



# Australasian Lichenology


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*Cladonia confusa* is widespread in the Southern Hemisphere. Highly variable, its synonyms include *Cladonia leptoclada*, *Cladina leptoclada* and *Cladina confusa*. It occurs throughout New Zealand from sea level to 2000 m elevation, and in Australia in Tasmania, South Australia and Victoria. It's known to have two chemodemes in New Zealand, one of them with only the depside perlatolic acid and the other with perlatolic acid plus usnic acid and the depside anziaic acid.

100 mm 

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**Further information on species of buellioid lichens  
(Caliciaceae, Ascomycota) from the Subantarctic islands**

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**Abstract**

The new combinations *Amandinea bouvetii* (Øvstedal) Elix, *A. conioptoides* (Nyl.) Elix and *A. parasemopsis* (Nyl.) Elix are made for *Buellia bouvetii* Øvstedal, *Lecidea conioptoides* Nyl. and *Lecidea parasemopsis* Nyl., respectively. In addition, *Buellia falklandica* Darb. is lectotypified.

This paper continues my investigation of buellioid lichens in the Subantarctic islands, and follows the previous accounts of *Buellia* and related genera in the region (Elix 2017a, 2017b, 2018, 2019). Three new combinations are made in *Amandinea*, several historic collections are described and *Buellia falklandica* Darb. is lectotypified.

**New combinations**

***Amandinea bouvetii*** (Øvstedal) Elix, comb. nov.  
Mycobank No.: **MB 848030**

Basionym: *Buellia bouvetii* Øvstedal, *Norsk Polarinstitutts Skrifter* **185**, 40 (1986).

*Type:* Bouvet Island [Bouvetøya], mountain ridge N of Nyroøya, *T. Engelskjøn 221* (holotype–BG, *n.v.*).

*Thallus* crustose, forming rosettes to 10 mm wide and 0.3 mm thick, rimose-areolate, with subeffigurate margins; individual areoles irregular, plane to convex, 0.5–1 mm wide; upper surface grey to yellowish ash-grey, shiny or matt; prothallus marginal, brown to brown-black; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub><sup>-</sup>), I<sup>-</sup>; photobiont cells 10–16 µm wide. *Apothecia* 0.5–1 mm wide, lecideine, adnate to sessile, dispersed or crowded; disc black, epruinose, plane then convex. *Excipulum* distinct, thin, excluded in convex apothecia, in section 30–50 µm thick, the outer zone dark brown, K<sup>-</sup>, paler brown within. *Epihymenium* 10–12 µm thick, brown to dark brown, K<sup>-</sup>, N<sup>-</sup>. *Hypothecium* 130–250 µm thick, brown to brown-black, K<sup>-</sup>, N<sup>-</sup>. *Hymenium* 120–140 µm thick, colourless, not interspersed. *Paraphyses* 1.5–1.7 µm wide, simple to sparsely branched, with apices 4–5 µm wide and brown caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* *Buellia*-type, 1-septate, brown, ellipsoid, 16–[18.6]–22 × 8–[8.7]–10 µm, becoming constricted at the septum, sometimes curved; outer spore-wall finely ornamented (microrugulate). *Pycnidia* common, pyriform, immersed, brown to black. *Conidia* filiform, curved, 18–20 × 0.7–1 µm.  
*Chemistry:* Thallus K<sup>-</sup>, P<sup>-</sup>, C<sup>-</sup>, UV<sup>-</sup>; no lichen substances detected.

**Remarks**

This species is characterized by the crustose, grey to yellowish ash-grey, rimose-areolate thallus with subeffigurate margins, a marginal, brown to brown-black prothallus, lecideine, sessile apothecia, a non-amyloid medulla, 1-septate, *Buellia*-type ascospores, 16–22 × 8–10 µm, curved, filiform conidia, 18–20 µm long, and the absence of lichen substances. At present it is known only from Bouvet Island in the South Atlantic Ocean. Illustrations, as *Buellia bouvetii*, are provided by Øvstedal (1986) and Øvstedal & Lewis Smith (2001).

***Amandinea conioptoides*** (Nyl.) Elix, comb. nov.  
Mycobank No.: **MB 848032**

*Lecidea conioptoides* Nyl., *Comptes Rendues Séanc. Hebd. Acad. Sci. Paris* **81**, 725 (1875). *Buellia conioptoides* (Nyl.) Zahlbr., *Cat. Lich. Univ.* **7**, 345 (1931). *Type*: Île St. Paul, *G. de l'Isle 9712* (holotype – H-NYL!).

*Amandinea discreta* (Darb.) Elix & H. Mayrhofer, *Australas. Lichenol.* **82**, 71 (2018) *Buellia discreta* Darb., *Wiss. Ergeb. Schwed. Südpolar-Exped. 1901–1903* **4**, 14 (1912). *Type*: Falkland Islands, Port Louis, *C. Skottsberg 88.89*, 25.vii.1901 (holotype – S!).

*Thallus* crustose, forming patches to 30 mm wide and up to 0.1 mm thick, endolithic and not apparent, or epilithic, discontinuous, white or pale grey, thin, membranaceous or rarely rimose-areolate; prothallus black or absent; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-; photobiont cells 7–17 µm wide. *Apothecia* 0.2–0.4 mm wide, lecideine, broadly adnate to sessile, scattered or crowded, rounded or distorted through mutual pressure; disc black, epruinose, weakly concave to plane. *Excipulum* distinct, thin, persistent, raised above the disc, in section 25–30 µm thick, with the outer zone dark brown to black-brown, K-, brown within. *Ephymenium* 7–10 µm thick, dark brown, K-, N-. *Hypotheecium* 30–50 µm thick, pale brown or continuous with underlying excipulum, then to 100 µm thick, dark brown to black-brown, in part K+ yellow solution, N+ orange-brown. *Hymenium* 70–100 µm thick, colourless, not interspersed with granules or oil droplets; subhymenium 15–20 µm thick, pale brown, not interspersed. *Paraphyses* 1.2–1.5 µm wide, simple to moderately branched; apices 4–5 µm wide, with dark brown caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* *Physconia*- then *Buellia*-type, 1-septate, brown, ellipsoid, 12–[13.9]–16 × 6–[7.9]–10 µm, older spores very rarely constricted at the septum; outer spore-wall microrugulate. *Pycnidia* immersed, black. *Conidia* filiform, curved, 14–18 × 0.7–1 µm.

*Chemistry*: Thallus K-, P-, C-, UV-; no lichen substances detected by TLC.

#### Remarks

This species is characterized by an immersed or inconspicuous off-white to pale grey, crustose thallus lacking lichen substances, a non-amyloid medulla that lacks calcium oxalate, adnate to sessile, lecideine apothecia, 0.2–0.4 mm wide, a brown N- ephymenium, broad, ellipsoid *Physconia*- then *Buellia*-type ascospores, 12–16 × 6–10 µm, which are usually not constricted at the septum and have a microrugulate outer wall, and curved, filiform conidia, 14–18 µm long. It is known from New Zealand (Elix & Mayrhofer 2018), the Falkland Islands (Islas Malvinas) and Île St. Paul (southern Indian Ocean). An illustration is provided in Elix & Mayrhofer (2018, as *A. discreta*).

***Amandinea parasemopsis*** (Nyl.) Elix, comb. nov.

Mycobank No.: **MB 848033**

*Lecidea parasemopsis* Nyl., *Comptes Rendues Séanc. Hebd. Acad. Sci. Paris* **81**, 725 (1875). *Buellia parasemopsis* (Nyl.) Zahlbr., *Cat. Lich. Univ.* **7**, 386 (1931). *Type*: Île St. Paul, *G. de l'Isle 9715* (H-NYL – holotype!).

*Lecidea tristiuscula* Nyl., in Crombie, *J. Bot. (London)* **15**, 190 (1877). *Buellia tristiuscula* (Nyl.) Zahlbr., *Catal. Lich. Univ.* **7**, 424 (1931). *Amandinea tristiuscula* (Nyl.) Elix, *Australas. Lichenol.* **84**, 17 (2019). *Type*: Kerguelen Islands, Swain's Bay, on coastal rock, *A.E. Eaton* [Transit of Venus Expedition], i.1875 (BM 001097145 – holotype!).

*Buellia kerguelensis* C.W. Dodge, *Comité Français des Recherches Antarctiques (Paris)* **15**, 8 (1966). *Type*: Kerguelen Islands, Presqu'île Courbet, Plaine des Drumlins, on pebbles of denuded moraines with *Usnea*, *E. Aubert de la Rüe 77*, 1963 (HUH – holotype!).

*Thallus* crustose, forming patches to c. 20 mm wide, epilithic, grey-white to grey-brown, to 0.4 mm thick, effuse and discontinuous to rimose-areolate or subverrucose, individual areoles 0.2–0.4 mm wide; prothallus black when abutting other lichens, or not apparent; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-; photobiont cells 7–14 µm wide. *Apothecia* 0.1–

0.8 mm wide, lecideine, immersed then broadly adnate or becoming sessile and constricted at the base, scattered or crowded, rounded or irregular through mutual pressure; disc dark brown to black, epruinose, weakly concave to plane; proper excipulum distinct, persistent, often slightly higher than the disc, in section 35–60 µm thick; outer zone dark brown to black-brown, K-, paler brown within. *Ephymenium* 10–15 µm thick, dark brown, K-, N-. *Hypotheecium* 50–110 µm thick, pale to dark brown; subhypotheecium and stipe to 150–250 µm thick, brown-black, K-, N+ orange-brown. *Hymenium* 80–110 µm thick, colourless, not interspersed; subhymenium 30–40 µm thick, pale brown, densely interspersed with oil droplets. *Paraphyses* 1.5–1.8 µm wide, simple to sparsely branched; apices 4–5 µm wide, with dark brown caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* at first *Orcularia*-type, later *Physconia*-type or rarely *Buellia*-type, 1-septate, pale olive-green to brown, ellipsoid, 17–[20.1]–24 × 8–[11.4]–14 µm, rarely constricted or dilated at the septum; outer spore wall rugulate. *Pycnidia* common, pyriform, superficial, black. *Conidia* filiform, curved, 16–24 × 0.7–1 µm. *Chemistry*: Thallus K-, C-, P-, UV-; no lichen substances detected.

#### Remarks

This species is characterized by an inconspicuous to rimose-areolate, grey-white to grey-brown, crustose thallus lacking lichen substances, a non-amyloid medulla that lacks calcium oxalate, adnate to sessile, lecideine apothecia, 0.1–0.5 mm wide, a brown N- ephymenium, a subhymenium interspersed with oil droplets, *Orcularia*- then *Physconia*-type ascospores, 17–24 × 8–14 µm, which are usually not constricted at the septum and have a rugulate outer wall, and curved, filiform conidia, 16–24 µm long. Authentic material of *A. parasemopsis* has been seen from the Falkland Islands (Islas Malvinas), Kerguelen Islands (Elix 2019, as *A. tristiuscula*) and Île St. Paul. It has also been reported [as *A. tristiuscula*] for subantarctic Prince Edward Island (Øvstedal & Gremmen 2007), Heard Island (Øvstedal & Gremmen 2008) and Marion Island (Øvstedal & Gremmen 2014). Illustrations are provided in Elix (2019, as *A. tristiuscula*).

#### ADDITIONAL SPECIMENS EXAMINED

*Falkland Islands*. • East Falkland, Port William, N side of Hells Kitchen, on coastal rocks, *H.A. Imshaug 41641C* & *R.C. Harris*, 31.i.1968 (CANB). • West Falkland, Weddell Island, summit of Circum Peak, on rock, *H.A. Imshaug 42015A* & *R.C. Harris*, 6.ii.1968 (CANB).

#### Lectotypification of *Buellia falklandica*

As a consequence of some recent misunderstandings regarding this species (Fryday 2019), *Buellia falklandica* is lectotypified here and a detailed description is provided. In his original description Darbishire (1912) recorded the species from Port Louis, Falkland Islands (Islas Malvinas), but he did not cite a type specimen. Two original collections from the type locality are deposited in S, both made by Carl Skottsberg (*C. Skottsberg 90* and *C. Skottsberg 127/128*). The former is designated here as the lectotype as it is homogeneous and better developed (the latter comprised three rock fragments). Both specimens have short, bacilliform conidia (observations originally made by F. Bungartz in 2003, and confirmed by the present author), in contrast to the filiform structures reported by Fryday (2019).

***Buellia falklandica*** Darb., *Wiss. Ergeb. Schwed. Südpolar-Exped. 1901–1903*, **4** (2/11): 14 (1912)

Lectotype here designated: Falkland Islands, Port Louis, *C. Skottsberg 90*, 25.vii.1902 (S) (Fig. 1)

*Thallus* crustose, to 60 mm wide, rimose to rimose-areolate; areoles angular, irregular, 0.1–0.4 mm wide, white, grey-white or grey-green, pustulate-sorediate; soredia developing from fissures in the surface, 60–80 µm wide; prothallus black or paler, marginal when abutting other lichens or not apparent; photobiont cells 8–20 µm wide. *Medulla* white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-. *Apothecia* 0.2–0.7 mm wide, abundant, lecideine, scattered and roundish, immersed then broadly adnate to sessile; disc black, epruinose, weakly concave to plane or weakly convex. *Excipulum* thin, distinct, initially raised above the disc but excluded in older convex apothecia, in section 45–55 µm thick; outer part dark brown to brown-black, K-, N-; inner part brown. *Ephymenium* 8–10 µm thick, dark brown, K-, N-. *Hypotheecium*



85–130 µm thick, dark brown to brown-black, K–. *Hymenium* 55–70 µm thick, colourless, not inspersed; subhymenium 25–35 µm thick, pale brown, not inspersed. *Paraphyses* 1–1.5 µm wide, sparingly branched; apices 3–4 µm wide, with brown caps. *Asci* *Bacidia*-type, 8-spored. *Ascospores* *Orcularia*-, *Physconia*- then *Buellia*-type (Fig. 2), brown, ellipsoid, 13–[15.9]–18 × 8–[9.1]–11 µm, becoming dilated at the septum; outer spore-wall microrugulate. *Pycnidia* immersed, black, punctiform. *Conidia* bacilliform, 4.5–5.5 × 0.7–1 µm. *Chemistry*: Thallus K–, P–, C–, UV–; no lichen substances detected.

#### Remarks

*Buellia falklandica* is characterized by the crustose, areolate to rimose-areolate, white, grey-white or grey-green, pustulate-soeradiate thallus where the soeradia develop from fissures in the surface, the *Orcularia*-, *Physconia*- then *Buellia*-type ascospores, 13–18 × 8–11 µm, which become dilated at the septum with age and have a microrugulate outer wall, short, bacilliform conidia, 4.5–5.5 µm long, and by the absence of lichen substances. Fryday (2019), reported it as having larger ascospores, 18–24 × 6–12 µm, and curved, filiform conidia, but this obviously refers to a different species. It is also known to occur in Antarctica (Øvstedal & Lewis Smith 2001).

#### ADDITIONAL SPECIMENS EXAMINED

*Falkland Islands*. • East Falkland, Kidney Island, S shore E of landing bay, on coastal rocks, *H.A. Imshaug 40525 & R.C. Harris*, 16.i.1968 (CANB). • West Falkland, Westpoint Island, cliffs facing The Woolly Gut, on rock in *Hebe* scrub, *H.A. Imshaug 40919B & R.C. Harris*, 22.i.1968 (CANB). • West Falkland, New Island, base of Sabina Point Peninsula, 150 ft, on rock in clay area, *H.A. Imshaug 41822 & R.C. Harris*, 3.ii.1968 (CANB).

#### Acknowledgements

I thank the curators of BM, H, and S for their kind cooperation in providing loans of key collections, and to Mr Brendan Lepschi (CANB) for organizing the loans. I also thank Dr Christine Cargill and Ms Judith Curnow for their kind cooperation in providing access to key collections in CANB.

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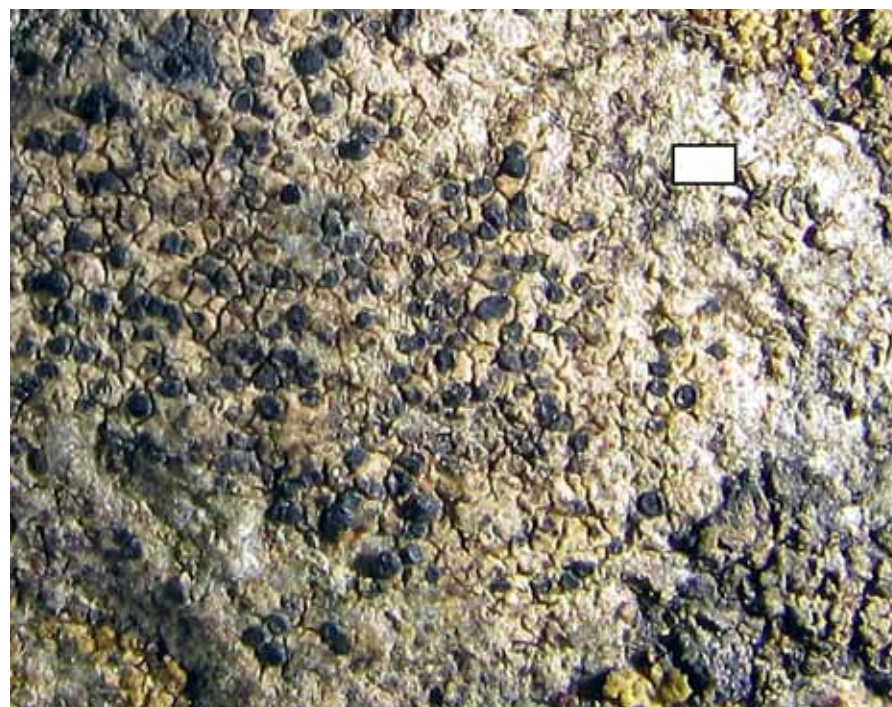


Fig. 1. *Buellia falklandica* (lectotype in S). Scale = 2 mm.

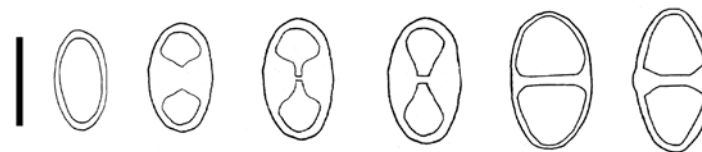


Fig. 2. Ascospore ontogeny of *Buellia falklandica*. Scale = 10 µm.

***Buellia oevstedalii* (Caliciaceae, Ascomycota),  
a new buellioid lichen from Antarctica**

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**Abstract**

*Buellia oevstedalii* Elix is described as new to science from Graham Land, Antarctica.

This paper continues my investigation of *Buellia*-like lichens in Antarctica, and follows from the previous accounts of *Buellia* and related genera (Elix 2018, 2019, 2021, 2022; Elix *et al.* 2020). A new species, *B. oevstedalii*, is described from Graham Land.

**New species**

***Buellia oevstedalii*** Elix, sp. nov.  
Mycobank No.: **MB 848687**

Figs 1, 2

Similar to *Buellia ocellata* (Flot.) Körb., but differs in having a continuous thallus, an inspersed, hyaline hypothecium, and in containing gyrophoric and stictic acids.

*Type*: Antarctica, Graham Land, James Ross Island, hilltop on S side of St Marthas Cove, on rock in pockets of soil amongst large block boulders, *R.I. Lewis Smith 07557A*, 6.ii.1989 (holotype – AAS).

*Thallus* crustose, to 40 mm wide and 0.8 mm thick, epilithic, continuous, with numerous, somewhat paler, elevated warts; upper surface yellow-brown to pale rusty brown, roughened, matt; prothallus not apparent; photobiont cells 8–18 µm wide; medulla white, lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), I-. *Apothecia* 0.2–0.8 mm wide, abundant, occurring in elevated warts, 0.7–1.2 mm wide, individual warts containing 1–5 apothecia, cryptolecanorine then lecideine, roundish, initially immersed, ultimately broadly adnate; disc black, epruinose, plane to weakly convex; proper exciple thin, persistent, in section 35–65 µm thick, outer part dark brown to greenish black, N+ purple to purple-brown, inner part brown, K-. *Epihymenium* 12–15 µm thick, dark brown to brown-black or greenish black, N+ red to purple-brown. *Hypothecium* 50–180 µm thick, colourless, interspersed with oil drops, K-. *Hymenium* 60–90 µm thick, colourless, not interspersed; subhymenium 10–20 µm thick, colourless, not interspersed; paraphyses 1–2.5 µm wide, sparingly branched, with apices 3.5–5 µm wide and dark brown caps. *Asci* 8-spored, *Bacidia*-type. *Ascospores* *Physconia*- then *Buellia*-type, 1-septate, pale then dark brown, ellipsoid, 13–[14.7]–18 × 6.5–[8.2]–11 µm, becoming constricted at the septum with age; outer wall microrugulate. *Pycnidia* and conidia not seen.

*Chemistry*: Thallus K+ yellow, P+ yellow, C-, UV-; containing stictic acid (major), gyrophoric acid (major).

*Etymology*: This species is named in honour of the Norwegian lichenologist Dag Olav Øvstedal in recognition of his contributions to Antarctic lichenology.

**Remarks**

*Buellia oevstedalii* is characterized by the continuous, yellow-brown to pale rusty brown thallus, with numerous, somewhat paler, elevated warts bearing apothecia, the immersed cryptolecanorine then adnate lecideine apothecia, the non-amyloid medulla, the dark brown to brown-black or greenish black, N+ red to purple-brown epihymenium, the colourless hypothecium interspersed with oil droplets, the *Physconia*- then *Buellia*-type ascospores, 13–18 × 6.5–11 µm, which become constricted at the septum with age and by the presence of

gyrophoric and stictic acids. The somewhat similar *B. ocellata* differs in having an often dispersed, areolate to subsquamulose thallus, a non-inspersed, dark brown hypothecium and in containing arthothelin (Elix 2011). *Buellia oevstedalii* was referred to as *Buellia* aff. *aethalea* (Ach.) Th.Fr. in Øvstedal & Lewis Smith (2001).

**Acknowledgements**

I thank the curators of AAS for their kind cooperation in providing a loan of the holotype cited above and to Mr Brendan Lepschi (CANB) for organizing this loan for me. Many thanks to Dr Gintaras Kantvilas (HO) for his assistance with thin-layer chromatography.

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**A new combination and new record of *Cratiria*  
(Caliciaceae, Ascomycota) from Papua New Guinea**

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**Abstract**

The corticolous *Cratiria confusa* (Awasthi) Elix comb. nov. is recorded from Papua New Guinea for the first time.

**Introduction**

This paper continues my investigation of *Buellia*-like lichens in the Pacific islands. For recent additions see Elix (2016, 2019, 2022) and Elix & Mayrhofer (2019). The genus *Cratiria* Marbach includes species that are characterized by relatively large, submuriform, 1- or 3-septate ascospores, 15–32 × 7–13 μm, with apical wall-thickenings, short, bacilliform conidia 4–6 μm long, a hymenium that can be interspersed with oil droplets or not and an excipulum containing lichen substances (Marbach 2000; Elix 2014; Elix & Mayrhofer 2020). Methods are as described in the previous papers cited above.

***Cratiria confusa*** (Awasthi) Elix, comb. nov.  
Mycobank No.: **MB 849102**

Figs 1, 2

*Buellia confusa* Awasthi, *Biblioth. Lichenol.* **40**, 2 (1991)

*Type:* India, Tamil Nadu, Nilgiri Hills, Mettupalayam Road, near Hill Grove Station, in Adderly Shola, on bark of tree, *K.P. Singh 71.818*, 28.xii.1971 (holotype – LWU, not seen).

*Thallus* crustose, to 20 mm wide and 70 μm thick, weakly granulose to verruculose, sparingly rimose; upper surface white to whitish grey or pale yellowish grey; prothallus marginal, black or not apparent; medulla lacking calcium oxalate (H<sub>2</sub>SO<sub>4</sub>-), 1-; photobiont cells 6–11 μm wide. *Apothecia* 0.8–1.2 mm wide, sessile; disc black, epruinose, weakly concave to plane. *Excipulum* margin persistent, moderately broad, in section 35–75 μm thick, brown-black, K<sup>+</sup> yellow then red, forming red, needle-like crystals. *Epihymenium* 10–15 μm thick, pale brown to brown, N<sup>-</sup>. *Hypothecium* 120–150 μm thick, brown-black. *Hymenium* 100–150 μm thick, colourless, densely interspersed with oil droplets. *Paraphyses* 1.5–1.8 μm thick, sparingly branched, with apices 2.5–3 μm wide and brown caps. *Asci* *Bacidia*-type, (3–6)–8-spored. *Ascospores* *Cratiria*-type, dark olive-brown, 1-septate, 19–[27.5]–32 × 9–[11.6]–14 μm, with marked apical and median wall thickenings; outer spore-wall rugulate. *Pycnidia* not seen. *Chemistry:* Thallus K<sup>+</sup> yellow then red, C<sup>-</sup>, P<sup>+</sup> yellow-orange; containing atranorin (major or minor), norstictic acid (major), connorstictic acid (minor).

**Remarks**

This species is characterized by the white to whitish grey or yellowish grey, crustose thallus, the black, epruinose discs, the densely interspersed hymenium, *Cratiria*-type ascospores, 19–32 × 9–14 μm, and by the presence of atranorin and norstictic acid (Awasthi 1991). The pantropical *C. rutilans* Marbach has an interspersed hymenium and chemistry identical to that of *B. confusa*, but it differs in having smaller ascospores, 18–[23.2]–28 × 10–[10.9]–12 μm, and reddish black apothecial discs (Marbach 2000).

At present *Cratiria confusa* is known from India and Papua New Guinea. In Papua New Guinea associated species include *Dirinaria aegialita* (Ach.) Moore, *Heterodermia galactophylla* (Tuck.) Trevis., *Leucodermia leucomelos* (L.) Kalb, *Parmotrema cristiferum* (Taylor) Hale, *P. subrugatum* (Kremp.) Hale and *P. tinctorum* (Despr. ex Nyl.) Hale.



Fig. 1. *Buellia oevstedalii* (holotype in AAS). Scale = 2 mm.



Fig. 2. Ascospore ontogeny of *Buellia oevstedalii*. Scale = 10 μm.

#### SPECIMEN EXAMINED

Papua New Guinea: • Morobe Province, Manki Trig., Bulolo-Watut Divide, 10 km SW of Bulolo, 4 km S of Bullaroo River Bridge, on lower stem of *Wendlandia* on gentle ridge top in grasslands with *Gleichenia*, *Wendlandia*, *Timonius* and *Banksia*, H. Streimann 12806A, 26.i.1981 (CANB).

#### Acknowledgement

I thank Dr Christine Cargill and Ms Judith Curnow for their kind cooperation in providing access to key collections in CANB.

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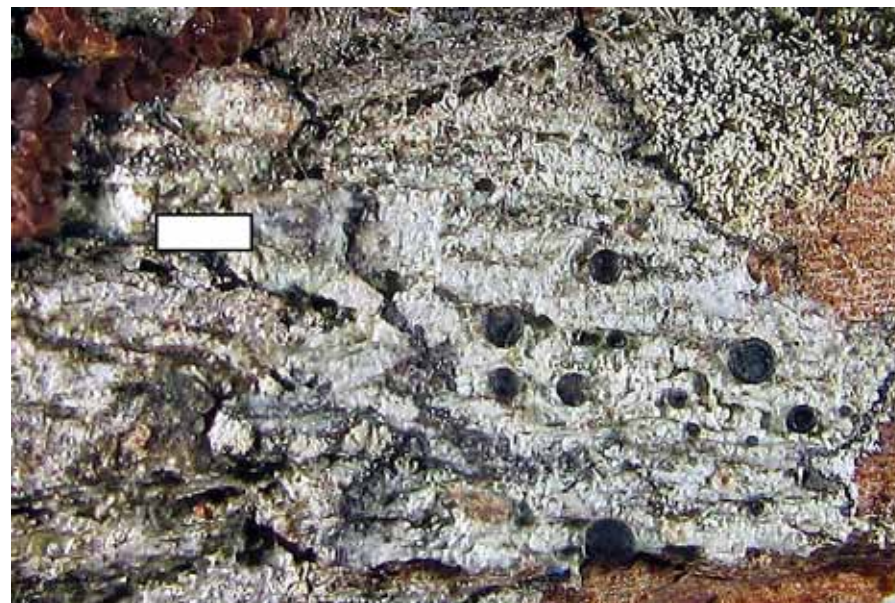


Fig. 1. *Cratiria confusa* (H. Streimann 12806A in CANB). Scale = 2 mm.

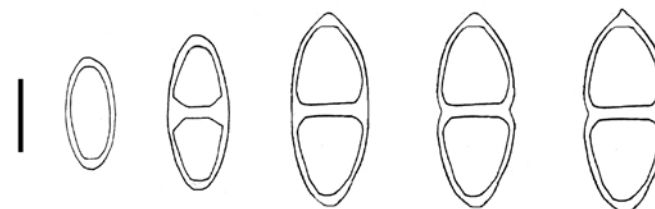


Fig. 2. Ascospore ontogeny of *Cratiria confusa*. Scale = 10  $\mu$ m.

**Distinguishing features and new distributions of three similar species of *Pertusaria* (lichenised ascomycota, Pertusariaceae) in southern New Zealand**

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**Abstract**

Three species of superficially similar white, saxicolous, verruciform, large-spored *Pertusaria* occurring in New Zealand are compared: *Pertusaria knightiana* Müll.Arg., *Pertusaria otagoana* D.J.Galloway and *Pertusaria subverrucosa* Nyl. Fresh and herbarium specimens were examined, their salient distinguishing features tabulated and illustrated, and significant extensions of geographical distribution recorded.

**Introduction**

The genus *Pertusaria* DC. is widely distributed throughout the world. A preliminary world key (Archer and Elix 2018) covers 794 taxa, including the recently resurrected genus *Lepra* Scop. and other species transferred to *Varicellaria* Nyl. It is well represented in Australasia, with 169 taxa known from Australia (Archer and Elix 2016) and 54 from New Zealand (Galloway 2007). Apothecial structure, the number and structure of ascospores and thalline chemistry are taxonomic features important for identification.

The three species of *Pertusaria* compared here are found in New Zealand southwards from Wellington. Two, *Pertusaria otagoana* and *P. subverrucosa*, are endemic to New Zealand and not as well documented as the Australasian *P. knightiana*. Galloway (2007) reported *P. otagoana* and *P. knightiana* as known in New Zealand from only their type specimens. All three have overlapping habitats and distributions, grow on various rock types, and are found in coastal, lowland, subalpine and alpine areas. Their superficial appearance is similar, with whitish thalli, and raised fertile verrucae with black ostioles (Figs 1–3). The aim of this study was to determine the characters that are most diagnostic and to report updated distributions based on historical and recent collections.

**Methods**

The presence of norstictic acid was determined by mounting hand-cut sections of the verrucae in 10% KOH and checking for crystal formation, while xanthones were detected using long wavelength UV light. Measurements of ascospores were made in 10% KOH. Other ascospore features were examined in KOH or in Lactothymol Cotton Blue, which made the ascospore structure clearer (Bannister *et al.* 2023). Photomicrographs and measurements were made on ascospore mounts using a Leica DM 1000 microscope with LASX software. Only mature ascospores outside the ascus were measured. Ascospore lengths were displayed as box and whisker plots (Tukey 1977) using the `boxplot` function of the R statistical software Version 4.3.0 (R Core Team 2023). Boxplots facilitate viewing the overall shape of the way data values are distributed along their range. Testing whether species were significantly different in ascospore length used the `t.test` function of R on specimen means.

**Results and discussion**

The main distinguishing features are summarised in Table 1 (below). Full descriptions of the three species are available in Galloway (1985, 2007).

Species	<i>P. knightiana</i>	<i>P. otagoana</i>	<i>P. subverrucosa</i>
Distribution	Australasian	New Zealand endemic	New Zealand endemic
Known from	Tasmania, Tasman, **Wellington, Canterbury, Otago	West Coast, *Otago, Southland, Campbell Island	**Wellington, Canterbury, Otago, Stewart Island
Ecology	coastal to alpine	subalpine to alpine	coastal to low subalpine
Chemistry	norstictic acid xanthone UV+ orange	norstictic acid no xanthone not UV+ orange	norstictic acid no xanthone not UV+ orange
Mature ascospores	2	1	2
Number per ascus	2	1	2
Length (µm)	(125)–166–(212)	(65)–77.5–(325)	(138)–189–(275)
Width (µm)	(50)–56–(75)	(50)–78–(105)	(42)–68–(87)
Number measured	23	34	19
Ascospore wall	minutely rough sculptured	papillate not sculptured	smooth or with radial canals not sculptured

\* Location of type specimen, \*\* Location of types “*sine loco*, probably Wellington”



### Distribution

The Australasian *P. knightiana* was previously known in New Zealand only from a single collection from Wellington, but here we report another collection from Wellington and new regional records from Canterbury, Tasman and Otago. Despite having the widest geographical range, extending to Tasmania, *P. knightiana* was the least frequently collected of the three species in New Zealand. *Pertusaria otagoana* is endemic to New Zealand, and was previously known only from the type collection in Otago. Here we report its presence in West Coast and Southland, as well as several new sites in Otago. Fryday (2022) reported *P. otagoana* from Campbell Island, and pointed out that corticolous *Pertusaria platystoma* Malme is a synonym of *P. simulans* Malme, not *P. simulans* Zahlbr., and so has been incorrectly applied to *P. otagoana*. The endemic *Pertusaria subverrucosa* is the most common species in New Zealand, and the most frequently collected. We report four new locations in Otago. In addition, the Australian National Herbarium (CANB) has several New Zealand collections of all three species, which include the following additional locations: *P. knightiana*, Nelson; *P. otagoana*, Tasman and Marlborough; and *P. subverrucosa*, Nelson (Consortium of Lichen Herbaria 2023). These collections have not been seen by us.

### Thallus variation

Figures 1–3 show that all three species have a rough, whitish thallus when fresh. There is considerable variation both within and among species in the size and shape of ascomatal verrucae, which can range from confluent to separate even in the same collection. Likewise, the black ostioles range in size and shape both within and among specimens of the same species. This variation makes it very difficult to distinguish species in the field. *Chemistry*: because all three species contain norstictic acid, they can not be fully distinguished by simple spot-tests. However, only the thallus of *Pertusaria knightiana* contains 4,5-dichlorolichexanthone, which fluoresces UV+ orange, a useful diagnostic feature. The full chemistry of *P. knightiana*, but not the other two species, is given by Galloway (2007).

### Ascospore measurements

*Pertusaria otagoana* has monosporous asci, whereas the other two taxa have two-spored asci. When assessing that character, it is important to ensure that the ascus is intact, so that a half-empty ascus is not erroneously recorded as containing only a single ascospore. *Pertusaria otagoana* is also the only species with ascospores that can grow to more than 300 µm long and 100 µm in width. *Pertusaria knightiana* has the smallest ascospores, and those of *P. subverrucosa* are intermediate between the other two species (Table 1, Fig. 4).

### Ascospore lengths

Individual ascospore lengths show little overlap among New Zealand collections of the three species (Fig. 4). Both *P. knightiana* and *P. subverrucosa* have significantly (i.e. reliably) shorter ascospores than *P. otagoana* ( $t = 8.8$ ,  $t = 2.9$ , respectively;  $p < 0.05$ ), but measurements of currently available specimens do not indicate that *P. knightiana* has significantly shorter ascospores than *P. subverrucosa* ( $t = 3.0$ ;  $p = 0.08$ ).

### Ascospore walls

*Pertusaria* ascospores have an inner and an outer wall, and it is important to distinguish between them. Galloway (1985, 2007) described *P. knightiana* as having a ‘rough’ wall, *P. otagoana* as having a ‘double’ wall and *P. subverrucosa* as having ‘smooth’ ascospore walls. When we examined the walls more closely we found that only *P. knightiana* has a sculptured inner wall, with transverse bands of thickening surrounding the ascospore contents. The outer wall of that species is minutely rough (Fig. 1E, F). The outer, but not the inner, ascospore walls of the other two species appear rough at times. In *P. otagoana* the outside of the outer wall is papillate (Fig. 2E, F), whereas the outer wall of *P. subverrucosa* ascospores can appear smooth or they can show somewhat rough-looking radial canals (Fig. 3E, F) that are distinctly different from the sculptured inner ascospore walls of *P. knightiana*.

### The species

***Pertusaria knightiana*** Müll. Arg., *Bull. Soc. R. Bot. Belg.* **31**(2): 31 (1892) Fig. 1  
*Type*: New Zealand. *Sine loco* (probably Wellington), 1883, C. Knight 25. (Holotype—G-6 38/2, specimen not seen by us, but high resolution image seen).  
= *Pertusaria ceuthocarpa* \*crenulata Stirt., *Proc. Roy. Phil. Soc. Glasgow* 10: 296 (1877).

### Distinguishing features

*Pertusaria knightiana* is the only species with a rough, sculptured inner cell wall and the only one to fluoresce UV+ orange due to the presence of 4,5-dichlorolichexanthone.

**Distribution** (Regions in **bold** are additional to those included in Galloway 2007)

Australia: *Tasmania*.

New Zealand: *North Island*, Wellington (Cape Palliser). *South Island*: **Tasman** (Red Hills); **Canterbury** (Hanmer Springs Junction); **Otago** (Trotters Gorge, Matukituki R., Silver Peaks, Kakanuis).

### SELECTED SPECIMENS EXAMINED

*North Island*: Wellington, ● **Cape Palliser Road**, on basalt, 41.39742S, 172.46284E, 77 m alt., *Marley Ford*, MF1161, 7.iii.2022 (OTA 75648). *South Island*: Tasman, ● **Red Hills**, on peridotite ultramafic boulder, 41.7146S, 173. 0156E, 1138 m alt., *Marley Ford* MF1632, 10.i. 2023 (OTA 75647); Canterbury, ● **Hanmer Springs Junction**, in grazed grassland, 42.516596S, 172.944427E, *H.A. Imshaug*, 4.xii.1972, det. A. Fryday (MSC0142088); Otago: ● **Kakanuis**, 3000', *B.W. Campbell*, viii.1959, det. A.W. Archer (OTA 48451); ● **Silver Peaks**, Pulpit Rock, 2460' alt., *J. Murray* 4209, iii.1959, det. A.W. Archer (OTA 48450); ● **Trotters Gorge**, Dunedin, *J. Murray* 3851, i.1959, det. A.W. Archer (OTA 48452); ● **Matukituki River**, on rock, *D. Scott*, v.1969, det. A.W. Archer (OTA 48453).

***Pertusaria otagoana*** D.J.Galloway, *N. Z. Jour. Bot.* **21**(2): 195 (1983) Fig. 2  
*Type*: (*P. simulans* Zahlbr., *Denkschr. Kaiserl. Akad. Wiss. Wien, Math.-Naturwiss. Kl.* **104**: 334 (1941) non Malme, *Ark. Bot.* **28A**(no. 9): 19 (1936)); New Zealand, Otago, Silver Peaks near Dunedin, on rocks in tussock grassland, *J.S. Thomson* T1166, x.1983 (Holotype—W-ZA3890; Isotypes—CHR 374711, OTA 47485!; only OTA isotype seen by us).

### Distinguishing features

*Pertusaria otagoana* is the only one of the three species to have just one ascospore per ascus, and to have ascospores that can grow over 300 µm long or 100 µm wide (Table 1 and Fig. 2). The outside of the outer ascospore wall is papillate (Fig. 2E, F).

### Distribution

New Zealand, South Island: **West Coast** (Mt Luna); Otago (McPhees Rock, Silver Peaks, Maungatua, Mihiwaka, Mopanui, Trotters Gorge, Matukituki, Kakanuis); **Southland** (Slope-down Forest, Longwood). **Campbell Island**.

### SELECTED SPECIMENS EXAMINED

South Island: West Coast, ● **Mt Luna**, on rock, 41.39742S, 172.46284E, 1428 m alt., *T. Aldridge* s.n., 25.i.2023 (OTA 75646); Otago: ● **McPhees Rock**, schist tor, 1300 m alt, 4528'15"S, 16959'30"E, *Allison Knight* s.n. (OTA 63947); ● **Maungatua**, by Big Rock, 2900' *J. Murray* 5688, ii.1961, det. A.W. Archer (OTA 48359); ● Silver Peaks, Pulpit Rock 2450', *J. Murray* 4208, iii.1959, det. A.W. Archer (OTA 48355); ● Trotters Gorge, on limestone, 400', *J. Murray* i.1959, det. A.W. Archer (OTA 46989); ● **Mihiwaka**, on vertical SE face of weathered phonolite outcrop, by track to summit off Cedar Farm Rd, 534 m, 4547'18"S, 17035'58"E, *Allison Knight* AKM7, 16.vii.2022 (OTA 75645); ● **Mopanui** on vertical face of basalt outcrop, 451 m, 4546'11"S, 17036'29"E, *Allison Knight* AK2302, 7.v.2023 (OTA

73190); Southland: ● **Slopedown Forest**, on rock, 46.319893S, 169.163984E, 572 m alt., *Marley Ford MF 1396*, 16.xi.2022 (OTA 75650); ● **Longwood**, Bald Hill, on granite boulders, 46.170397S, 167.828136E, 781 m alt., *Marley Ford MF1402*, 28.v.2022 (OTA 75651). **Campbell Island**: ● summit ridge of St. Col Peak, 52.539°S, 169.13°E, 984 ft [300 m], *H.A. Imshaug 45974 A*, 1969. Det. A. Fryday (MSC-0004019); ● cliffs around Mt. Lyall pyramid, 52.535°S, 169.171°E, 1300 ft [396 m], *H.A. Imshaug 46476 B*, 1970, det. A. Fryday (MSC-0004017).

**Pertusaria subverrucosa** Nyl., *Linn. Soc., Bot.* **9**, 253 (1865) Fig. 3  
*Type*. sine loco (?Wellington), *W. Colenso 4694* (Lectotype—BM, ex Herb. Hooker, designated by Galloway, New Zealand Fl.: 380, 1985; Isolectotype—H-Nyl 22964; lectotype and isolectotype not seen by us, but high resolution image of the isolectotype seen).  
= *Pertusaria callispora* Zahlbr. *Denkschr. Kaiserl. Akad. Wiss. Wien, Math.-Naturwiss. Kl.* **104**: 334 (1941). *Type*: New Zealand. Wellington, Table Top, Tararua Ra., c. 1000 m, ix.1933, *E.E. Chamberlain* (Holotype ZA 193 – W; Isotype – CHR 374710; holotype and isotype not seen by us).

#### Distinguishing features

*Pertusaria subverrucosa* has two ascospores per ascus, which distinguishes it from *P. otagoana*. It has no xanthonenes, and the inner ascospore wall is not sculptured, which distinguishes it from *P. knightiana*. The outer cell wall sometimes shows radial canals.

#### Distribution

New Zealand, *North Island*: Wellington (**Cape Palliser**). *South Island*: Canterbury (Banks Peninsula); Otago (Central Otago, **Trotters Gorge**, **Moonlight**, **Benmore Dam** and **Maungatua**). *Stewart Island*.

#### SELECTED SPECIMENS EXAMINED

North Island: Wellington: ● **Cape Palliser Road**, on basalt. 41.39742S, 172.46284E, 77 m alt. *Marley Ford MF1179*, 7.iii.2022 (OTA 75649) ● Pencarrow Heads, *D. Scott*, 14.v.1960, Det. A.W. Archer (OTA 67321). South Island: Canterbury, ● Banks Peninsula, on volcanic outcrop in small clearing above Brocherries Rd., 4348'31"S, 17300'42"E, 610 m., *Allison Knight AKBPI*, 18.i.2021 (OTA 75653); Otago: ● **Moonlight**, on schist outcrop by Butter and Egg Rd, 4525'53"S, 17020'17"E, 457 m, *Allison Knight AKML1*, 13.xi.2021 (OTA 75644), ● **Trotters Gorge**, Loop track, on rock outcrop, 4524'20"S, 17046'27"E, *Allison Knight s.n.*, 7.ix.2013 (OTA 63739), ● Trotters Gorge, 400', *J. Murray 3850*, i.1959, Det. A.W. Archer (OTA 48381), ● **Maungatua**, on rock. 2500' alt. *J. Murray 0533*, iii.1954, Det. A.W. Archer (OTA 67320), ● **Benmore Dam**, *J. Murray 5756*, iii.1961, Det. A.W. Archer (OTA 48379).

#### Acknowledgements

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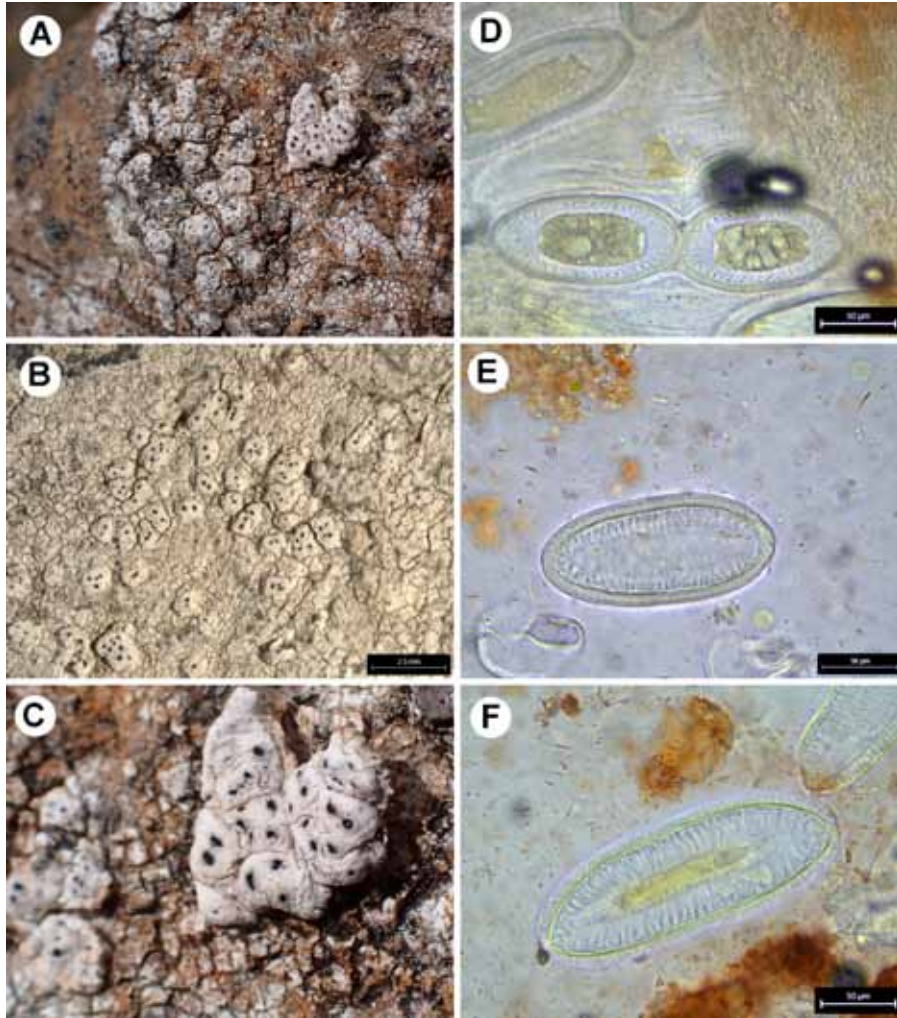


Fig. 1. *Pertusaria knightiana* A, Habitat; B, Habit; C, Verrucae and ostioles; D, Ascus containing two ascospores with sculptured inner walls; E, Mature ascospore with sculptured inner wall; F, Ascospore with sculptured inner wall and minutely rough outer wall. Scales: B = 2.5 mm; D–F = 50  $\mu$ m. Locations: A, C, Red Hills, Tasman; B, Kakanui, Otago; D–F Cape Palliser, Wellington. Photographers: Marley Ford (A, C); JMB (B, D–F).

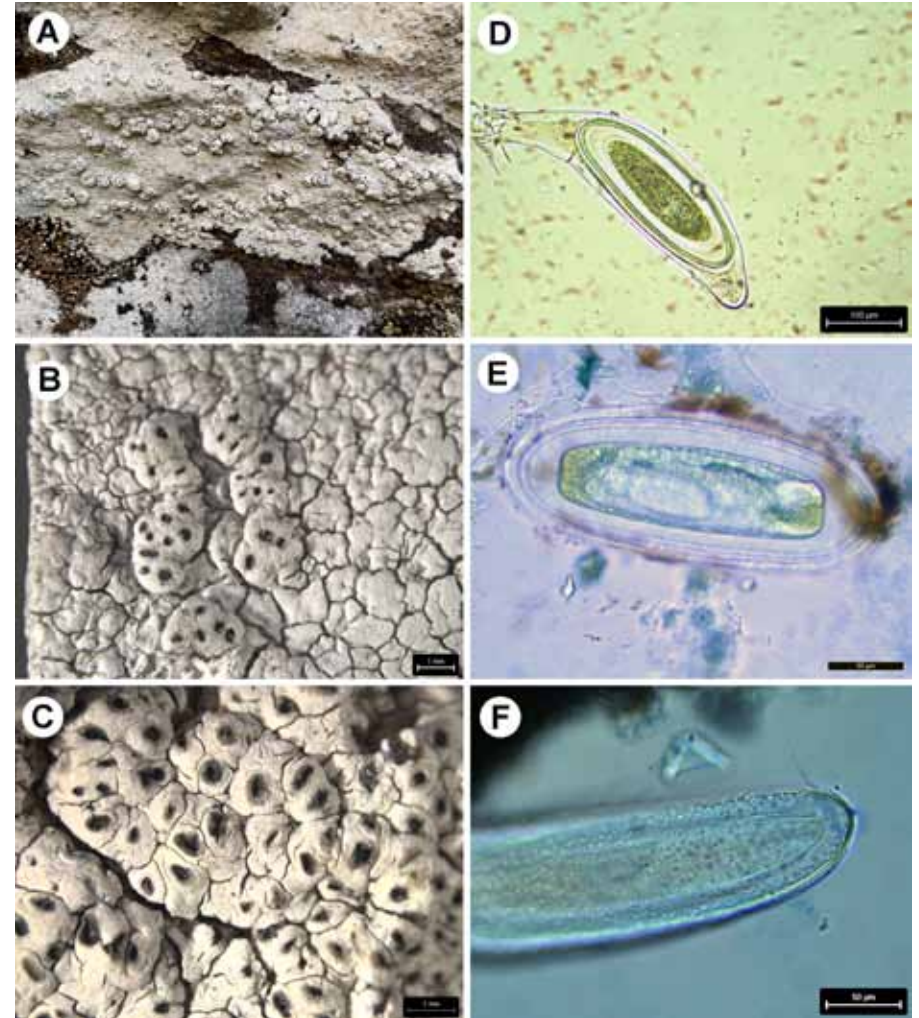


Fig. 2. *Pertusaria otagoana* A, Habitat; B, Habit; C, Verrucae and ostioles; D, One ascospore in ascus, among norstictic acid crystals; E, Mature ascospore with smooth walls; F, Papillae on outer wall of ascospore. Scales: B, C = 1 mm; D = 100  $\mu$ m; E, F = 50  $\mu$ m. Locations: A, Mopanui, Otago; B, Slopedown, Southland; C, McPhees Rock, Otago; D, Trotters Gorge, Otago; E, F, Mihiwaka, Otago. Photographers: AK (A); JMB (B–F).



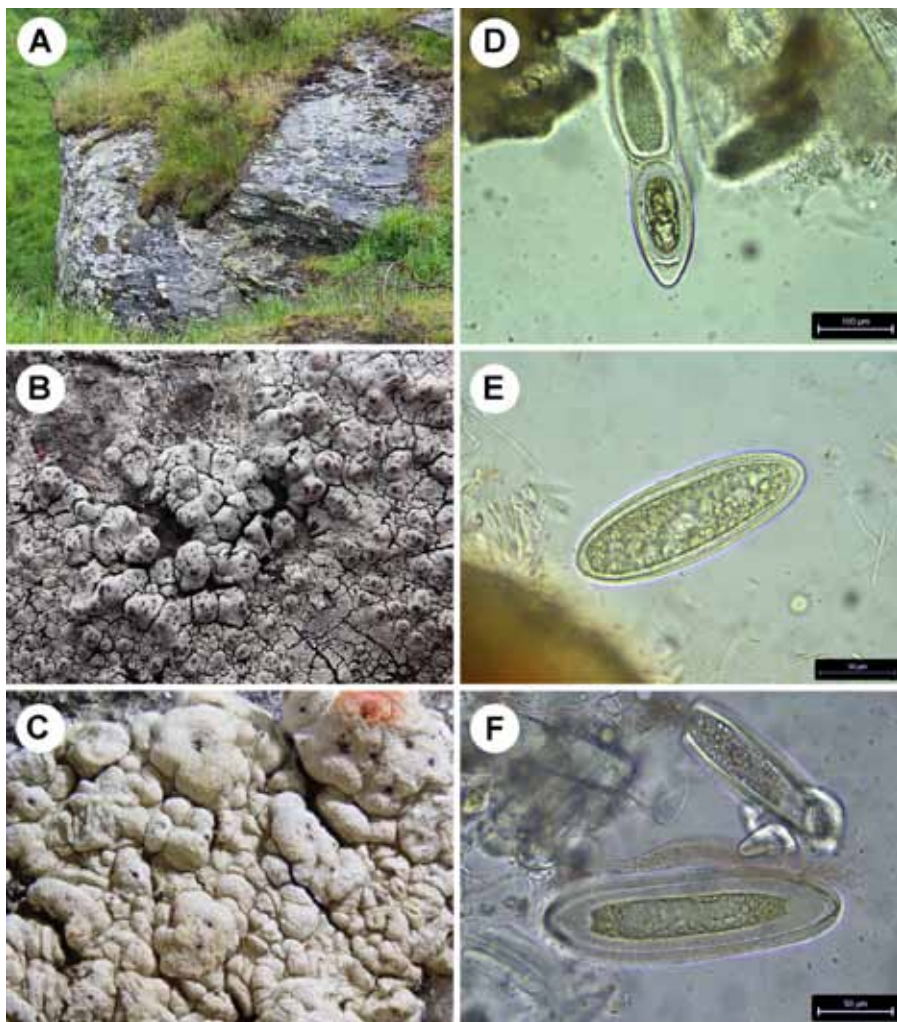


Fig. 3. *Pertusaria subverrucosa* A, Habitat, B, Habit; C, Ostioles and verrucae with norstictic acid spot; D, Two ascospores in ascus; E, Mature ascospore with smooth double walls; F, Radial lines on outer ascospore wall. Scales: D = 100 µm; E, F = 50 µm. Locations: A, C, D, Moonlight, Otago; B, Banks Peninsula, Canterbury; E, Pencarrow, Wellington; F, Cape Palliser, Wellington. Photographers: AK (A–C); JMB (D–F).

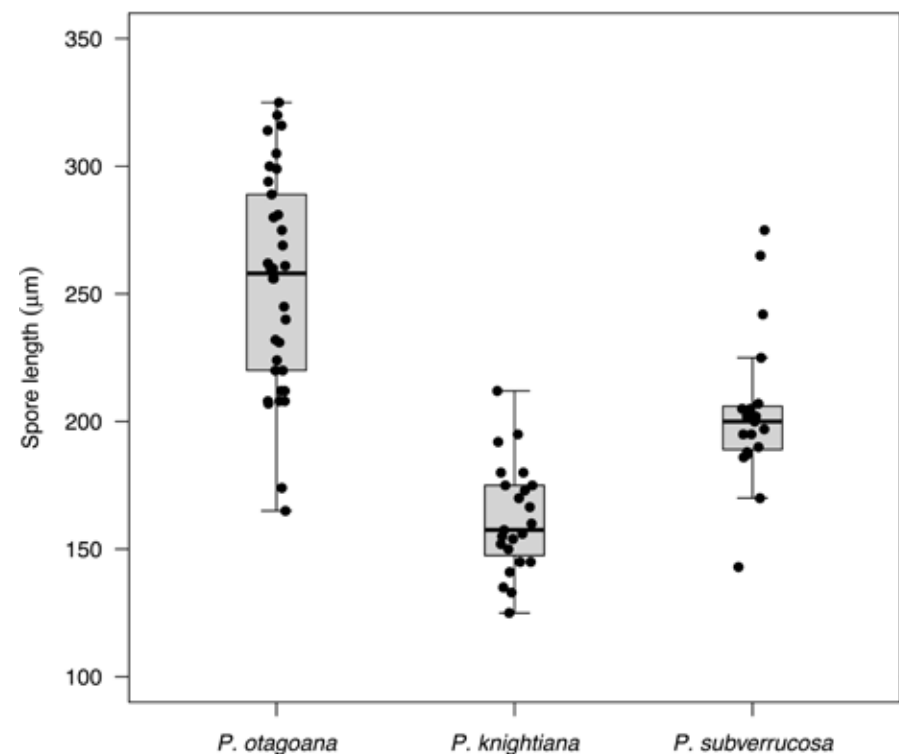


Fig. 4. Boxplots of ascospore lengths for three species of New Zealand *Pertusaria*. Individual ascospore lengths (solid symbols) have a slight horizontal jitter to avoid overplotting values. *P. otagoana*, seven specimens (8, 8, 7, 5, 4, 1, 1 ascospores, 34 total); *P. knightiana*, two specimens (15, 8 ascospores, 23 total); *P. subverrucosa*, three specimens (7, 6, 6 ascospores, 19 total). The lower and upper part of each box are quartiles, so the box contains 50% of ascospore lengths, while a heavy line in the middle is the median ascospore length. Whiskers extend beyond each box to approximate 95% confidence limits for the range of ascospore lengths. Ascospore lengths beyond whiskers are considered possible extremes or outlying values.

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