Acta Biológica Catarinense
2020 Abr-Jun;7(2):40-47

Phyllobaeis Kalb & Gierl (Baeomycetaceae, Ascomycota) in Southern Brazil

Phyllobaeis *Kalb & Gierl (Baeomycetaceae, Ascomycota) no sul do Brasil*

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ABSTRACT
Phyllobaeis is mainly a Neotropical genus and contains six species. It has a squamulose primary thallus (except for one species with crustose primary thallus), stipitate podetia, and simple or 1-septate hyaline, ovoid to fusiform ascospores. The species occur mainly on soil in altitudes of 700 to 4,400 m. In Brazil three species are known, recorded mainly from the southeast. The aim of this work is contributing to the knowledge of the distribution of *Phyllobaeis* in Brazil. We studied specimens from southern Brazil. The morphological, anatomical and chemical analyses follow standard lichenological protocols. We found two species in southern Brazil: *Phyllobaeis erythrella*, which is the first record to Paraná and Rio Grande do Sul states; and *P. rubescens*, which is the first record to Paraná and Santa Catarina states. Both occur in environments on the plateau, as well as in high-grasslands, between 700 to 1400 m altitude. A distribution map in Brazil, descriptions, figures and a key to the species of *Phyllobaeis* are given.
Keywords: *Baeomyces*; *Dibaeis*; fungi; lichen; rain forest.

RESUMO
Phyllobaeis é um gênero principalmente neotropical, que contém seis espécies. Apresenta talo primário escamuloso (exceto por uma espécie com talo primário crostoso), podécio estipitado e ascósporos simples ou 1-septados hialinos, ovoides a fusiformes. As espécies ocorrem principalmente no solo em altitudes de 700 a 4.400 m. No Brasil três espécies são conhecidas, tendo sido registradas principalmente na Região Sudeste. O objetivo deste trabalho é contribuir para o conhecimento da distribuição de *Phyllobaeis* no Brasil.
Foram estudados espécimes ocorrentes na Região Sul do Brasil. As análises morfológicas, anatômicas e químicas seguem protocolos padronizados em Liquenologia. Foram encontradas duas espécies no sul do Brasil: *P. erythrella*, sendo este o primeiro registro para os estados do Paraná e Rio Grande do Sul; e *P. rubescens*, sendo este o primeiro registro para os estados do Paraná e Santa Catarina. Ambas ocorrem em ambientes no planalto, assim como nos campos de altitude, entre 700 e 1.400 m de altitude. Um mapa de distribuição, descrições, figuras e uma chave de identificação para as espécies conhecidas de *Phyllobaeis* são fornecidos.
Palavras-chave: *Baeomyces*; *Dibaeis*; floresta atlântica; fungo; líquen.

Recebido em: 6 ago. 2019
Aceito em: 11 jun. 2020

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INTRODUCTION

The genus *Phyllobaeis* belongs to Baeomycetaceae (STENROOS *et al.*, 2002; MIADLIKOWSKA *et al.*, 2006). It contains six species worldwide and is mainly Neotropical (VRIES & SIPMAN, 1984; GIERL & KALB, 1993; APTROOT, 2002; KIRK *et al.*, 2008), except for the species *P. crustacea* S.N. Cao & J.C. Wei that was described from Hainan Island, Southern China (CAO *et al.*, 2013). The species of *Phyllobaeis* usually occur on the soil and in ravines, near trails and roads, sometimes on exposed rocks, in altitudes from 700 m to 4400 m (VRIES & SIPMAN, 1984), except for *P. crustacea* that occurs at c. 300 m altitude (CAO *et al.*, 2013).

Morphologically, *Phyllobaeis* is characterized by a squamulose primary thallus (GIERL & KALB, 1993), except for *P. crustacea* that shows a crustose primary thallus (CAO *et al.*, 2013). The primary thallus produces norstictic acid (GIERL & KALB, 1993). The apothecia are formed essentially by the mycobiont, and are stipitate, with 0.5 mm up to 6.0 mm tall. The discs are pinkish to brownish, up to 6.0 mm in diameter, with 8-spored asci. The ascospores are simple or 1-septate, hyaline, ovoid to fusiform (*e.g.*, GIERL & KALB, 1993; CAO *et al.*, 2013).

Three species were recorded from Brazil: *Phyllobaeis erythrella* (Mont.) Kalb, recorded for the states of Minas Gerais (VRIES & SIPMAN, 1984; APTROOT, 2002), Rio de Janeiro, São Paulo (VRIES & SIPMAN, 1984) and Santa Catarina (MÜLLER, 1891a, 1891b); *P. rhodochroa* (Kremp.) Kalb for the state of Rio de Janeiro (KREMPELHUBER, 1876); and *P. rubescens* (Vain.) Kalb only from the state of Minas Gerais (VAINIO, 1890; APTROOT, 2002).

The aim of this work is to contribute to the knowledge of the diversity of Brazilian lichens, with new records to southern Brazil.

MATERIAL AND METHODS

STUDY AREA

The southern region of Brazil, comprising the states of Paraná, Santa Catarina and Rio Grande do Sul, covers a land area of c. 575,000 km² (IBGE, 2012). Crossed by the Tropic of Capricorn in the northernmost portion, the region has a subtropical climate, with average temperatures varying from 16°C to 20°C per year, with temperatures in winter below 0°C and, on warmer days, around 40°C (IBGE, 2004, 2012). Rainfall is almost evenly distributed throughout the year. The relief of the southern Region consists mainly of an extensive plateau, divided between the Atlantic and the southern plateau, the highest point being the Paraná Peak, with 1922 m altitude (IBGE, 1977). The Atlantic rain forest biome is the main plant formation, with also an expressive portion of the *Pampa* biome in the southern half of the state of Rio Grande do Sul, and with *Cerrado* biome intrusions in the northern part of Paraná State (IBGE, 2012). The environments vary from mangroves, *restingas* (sand dunes), rain forest and araucaria forest, as well as portions of seasonal forests and high-grasslands (IBGE, 1977, 2004, 2012).

METHODS

The specimens were collected in different places from the southern Brazilian plateau since 2012, with a focus on the 'Serra do Mar' mountain range. Newly collected specimens are stored at JOI herbarium. Specimens from UPCB, ICN, and HAS herbaria were reviewed.

In the laboratory, the specimens were dried and studied according to standard protocols in lichenology (BRODO *et al*., 2001). For the identification of secondary metabolites spot tests, UV light and thin layer chromatography (solvent C), according to Huneck & Yoshimura (1996), Orange *et al*. (2001) and Elix (2014) were used. The key was performed according to Vainio (1890), Vries & Sipman (1984) and Cao *et al*. (2013).

RESULTS AND DISCUSSION

There were found two species of *Phyllobaeis* in southern Brazil: *Phyllobaeis erythrella* (Mont.) Kalb and *P. rubescens* (Vain.) Kalb. Both occur in environments of the plateau, mainly on mountain rain forest as well as in the high-grasslands, between 700 to 1400 m altitude (Figure 1). The majority of the specimens was found on soil, usually on ravines along roadsides and trails. Few specimens were found on rocks, usually on a thin layer of sediments between the thalli and the rock.

Phyllobaeis erythrella was found in the three southern states of Brazil, and these are the first records for Parana and Rio Grande do Sul states. *P. rubescens* was found in Paraná and Santa Catarina states and is the first record for both states.

Phyllobaeis erythrella (Mont.) Kalb, in Gierl & Kalb, Herzogia 9(3–4): 610. 1993.
≡*Biatora erythrella* Mont., Annls Sci. Nat., Bot., sér. 2 8: 356. 1837.
Type: *ad terram in montibus apricis Insulæ Dominicæ Antillarum* [Dominica Island, Central America] *lectam cel. Bory* (PC?).
Figure 2A-B.
Primary thallus: squamulose, 1.0–3.0 mm long, 0.5–1.5 mm wide, laciniate, mainly ascending from the center to the tips, mainly with crenate margins, smooth upper surface, effigurate to somewhat spotted maculate when fresh, green to greenish in field, whitish to bluish in herbaria, smooth under whitish surface; schizidia usually present, mainly marginal to laminal, spherical to irregularly spherical, 0.2–0.4 mm in diameter, usually pruinose. Anatomy: cortex 30–110 µm thick, algal layer 80–130 µm thick, medulla 40–70 µm thick. **Podetium**: stipitate, (1.7–)2.0–4.5 mm tall, 0.5–1.0 mm wide, smooth to rugose surface, longitudinally striate, pinkish to brownish; Apothecia 0.9–1.5 mm in diameter, pinkish to reddish, flat, no pruinose. Epihymenium brownish, 4–9 µm thick, himenium hyaline, 65–80 µm thick, hypohymenium hyaline, 25–35 µm thick, asci clavate, up to 50 µm tall, 8-spored, ascospores hyaline, simple, 6–10 × 3–4 µm. Pycnidia not found.
Chemistry: K+ yellow→red, C-, KC-, UV-. Thin layer chromatography: norstictic acid.

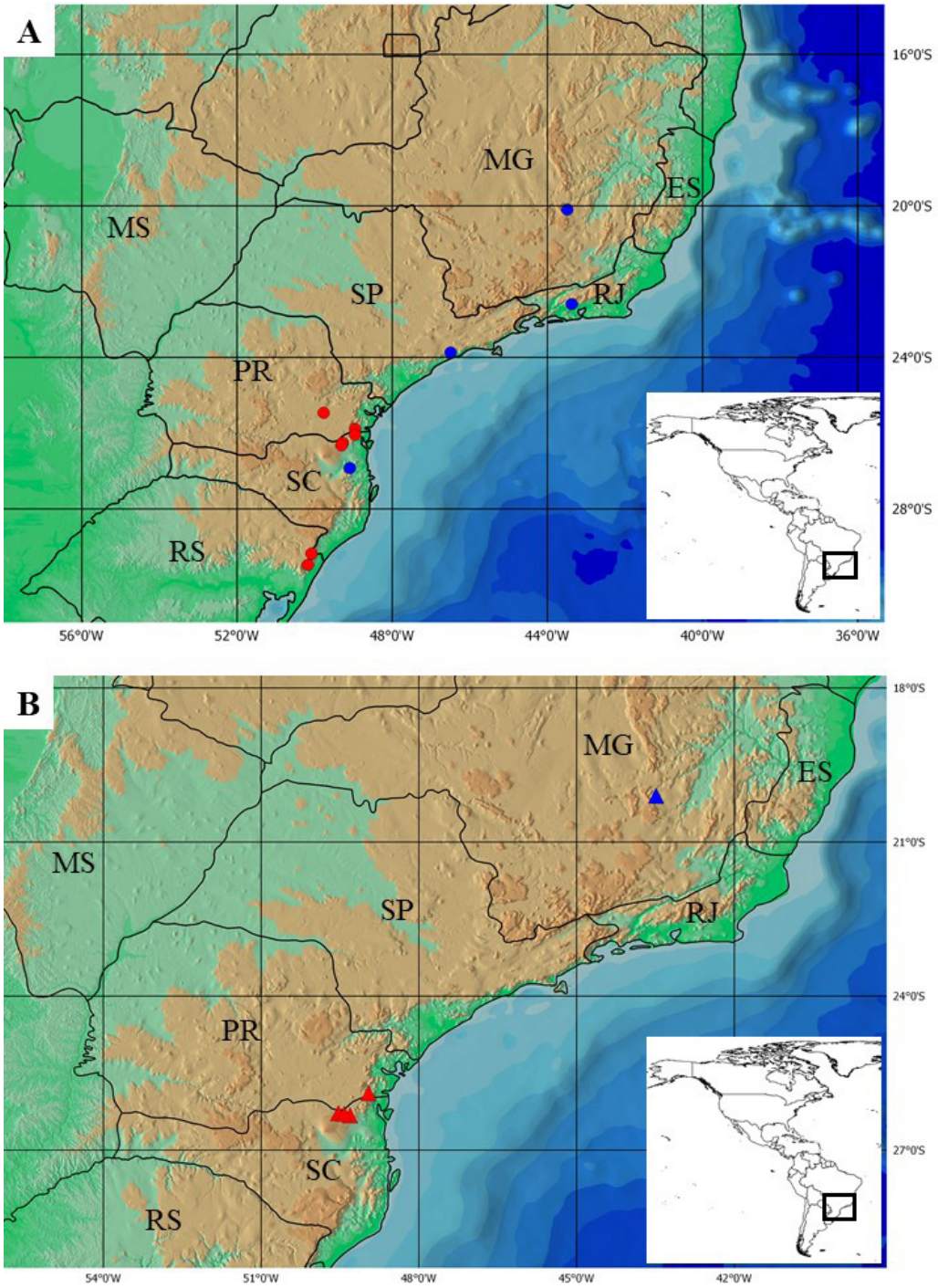

Figure 1A-B – Distribution map of the species of *Phyllobaeis*. A – Distribution of *P. erythrella*. B – Distribution of *P. rubescens*. (Blue symbols are the old records, and the red symbols are the new records. The states are represented by their official initials: RS – Rio Grande do Sul; SC – Santa Catarina; PR – Paraná; MS – Mato Grosso do Sul; SP – São Paulo; MG – Minas Gerais; RJ – Rio de Janeiro; ES – Espírito Santo).

Comments. *Phyllobaeis* erythrella is characterized by the short laciniate and crenate squamules up to 3.0 mm long, by the effigurate and spotted maculate surface, usually with spherical schizidia (Figure 2B) of up to 0.4 mm wide, and by the stipitate apothecia up to 4.5 mm tall.

Phyllobaeis erythrella differs from *Phyllobaeis imbricata* (Hook.) Kalb & Gierl as the latter has the primary squamules clearly divided into crenate lobes, with 2.0–6.0 mm long, and by the schizidia with 0.5–1.0 mm in diameter (VRIES & SIPMAN, 1984), while *P. erythrella* have shorter primary squamules, with 1.5–3.0 mm long, and the schizidia with 0.2–0.4 mm in diameter.

Specimens examined: BRAZIL. **Parana State**. Municipality of Guaratuba, Morro dos Perdidos, high grasslands, on soil, 03.VI.2013, *E. Gumboski; A.C.L. Gerlach & S. Eliasaro 4490*, *4491* (JOI); Municipality of Palmeira, Recanto dos Papagaios, Araucaria forest, on soil, 18.VIII.2012, *E. Gumboski; F. Beilke & A. Gerlach 3799*, *3800* (JOI). **Rio Grande do Sul State.** Municipality of Cambara do Sul, Itaimbezinho, in ravine, on soil, 23.07.1981, *M. Fleig 1392* (ICN), 28.11.1983, *M. Fleig 2256* (ICN), VI.1983, *R. Bueno s.n.* (ICN 55417); Municipality of Sao Francisco de Paula, PróMata, in ravine, FOM, on soil, 10.V.2007, *S. Martins & M. Käffer s.n.* (HAS 46427). **Santa Catarina State.** Municipality of Campo Alegre, Campos do Quiriri, high grasslands, on soil, 03.II.2012, *E. Gumboski, A. A. Spielmann & L. S. Canêz 3445* (JOI), 30.IV.2012, *E. Gumboski 3589* (JOI), 17.XI.2012, *E. Gumboski 4133* (JOI), 17.XI.2012, *E. Gumboski 4200*, *4203*, *4225* (JOI), 30.III.2019, *E. Gumboski & A. Aptroot 5600* (JOI); *A. Aptroot 78541, 78545* (CGMS); Municipality of Sao Bento do Sul, APA Rio Vermelho/ Humboldt, Araucaria forest, on soil, 12.III.2013, *E. Gumboski 4261* (JOI), Bairro Serra Alta, on ravinea along a dirt road, rural area, on soil, 22.V.2009, *E. Gumboski s.n.* (JOI); CEPA Rugendas, FODM, on rock, 01.IV.2019, *E. Gumboski & A. Aptroot 5690* (JOI).

Phyllobaeis rubescens (Vain.) Kalb, in Gierl & Kalb, Herzogia 9(3-4): 610. 1993.
≡*Baeomyces rubescens* Vain., Acta Soc. Fauna Flora fenn. 7(no. 2): 4. 1890.
Type: *prope Sitio (1000 m. s. m.) in civ. Minarum* [Brazil, State of Minas Gerais] (BM001097690, Isotype!).
Figure 2C-D.
Primary thallus: squamulose, 1.0–2.0 mm long, 0.4–1.5 mm wide, short laciniate, mainly prostrate, smoothly crenate at the tips, margins mainly entire, smooth upper surface, clearly longitudinally green striated when fresh, green to greenish in field, whitish in herbaria, smooth under whitish surface; schizidia absent. Anatomy: cortex 100–160 µm thick, algal layer 50–100 µm thick, medulla 40–80 µm thick. **Podetium**: stipitate, 0.5–1.5(–2.0) mm tall, 0.5–1.0 mm wide, smooth surface, longitudinally striate, whitish to soft pinkish; Apothecia 0.7–1.0 mm in diameter, pinkish to almost reddish, flat, no pruinose. Epihymenium brownish, 5–8 µm thick, hymenium hyaline, 50–65 µm thick, hypohymenium hyaline, almost indistinct, 10–25 µm thick, asci clavate, up to 50 µm tall, 8-spored, ascospores hyaline, simple, 6–12 × 3–5 µm. Pycnidia not found.
Chemistry: K+ yellow→red, C-, KC-, UV-. Thin layer chromatography: norstictic acid.
Comments. The species *P. rubescens* is characterized by the smaller thallus, by the short laciniated squamules, longitudinally green striated when fresh (Figure 2D), and by the small podetial with simple ascospores.
P. rubescens is similar to *Phyllobaeis rhodochroa* (Kremp.) Kalb in having small primary squamules, but *P. rubescens* has simple ascospores, with 7–11 × 3–4 µm, while *P. rhodochroa* have 1-septate ascospore, with 4–5 × 1.5–2.0 µm (KREMPELHUBER, 1876; VAINIO, 1890).

Specimens examined: BRAZIL. **Minas Gerais State.** Municipality of Caraça, Piscina, rocky highlands, on soil, 28.VII.2010, *E. Gumboski; A. Gerlach & F. Beilke, 2106* (JOI). **Parana State**. Municipality of Guaratuba, Morro dos Perdidos, high grasslands, on soil, 03.VI.2013, *E. Gumboski; A.C.L. Gerlach & S. Eliasaro 4557*, *4558* (JOI). **Santa Catarina State.** Municipality of Rio Negrinho, Rio dos Bugres, rural area, on soil, 08.XI.2012, *E. Gumboski 4103* (JOI), Municipality of São Bento do Sul, CEPA Rugendas, Araucaria forest, on rock 01.IV.2019, *E. Gumboski & A. Aptroot 5691* (JOI), Sertaozinho Road, near to the small church of Vila Piltz, rural area, on soil, 20.VII.2012, *E. Gumboski 3691*, *3692* (JOI).

Key to species of *Phyllobaeis* Kalb & Gierl

1. Crustose primary thallus ..... *P. crustacea*

1. Squamulose primary thallus 2

2. Long squamules, deeply divided in lacinules, 5.0–20.0 mm long ..... *P. linearis*

2. Squamules not deeply divided in lacinules, 0.5–6.0 mm long 3

3. Podetia with 0.5–1.5(–2.0) mm tall 4

3. Podetia with 2.0–6.0 mm tall 5

4. Ascospores 1-septate, 4–5 × 1,5–2,0 µm ..... *P. rhodochroa*

4. Ascospores simple, 7–11 × 3–4 µm ..... *P. rubescens*

5. Squamules shorter and not clearly divided in lobes, 1.5–3.0 mm long, schizidia 0.2–0.4 mm in diameter ..... *P. erythrella*

5. Squamules clearly divided into crenate lobes, 2.0–6.0 mm long, schizidia 0.5–1.0 mm in diameter ..... *P. imbricata*

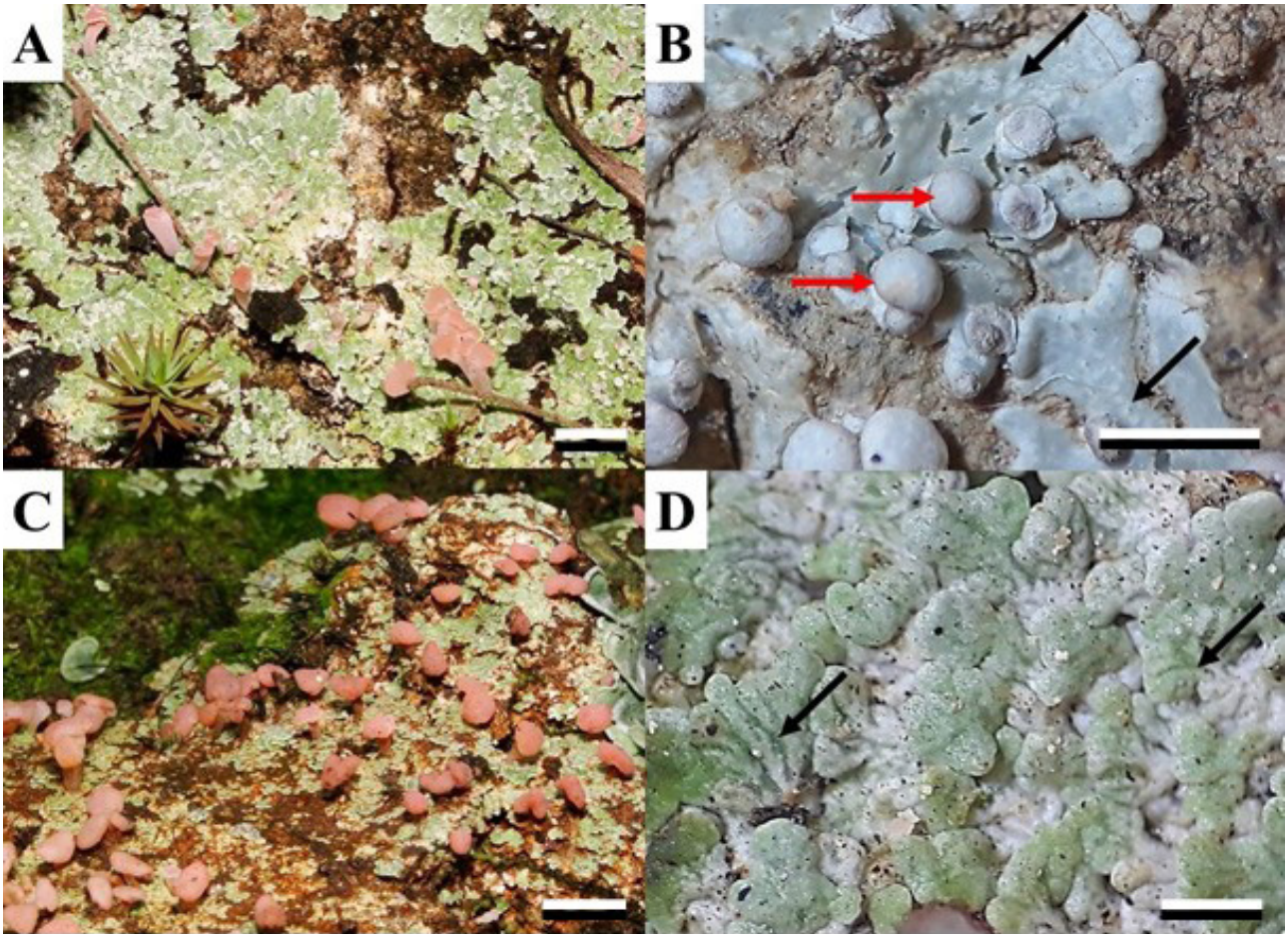

Figure 2A-D – Species of *Phyllobaeis* found in Southern Brazil. A-B, *Phyllobaeis erythrella* in field, A – primary thallus and podetia; B – detail of the squamules showing the effigurate maculae (black arrows) and spherical schizidia (red arrows); C-D, *Phyllobaeis rubescens* in field, C – primary thallus and podetia; D – detail of the squamules showing the longitudinally green stria (black arrows) in fresh specimen.

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