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New *Pertusaria* (lichenized Ascomycota) from Australia and Thailand

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Abstract

Pertusaria alloluteola, ***P. flavopunctata***, ***P. georgeana*** var. ***victoriana***, ***P. glomelliferica, P. roseola*** and ***P. variabilis*** from Australia, ***P. allomicrostoma*** and ***P. phusoidaoensis***, from Thailand, and ***P. confluentica***, from Australia and Thailand, are described as new to science. 2'-*O*-methylanziaic acid, methyl 2'-*O*-methylmicrophyllinate and thuringione [2,4,5-trichloro-3-*O*-methylnorlichexanthone] are reported for the first time in the genus *Pertusaria*.

Introduction

Pertusaria DC. is a genus of more than 300 species (Kirk et al. 2001), well-represented on all the continents of the world including Antarctica. Species of *Pertusaria* colonise bark, wood, rock or soil, or may overgrow bryophytes and other small plants. The genus has a diverse chemical composition that underpins the delimitation of many taxa (e.g., see Hanko 1983, Archer 1993). Generic delimitation has been explored by Schmitz et al. (1994).

A recent account of the lichen genus *Pertusaria* in Australia (Archer 1997) listed a total of 128 species and an additional six taxa have since been described (Archer & Elix 2005, Elix & Archer 2007a, Elix & Archer 2007b). Recent examination of further Australian specimens has revealed a further seven new taxa, viz. *Pertusaria alloluteola, P. confluentica, P. flavopunctata*, *P. georgeana* var. *victoriana, P. glomelliferica, P. roseola* and *P. variabilis. Pertusaria confluentica* has been found to also occur in Thailand, and, in addition, a further two new species have been found in that country, viz. *P. allomicrostoma* and *P. phusoidaoensis.* These specimens were collected during a study of the taxonomy and ecology of the family Pertusariaceae in Thailand (Jariangprasert 2005).

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Materials and Methods

The morphology of the lichen specimens was examined using a Zeiss Stemi 2000C stereomicroscope, and the anatomy, conidia and ascospores were studied using a Zeiss Axiolab compound microscope. Hand sections and squash preparations were examined in water and in 10% KOH; asci were also examined in Lugol's iodine. The chemical constituents were identified by thin-layer chromatography (Culberson 1972, Culberson & Johnson 1982, Elix & Ernst-Russell 1993), high-performance liquid chromatography (Elix et al. 2003) and comparison with authentic samples.

The Species

Pertusaria alloluteola A.W.Archer & Elix, ***sp.nov.*** **Fig. 1**

Pertusariae trimerae (Müll.Arg.) A.W.Archer similis, a qua differt ascis bisporis.

Type: Australia, New South Wales: Goonoo State Forest, Mogriguy Forest Road, 5 km E of Mogriguy, 23 km NNE of Dubbo, 32°04'16''S, 148°42'53''E, alt. 330 m, on *Melaleuca* in *Eucalyptus-Callitris* woodland with *Calytrix* and *Westringea* understorey, *J.A. Elix 36773,* 11 Oct 2005; holotype: CANB.

Thallus pale yellow-green, thin, cracked, surface smooth and dull, corticolous. Apothecia verruciform, conspicuous, scattered, concolorous with the thallus, flattened hemispherical, not constricted at the base, 0.5–0.8 mm diam. Ostioles black, conspicuous, often 1 per verruca but sometimes up to 5 per verruca. Asci amyloid with a distinctive ocular chamber; hymenium non-amyloid. Ascospores 2 per ascus, ellipsoid, smooth, 95–118 µm long, 35–40 µm wide.

Chemistry: thiophaninic acid (minor), 2-chloro-6-*O*-methylnorlichexanthone (trace), 4-chloro-6-*O*-methylnorlichexanthone (trace) and norstictic acid (major).

Specimens examined: Australia: **Western Australia**: Gwambygine Nature Reserve, 11 km S of York, 31°58'24''S, 116°48'38''E, alt. 245 m, on *Allocasuarina*, *J.A. Elix 37413*, 4 Apr 2006 (CANB); *ibid*., on *Melaleuca, J.A. Elix 31736,* 22. Apr 2004 (CANB); Kendenup [c. 7 km NNW of Albany], on fig tree, *R.F. Allen 10*, Nov 1971 (PERTH).

Pertusaria alloluteola is characterised by the yellow thallus, black ostioles, asci with 2 ascospores and the presence of thiophaninic acid and norstictic acid. It is distinguished from the somewhat similar *P. trimera* by the two-spored asci, whereas *P. trimera* has 3- or 4-spored asci. The new species resembles the chemically similar, two spored *P. luteola* Boqueras, described from Spain (Boqueras & Llimona 2003) but can be distinguished from that species by the larger ascospores (95–118 × 35–40 µm vs. 70–95 × 25–35 µm) and the conspicuous ostioles.

Pertusaria allomicrostoma Jariangpr. ***sp. nov.*** **Fig. 2**

Pertusariae microstomae var. *isidiatae* Jariangprasert similis, a qua lichexanthonen continentib et acidum 2'-*O*-methylperlatolicum deficienti differt.

Type: Thailand: Tak Province, Mueang District, Tambon Mae To, Lan Sang National Park, between Tak Province and Mae Sod District, on the way to Musoe Dam and Musoe Lhueang Agricultural Station, on *Knema linifolia,* 970 m, *S. Jariangprasert 3917,* 20 Nov 2002; holotype: QBG.

Thallus greyish green, surface slightly rough, corticolous; isidiate, soredia absent. Isidia concolorous with the thallus, initially globose to branched, appearing moniliform, 0.15–0.2 mm diam., 0.4–0.7 mm long. Apothecia verruciform, conspicuous, slightly flattened above to concave, sometimes constricted at the base, sometimes confluent, 1–3 apothecia per verruca, 0.5–1.1 mm diam. Ostioles black, conspicuous, centrally depressed, not fused, 1–3 per apothecia. Asci amyloid with a distinctive ocular chamber; hymenium non-amyloid. Ascospores (1–)2 per ascus, ellipsoid, smooth, 110–190 µm long, 30–52 µm wide.

Chemistry: lichexanthone (major), stictic acid (major), constictic acid (minor), skyrin (minor), norstictic acid (trace), cryptostictic acid (trace), methyl stictic acid (trace), peristictic acid (trace).

Pertusaria allomicrostoma is characterized by the verruciform apothecia and the isidiate thallus, asci with two smooth ascospores per ascus and its chemistry. The chemistry and the amyloid asci place the species in *Pertusaria* s.str. (*sensu* Schmitt & Lumbsch 2004). There are few fertile isidiate *Pertusaria* species with two ascospores per ascus. *Pertusaria microstoma* var. *isidiata* Jariangprasert, from Thailand, has black ostioles and an isidiate thallus but differs from *P. allomicrostoma* in ascospores and chemistry. Thus *P. microstoma* var. *isidiata* has two rough ascospores and contains 4,5-dichlorolichexanthone and 2'-*O*-methylperlatolic acid (Jariangprasert 2006). The Australian species, *P. isidiosa* A.W. Archer (Archer 1991), also has two smooth ascospores and contains lichexanthone and stictic acid but differs in having pale inconspicuous ostioles and in containing 2'-*O*-methylperlatolic acid as an additional secondary metabolite. At present the new species is only known from the type locality in Tak Province in northern Thailand.

Pertusaria confluentica Jariangpr. & Elix, ***sp. nov***. **Fig. 3**

Pertusariae scaberulae A.W. Archer similis, a qua acidum confluenticum continenti differt. Apothecia ignota.

Type: Australia: Queensland: Mossman–Mt. Molloy Road, 1 km S of Lions Lookout, 20 km N of Mt. Molloy, 16°32'05''S, 145°22'59''E, alt. 390 m, margins of rainforest, on canopy of roadside tree, *J.A. Elix 36883*, 4 Aug 2006; holotype: BRI.

Thallus pale olive-green, surface somewhat roughened, dull, corticolous, sorediate, lacking isidia. Soralia white, conspicuous, sessile, flattened, 0.8–1.5 mm diam. Apothecia unknown.

Chemistry: lichexanthone (major), confluentic acid (major), ± 2'-*O*-methyl-microphyllinic acid, ± two unknowns (minor).

Specimens examined: **Australia**: **Queensland**, type locality, *J.A. Elix 36902, 36904*, 4 Aug 2006 (CANB); Girringun National Park, Stoney Creek, above Wallaman Falls, 51 km W of Ingham, 18°35'54''S, 145°47'51''E, alt. 545 m, on dead tree, *J.A. Elix 38112, 38115*, 25 Jul 2006 (CANB). **Thailand**: **Loei Province:** Phu Lhuang Wildlife Sanctuary, alt. 1460 m, *S. Jariangprasert 2200*, 3 Feb 2002 (QBG); *ibid.*, *S. Jariangprasert 2265* (RAMK).

Pertusaria confluentica is characterised by the sorediate thallus, the absence of apothecia and the presence of lichexanthone and confluentic acid. Confluentic acid is not known from any other sorediate species of *Pertusaria* but is known from several fertile, corticolous species including *P. ewersii* A.W. Archer & Elix (from Australia), *P. cinchonae* Müll. Arg. (from India), *P. nana* Müll. Arg. (from Argentina), *P. sublaeviganda* Vain.

(from Japan), *P. inthanonensis* Jariangpr. (from Thailand) and *P. weberi* A.W. Archer & Elix (from Papua New Guinea).

Confluentic acid is reported to be a character unique to *Pertusaria s. str.* (Schmitt & Lumbsch 2004). The new species occurs in rainforest in northern Australia (Queensland), and also in Thailand (Loei Province) where it grows on *Persea* and *Acronychia,* and from where it was first reported (S. Jariangprasert 2004, *in litt.*).

Pertusaria flavopunctata A.W.Archer & Elix, ***sp. nov.*** **Fig. 4**

Pertusariae scaberulae A.W.Archer similis, a qua sorediis flavis et arthothelin et thuringionen continenti differt. Apothecia ignota.

Type: Australia: New South Wales: Washpool National Park, Gibraltar Range, Hakea Walk, 78 km E of Glen Innes, 29°28'10''S, 152°21'01''E, alt. 895 m, on dead tree in mixed rainforest with scattered *Eucalyptus*, *J.A. Elix 37278,* 2 May 2005; holotype: CANB.

Thallus pale yellow-green, surface scurfy and cracked, corticolous. Isidia lacking, sorediate, soralia conspicuous, sessile or slightly raised, scattered, composed of bright yellow to yellow-green soredia, 0.5–1.0 mm diam. Apothecia unknown.

Chemistry: arthothelin (major), thuringione (major), 3-*O*-methylthiophanic acid (minor), and 4,5-dichloronorlichexanthone (trace).

Specimens examined: Australia: Queensland: Paluma Rainforest Walk, Paluma, 19°00'27''S, 146°12'24''E, alt. 830 m, on tree trunk, *J.A. Elix 37590*, 24 Jul 2006 (CANB). **New South Wales:** Tomaga River Estuary, 15 km SE of Batemans Bay, 35°49'25''S, 150°10'47''E, alt. 1 m, on *Casuarina, J.A. Elix 23337,* 29 Nov 1989 (CANB).

This species is characterised by the conspicuous yellow-green soralia and the presence of arthothelin and thuringione [2,4,5-trichloro-3-*O*-methylnorlichexanthone] as major compounds. Arthothelin occurs in other *Pertusaria* species, including *P. oblongata* Müll. Arg. from Brazil, *P. melanospora* Nyl. from Chile and *P. bartlettii* A.W. Archer & Elix from New Zealand, but *P. flavopunctata* is the first *Pertusaria* species found to contain thuringione as a major compound. The compound was first isolated from *Lecidea carpathica* (Körb.) Szatala (Huneck & Santesson 1969).

Pertusaria georgeana var. ***victoriana*** Elix & A.W.Archer, ***var. nov.*** **Fig. 5**

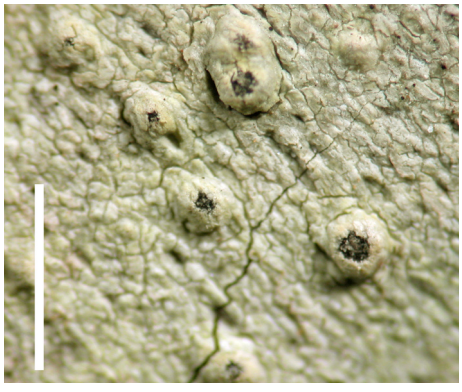
Pertusariae georgeanae A.W.Archer & Elix affinis a qua acidum planaicum continenti differt. Apothecia ignota.

Type: Australia: Victoria: Reef Hills State Park, 7 km SSW of Benalla, 36°36'53''S, 145°56'03''E, alt. 155 m, on dead stump in open *Eucalyptus* woodland, *J.A. Elix 36957*, 5 May 2006; holotype: CANB; isotype: MEL.

Thallus off-white to greenish-white, surface smooth and dull, corticolous. Lacking soredia, isidiate, isidia inconspicuous, numerous, concolorous with the thallus, simple, rarely branched, 0.1–0.2 mm tall, 0.05 mm diam. Apothecia unknown.

Chemistry: 4,5-dichlorolichexanthone (minor) and planaic acid (major).

Specimens examined: **Australia**: **Victoria**: Chiltern-Mt. Pilot National Park, 2 km N of Chiltern, 36°07'47''S, 146°36'42''E, alt, 200 m, on dead wood in open *Eucalyptus* woodland, *J.A. Elix 36923, 36927, 36957*, 5 May 2006 (CANB).



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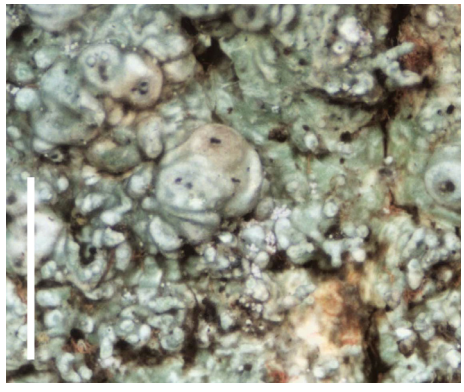

Fig. 2.

Fig. 3.

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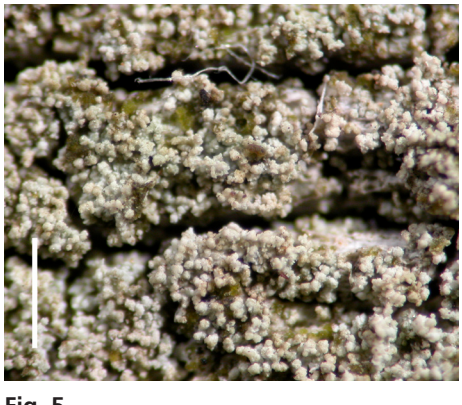

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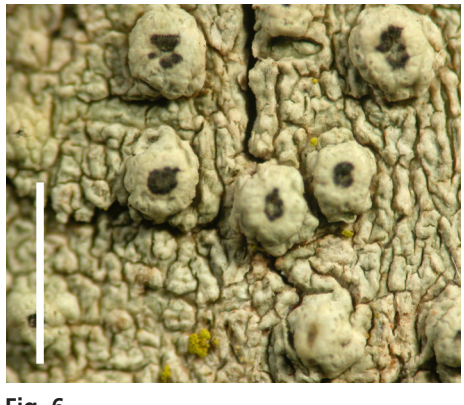

Fig. 6.

Fig. 1. *Pertusaria alloluteola,* holotype. Scale bar = 2 mm. **Fig. 2.** *Pertusaria allomicrostoma*, holotype. Scale bar = 2 mm. **Fig. 3.** *Pertusaria confluentica*, holotype. Scale bar = 1 mm. **Fig. 4.** *Pertusaria flavopunctata*, holotype. Scale bar = 1 mm. **Fig. 5.** *Pertusaria georgeana* var. *victoriana,* holotype. Scale bar = 1 mm. **Fig. 6.** *Pertusaria glomelliferica*, holotype. Scale bar = 2 mm.

Pertusaria georgeana var. *victoriana* is characterised by the isidiate thallus and the presence of 4,5-dichlorolichexanthone and planaic acid. The planaic acid distinguishes the taxon from var. *goonooensis* Elix & A.W. Archer (Elix & Archer 2007b), which contains the rare depside 2,4-di-*O*-methylolivetoric acid, and var. *georgeana*, which contains 2-*O*-methylperlatolic acid (Archer 1997). At present the new variety is known only from a limited area in Victoria.

Pertusaria glomelliferica Elix & A.W.Archer, ***sp. nov.*** **Fig. 6**

Pertusariae thiospodae Knight similis a qua acidum glomellifericum continenti differt.

Type: Australia, Western Australia: Burma Road, 29 km SE of junction with Walkaway-Nangetty Road, 29°04'07''S, 115°09'26''E, alt. 240 m, on *Melaleuca* in roadside heath with *Melaleuca* among laterite outcrops, *J.A. Elix 33773*, 4 May 2004; holotype: PERTH.

Thallus pale yellow to yellow, surface smooth and dull, corticolous, isidia and soredia absent. Apothecia verruciform, concolorous with the thallus, conspicuous, numerous, scattered or crowded, sometimes confluent, hemispherical to flattened hemispherical, not constricted at the base, 0.5–0.75(–1.0) mm diam. Ostioles black, punctiform, 0.1–0.2 mm diam., 1(–4) per verruca, sometimes in a pale yellow translucent zone. Asci amyloid with a distinctive ocular chamber; hymenium non-amyloid. Ascospores elongate ellipsoid, hyaline, smooth, 3 (sometimes 2) per ascus, 80–105(120) µm long, (25–)30–36(–40) µm wide.

Chemistry: thiophaninic acid (major), 2-chloro-6-*O*-methylnorlichexanthone (minor), 4-chloro-6-*O*-methylnorlichexanthone (minor), glomelliferic acid (major-minor), ± 4-*O*-demethylgomelliferic acid, ± glomellic acid (minor).

Specimens examined: Australia: **Western Australia**: Coolimba–Eneabba Road, Nature Reserve, 20 km by road W of Enneaba, 29°52'30''S, 115°05'41"E. alt. 70 m, on dead *Acacia* in *Eucalyptus* woodland with *Melaleuca*, *Patersonia*, *Acacia* and limestone rocks, *J.A. Elix 28904*, 5 May 2004 (CANB); Ellendale Pool, 23 km W of Walkaway, 28°51'38''S, 114°58'25''E, alt. 100 m, on *Acacia* in *Dryandra*, *Eucalyptus*, *Acacia* woodland beside river, *J.A. Elix 33761*, 4 May 2004 (CANB); type locality, *J.A. Elix 33767*, 4 May 2004 (CANB); Wabeling, Quarrell Range, Moora–New Norcia Road, 22 km by road S of Moora, 30°41'S, 116°12'20''E, alt. 275 m, *J.A. Elix 37563B*, 2 Apr 2006 (CANB); Kalbarri National Park, along road to The Loop and Z-bend, 24 km NW of Kalbarri township, 27°37'13''S, 114°23'13''E, alt. 210 m, on *Melaleuca, J.A. Elix 33650*, 2 May 2004 (CANB).

Pertusaria glomelliferica is characterised by the yellow thallus and ostioles, asci with 2 or 3 ascospores and the presence of glomelliferic acid. This compound was first isolated from *Parmelia glomellifera* (Nyl.) Nyl. [*Xanthoparmelia verruculifera* (Nyl.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch] by Zopf in 1899 (Culberson 1969). It is very common in brown *Xanthoparmelia* (Vain.) Hale species (formerly *Neofuscelia* Essl.) (Esslinger 1977, Elix 1994) but has previously been found in only one species of *Pertusaria* namely, *P. corrugata* Kremp. from Brazil (K. Kalb *in litt.*), where co-metabolites included perlatolic acid and stenosporic acid, but xanthones (e.g. thiophaninic acid) were absent. Glomelliferic acid is closely related to perlatolic acid which, with its derivatives, is common in the genus *Pertusaria*.

Pertusaria phusoidaoensis Jariangpr., ***sp. nov.*** **Fig. 7**

Pertusariae meeanae A.W. Archer & Elix similis a qua acidum 2'-*O*- methylanziaicum continenti differt.

Type: Thailand, Uttaradit Province, Nam Paad District, Baan Huay Muun, Phusoidao National Park, 500 m alt. on dry trunk without bark, *S. Jariangprasert 3925,* 27 Nov 2002*;* holotype*:* QBG.

Thallus lignicolous and corticolous, dark green, surface rough, subtuberculate, isidia and soredia absent. Apothecia verruciform, conspicuous, flattened hemispherical and contorted, constricted at the base, confluent, 1–3 apothecia per verruca, 0.5–1.5 mm diam. Ostioles black, conspicuous, sunken, sometimes fused and surrounded with yellow tissue, 1–5 per apothecia. Asci amyloid with a distinctive ocular chamber; hymenium non-amyloid. Ascospores 2(3) per ascus, ellipsoid, smooth, 84–146 µm long, 40–56 µm wide.

Chemistry: K ± yellow, C+ rose red, KC+ rose red, Pd-, UV+ reddish orange; 4,5-dichlorolichexanthone (minor), 2'-*O*-methylanziaic acid (major), ± anziaic acid (trace).

Specimens examined: Thailand: **Uttaradit Province**: type locality, *S. Jariangprasert 3966*, 27 Nov 2002 (QBG); *ibid. S. Jariangprasert 4003* (RAMK).

Pertusaria phusoidaoensis is characterised by asci with 2 or 3 smooth ascospores and the presence of 4,5-dichlorolichexanthone and 2'-*O*-methylanziaic acid. This depside has not previously been reported in the genus *Pertusaria* and is responsible for the C+ and KC+ rose red colours produced with C and KC. 2'-*O*-methylanziaic acid was previously reported in the genera *Cryptothecia, Lecidea* and *Hypotrachyna* (Lücking et al. 2006) but *P. phusoidaoensis* is the first *Pertusaria* species reported to contain this depside. The new species is morphologically similar to *P. meeana* but differs chemically; *P. meeana* contains 4,5-dichlorolichexanthone and 2-*O*-methylperlatolic acid as major compounds (Archer 1997). The new species grows on the dry trunks and bark of *Shorea* in dry dipterocarp forest, on the way to Huay Tawn pass, in northern Thailand.

Pertusaria roseola A.W.Archer & Elix***, sp. nov.*** **Fig. 8**

Pertusariae erythrellae Müll. Arg. similis a qua thallis isidiatis differt. Apothecia ignota.

Type: Australia: New South Wales, Mann River Nature Reserve, Diehard Creek, 50 km E of Glenn Innes, 29°40'29''S, 152°05'19''E, alt. 595 m; on vine in *Allocasuarina-Eucalyptus* woodland along stream, *J.A. Elix 37038*, 1 May 2005; holotype: CANB.

Thallus pale pink to pale orange, surface smooth and dull, corticolous, isidiate, lacking soralia. Isidia simple, 0.1–0.25 mm tall, 0.05 mm diam., almost completely covering the thallus. Apothecia unknown.

Chemistry: norstictic acid (major) and connorstictic acid (minor-trace)

Specimens examined: Australia: New South Wales: type locality, 1 May 2005, *J.A. Elix 37038* (CANB); Washpool National Park, Gibraltar Range, Hakea Walk, 78 km E of Glenn Innes, 29°28'10''S, 152°21'01'', alt. 895 m, on dead tree, *J.A. Elix 37276*, 2 May 2005 (CANB); *ibid. J.A. Elix 37287*, 2 May 2005 (CANB).

Fig. 7.

Fig. 8.

Fig. 7. *Pertusaria phusoidaoensis*, holotype. Scale bar = 1 mm. **Fig. 8.** *Pertusaria roseola,* holotype. Scale bar = 1 mm.

Pertusaria roseola is characterised by the isidiate thallus and the presence of norstictic acid and differs from the chemically similar *P. erythrella* Müll. Arg. by the presence of isidia in place of soralia. It is distinguished from the chemically similar *P. ramulifera* H. Magn., from Hawaii (Magnusson & Zahlbruckner 1944), by the shorter, predominantly simple isidia, in contrast to the longer, thicker isidia (0.3–0.5 mm wide, to 3 mm long) present in *P. ramulifera*. The two species might be conspecific and the difference in morphology possibly due to environmental differences. In the absence of any intermediate forms the two species are retained here.

Pertusaria variabilis Elix & A.W.Archer, ***sp. nov.*** **Fig. 9**

Pertusariae scaberulae A.W.Archer similis a qua sorediis inconspicuis et methyl 2'-*O*-methymicrophyllinaten continenti differt. Apothecia ignota.

Type: Australia: Northern Territory, Kakadu National Park, Gungarre Forest Walk, South Alligator, 12°40'36''S, 132°28'44''E, alt. 30 m, on dead branches in lowland

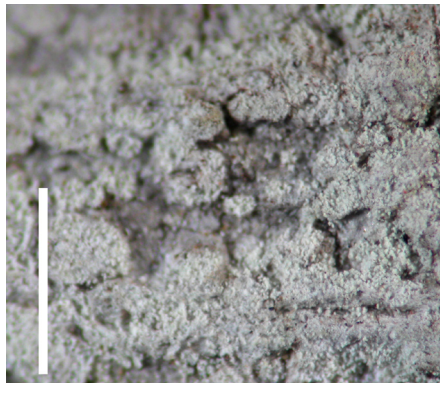

Fig. 9.

Fig. 9. *Pertusaria variabilis*, holotype. Scale bar = 1 mm.

rainforest, *J.A. Elix 37897*, 10 Aug 2005; holotype CANB.

Thallus white, surface smooth and dull, corticolous, isidia lacking, sorediate. Soralia flattened, inconspicuous, white to off-white, scattered to sometimes confluent, 0.2–0.5 mm diam. Apothecia unknown.

Chemistry: methyl 2'-*O*-methylmicrophyllinate (major), ± lichexanthone (major), ± psoromic acid (minor).

Specimens examined: **Australia: Northern Territory**:, type locality, *J.A. Elix 37870, 37876,* 10 Aug 2005 (CANB).

Pertusaria variabilis is characterised by the sorediate thallus, the absence of apothecia and the presence of methyl 2'-*O*-methylmicrophyllinate. One of the collections (*Elix 37876*) was infected with a lichenicolous *Sphinctrina* sp., consistent with this sorediate crust being a species of *Pertusaria*. The new species is one of a number of sterile *Pertusaria* taxa that are characterised and separated by their chemistry *cf. P. confluentica* and *P. flavopunctata* above. This is the first report of methyl 2'-*O*-methylmicrophyllinate from *Pertusaria*. Previously this rare depside has been identified in *Porpidia contraponenda* (Arnold) Hertel & Knoph and *P. diversa* (Lowe) Gowan (Gowan 1989).

This new species has only been collected from the type locality where it occurs on twigs and branches of trees in monsoon forest.

References

Archer AW (1991) New species and new reports of *Pertusaria* (lichenized *Ascomycotina* from Australia and New Zealand with a key to the species in Australia. *Mycotaxon* 41: 223–269.

Archer AW (1993) A chemical and morphological arrangement of the lichen genus *Pertusaria*. *Bibliotheca Lichenologica* 53: 1–17.

Archer AW (1997) The lichen genus *Pertusaria* in Australia. *Bibliotheca Lichenologica* 69: 1–249.

Archer AW (2004) Pertusariaceae. Pp. 116–172 in McCarthy PM (ed.) *Flora of Australia*, vol. 56A. (CSIRO Publishing: Melbourne)

Archer AW & Elix JA (2005) A new species of *Pertusaria* from Western Australia. *Mycotaxon* 94: 133–135.

Boqueras M & Llimona X (2003) The genus *Pertusaria* (Lichenised Ascomycotina) on the Iberian Peninsula and Balearic Islands. I. Subgenus *Pertusaria*. *Mycotaxon* 88: 471–492.

Culberson CF (1969) *Chemical and botanical guide to lichen products*. (The University of North Carolina Press: Chapel Hill)

Culberson CF (1972) Improved conditions and new data for the identification of lichen products by a standardized thin layer chromatographic method. *Journal of Chromatography* 72: 113–125.

Culberson CF & Dibben MJ (1972) 2-*O*-Methylperlatolic and 2'-*O*-methylperlatolic acids, two new lichen depsides from *Pertusaria*. *Bryologist* 75: 362–365.

Culberson CF & Johnson A (1982). Substitution of methyl *tert.*-butyl ether for diethyl ether in the standardized thin-layer chromatographic method for lichen products. *Journal of Chromatography* 238: 483–487.

Elix JA (1994) *Neofuscelia*. Pp. 68–85 in Grgurinovic C (ed.) *Flora of Australia*, vol. 55. (ABRS: Canberra)

Elix JA & Archer AW (2007a) Four new species of *Pertusaria* (lichenized Ascomycota) from Australia. *Australasian Lichenology* 60: 20–25.

Elix JA & Archer AW (2007b) A new variety of *Pertusaria georgeana* (lichenized Ascomycota) containing a new depside. *Australasian Lichenology* 61: 26–29.

Elix JA & Ernst-Russell KD (1993) *A catalogue of standardised thin-layer chromatographic data and biosynthetic relationships for lichen substances*, 2nd. edition. (Australian National University: Canberra)

Elix JA, Giralt M & Wardlaw JH (2003) New chloro-depsides from the lichen *Dimelaena radiata*. *Bibliotheca Lichenologica* 86: 1–7.

Esslinger TL (1977) A chemosystematic revision of the brown Parmeliae. *Journal of the Hattori Botanical Laboratory* 42: 1–211.

Gowan SP (1989) A character analysis of the secondary products of the Porpidiaceae (lichenized Ascomycotina). *Systematic Botany* 14: 77–90.

Hanko B (1983) Die Chemotypen der Flechtengattung *Pertusaria* in Europa. *Bibliotheca Lichenologica* 19: 1–297.

Huneck S & Santesson J (1969) Mitteilung über Flechteninhaltstoffe. 65. Die Inhaltstoffe von *Lecidea carpathica* (Koerb.) Szat. und die Struktur des Thuringions, eines neuen Xanthons. *Zeitschrift für Naturforsch*ung 24b: 756–760

Jariangprasert S (2005) *Taxonomy and ecology of the lichen family Pertusariacae in Thailand.* Doctoral thesis. Chiang Mai University, Thailand.

Jariangprasert S (2006) New taxa of the lichen genus *Pertusaria* (*Ascomycota*) from Thailand. *Mycotaxon* 96: 109–121.

Kirk PM, Cannon PF, David JC & Stalpers JA (2001) *Ainsworth and Bisby's Dictionary of the Fungi*, 9th edition. (CAB International: Wallingford)

Lücking R, Thor G, Aptroot A, Kalb K & Elix JA (2006) The *Cryptothecia candida* complex revisited. *Lichenologist* 38: 235–240.

Magnusson AH & Zahlbruckner A (1944) Hawaiian Lichens. Pertusariaceae. *Arkiv för Botanik* 31A (6): 54–62.

Schmitt I & Lumbsch HT (2004) Molecular phylogeny of the *Pertusaria* supports secondary chemistry as an important systematic character set in lichen-forming ascomycetes. *Molecular Phylogenetics and Evolution* 33: 43–55.

Schmitz KE, Lumbsch HT & Feige GB (1994) Systematic studies in the Pertusariales II. The generic concept in the Pertusariaceae (lichenised Ascomycotina). *Acta Botanica Fennica* 150: 153–160.

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