentepohlia*, a cupulate proper exciple, and usually strongly amyloid ascospores. *Xerotrema megalosporum* is detected in the field by the abundant, speck-like, black, erumpent apothecia (pl. 6A). In some cases, the contents of the asci break down into conidia (pl. 7B), a feature seen in some other lichens with large, muriform ascospores, for example, *Gyalideopsis graminicola* Vězda & Kantvilas. The apothecia of Tasmanian specimens appear to be somewhat smaller than those of Northern Hemisphere populations, where 0.3–0.6 mm has been reported.

#### Additional specimens examined

Fisher Bluff, c. 700 m E of summit, 41°43'S 146°20'E, 1340 m, 2022, *G Kantvilas* 395/22 (HO); Blue Peaks, southern slope overlooking Middle Lake, 41°44'S 146°23'E, 1240 m, 2023, *G Kantvilas* 8/23 (HO); c. 500 m N of Little Throne, 41°45'S 146°23'E, 1230 m, 2023, *G Kantvilas* 22/23 (HO); saddle c. 600 m E of Turrana Heights, 41°46'S 146°23'E, 1290 m, 2024, *G Kantvilas* 27/24 (HO).

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