

A second species of *Lithographa* with submuriform ascospores

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Abstract: The new combination *Lithographa skottsbergii* (Zahlbr.) Fryday & Coppins is made for *Enterostigma skottsbergii* Zahlbr., described from the Juan Fernandez Islands off the coast of Chile. The species is known only from Chile but its geographical range is here extended to include maritime regions of south-west Chile. The distribution pattern of the *Lithographa* species with submuriform ascospores is also discussed.

Key words: *Agyriaceae*, austral lichens, biogeography, Campbell Plateau, Chile, *Enterostigma*, Juan Fernandez

Introduction

The genus *Enterostigma* was erected by Müller Argoviensis (Müller 1885) for the single species *Enterostigma compunctum* (Ach.) Müll. Arg. (basionym *Porina compuncta* Ach.), a neotropical, corticolous species that is now included in *Leucodecton* A. Massal., a recently resurrected segregate of *Thelotrema* Ach. (Frisch 2006; Salisbury 1972). Zahlbruckner (1917) described the new species *Enterostigma skottsbergii* Zahlbr. from a collection made by Carl Skottsberg from the Juan Fernandez Islands but, because his new species had persistently hyaline ascospores and *Enterostigma compunctum* (= *Leucodecton compunctum* (Ach.) A. Massal.) had pigmented (pale brown) ascospores, Zahlbruckner included it in *Enterostigma* with some hesitation. However, he reasoned that the pigmented ascospores of *E. compunctum* could have been caused by their being overmature, or that the hyaline ascospores of *E. skottsbergii* could have been immature (Zahlbruckner 1917). As *Enterostigma skottsbergii* is clearly not a member

of the *Thelotremataceae*, it is, in effect, an orphaned taxon.

Enterostigma skottsbergii was previously known only from two collections from the Juan Fernandez Islands (see below). It was not included in the Chilean checklist of Galloway & Quilhot (1998), but was included in that of Elix & McCarthy (1998) for Juan Fernandez. However, in the rich collections made by Henry Imshaug and co-workers from Juan Fernandez and south-west Chile in the 1960s and now housed in the herbarium of Michigan State University (MSC; Fryday & Prather 2001), there are several collections that Imshaug had referred to *E. skottsbergii*. Comparison of these collections with Skottsberg's original collections (in W) showed that they were correctly named, and examination revealed that they had a very close resemblance to the recently described *Lithographa serpentina* Coppins & Fryday (2006). Consequently, we here transfer *E. skottsbergii* to *Lithographa*.

Materials and Methods

Apothecial characteristics were examined by light microscopy on hand-cut sections mounted in water, 10% KOH (K), 50% HNO₃ (N) or 0.15% aqueous IKI. Thallus sections were investigated in water, 10% KOH (K) and lactophenol cotton-blue. The ascus structure was studied in 0.15% aqueous IKI, both without prior treatment and after pretreatment with

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10% KOH. Measurements of ascospores, paraphyses and conidia were made in 10% KOH. For irregularly shaped areoles, the width was taken as the lowest measurement.

Additional comparative material examined.

Lithographa graphidioides (Cromb.) Imshaug ex Coppins & Fryday: **Argentina:** *Isla de la Estados:* Puerto Celular, on S side of cove, summit of mountain, 54°48'S, 64°19'W, 430 m., 1971, *H. A. Imshaug* (52496) & *K. E. Ohlsson* (MSC); *ibid.*, Puerto Alexander: west of sea cliffs opposite Islote Alexander, 54°51'S, 64°25'W, 360 m., *Marsippospermum* covered basin with scattered *Nothofagus* krummholz, 1971, *H. A. Imshaug* (52795) & *K. E. Ohlsson* (MSC).

Rimularia gibbosa (Ach.) Coppins, Hertel & Rambold: **USA:** *Arizona:* Gila Co., Workman Creek, c. 33°52.25'0N, 111°0.5'W, c. 1400 m., sunny, exposed rock-face, 2002, *Fryday* 8508 (MSC).

Rimularia gyrizans (Nyl.) Hertel & Rambold: **Great Britain:** *Scotland:* **VC 92**, South Aberdeenshire, Braemar, Mar Lodge Estate, Clais Fhearnaig, 37(NO)06.93, alt. 500 m, NE-facing acid rock scree; 2005, *Fryday* 8982 (MSC).

The Species

***Lithographa skottsbergii* (Zahlbr.)
Fryday & Coppins comb. nov.**
Mycobank MB 510491

Enterostigma skottsbergii Zahlbr., *Kgl. Svensk. Vetensk.-Akad. Handl.* 57(6): 9. 1917. Type: Chile, Juan Fernandez, auf dem Hochplateau von Masafuera, bei 1200 m über dem Meere, auf Lava, 1907–9, *C. Skottsberg* (W!).

(Figs 1–3)

Thallus delimited, c. 3–7 cm (or more) diam., ± placodioid, sometimes with a narrow black edge, deeply rimose-areolate with areoles 0.3–2.4 mm across, ochraceous, matt or sometimes ± glossy in younger parts; prothallus not evident. In section: thallus 0.1–0.5 mm thick; cortex 65–70(–95) µm thick, hyaline or upper part dilute straw-brown, hyphae densely compacted, ± overlain by a hyaline epinecral layer c. 5 µm thick; algal layer 70–120 µm thick; medulla I+ blue-mauve, up to 0.4 mm thick, hyaline, but containing large amounts of mineral particles from the substratum giving an outward, grey to pale ochraceous appearance. *Photobiont* cells ± globose, 6.5–9.5 µm diam., a few seen to be dividing by binary fission; cells ± vertically arranged, together with associated mycobiont hyphae.

Apothecia lirelliform, often tightly arranged in ± stellate, or non-radiating clusters c. 1.2–2 mm diam. (Fig. 1), innate within the areoles, or with the margins raised above the surface layer of the thallus; lirellae elongate, serpentine and frequently branched, (0.3–)0.4–1.8 mm long and 0.1–0.34 mm wide, black, but margin often coated with a rusty ochraceous 'pruina'; disc slit-like, bordered by a black margin (upper exciple). In section, lirellae 140–240 µm wide and 180–300 µm tall. *Exciple* cupulate, dark reddish brown, K–, N–, 42–52 µm thick at base, 24–45 µm laterally, and 35–95 µm thick at apex [margin or 'labium']. *Hymenium* 130–140 µm tall, hyaline, without a well-defined epithecium, I+ blue. *Hypothecium* not well delimited from the hymenium, c. 35–47 µm tall, mottled reddish brown. *Paraphyses* richly branched and anastomosed, not moniliform, 1.2–1.7 µm wide. *Asci* clavate, 97–121 × 19–31 µm, 8-spored; in K/I with an amyloid outer wall, and an apparently non-amyloid tholus [few good preparations obtained]. *Ascospores* (Fig. 2) (17–)19–31 × (8–)9–12 µm, ellipsoid, ovoid-ellipsoid or oblong-ellipsoid, submuriform with 3–5 transverse septa and 4–11 cells in optical section; no perispore observed.

Conidiomata not seen.

Chemistry. Thallus K–, C–, KC–, P–, UV–; no substances detected by TLC.

Notes. *Lithographa skottsbergii* is very similar to *L. serpentina*, known only from the type collection on Campbell Island, New Zealand (Coppins & Fryday 2006). The ascomata have the same general appearance and, presumably, mode of development, the thallus edge is often well delimited, and both species have submuriform ascospores and an ascus dome with a non-amyloid interior. However, *L. skottsbergii* differs in having larger ascospores (14–19 × 8–9 µm in *L. serpentina*), non-moniliform paraphyses, and an I+ blue-mauve medulla.

The aggregation of ascomata seen in *L. serpentina* and *L. skottsbergii* is a distinctive

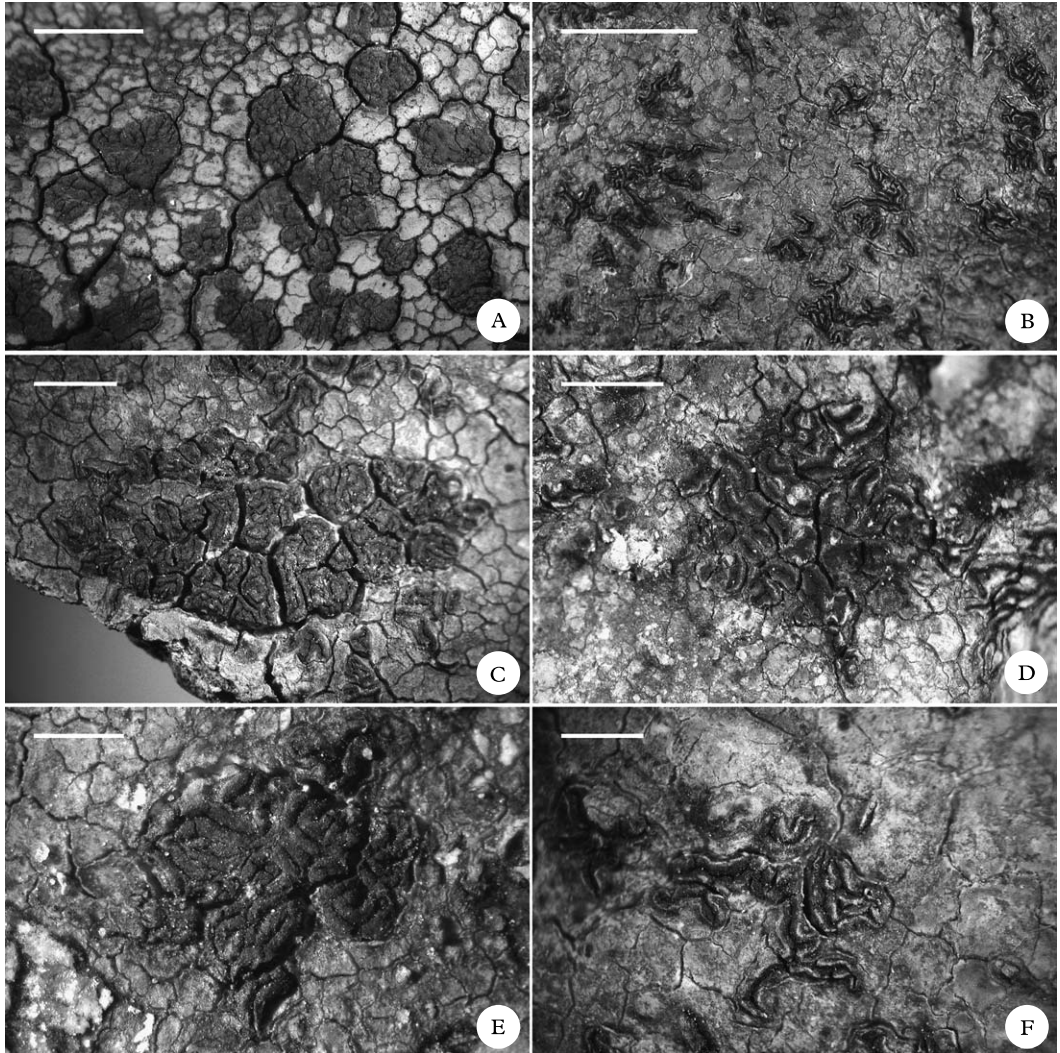


FIG. 1. *Lithographa skottsbergii*, variation in ascocarp morphology. A, holotype, Juan Fernandez; B–F, SW Chile; B & F, Imshaug 44199; C, Imshaug 43584; D, Imshaug 46383; E, Imshaug 43854. Scales: A & B=5.0 mm, C & D=2.0 mm; E & F=1.0 mm.

feature of the two species, but can also be seen (to a lesser extent) in *L. olivacea* Fryday. Interestingly, this species has a similar distribution to the combined distribution of *L. serpentina* and *L. skottsbergii*, being known only from south-west Chile (Isla Desolación) and Campbell Island (Fryday 2004).

Several cells of the photobiont of *L. skottsbergii* appeared to be dividing by binary

fission, an observation we also made when describing *L. serpentina* (Coppins & Fryday 2006). Unfortunately, the photobiont cells could not be clearly observed because of the age of the collections, but inspection of the photobiont of some more recent collections of *Rimularia* spp. (see Materials and Methods) showed that they had photobiont cells of the same type. However, it could be what we are interpreting as binary fission is

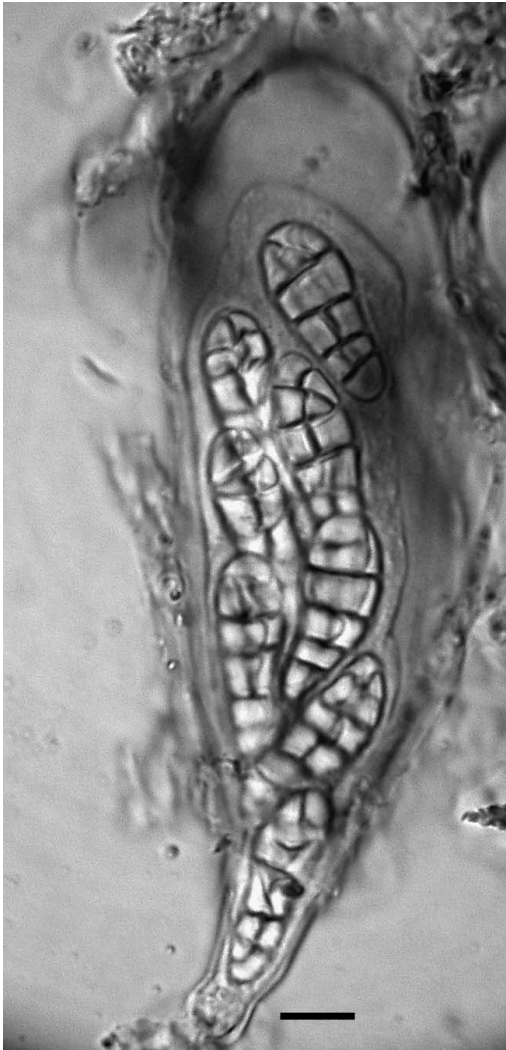


FIG. 2. *Lithographa skottsbergii*, ascus and ascospores (Imshaug 44143). Scale = 10 μ m.

division into 2–4 large autospores. A photobiont dividing by binary fission (*Chlorella*-type) has been reported previously in the *Agyriaceae* in *Placynthiella* Elenkin and *Trapeliopsis* Hertel & Goth. Schneid. (Coppins & James 1984).

Zahlbruckner (1917) compared *Enterostigma skottsbergii* with *Stigmatidium graphidioides* Cromb. (now *Lithographa graphidioides* (Cromb.) Imshaug ex Coppins & Fryday, syn. *L. subantarctica* Hertel &

Rambold) but concluded that, even in the absence of ascospores in the latter, they were not the same because of the development of the ascomata, which are single in *L. graphidioides*. However, some collections of *L. skottsbergii* do have individual ascomata (e.g. Imshaug 44199, Fig. 1B & F) and these collections are almost indistinguishable in the field from *L. graphidioides*, although *L. skottsbergii* can usually be recognized by the presence of orange 'pruina' on the ascomata and by tending to have a thicker thallus.

We strongly suspect that a new genus will be required to accommodate *L. serpentina* and *L. skottsbergii* but, in the absence of corroborating molecular data, we are reluctant to do so here. Unfortunately, no fresh material of either species is available for molecular analysis, the most recent collection being made in 1969–70.

Lithographa skottsbergii was previously known only from the Juan Fernandez Archipelago but the new records reported here extend its range to maritime southwest Chile (Fig. 3).

Additional specimens examined. Chile: Juan Fernandez Islands: Más Afuera [Isla Alejandro Selkirk], Hochplateau, 11–1200 m, 15 ii 1917, C. & A. Skottsberg (Svensk Pacificexpeditionen 1916–1917; W); *ibid.*, Campo Correspondencia, at east base of Cerro Correspondencia, large, scattered specimens of *Lophosoria* in grassland, 1965, Imshaug 37024, 37044 (MSC); *ibid.*, Cordon del Barril: Ridge, grassland and scattered *Lophosoria*, 1965, Imshaug 37247 (MSC); Más A Tierra [Isla Robinson Crusoe], Cordon Salsipuedes, on exposed ridge, scrub, 1965, Imshaug 38148 (MSC). *Patagonian Channels:* Prov. Aisen, on ridge, Puerto Island, moorland, 1969, Imshaug (43211) & Ohlsson (MSC); *ibid.*, on N side of Fiordo Témpano, near glacier, moorland & rock outcrops, 1969, Imshaug (43343) & Ohlsson (MSC). *Prov. Magallanes:* on small peninsula, Pto Edén, second growth scrub around *Sphagnum* moor, 1969, Imshaug (43539) & Ohlsson (MSC); *ibid.*, E of Pta Brown, Pto Charrúa, moorland & scattered outcrops, 1969, Imshaug (43584) & Ohlsson (MSC); *ibid.*, W side of Isla Grant (Pto del Morro), open hillside with outcrops, 1969, Imshaug (43683, 43692) & Ohlsson (MSC); *ibid.*, on ridge, W side of Pto Alert, moorland & outcrops, 1969, Imshaug (43854, 43886) & Ohlsson (MSC); *ibid.*, in gap at head of fiord E of Mte Roberto, I. Madre de Dios, moorland, 1969, Imshaug (44143, 44158) & Ohlsson (MSC); *ibid.*, on ridge, E side of I. Juan, moorland with scattered *Nothofagus*, 1969, Imshaug (44199, 44265) & Ohlsson (MSC); *ibid.*, on slopes & ridges, E side of Puerto

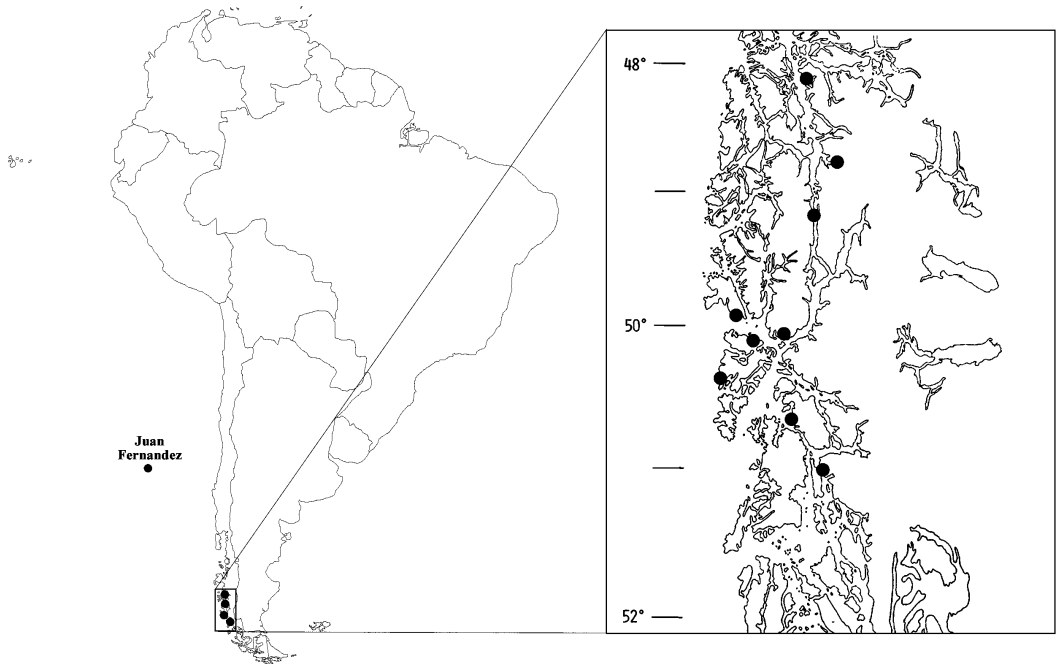


FIG. 3. Known distribution of *Lithographa skottsbergii*.

Bueno, moorland, 1969, *Imshaug* (44589) & *Ohlsson* (MSC).

Biogeography

Lithographa skottsbergii and *L. serpentina*, the only other species of the genus with submuriform ascospores, have a combined distribution of Campbell Plateau–southern Chile, whereas *L. graphidioides*, the species that is apparently most closely related to the *L. serpentina*–*L. skottsbergii* group, has a very different distribution pattern. Although *L. graphidioides* also occurs in maritime SW Chile, its distribution extends eastwards through Tierra del Fuego and the Falkland Islands and also includes the subpolar islands in the southern Indian Ocean (i.e., Kerguelen, Marion Island), Tasmania, and South Island, New Zealand (Coppins & Fryday 2004, D. Galloway, pers. comm.). However, it is unknown on the islands of the Campbell Plateau and has not been reported from Juan Fernandez.

The Campbell Plateau–southern Chile disjunction shown by *L. skottsbergii*–*L. serpentina* is shared by a small number of other saxicolous species (e.g. *Degelia symptychia* (Tuck.) P. M. Jørg., *Fuscidea subasbolodes* Kantvilas, and *Lithographa olivacea*; Fryday 2003, 2004, 2007). Some of these species are known also from Tasmania but have not been reported from any of the other southern subpolar islands, Tierra del Fuego, or South Island, New Zealand. These species clearly belong to the paleoaustral element of the Austral biota, which are considered to represent primitive Gondwanan groups poorly adapted for transoceanic dispersal. Galloway (1991) presents evidence to suggest that this paleoaustral element is derived from the Cretaceous (or earlier) when the Protopacific margin of Gondwanaland, where cool temperate conditions prevailed, was available for colonization and where a vegetated West Antarctica could link the

South America and South Pacific landmasses. The disjunct pattern between the Campbell Plateau and SW Chile is possibly especially pronounced because evidence suggests that the Campbell Plateau is a remnant of Gondwanaland bordering the Panthalassic Ocean (the Protopacific) that split away from West Antarctica in the vicinity of Marie Byrd Land (in the late Cretaceous) some 81 Ma ago (Adams 1986; Korsch & Wilkman 1988). Fife (1986) suggested that the Campbell Plateau region may have provided a refuge for a cold-adapted flora forced out of West Antarctica by advancing continental ice-sheets developed in Antarctica in the Oligocene.

We gratefully acknowledge financial support from the US National Science Foundation (NSF) for Awards No. DBI-9808735 and DBI-0237-401 (Alan Prather, PI) to Michigan State University that facilitated access to Dr Imshaug's extensive collections, and financed the visit of Dr Coppins to MSC. We also acknowledge the work of Dr Henry Imshaug and his student, Karl Ohlsson, who collected the material reported here and did much of the early research on it. We also thank the curator of W for the loan of the type collection of *Enterostigma skottsbergii*.

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Accepted for publication 23 February 2007