Lichenicolous species of the Ascomycete genus Arthonia Ach. from Kangaroo Island

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Abstract

Three lichenicolous species of Arthonia Ach. are reported from Kangaroo Island, South Australia. Two are described as new: Arthonia caliciae Kantvilas & Wedin grows on the thallus of the lignicolous species Calicium tricolor F.Wilson, whereas Arthonia insularis Kantvilas & Wedin grows on the saxicolous Caloplaca eos S.Y. Kondr. & Kärnfelt. A third species, the widespread A. intexta Almq., infects the apothecia of the saxicolous crustose lichen, Lecidella sublapicida (Knight) Hertel. A key to the eight lichenicolous species of Arthonia recorded for Australia is provided.

Key Words: biodiversity, lichens, lichen parasites, new taxa, Arthoniaceae, South Australia.

Introduction

Arthonia is a cosmopolitan genus of ascomycete fungi that occurs in most habitats, ranging from dry steppes and savannahs to closed wet forest, and from littoral to alpine elevations. It has been estimated to contain approximately 400 species (Kirk et al. 2001), but this is an old and certainly outdated estimate. It is obvious both from the large variation in morphological traits (Grube & Matzer 1997, Sundin & Tehler 1998, Wedin & Hafellner 1998, Ihlen & Wedin 2008) and molecular phylogenies (Frisch et al. 2014) that Arthonia in its current circumscription is not monophyletic, and it is likely that a substantial change in its generic concept and delimitation will eventually occur. The majority of species are lichenised with the filamentous green alga Trentepohlia, and can be found on bark, wood, rocks or living leaves. These species are well represented in the Australian biota with 40 taxa recorded by McCarthy (2015). This figure is undoubtedly a very large underestimate, because the genus remains poorly collected and largely unstudied in the region. Most Australian herbaria hold significant numbers of specimens identified to genus only or tentatively identified to species using some of the more accessible Northern Hemisphere publications, such as Coppins & Aptroot (2009), Grube (2007) and Willey (1890), or the account of the genus for New Zealand (Galloway 2007).

Some species of Arthonia may be non-lichenised or weakly or only putatively lichenised, and occur as saprophytes on bark, although it is sometimes difficult to confirm this lifestyle without detailed anatomical study. Another highly diverse group within Arthonia comprises lichenicolous species, growing on the thalli of a wide range of fruticose, foliose or crustose genera. Collections of such species are also well-represented in Australian herbaria but are largely unstudied and filed under the name of the host species. However, a few of these have been studied and described on the basis of Australian collections, for example, Kondratyuk (1996), Wedin (1993), Wedin & Hafellner (1998) and Kantvilas & Vežda (1992). Based on the literature, McCarthy (2012) records five lichenicolous species for Australia. It is three species from this group that are the focus of the present study.

Methods

The study is based on collections of the first author, housed in the Tasmanian Herbarium (HO), but with some duplicates distributed to other herbaria, as cited in the text, and on comparisons with reference herbarium material (also as cited). The descriptions are based on hand-cut sections of the ascomata, mounted in water, 15% KOH, lactophenol cotton blue and Lugols Iodine, with (K/I) or without (I) pretreatment in KOH, and examined at high-power with a light microscope. Measurements of ascospores are based on more than 50 observations for each taxon and are presented in the form 5th percentile–average–95th percentile; outlying values are given in brackets.
Taxonomy

1. *Arthonia caliciae* Kantvilas & Wedin, sp. nov.

_Hospitum singulare* (*Calicium* tricolor *F.Wilson), *ascosporis hyalinitis, ellipsoiditis, uni-septatis, 10–14 µm longis, 3–5 µm latis et ascis omnino non-amyloideis recognita.

_Mycobank no.: MB 812915._

_Typus: AUSTRALIA, Kangaroo Island: Billy Goat Falls, 35°42’S 136°55’E, 200 m alt., on thallus of *Calicium tricolor* on dead wood in dry sclerophyll forest, 20 Sep. 2012, G. Kantvilas 773/12 (holo: HO; iso: AD, S)._ 

Growing on the scurfy crustose thallus of *Calicium tricolor* *F.Wilson*, _thallus_ lacking, trebouxioidean photobiont cells of the host lichen often penetrating the base of the ascomata. _Ascomata_ irregularly roundish, 0.12–0.3 cm wide, blackish brown to black, convex, minutely scabrid-verruculose, immargnate, slightly basally constricted to sessile, in section 60–120 µm thick, lacking any differentiated exciple. _Hypothecium_ hyaline to pale olive-brown, poorly differentiated from the hymenium. _Hymenium_ 30–55 µm thick, diffusely pale olive-brown, intensifying olive-greenish in K, I+ red, K/I+ blue, overlain by a more intensely pigmented epihymenial layer c. 5 µm thick; paraphysoids highly branched and anastomosing, rather indistinct, remaining rather coherent in K, c. 1 µm thick, with apices neither expanded nor capitulate but strongly conglutinated with pigment; asci 8-spored, 23–38 × 12–20 µm, of the _Arthonia_-type: broadly clavate to subglobose, mostly with a short ‘foot’ at the base and a well-developed tholus 1–, K/I–, lacking an amyloid ring-structure; apex of ascoplastic variable with age, concave, rounded or extending in a beak-like ocular chamber. _Ascospores_ hyaline, 1-septate, 10–11.3–13 (–14) × (3–) 4–4.7–5 µm, narrowly ellipsoid, typically with the upper cell a little larger and the septum slightly constricted. _Pycnidia_ immersed at the base of ascomata; conidia rod-shaped, 4–5 × 0.5 µm. _Fig. 1, 2A–E._

_Etymology._ The specific epithet refers to the unusual host of this new species.

Remarks. _Arthonia caliciae_ is characterised by its completely hyaline, ellipsoid, 1-septate ascospores, its totally non-amyloid asci, and by its host. Most lichenicolous fungi that grow on species of *Calicium* are themselves other calicioid fungi; for example, species of _Chaenothecopsis_ or _Microcalicium_. Thus _Arthonia caliciae_ is the first species of _Arthonia_ to be reported growing on a *Calicium*. Among other _Arthonia_ species known to occur on lichens related to the host (i.e. the non-mazaediate _Caliciaceae_; Wedin et al. 2002) are _A. epimela_ (Almq.) I.M.Lamb, which grows on the thallus of _Amandinea punctata_ (Hoffm.) Coppens & Scheid. This species differs from _A. caliciae_ by the considerably larger ascomata (c. 0.4–0.6 mm diam.) and the hyaline hymenium. _Arthonia punctella_ Nyl. grows on various crustose lichens, including _Diplotomma alboatrum_ (Hoffm.) Flot., but is clearly parasitic and has ascospores that turn brown and verrucose. None of these species are currently known from Australia. Indeed few calicioid species are associated with _Arthonia_ sens. lat.; _Chaenothecopsis vainioana_ (Nádv.) Tibell (Tibell 1981, 1999), which is associated with both free-living _Trentepohlia_ and _Trentepohlia_-containing lichens, is an exception.

The new species is known only from the type collection, growing on decorticated, bleached, rotting eucalypt lignin in dry open eucalypt forest. Other species growing on the same substratum included *Calicium abietinum* Pers., _C. salicinum_ Pers., _Ochrolechia glyrophorica_ (A.W.Archer) A.W.Archer & Lumbsch, _Ramboldia Stuartii_ (Hampe) Kantvilas & Elix, _Lecidella xylogena_ (Müll.Arg.) Kantvilas & Elix and _Caloplaca wilsonii_ S.Y.Kondr. & Kärnefelt.

2. _Arthonia insularis_ Kantvilas & Wedin, sp. nov.

_Arthonia_ anjutii _A. synnique similis et item ascis non-amyloideis et ascopsoris brunnescentibus, 10–18 µm longis, 5–9 µm latis sed thallum _Caloplaca_ eos S.Y.Kondr. & Kärnefelt incolens et apothecios non-immersis, gallas non-formantibus vel thallum hospitis non decolorantibus._

_Mycobank no.: MB 812916._

Growing on the thallus or, very rarely, the apothecia of *Caloplaca eos* S.Y.Kondr. & Kärnefelt, thallus lacking. *Ascomata* roundish, 0.05–0.4 mm wide, black, slightly to strongly convex, rarely ± plane, immarginate, at first immersed in the cortex of the host, soon emergent and adnate, in section 80–150 µm thick. *Hypothecium* dilute reddish brown, K+ deep olive-grey, poorly differentiated from the hymenium, subtended by a cupulate, excipulum-like tissue 10–20 µm thick, composed of densely packed, rather cellular hyphae, deep reddish brown, K+ dark olive-grey. *Hymenium* 50–60 µm thick, hyaline to diffusely pale reddish brown, K+ olive-grey, I+ red, K/I+ blue, overlain by a dark reddish brown, K+ dark olive-grey epihymenial layer c. 10 µm thick; paraphysoids highly branched and anastomosing, coherent in K, 2–3 µm thick, with apices neither expanded nor capitate but strongly conglutinated with pigment; asci initially 8-spored but usually with several spores aborted at maturity, 20–45 × 15–25 µm, of the *Arthonia*-type: broadly clavate to subglobose, mostly with a short ‘foot’ at the base and a well-developed tholus I–, KI–, lacking an amyloid ring-structure; apex of ascoplasm variable with age, concave, rounded or extending in a beak-like ocular chamber. *Ascospores* 1-septate, hyaline at first but soon becoming pale reddish brown, K+ olive-grey, (10–) 12–14.3–17 (–18) × 5–7.2–8.5 (–9) µm, oblong-ovoid to ellipsoid, mostly with the upper cell a little larger, not markedly constricted at the septum; wall becoming minutely papillate in older spores. *Pycnidia* immersed at the base of the ascomata; conidia narrowly fusiform to rod-shaped, 4–6 × 1–1.5 µm. Fig. 2F–J, 3.

*Etymology.* The specific epithet refers to the island provenance of the type collection.

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**Fig. 2.** Anatomy of the new species. **A–E Arthonia caliciae:** A–C non-amyloid asci mounted in K/I; D ascospores; E transverse section of ascoma (semi-schematic). **F–J Arthonia insularis:** F–H non-amyloid asci mounted in K/I; I ascospores; J transverse section of ascoma (semi-schematic). — Scale bars: A–D, F–I = 10 µm; E, J = 40 µm. — A–E G.Kantvilas 773/12, F–J G.Kantvilas 506/12.
Remarks. Species of Teloschistaceae are known to serve as hosts for several species of Arthonia. The common and widespread *A. molendoi* (Heufl. ex Frauenf.) R.Sant., which occurs on various Teloschistaceae, differs from *A. insularis* by having smaller ascomata (rarely more than 0.2 mm diam.), somewhat smaller ascospores (c. 12–15 × 5–6 μm) that do not become brownish and papillate, and asci with an apical K/I+ blue ring-structure. There are two further *Arthonia* species known to occur on Teloschistaceae (Kondratyuk 1996) that share with *A. insularis* similar-sized ascospores and entirely non-amyloid ascii, but which differ from the new species by being clearly parasitic: *A. sytnikii* S.Y.Kondr., described from Australia (Adelaide), forms distinct, raised galls on its host *Xanthoria ligulata* (Körb.) P.James, whereas *A. anjutii* S.Y.Kondr. & Alstrup, which grows on species of Teloschistes in the highlands of Victoria, differs by causing ± discoloured and sometimes almost deformed areas on its host. The latter in particular has ascomata that are initially immersed, but break through the host thallus, frequently retaining some host cortical tissue as a thin, discontinuous veil that is also discernible in thin transverse sections.

The new species is known only from the type locality, where it grew on granite boulders in windswept, exposed, low coastal heathland. It infected the thallus of *Caloplaca eos*, associated with other species of the genus, including *C. gallowayi* S.Y.Kondr., Kärnefelt & Filson and *C. tomarevana* S.Y.Kondr. & Kärnefelt. Significantly, the thalli of these related lichens were not infected by the *Arthonia*.

Comparative material of *A. anjutii* studied:


**Victoria**: “The Sentinel” peak, SE of Lake Tali Karrg, Mt Wellington area, 1450 m alt., on *Teloschistes velifer*, 12.iii.1966, J.H. Willis s.n. (MEI); Bogong High Plains, Mt Cope, on *Teloschistes velifer*, 19.ii.1966, R. Filson 8104 (MEI); Bogong High Plains, Spion Kopje ridge, 1820 m alt., on *Teloschistes velifer*, 23.i.1967, R. Filson 9533 (MEI).


Growing within the apothecia of *Lecidella sublapicida* (Knight) Hertel, thallus lacking. Ascomata poorly differentiated from those of the host. *Hymenium* entirely within and at length completely supplanting the hymenium of the host, I+ red, K+I+ red; paraphyses highly branched and anastomosing, rather indistinct, coherent in K, 1.5–2 μm thick, with apices internally olive-brown, K+ olive-grey, 2–5 μm wide; asci 8-spored, 27–33 × 10–15 μm, of the *Arthonia*-type: broadly clavate, mostly with a short ‘foot’ at the base and a well-developed tholus I–, K–I–, lacking an amyloid ring-structure. *Ascospores* hyaline, (1–) 2-septate, 10–11–13 (–14) × 3–4–5 μm, narrowly ellipsoid. *Pyrcnidia* immersed in the apothecia of the host; conidia fusiform, 4–5 × 1–1.2 μm.

**Remarks.** This remarkable species is characterized mainly by its unique habitat, and by the 2-septate, hyaline ascospores. It was first observed rather fortuitously in the course of routine sectioning of a specimen of *Lecidella sublapicida*. In earlier stages of its development, the asci of the *Arthonia* are interspersed amongst the asci of the *Lecidella*, and are easily distinguished by their different amyloid reactions, those of *Lecidella* being K/I+ blue. In later stages, the normally black, discoid apothecia of *Lecidella* become deformed, strongly contorted and convex, and their margin becomes rather indistinct. In such apothecia, the asci of the *Arthonia* dominate the whole apothecium, although the typical blue-green pigmented, *Lecidella*-type excipulum and the yellow-brown hypothecium remain evident. For a description of *L. sublapicida* see Kantvilas & Elix (2013). The observation of pyrcnidia was entirely by chance; they were seen in just one of a large number of apothecial sections made in the course of compiling the above description.

The description given here is based solely on the single Kangaroo Island specimen studied. It accords well with accounts of the species in the Northern Hemisphere, although European authors, for example Coppins & Aptom (2009), Triebel (1989) and Ihlen & Wedin (2008), report ascospores that are somewhat larger, 11–20 × 3–6 μm.

The species was collected on Kangaroo Island as part of a large specimen of *Lecidella sublapicida*, growing on sunny rocks in pasture at the margins of mallee woodland. Other lichens present included *Lecidea sarcogynoides* Körb. and *Diploschistes gyrophoricus* Lumbsch & Elix.

**Species examined:**

**South Australia,** Kangaroo Island: Cape Willoughby Rd, 35°50’S 138°06’E, 110 m alt., 29 Sep. 2011, G. Kantvilas 325/11 (HO).

![Image](image-url)
Provisional key to the lichenicolous species of Arthonia recorded for Australia

The study of lichenicolous Arthonia in Australia is in its infancy and it is very likely that many more species are yet to be discovered. Consequently, it is recommended that this key is used in conjunction with others, such as those of Clauzade et al. (1989) and Ihlen & Wedin (2008).

1. Ascomata orange-red, infused with a K+ purple pigment, forming necrotic patches on the thallus of Pseudocyphellaria; ascospores 1-septate, becoming brownish, 10–14.5 × 4–5.5 µm .......... A. pseudocyphellariae Wedin
2. Ascomata poorly differentiated from host tissues, entirely immersed within the apothecia of Lecidella; ascospores (1–) 2 (–3)-septate, hyaline, 10–20 × 3–6 µm ................. 3. A. intexta
3. Ascomata distinct; ascospores persistently 1-septate
4. Ascomata minute, 0.1–0.15 mm wide, growing on the thallus of Sagenidium molle in cool temperate rainforest; ascospores hyaline, 6–9 × 2–2.2 µm ................. A. sageniidi Vězda & Kantvilas
5. Ascomata and ascospores generally larger, not on Sagenidium
6. Ascomata and ascospores generally larger, not on Lobaria; hypothecium dark brown; ascospores hyaline, 11–15 × 3–4 µm .......... A. subconveniens Nyl.
7. Ascomata growing on the thallus of Calicium; ascospores hyaline, 10–14 × 3–5 µm ........ A. caliciae
8. Ascomata growing on the thallus of Caloplaca; ascospores becoming brown, 10–18 × 5–9 µm .......... 2. A. insularis
9. Ascomata inducing galls or necrotic patches on the host
10. Ascomata 0.15–0.45 mm wide, inducing galls on the thallus of Xanthoria; hypothecium hyaline; ascospores hyaline, 8–13 × 3–5 µm .......... A. sytnikii S.Y.Kondr.
11. Ascomata 0.25–0.35 mm wide, forming discoloured patches on the thallus of Teloschistes; hypothecium dark brown to black-brown; ascospores becoming brown, 11–16.5 × 4.5–7 µm .......... A. anutti S.Y.Kondr. & Alstrup

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