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Abstract

Twenty maritime species of *Verrucaria* are reported from Kerguelia (Kerguelen, Heard Island and Prince Edward Islands), including the new species *V. placodioides* Øvstedal. Taxonomy, ecology and distribution are discussed.

Introduction

The term Kerguelia was first introduced by Tuckerman (1875) for the island of Kerguelen. Dodge later (1948) added Crozet Island, Heard Island and the Prince Edward Islands (no material from Crozet Island was examined in the present work).

Kerguelen is situated in the Southern Indian Ocean at 48°27'–50°01'S, 68°25'–70°33'E. The main island, Grande Terre, is surrounded by many smaller islands. It is among the remotest places on earth, 450 km from Heard Island and 2400 km from the Prince Edward Islands. Grande Terre covers c. 6680 km², and with the smaller islands has an extensive coastline. The origin of the bedrock is volcanic, at least 30 Ma old (Wallace *et al.* 2002). The climate is oceanic and subantarctic, with strong winds throughout the year.

Heard Island is situated at 52°05'S, 73°30'E, and is a small island of 368 km². The continent nearest to it is Antarctica, 1650 km to the south, with Australia 3500 km to the north-west, and Africa 4800 km to the north-east. The island consists of a relatively young volcanic complex, less than 1 million years old, on a basement of much older formations (Quilty & Wheller 2000). The climate is cold and oceanic, usually with very strong winds.

Marion and Prince Edward Islands (47°S, 38°E) are situated in the Southern Indian Ocean some 2000 km southeast of the southernmost point of Africa. The nearest land is the Crozet archipelago. Marion Island covers 290 km², and reaches an elevation of 1230 m. It is situated 22 km from Prince Edward Island, which covers 90 km² and reaches an elevation of 672 m. The islands represent the summits of shield volcanoes rising from the West Indian Ocean Ridge (Verwoerd 1971), and geologically are relatively young. The climate is oceanic, with strong winds.

Material and methods

The collections by Imshaug and his collaborators (Imshaug 1971; Fryday & Prather 2001) studied for the present work are lodged in MSC. They were examined using a Zeiss Stemi 2000C microscope and a Zeiss Axiolab compound microscope. No lichen substances were detected in the material. Recent molecular data have supported separating several small genera from *Verrucaria*. However, because many of the species in the present work have not been sequenced, I have taken a conservative approach and retained them all in *Verrucaria* sens. lat.

The species

1. *Verrucaria aethioboliza* Nyl., *C. r. hebd. Séanc. Acad. Sci., Paris* **81, 726 (1875)**

Thallus thin, gelatinous, non-rimose, violet-brown. Fertile portions black, up to 0.8 mm wide, slightly thicker than the non-fertile portions, stroma-like, with 1–3 protruding ostioles. Involucrellum in only the upper part, spreading laterally. Exciple entire, brown. Ascospores 10–15 × 4–6 µm.

Ecology: upper littoral zone?

Distribution: St. Paul Island, Heard Island (Øvstedal & Gremmen 2006).

Remarks

Described from St. Paul Island. The extended black, stroma-like areas laterally surrounding the perithecia are characteristic.

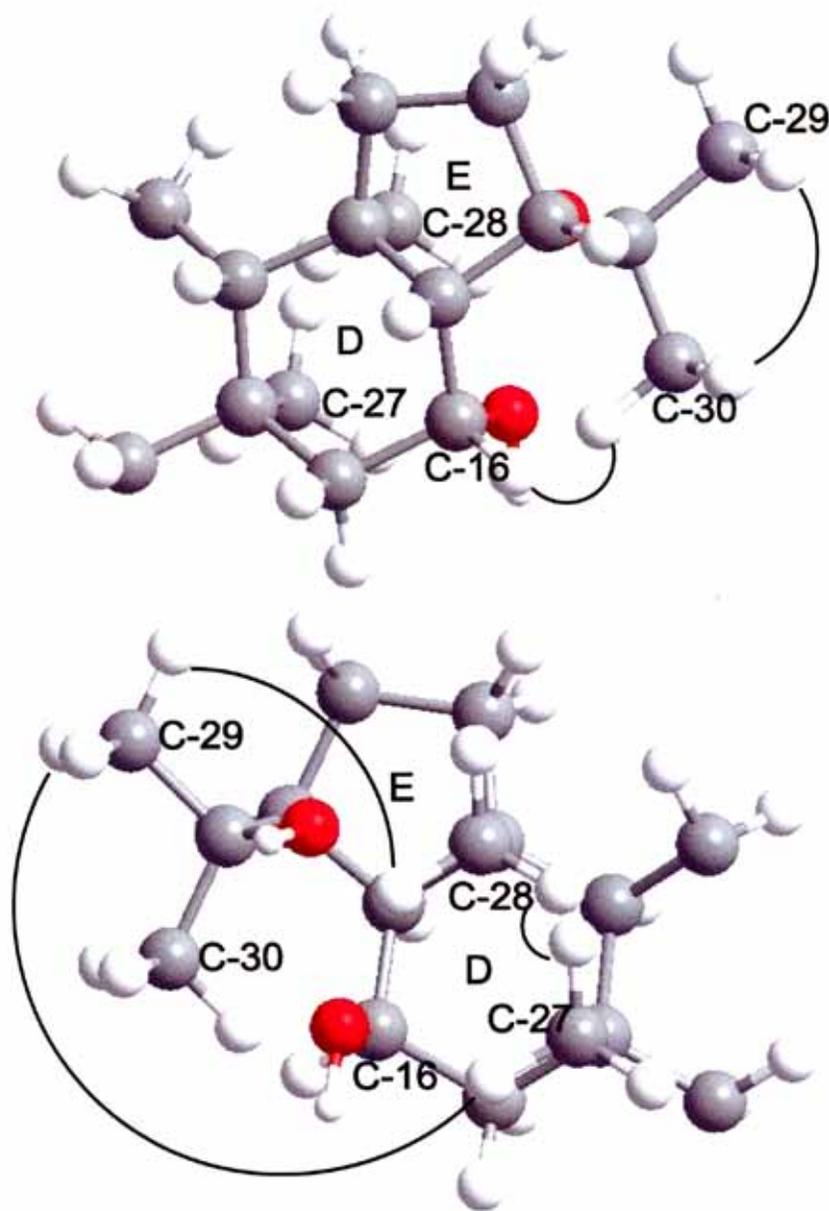


Figure 3B. NOESY associations of compound 1 in ring D and E (upper is frontal, lower is rear)

2. Verrucaria bubalina P.M. McCarthy, *Muelleria* 7, 327 (1991)

Thallus up to 10 cm wide but usually smaller, dark brown, with fine secondary cracks. Perithecia immersed in the thallus up to halfway, the protruding portion black, sometimes with fine striae. Involucrellum entire to subentire. Exciple brown. Ascospores $15\text{--}16 \times 8\text{--}10 \mu\text{m}$.

Ecology: upper littoral zone.

Distribution: Macquarie Island (McCarthy 1991b), New Zealand, Prince Edward Islands (Øvstedal & Gremmen 2014).

3. Verrucaria ceuthocarpa Wahlenb. in E. Acharius, *Methodus* 22 (1803)

Thallus blackish to grey-brown, strongly areolate, the areolae 0.2–0.3 mm across, rimae concolorous with the thallus. Perithecia almost entirely immersed in the thallus, with only the black ostiole protruding. Involucrellum in only the upper part. Exciple colourless. Ascospores $9\text{--}12 \times 6\text{--}7 \mu\text{m}$.

Ecology: upper littoral zone.

Distribution: bipolar. Kerguelia distribution: Heard Island (Øvstedal & Gremmen 2006), Kerguelen (see below), Prince Edward Islands (Øvstedal & Gremmen 2001).

Remarks

Verrucaria ceuthocarpa is variable in colour, but always has rimae. Its relationship with *V. werthii* and *V. psychrophila* should be studied more closely.

SPECIMENS EXAMINED

Kerguelen: ● Bras de la Fonderie, coastal rocks and cliffs W of Mt. Gergovie, sea level, *G.C. Bratt* 395, 3.iii.1971 (MSC); ● Presqu'Île Jeanne D'Arc, point at N end of Anse Île Sabine, sea level, *R.C. Harris* 6677, 21.ii.1971 (MSC).

4. Verrucaria dagolavii Fryday, *Bothalia* 45, 2 (2015)

= *V. umbilicata* Øvstedal, *South African J. Bot.* 67, 569 (2001), non *V. umbilicata* Hoffm. *Deutsch. Flora* 171, 1796

Thallus umbilicate, 1–3 mm wide, attached to the rock centrally; margins free. Upper surface greyish ochre, non-rimose, lower surface black, irregularly papillose. Perithecia black, semi-immersed, to 0.2 mm diam. Involucrellum black, reaching halfway down the perithecium. Exciple dark brown in upper part, colourless in lower part. Ascospores $9\text{--}10 \times 5\text{--}7 \mu\text{m}$.

Ecology: in or just above the intertidal zone.

Distribution: Prince Edward Islands (Øvstedal & Gremmen 2001), Heard Island (Øvstedal & Gremmen 2006), Kerguelen (see below).

SPECIMEN EXAMINED

Kerguelen: ● Presqu'Île Jeanne D'Arc, small bay SE of Halage des Swains, sea level, *R.C. Harris* 6689, 21.ii.1971 (MSC).

5. Verrucaria ditmarsica Erichsen, *Sch. Naturw. Ver. Schl.-Holst.* 22, 90 (1937)

Thallus gelatinous, very thin, 2–3 mm wide, without a prothallus, green-grey, with numerous punctae that sometimes coalesce into uneven ridgelike structures. Perithecia half-sessile, 0.2–0.3 mm diam., with a rugulose surface. Involucrellum reaching the exciple base. Exciple pale. Ascospores $8\text{--}9 \times 5\text{--}6 \mu\text{m}$.

Ecology: on intertidal rocks.

Distribution: bipolar. Kerguelia distribution: Prince Edward Islands (Øvstedal & Gremmen 2001).

Remarks

The rugulose surface of the perithecia is not mentioned in European Floras, including Orange *et al.* (2009), but is also seen in some northern European specimens (material in BG).

6. Verrucaria durietzii M.Lamb, *Lilloa* 14, 205 (1948)

Thallus effigurate, to several cm diameter, margin thick, with radiating lobes separated by black cracks, smooth, pale brownish grey to dark brown. Perithecia immersed, up to 0.3 mm diam. Involucrellum entire, black. Exciple pale. Ascospores $13\text{--}15 \times 8\text{--}9 \mu\text{m}$.

Ecology: rocks from intertidal zone to further inland, but always within the saltspray zone.

Distribution: circumantarctic-subantarctic. Kerguelia distribution: Kerguelen (see below).

SPECIMEN EXAMINED

Kerguelen: ● Istme du Lac, along shore at head of Anse de St. Malo, sea level, *H.A. Imshaug* 48987 *p.p.*, 8.iii.1971 (MSC).

7. Verrucaria efflorescens Øvstedal, *Nova Hedwigia* 85, 254 (2007)

Thallus composed of small, fertile corticate areas with perithecia, dispersed in a vegetative thallus dissolved into goniocysts. Fertile areas up to 5 mm wide, thick, secondarily cracked, pale grey-ochre; upper part of perithecia black, irregularly star-shaped, up to 0.3 mm wide. Vegetative portion covered by goniocysts, somewhat greener than the fertile parts. Goniocysts 20–28 μm diam., coalescing to larger structures 250–300 μm wide. Hypothallus massive, with irregular extensions up into the thallus. Involucrellum prominent, reaching down to and merging with the hypothallus. Exciple dark brown. Ascospores $9\text{--}10 \times 7\text{--}9 \mu\text{m}$.

Ecology: upper littoral zone.

Distribution: found in only the Prince Edward Islands (Øvstedal & Gremmen 2007).

8. Verrucaria evanidula Nyl., *Flora* 70, 136 (1887)

Thallus irregular, very thin, brownish, gelatinous. Perithecia up to 0.2 mm diam, semiglobose, shiny, black. Involucrellum prominent, reaching down to the base. Exciple colourless. Ascospores $7\text{--}9 \times 2\text{--}3 \mu\text{m}$.

Ecology: on limestone, not clear whether it is a maritime or lacustrine/terrestrial species.

Distribution: Kerguelen endemic.

Remarks

Verrucaria cylindrophora Vain. from the Antarctic (Lamb 1948; Øvstedal & Lewis Smith 2001) is very similar; the only apparent difference is the form of the ascospores.

SPECIMEN EXAMINED

Kerguelen: ● H-NYL 2776 (holotype).

9. Verrucaria halizoa Leight., *Lich. Fl. Gr. Brit.* 436 (1871)

Thallus gelatinous, very thin, brown-green, generally smooth but sometimes secondarily cracked, up to 5 cm diam., occasionally only as a narrow rim around the perithecia. Perithecia emergent, black, smooth, up to 0.2 mm diam. Involucrellum in upper part only. Exciple brownish, pale in lower part. Ascospores $7\text{--}12 \times 4\text{--}5 \mu\text{m}$.

Ecology: in intertidal zone.

Distribution: bipolar. Kerguelia distribution: Kerguelen (see below).

SPECIMEN EXAMINED

Kerguelen: ● Bras de la Fonderie, shore W of Mt. Gergovie, sea level, *H.A. Imshaug* 48734 *p.p.*, 3.iii.1971 (MSC).

10. Verrucaria hebena C.W.Dodge, *B.A.N.Z. Ant. Res. Exp. 1929–31, Rep. Ser. B* 3, 40 (1948)

Thallus black, minutely areolate, without punctae. Perithecia immersed, covered by the thallus. Involucrellum extensive. Ascospores $15\text{--}16 \times 7\text{--}8 \mu\text{m}$.

Ecology: littoral zone.

Distribution: Kerguelen endemic.

Remarks

Not seen; the description is taken from Dodge (1948), who did not give perithecia dimensions. This could be a form of *V. maura* in which the punctae are suppressed. The type or any other material has not yet been found (M. Schull, pers. com. 2017)

11. *Verrucaria maura* Wahlenb. in E. Acharius, *Methodus* 19 (1803)

Thallus black, 3–4 cm wide, rimose, cracks concolorous with the thallus, areolae up to 1 mm diam., with black punctae. Perithecia externally variable, from about level with the thallus to distinctly protruding with a conical shape, 0.6–0.9 mm diam. Involucrellum entire, black. Exciple pale. Ascospores 16–19 × 8–13 µm.

Ecology: delimits the upper edge of the littoral zone.

Distribution: bipolar. Kerguelia distribution: Kerguelen (see below), Prince Edward Islands (Øvstedal & Gremmen 2001).

SPECIMENS EXAMINED

Kerguelen: ● Presqu'île Jeanne D'Arc, small bay at mouth of stream 1 km W of Port-Jeanne D'Arc, sea level, *R.C. Harris 6794*, 24.ii.1971 (MSC); ● Peninsula Courbet, E side of base of Pointe Molloy peninsula, sea level, *R.C. Harris 6561*, 16.ii.1971 (MSC).

12. *Verrucaria mawsonii* C.W.Dodge, *B.A.N.Z. Ant. Res. Exp. 1929–31, Rep. Ser. B* 3, 40 (1948)

Thallus up to 2 cm diam., 0.2–0.3 mm thick, strongly rimose, green-brown. Rimae black, partly with raised edges. Areolae with small black punctae that sometimes coalesce into irregular ridges. Perithecia completely immersed in the thallus, inner diameter *c.* 130 µm. Involucrellum entire, irregular and expanded in the upper part, thin and regular in the lower part. Excipulum colourless. Ascospores 12–14 × 6–7 µm.

Ecology: upper littoral zone.

Distribution: Heard Island (Øvstedal & Gremmen 2006).

13. *Verrucaria mucosa* Wahlenb. in E. Acharius, *Methodus* 23 (1803).

Thallus subgelatinous, relatively thick, continuous, smooth, olive-green to black-green, 3–4 cm diam. Perithecia immersed, to 0.3 mm diam. Involucrellum only in uppermost part. Exciple colourless. Ascospores 9–13 × 6–7 µm.

Ecology: mid-littoral zone.

Distribution: bipolar. Kerguelia distribution: Prince Edward Islands (Øvstedal & Gremmen 2001).

14. *Verrucaria obfuscata* Nyl. in Crombie, *J. Linn. Soc. London, Bot.* 15, 191 (1876)

Syn. *V. kerguelensis* C.W.Dodge, *B.A.N.Z. Ant. Res. Exp. 1929–31, Rep. Ser. B* 3, 38 (1948)

Thallus effuse, gelatinous, 6–7 cm wide, smooth, non-rimose, grey-brown with a violet tinge. Perithecia half-emergent, black, 0.1–0.3 mm wide. Involucrellum thin, reaching down to base of perithecium; exciple yellowish. Ascospores 23–32 × 9–11 µm, sometimes with oil droplets. *Ecology*: upper littoral zone, or supralittoral. The type of *V. kerguelensis* grows on the lower side of a small pebble, with *Steinera glaucella* on the upper side. Nylander (in Crombie, 1876) stated: "On rock. Royal Sound".

Distribution: Kerguelen, Heard Island (Øvstedal & Gremmen 2006).

Remarks

The type of *V. kerguelensis* conforms with the type of *V. obfuscata* and the other material studied, except that the ascospores are somewhat shorter (mean value 25 × 11 µm) and the exciple is almost black. *Gremmen 846* from Kerguelen differs in having distinct black plates on the surface of the perithecia; otherwise it is similar to the other material.

SPECIMENS EXAMINED

Type (H-NYL), type of *V. kerguelensis* C.W.Dodge (*Banzare B 177–1*, FH), *Gremmen 846* (Kerguelen, BG), *Gremmen H–3000*, (Heard Island, BG).

15. *Verrucaria placodioides* Øvstedal sp. nov.

Fig. 1

MycoBank No. **MB 822530**

Diagnosis: Characterized by a placodioid thallus with a thick, black hypothallus and black radiating jugae. No perithecia seen.

Type: Kerguelen, Presqu'île Jeanne D'Arc; small bay at mouth of stream 1 km W of Port-Jeanne D'Arc, sea level, *R.C. Harris 6785*, 24.ii.1971 (holotype – MSC).

Thallus placodioid, up to 10 mm diam, with radiating lobes, 0.3–0.1 mm wide at the margin. Surface shiny brown, margins of lobes with elongate, sparsely branched, elevated black jugae. No perithecia seen. In section the thallus is 250–270 µm tall, lowermost 170–190 µm a black hypothallus, composed of a textura intricata; the jugae are extensions of the hypothallus. Lower margin composed of scattered hyphal tips, *c.* 8 µm long and 3 µm broad; Between jugae a vegetative tissue, 75–80 µm high; cells angular, 2–3 µm diam., uppermost brownish. Photobiont difficult to observe (old specimen), yellow-green, 3–4 µm diam.

Ecology: in *V. maura* zone, partially overgrowing *V. maura*.

Distribution: endemic.

Remarks

The ecology and the anatomy of the thallus (in particular the jugae) indicate that this is a *Verrucaria*, although no perithecia could be found. The other placodioid/effigurate maritime *Verrucaria* known are (1) *V. epimaura* Brodo, from Canada (Brodo & Santesson 1997), a quite different species (specimens in MSC and BG seen), that is, effigurate with a greyish colour, thallus regularly cracked and without jugae, and (2) *V. durietzii*, also effigurate, from pale brownish grey to dark brown and black fissures, but with no jugae.

ADDITIONAL SPECIMEN EXAMINED

Kerguelen: ● Bras de la Fonderie, shore W of Mt Gergovie, sea level, *H.A. Imshaug 48734* (growing with *V. halizoa* and *V. tessellatula* var. *dermoplaca*), 3.iii.1971 (MSC).

16. *Verrucaria psychrophila* I.M.Lamb, *Discovery Reports* 25, 18 (1953)

Thallus dull brown-grey to blackish, cracked, to 4 cm. Rimae irregular, not blackened, dividing the thallus into areolae *c.* 1.5 mm wide. Perithecia protruding only slightly, the visible portion dark brown, *c.* 0.1 mm diam. Involucrellum in only the upper part, brown-black. Exciple colourless. Ascospores 10–15 × 6–9 µm.

Ecology: intertidal, near high water mark.

Distribution: Antarctica, Prince Edward Islands (Øvstedal & Gremmen 2001), Kerguelen (see below).

Remarks

The specimen (*Harris 6569*, MSC) from Kerguelen has perithecia that are entirely immersed in the areolae, and thus might be determined as *V. mucosa*, but the dark brown, rimose thallus indicates that it belongs in *V. psychrophila*.

SPECIMEN EXAMINED

Kerguelen: ● Peninsula Courbet, E side of base of Pointe Molloy Peninsula, sea level, *R.C. Harris 6569*, 16.ii.1971 (MSC).

17. *Verrucaria subdiscreta* P.M.McCarthy, *Muelleria* 7, 327 (1991)

Thallus subgelatinous, olive-green, in patches up to 4 cm wide, smooth, thin, with small, black punctulae. Perithecia sessile, up to 0.3 mm diam., ostiole slightly depressed. Involucrellum

extending halfway down; exciple pale brown. Ascospores $9\text{--}11 \times 4.5\text{--}6 \mu\text{m}$.

Ecology: upper littoral zone.

Distribution: Marion Island (Øvstedal & Gremmen 2014), Australia and Macquarie Island (McCarthy 1991a).

18. *Verrucaria tessellata* (C.W.Dodge) Øvstedal, *South Afr. J. Bot.* **67**, 570 (2001) Fig. 2
Hypothallus black, of variable thickness. Thallus milky white to pale ochre or grey-brown, fairly thick (up to c. 0.8 mm), effuse, secondarily cracked, thalli up to 4–5 cm diam., margin not effigurate; surface often with numerous minute pits or dark brown spots that appear to be either pycnidia ostioles or young parasymbionts. Photobiont green. Perithecia semiglobose, raised above the thallus, half-covered by thalline tissue, up to 0.7 mm diam., uppermost part black, 0.1–0.4 mm diam., often star-shaped. Involucrellum extensive, spreading laterally; exciple black, entire. Ascospores narrowly ellipsoid, $15\text{--}22 (17.3 \pm 1.7) \times 6\text{--}8 (7.5 \pm 0.2) \mu\text{m}$.
Ecology: upper littoral zone.
Distribution: Heard Island, Kerguelen (see below).

Remarks

Verrucaria tessellata appears to be related to *V. durietzii*, which has a very thick, black hypothallus, a thick, pale brownish grey to dark brown thallus, an entire, brown-black exciple and an involucrellum that spreads laterally. However, *V. durietzii* differs in its effigurate thallus, which has prominent, longitudinal black cracks, perithecia that are smaller and less protruding and smaller ascospores.

SELECTED SPECIMENS EXAMINED

Kerguelen: ● Peninsula Courbet, E side of base of Pointe Molloy Peninsula, sea level, *R.C. Harris 6571*, 16.ii.1971 (MSC); ● Kerguelen, Ile Haute, coastal rocks along bay NE of Anse des Rennes, sea level, *R.C. Harris 6607*, 18.ii.1971 (MSC); ● Kerguelen, Isthme du Lac, along shore at head of Anse de St Malo, sea level, *H.A. Imshaug 48987*, 8.iii.1971 (MSC).

19. *Verrucaria tessellatula* Nyl. in Crombie, *J. Bot. London* **13**, 335 (1875)

Thallus pale to medium brown-grey, to 0.5 mm thick, 1–3 cm wide, with an irregular system of dark rimae. Thallus sometimes coalescing to form larger composite thalli. Perithecia emergent to 1/3–1/4, visible part blackish, to 0.3 mm diam. Involucrellum weakly developed, dark brown, in uppermost part only; exciple colourless. Ascospores $11\text{--}13 \times 6\text{--}8 \mu\text{m}$.

Ecology: upper littoral zone.

Distribution: circumantarctic-subantarctic. Kerguelia distribution: Kerguelen (see below), Prince Edward Islands (Øvstedal & Gremmen 2001).

Remarks

Common. The variety *V. tessellatula* var. *dermoplaca* (Nyl.) I.M.Lamb is present on Kerguelen. It differs from the nominate form in having isolated, unconnected rimae. It is a distinct and uniform taxon that should be studied more closely.

SELECTED SPECIMENS EXAMINED

Verrucaria tessellatula var. *dermoplaca*: Kerguelen: ● Bras de la Fonderie, shore W of Mt Gergovie, sea level, *H.A. Imshaug 48734 p.p.*, 3.iii.1971 (MSC).

Var. *tessellatula*: Kerguelen: ● Bras de la Fonderie, coastal rocks and cliffs W of Mt Gergovie, sea level, *G.C. Bratt 404*, 3.iii.1971 (MSC).

20. *Verrucaria werthii* Zahlbr., *Deutsche Südpolar. Exp.* **8**, 31 (1906)

Thallus small, tartareus, subareolate-rimose, grey-brown (“cinerascenti umbrinus vel rufescenti-cinereus” in Zahlbruckner 1906). Perithecia semiglobose, 0.3–0.5 mm wide, involucrellum brown, disappearing at base. Ascospores $16\text{--}22 \times 6\text{--}8 \mu\text{m}$.

Ecology: upper littoral zone?

Distribution: Kerguelen.

Remarks

Neither the type nor any other specimens were available; the description is based on Zahlbruckner (1906). *Verrucaria werthii* resembles pale forms of *V. ceuthocarpa*, but its ascospores are almost twice as long ($9\text{--}12 \mu\text{m}$ versus $16\text{--}22 \mu\text{m}$). Pale forms of *V. ceuthocarpa* have been observed from the Antarctic (own observations); it has been described as “grey- or green-brown to black” in Great Britain (Orange *et al.* 2009).

Discussion

Eight of the 20 maritime *Verrucaria* species in Kerguelia are endemic. That compares with three out of 17 in New Zealand (Galloway 2007), three out of 12 in Australia (McCarthy & Kantvilas 2015), and three out of 11 in Antarctica (including South Georgia) (Øvstedal & Lewis-Smith 2001). The percentage of endemics in Kerguelia seems too high in comparison with that of the other provinces, suggesting that many of the species in Kerguelia are likely to occur in those other provinces as well. Alternatively, some species currently considered endemic could turn out to be synonymous with other taxa.

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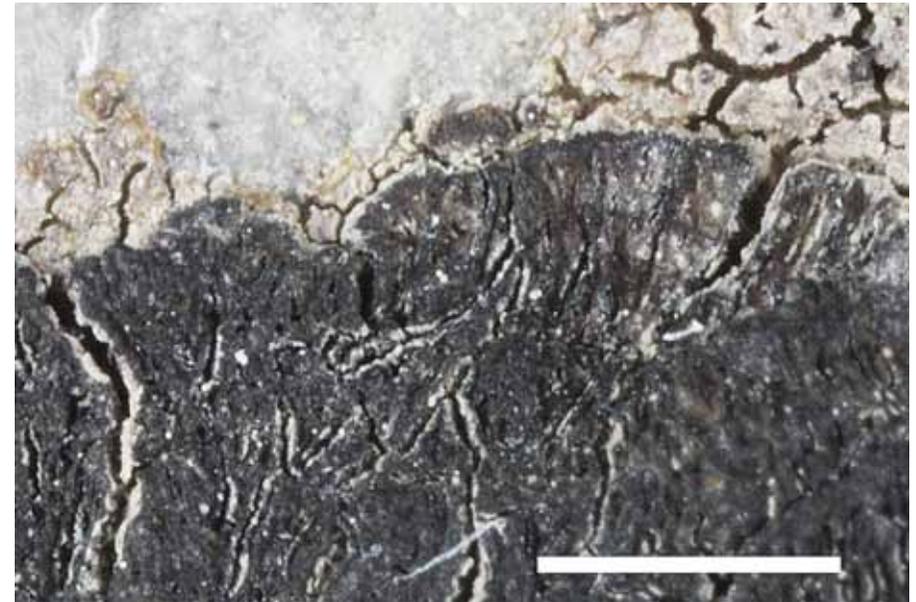


Figure 1: *Verrucaria placodioides* Øvstedal sp. nov. Holotype. Scale bar = 1 mm.



Figure 2: *Verrucaria tessellata*. Imshaug 48987 (MSC). Scale bar = 1 mm